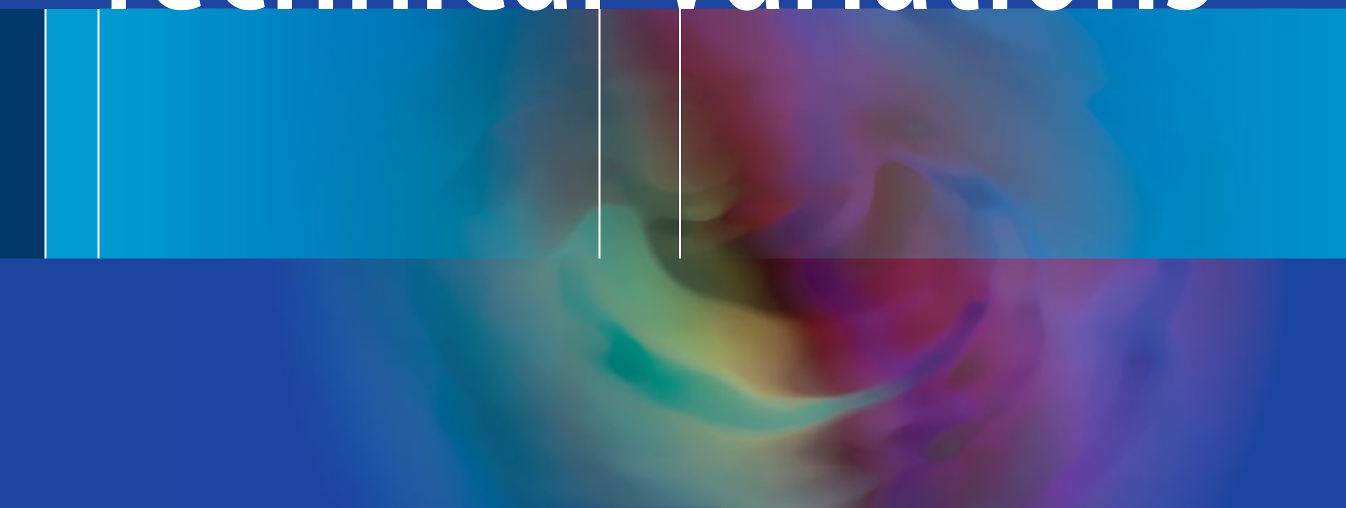
Gastrointestinal Operations and Technical Variations



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Introduction

Michael Korenkov, Christoph-Thomas Germer, and Hauke Lang

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Since the establishment of the abdominal surgery as an independent field, every operation will be performed according to the certain technical standards. These standards have been appropriately adapted for the new knowledge and technical developments. However deals a practical surgeon frequently with situations, in these originally similar operations can have very different development. A lot of predisposing factors can influence it: different anatomy and morphology of operational areas, different effects of the similar intraoperative steps (bleeding after tissue transection, organs injured during the abdominal opening), surgical experience, manual skill, drop out of instruments and devices, strategic problems, mental condition from every team member, as well as a quality of assistance. All these factors can make the performance of every operation difficult, especially in cases when a surgeon is "programmed" to achieve certain technical standards. Until today, there is no definition of what constitutes a difficult surgical situation, but every practical surgeon knows very well what it means and how important it is. We define the difficult surgical situation as an intraoperative surgical problem, which increases the likelihood of intraoperative and postoperative complications, if the initially planned surgical procedure was carried out without modifications. In a difficult surgical situation, the surgeon gets into dilemma whether to continue the intended operation "at all costs" or to deviate from the initially planned surgical procedure to some alternative technique. Choosing the first option can increase the risk of intra- and postoperative complications. For example, performance of a complete instead of "subtotal" cholecystectomy by severe fibrotic changes in Calot's triangle can lead to bile duct injury. Enforcement of hemithyroidectomy in case of the difficult surgical anatomy can have a recurrent lesion as a result. There are further examples on this subject. The consequence of the second alternative might be a lower risk of short-term complications but at the expense of worse results in the long term. In oncologic surgery, for example, earlier recurrences due to R1 resection status or unsatisfactory functional results represent typical problems. When making the decision to operate or not, but also when selecting the best surgical technique, it would be important to know a patient's individual risk of intraoperative difficulties. From a surgeon's perspective, intraoperative difficulties are therefore more than just a surrogate parameter for postoperative morbidity, because the prediction of such difficulties could directly lead to modifications of the surgical indication, improved selection of the surgical team, and intraoperative changes in surgical techniques. Ultimately, mortality and morbidity could be reduced by avoiding an operation with a high grade of intraoperative difficulty, by anticipating it and preplanning alternative surgical options, or by modifying the surgical strategy during the operation. Intraoperative changes in surgical strategies are of course not uncommon. In most cases, however, the surgeon has no objective facts to justify his or her decision. The need to justify one's actions may lead to some pressure not to deviate from the preoperative planning. Thus, surgeons tend to stick to the standards of surgical practice, even if the risk-benefit ratio in an individual patient changes intraoperatively. The present results should be seen as a stimulus for surgeons to take their "gut feelings" seriously. If the surgeon's subjective impression points toward an increased difficulty of surgery, it may be justified to deviate from the surgical textbook.

Although the surgeon's impression was partly explainable by well-known risk factors, the estimation of intraoperative difficulty obviously took into account more than the standard criteria, possibly even including subconscious thoughts and conclusions.

Analog to ASA classification, we propose [1] to classify patients according to intraoperative difficulty (I to IV) as (I) ideal patient (easy to operate, no problems), (II) not quite ideal patient (some minor difficulties may occur), (III) problematic patient (difficult to operate, some operative techniques are considerably more difficult than others), and (IV) very problematic patient (every operative step is difficult) (◘ Table 1.1).

The clinical usefulness of this classification is closely related to the point surgical standards and difficult intraoperative situations. If we consider that, we will assert that the surgical standards are good drafted for the standard surgical situation but not for the difficult one. As an example we can compare two patients with the same diagnosis of low rectal cancer. Both carcinomas are stage 2 (UICC). The first patient is male, 81 years old, multimorbid, and has a BMI of 40 kg/m^2. The other patient is a female, 56 years old, healthy with a BMI of 21 kg/m^2. The

▣ **Table 1.1** Classification of intraoperative status of difficulty

Grade of difficulty	Description
I	The ideal patient. It is easy to operate; every operative technique is technically unproblematic
II	Not quite ideal patient. Some minor technical difficulties may occur; some operative techniques can be more difficult than others
III	The problematic patient. Difficult to operate; some operative techniques are considerably more difficult than others
IV	Very problematic patient. Every operative step is very difficult

same medical standards in terms of oncology, surgery, and anesthesiology should be applied in these two cases, but obviously in the first case, it is more difficult to reach them. Our data demonstrate a high correlation between pre- and postoperative estimation in anticipation of difficult surgery. In this regard the preoperative choice of surgical procedure could be related to estimated degree of intraoperative difficulties. Also with regard to intraoperative degree of difficulties, it is sometimes justified to deviate from primary intended surgical procedure or even from surgical standards by a patient with grade III or IV of intraoperative difficulties. Variety of surgical techniques associates very close with the problem of surgical technical standards. The definition "standard" originates from the field of technique and will be used meaningfully in surgery. Standard means norm or unification according to a specific pattern. Not all operations from the field of visceral surgery have such standard. In fact there are a lot of different standards which coexist and will be accepted. Complexity and diversity from standards have been very exact characterized by a phrase from Grace Hopper: "*The wonderful thing about standards is, that there are so many of them to choose from.*"

The actual surgical standards are represented in numerous surgical textbooks and manuals. Variants and deviations from determined operation steps in technical difficult intraoperative situations are till now not enough elaborated. There is still need for further development of it.

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Risk Assessment and Decision Analysis Within Surgical Applications

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2.1 Introduction

Risk is an inherent consideration within any surgical operation. Even minor operations with high rates of success performed on otherwise healthy patients can sometimes induce severe intra- and postoperative complications. Conversely, major operations with low rates of success performed on chronically ill patients can sometimes lead to immediate recoveries with no complications. It is not uncommon when two identical procedures performed on two similar patients yield much different results.

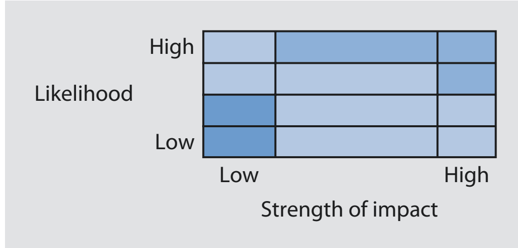
These outcomes of surgical procedures can be explained in terms of risk, an innate property of the field of surgery that doctors and patients alike are challenged to understand when making decisions. Potential complications could ultimately change the outcome of the operation and have different degrees of risk. Thus, it is important for surgeons to understand and be able to evaluate surgical risk in order to identify the course of action that minimizes the likelihoods and consequences of potential complications.

Systematic techniques for measuring risk exist and are employed by decision-makers in various fields. In this chapter, we will discuss one such technique, which integrates risk assessment with multi-criteria decision analysis (MCDA), and examine its potential application in the field of surgery.

2.2 What Is Risk Assessment and Decision Analysis?

Present in virtually every aspect of human life, risk can be defined as any potential negative outcome of a given activity or action. The risk associated with a potential negative outcome is comprised of both its probability of occurring along with an associated consequence or range of possible consequences. As any given activity may give rise to dozens or even hundreds of negative events, fully comprehending the activity's associated risks in an ad hoc manner becomes a near impossibility. Under such concerns, greater structure is required to assess risks and gain improved insight into the potential hazards and consequences of a particular course of action.

A well-designed and thorough assessment of risks covers a spectrum of potential negative outcomes, ranging from the near certain yet marginal (i.e., patient fatigue after surgery) to the rare yet catastrophic (death). In essence, risk is the product of the likelihood of a particular event occurring and the consequences of that event should it arise.



■ Fig. 2.1 Standard risk matrix: frequency of event by strength of impact

Formal risk assessments often utilize quantitative and visual tools, such as risk matrices, that provide structure when evaluating an activity's outcomes. When sufficient data is available, these tools allow their users to better understand the likelihoods of the various consequences associated with courses of action, along with the associated risks. Ultimately, risk assessment is a useful approach to identifying and measuring the various risks of a given course of action (■ Fig. 2.1).

However, simple risk assessment may not be optimal for comparing the risks of alternative courses of action in situations of uncertainty, when objective data is lacking. For example, hazard may not be easily assessed and there may not be a good model for exposure and effect assessment. In an uncertain context, evaluating alternative courses of action to identify the best option requires consideration of subjective information in addition to whatever data is available. In these situations, decision analysis can be used to integrate the preferences and opinions of physicians and patients with objective data and statistics. Decision analysis imparts structure within the decision-making process and offers methods for determining and interpreting how decision criteria may change due to the uncertainty of the situation. When used to supplement risk assessment, decision analysis can produce indications of relative risk levels for alternative courses of action, even in situations of uncertainty. Ultimately, decision analysis can be used to identify the most promising course of action given available data and stakeholder information.

Various approaches to decision analysis exist for different situations. One such approach is multi-criteria decision analysis (MCDA), which includes a set of methods and tools for integrating quantitative measurements and models with more qualitative attributes generally expressed as the formalized judgment of an expert or stakeholder. MCDA refers to a class of structured analytical frameworks used to evaluate alternatives that must be compared against several criteria. Most MCDA methods include the construction of a decision model, which lists each alternative and criterion in a grid-based or tree-based format, yet different methods of MCDA may utilize different weighting and evaluation algorithms [1]. Numerical scores are assigned to each alternative with respect to its performance on individual and weighted criteria, and scores are aggregated for each alternative [2]. Regardless of the type of MCDA, all methods allow decision-makers to structure decision problems in a logical and more formal manner.

As a field with myriad evaluation criteria and significant uncertainty, surgical risk assessment would greatly benefit from a formalized aid to review the risks associated with alternative surgical procedures for a given patient [3]. As we will examine later in this chapter, MCDA could allow surgeons to aggregate qualitative or subjective information, opinions, and preferences alongside more objectively driven data to measure surgical risk and support surgical decision-making.

2.3 A Brief History of Risk

Management of risk has existed for centuries. Many in ancient Egypt, Greece, and Rome turned their hand to a simplistic understanding of risk to estimate the flooding of the Nile River, one's chances of striking it rich in a gamble, or the possibilities of loss when shipping one's goods by sea [4, 5]. Especially due to a lack of computational power expressed by our electronics and devices today, early understandings of risk were measured based on qualitative assessments of one's ability to succeed. For decision-makers in antiquity, this early understanding of risk was characterized based upon experience and anecdotal information from similar circumstances of previous events rather than on quantitative projections due to current or futuristic data. Nevertheless, those with a greater understanding of risk were able to minimize opportunities for loss and maximize potential gains, leaving a fortunate few with more than they began with.

More recently, the need for increased precision and prediction of future events spurred the rise of quantitative assessment. A historical example of this shift includes an exchange of letters in 1654 between Blaise Pascal and Pierre de Fermat [6]. Known today as The Enigma of Méré's, Pascal and de Fermat were able to mathematically prove why Chevalier de Méré consistently lost a gamble of two dice through fundamental theorems of probability [5, 7]. In essence, Chevalier de Méré used a dice gambling rule that consistently lost matches, while Pascal and de Fermat demonstrated how de Méré should place bets on specific die based upon the probability that they should arise through quantitative assessment. Though simple compared to today's measures of probability estimation, the solution to the Enigma of Méré's demonstrated an ability of a capable analyst to use probability and available quantitative information to estimate the future. Quantitative probabilistic estimation stands as a central crux in modern risk and decision science, as risk is generally measured based upon the probabilities that a positive or negative outcome could occur.

Since then, the idea of using numbers to estimate outcomes under uncertainty has infiltrated virtually every discipline in the modern world. From understanding trends in the stock market to estimating the chance of technological failure in a nuclear power plant, mapping the probabilities of certain risks under uncertainty has offered the ability to improve the management of limited resources.

2.4 Risk Assessment in Medicine: Current Practices and Methods

Throughout their training and education, doctors are taught to base their decisions upon the aggregation of evidence, inference, and experience. As such, medical decision-making is undertaken via both an inductive analysis of a given patient's symptoms as well as through deductive and probabilistic decision making driven by medical experience and corresponding data on symptoms and outcomes. More recently, patient preferences have become a significant qualitative aspect of medical decision-making. In a sense, modern medicine has become individualized [8]. The risk communication involved when considering a range of treatment options is often altered to accommodate the concerns of the patient. Faced with constraints on time and information, however, doctors must often make decisions based entirely on classifications of common symptoms, given the characteristics of a specific patient [9].

In the field of surgery, the same constraints on time and information exist. When computing the risk of a particular procedure, myriad variables begin to apply. Many of these variables are difficult to quantify. Qualities such as the specialty of a particular surgeon may affect the procedural choice in an informal manner. When these aspects factor into a decision, the output is often affected detrimentally because the process may not be transparent or quantitatively robust. Ad hoc decision-making also becomes problematic when considering subjective variables such as quality of life. This is due to the difficult task of placing values on not only the cost of a particular procedure but also when evaluating the type of lifestyle that is likely to follow a major surgical procedure.

Robust methods that manage the risks for patients confronted with surgical options for a certain problem are difficult to find. This type of analysis should be transparent in order for the patient and practitioner to understand how risk is calculated and how to factor it into the underlying decision. In the past, cardiovascular risk calculators of this type have been used to determine procedure estimates. These forms of calculators are now being applied to more specialized surgeries, but in a very limited scope. Once the background of risk computation has been formalized, more advanced models such as decision analysis could be successfully applied.

Communication of the risks involved with a particular surgery is important for both the patient and doctors involved. Informed consent is required in order to conduct a surgical procedure involving risk. Landro depicts a typical communication of the risks involved with a certain procedure [10]. This case deals specifically with a female patient considering an abdominal surgery for colon and uterine cancer (◘ Fig. 2.2).

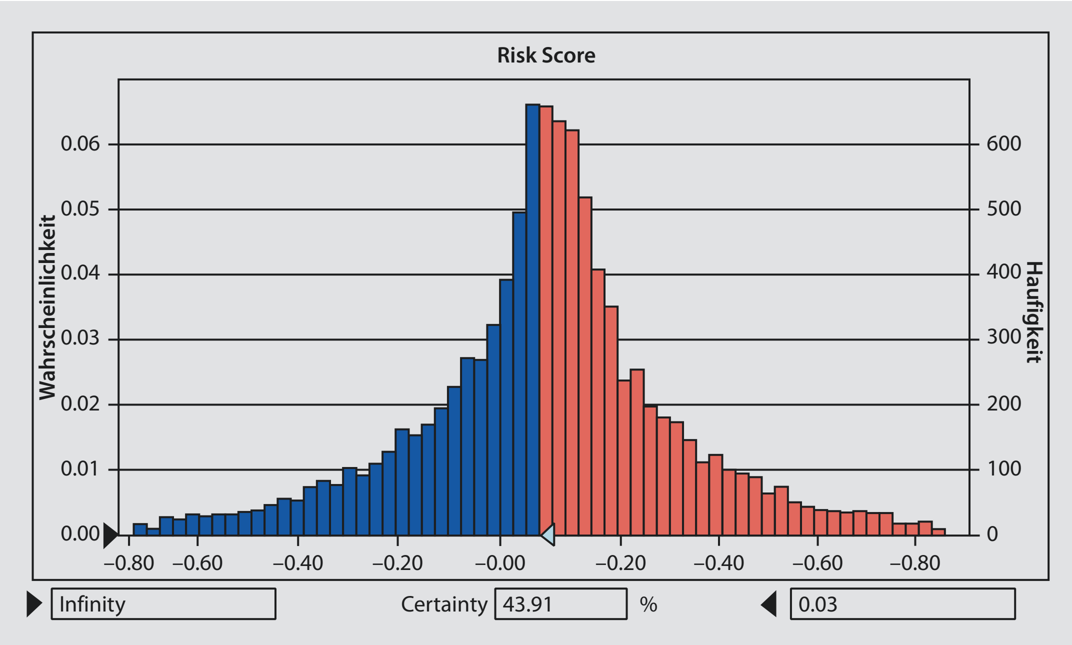
Statistics like these are valuable because they are reasonably easy to understand and communicate to a patient. This type of risk communication, however, provides no transparency of methodology. Further, the complication statistic does not reflect the severity of a particular complication to the specific patient being discussed. Current methods of surgical decision-making often involve the analysis of physical and intellectual databases of millions of patient cases and surgical procedures. Strategies such as data mining often take years to conduct, requiring large sample sizes which may not be available. Bias affects clinical decision-makers attempting to synthesize and apply tremendous amounts of data on an individual patient basis. This very often leads to classification of patients into groups, either consciously or subconsciously, in an attempt to expedite the process of diagnosis. This type of stereotype results from the natural desire to simplify a decision when faced with enormous amounts of data. Limitations on the conventional ad hoc methods of medical decision-making have established an interest in a more formal, quantitative method of risk assessment.

In some specific cases, formalized models of decision analysis have already been applied. These models have been generally linear and focus on a formal evaluation of a medical decision. Numerous forms of quantitative approaches to medical risk management have been developed for years. Weiss et al. offers an early decision model that couples robust statistical data with the opinions of physicians to make more informed medical decisions. In this model, computer-aided decision-making attempts an explicit approach through artificial intelligence (AI) of medical decision-making over the conventional implicit method that uses statistics from accumulated sample data [11]. This type of method accounts for a rapidly growing dynamic knowledge base, as commonly seen in the medical field.

Another approach to a quantitative risk assessment is through simulation. Simulation models in medicine could predict health outcomes of treatments using probabilities of events impacting dose-response models. These models are advantageous because of their ability to depict iterated

◘ **Fig. 2.2** Risk assessment and risk probabilities: female with colon cancer

Chance of complication at surgical incision site	18 %
Chance of serious complication (i.e. cardiac arrest)	8 %
Chance of death	1 %



■ **Fig. 2.3** Monte Carlo simulation of appendectomy dilemma

events or conditions that depend on time for more accurate representations. One such model includes Monte Carlo simulation, in which the probabilities of the best case, worst case, and best guess of an outcome are estimated and simulated thousands of times. Various methods of Monte Carlo assessment and imaging could be utilized to review a patient's risk for negative surgical outcome and could reduce uncertainty in surgical procedures by quantifying and communicating the many risks that affect a patient undergoing a surgical procedure that could yield a negative outcome.

To demonstrate how a Monte Carlo assessment would operate within this context, a surgical dilemma is noted below. A 28-year-old male patient is admitted with a perforated appendix, including a periappendiceal abscess along with acute inflammatory infiltration of the cecum. Though appendectomy is a relatively small operation, the presence of inflammation generates an increased risk of leakage from the appendiceal stump. In the presence of uncertainty, a simulation tool like Monte Carlo would be helpful to estimate the likelihood of surgical success along with an improved understanding of risk origin when paired with a decision support system such as multi-criteria decision analysis. Below, a normalized simulation is shown where a negative score indicates a negative surgical outcome, and a positive score results in a surgical success (■ Fig. 2.3). Under the set risk criteria of the patient's age, history, surgical complications, and others, an approximate failure rate of 43 % is expected.

Integration of expert and stakeholder views to the decision process has also been applied in a limited number of cases. Cairo et al. details an approach involving expert interviews that generate and assign risk scoring for each procedure [12]. This particular method utilizes the RAND appropriateness method (RAM) in order to determine whether or not a procedure or treatment option is applicable in a specific patient case. The output of the model is a scaled ordinal (1–3 inappropriate, 4–6 uncertain, 7–9 appropriate) system. This method establishes which alternatives may be the most appropriate, but may not clearly determine which method is optimal.

Formal decision methodologies have been used more recently in multiple publications. As a journal centered on discussions of risk and decision-making difficulties in a medical context, *Medical Decision Making* presents several decision models that involve more advanced quantitative methodologies which attempt to integrate subjective patient characteristics in a formal manner. For example, Pignone and Ransohoff [13] offer a cross-model comparison for colorectal cancer screenings, asserting that modeling is an effective way to evaluate cost-efficiency, as well as to integrate subtle differences in time intervals and the intervention of more than one procedure.

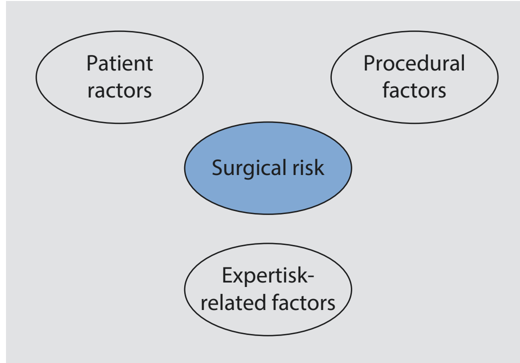
2.5 Risk-Based Decision Analysis for Application in Surgery

In any surgical procedure, various factors contribute to the risk of potential intra- and postoperative complications (◘ Fig. 2.4). These factors can be associated with the traits of the individual undergoing the procedure, or with the procedure itself. Different patient characteristics such as age, body mass index (BMI), and medical history can affect a person's susceptibility to certain complications. Alternative procedures also have different propensities to induce particular problems. Though there are often additional risk factors to consider, such as those associated with the technical expertise of the surgeon, we will focus only on patient and procedural factors in our discussion of how surgical risk can be measured.

In a preoperative situation, a surgeon must evaluate the surgical approaches available and choose the most promising option that best meets the patient's needs. In an intraoperative situation, a surgeon could encounter a problem and must decide whether to continue with the intended operation or to deviate from the initially planned surgical approach to some alternative technique or procedure [14]. In either case, a well-informed decision must consider all the risk factors associated with both the patient and the different alternative procedures in order to select a course of action that minimizes the risk of potential complications.

Decision analysis provides a structured framework for evaluating patient and procedural risk factors to assess the risks of potential complications. Applied in a difficult surgical situation, MCDA can be used to support effective decision-making by integrating qualitative reasoning, such as the inference and experience of the surgeon, with quantitative data, such as empirical results from clinical studies, to measure the relative risk levels of alternative courses of action. MCDA decision models, such as the one pictured in ◘ Fig. 2.5, offer a valuable tool for surgeons to quantify and analyze surgical risks.

The four-leveled decision model pictured in ◘ Fig. 2.5 is a representation of how MCDA might be applied to evaluate the potential risks of complications for different bariatric surgeries. While this general model is not meant to accurately represent the full complexity of a realistic surgical situation, it shows conceptually how factors associated with both the patient (level 2) and the procedure (level 4) contribute to the risk of potential complications (level 3) and thus affect the level of overall surgical risk (level 1) for a particular operation.



◘ **Fig. 2.4** Three types of factors that contribute to surgical risk

In any application of MCDA, decision models serve as a framework for organizing and analyzing all the criteria that is relevant to the decision at hand. These conceptual tools provide structure for a series of simple algorithms that describe mathematically how different criteria relate to each other and factor into the decision-making process. Used in conjunction, MCDA decision models and algorithms provide a transparent, systematic, and comprehensive approach to decision-making. To illustrate this approach, we explore below a hypothetical surgical case study that accompanies the decision model in ◘ Fig. 2.5.

2.6 Case Study: MCDA Application for Risk Assessment in Bariatric Surgery

Consider a patient who wishes to undergo bariatric surgery and must choose between available surgical options. For the purpose of this case study, we will limit the patient's choices to three alternative procedures: a gastric bypass (Roux-en-Y) option, a gastric banding (Lap-Band) option, and gastric sleeve (vertical sleeve gastrectomy)

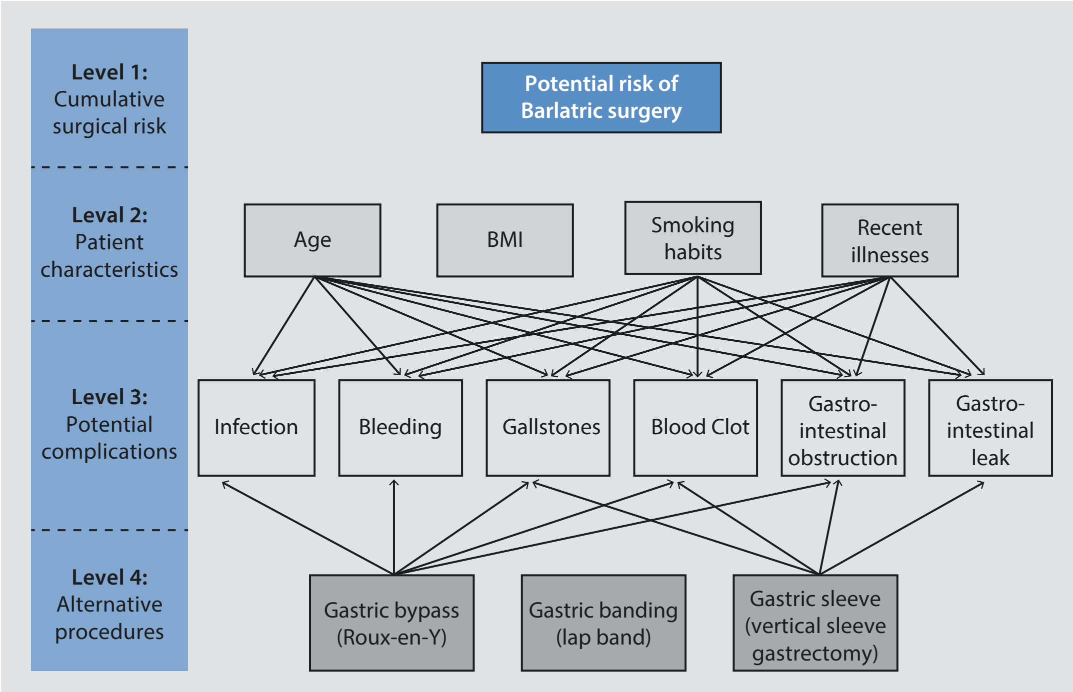


Fig. 2.5 Example MCDA decision model for assessing risks of alternative bariatric procedures

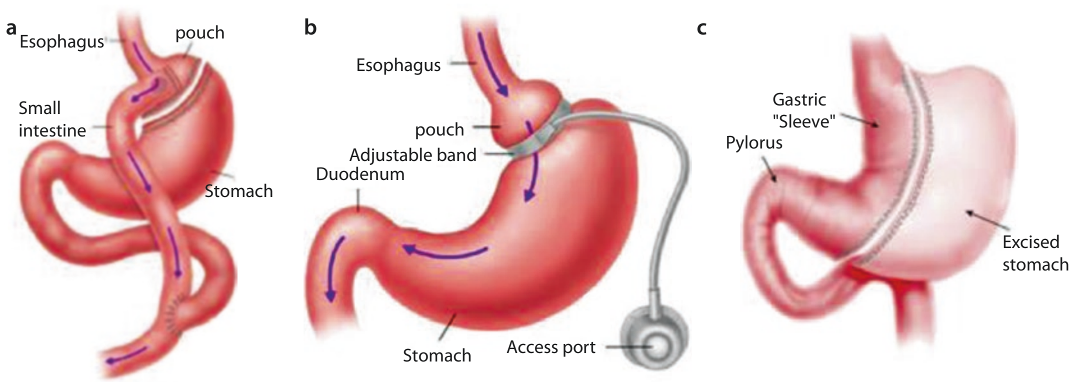


Fig. 2.6 Depictions of alternative bariatric procedures: (**a**) Roux-en-Y gastric bypass, (**b**) gastric banding, and (**c**) gastric sleeve

option. These three procedures are depicted in Fig. 2.6 and on level 4 of the decision model in Fig. 2.5. In order to make a well-informed decision, the patient should compare the overall surgical risk levels associated with each alternative operation.

For the surgeon to be able to provide the patient with cumulative measurements of risk for each alternative, he or she must consider all the potential complications for each procedure and evaluate the relevant factors that could affect their possibility of occurring. For the purpose of this scenario, we will consider a limited number of potential complications: infection (at the surgical site), bleeding (internal), gallstones, blood clots, gastrointestinal obstruction, and gastrointestinal leakage. These complications are listed on level 3 of the decision model in Fig. 2.5. Though a realistic surgical decision would likely need to consider a much wider array of potential complications, in our example we will assume that there is zero possibility for any complications outside of these six.

The surgeon, having compiled a list of all potential complications, must now assess the risks of each one occurring for each of the three procedures. To do this, he or she must understand the different factors that contribute to the risks of the various complications. The risk factors associated with both the patient and with the specific procedures must be evaluated.

Suppose the surgeon chooses to first assess patient risk factors. He or she must determine which patient characteristics are relevant to the decision at hand. In other words, he or she must identify the qualities of the patient that influence his or her susceptibility to any of the potential complications. For the purpose of this scenario, we will assume that there are only four relevant patient characteristics (which are listed on level 2 of the decision model in ◘ Fig. 2.5): age, body mass index (BMI), smoking habits, and recent illness. The surgeon knows that each of these general patient characteristics have been proven to influence the chance of one or more potential complication occurring. Thus, he must evaluate the patient's "score" with respect to each of the four characteristics. This information for our hypothetical patient is shown below in ◘ Table 2.1.

In order to evaluate how the patient's characteristics affect the overall risk levels of alternative procedures, the surgeon must not only know how the patient scores for each characteristic but must also understand how exactly these characteristics influence the patient's susceptibility to the various complications. For example, it is not exactly useful for the surgeon to know that the patient's BMI is 32 unless he or she also knows the propensity of BMI to influence the chance of surgical infection. Thus, for each of the potential complications, our surgeon must assess all relevant characteristics and integrate the patient's characteristic score with the characteristic's general propensity to induce the complication.

In a realistic application, there might be multiple ways of integrating a patient's score with the characteristic's propensity to determine the influence of the specific patient attribute on the risk of a given complication. These could range from purely mathematical algorithms to more qualitative approaches that place the patient in a "bin" or category, along a scale from one to ten, along a spectrum from "low susceptibility" to "high susceptibility," etc. The MCDA approach can be adapted to accommodate any and all methods of integration, which may vary with the context and/or with the medical data that is available.

As our case study is hypothetical and intended primarily to illustrate the larger MCDA approach, we will not explicitly define or integrate characteristic propensities but will instead randomly assign each patient characteristic and "influence score" from one to five with respect to each potential complication, representing the magnitude with which the patient's attribute increases his or her susceptibility to that complication. Our surgeon can combine these scores to derive our patient's "susceptibility score" for each potential complication. The results of these evaluations are pictured below in ◘ Table 2.2.

The surgeon has now completed a comprehensive assessment of the patient-related risk factors involved in the surgical decision. Having considered all relevant patient characteristics and determined the patient's own susceptibility to each potential complication, he or she must now assess the risk factors associated with the surgical procedures being considered. The distinct steps involved with each of the three bariatric operations might present varying levels of potential risk for different complications. Thus, the surgeon has to determine the propensity of each procedure to induce each of the potential complications.

Various sources of information can be utilized to determine the propensity of a particular procedure to induce a specific complication. The surgeon's own intuition, grounded in his or her experience performing the operation, might be a reliable gauge. Documented medical data and the results of clinical trials might also be potentially useful sources. Although the data that is available

◘ **Table 2.1** Patient characteristic "scores"

Patient characteristic	Patient score
Age	36
BMI	32
Smoking habits	None
Recent illness	None

Table 2.2 Patient characteristic influence scores and susceptibility scores for each potential complication

Patient characteristic	Patient score	Characteristic influence scores					
		Infection	Bleeding	Gallstones	Blood clot	Gastrointestinal obstruction	Gastrointestinal leak
Age	36	1	2	3	2	1	1
BMI	32	3	2	2	4	3	2
Smoking habits	None	0	0	0	0	0	0
Recent illness	None	0	0	0	0	0	0
Final complication susceptibility score		*4*	*4*	*5*	*6*	*4*	*3*

Table 2.3 Alternative propensity scores for each potential complication

Surgical alternative	Procedure propensity scores					
	Infection	Bleed ing	Gallstones	Blood clot	Gastrointestinal obstruction	Gastrointestinal leak
Gastric bypass (Roux-en-Y)	2	1	3	2	4	3
Gastric banding (Lap-Band)	1	1	2	1	3	2
Gastric sleeve (vertical sleeve gastrectomy)	3	4	2	2	1	2

in different surgical contexts may vary, it is important that the propensity scores for different procedures and complications are derived with as much fidelity as is possible.

For the purpose of our case study, we will randomly assign the three alternative procedure propensity scores from one to five for each potential complication. These propensity scores, displayed below in Table 2.3, represent the tendency of the procedure to induce the particular complication.

The surgeon has now comprehensively assessed both the patient and procedural risk factors that could contribute to the possibility of encountering potential complications during the bariatric surgery. He or she must now aggregate the patient's susceptibility scores with each procedure's propensity scores to produce cumulative measures of surgical risk that the patient can use to compare alternatives.

Before he or she can derive these final risk levels, however, the surgeon must perform one last assessment that explicitly considers the severities of each potential complication. In order for the patient to make a well-informed decision regarding which surgical alternative to pursue, he or she must not only understand his or her own susceptibility to potential complications and the procedures' varying propensities for inducing them, but he or she must also take into account the severity of the potential complications that could arise. Suppose the patient would favor a procedure with a high risk for a minor complication (i.e., gallstones) over a procedure with a low risk for a major complication. This preference must factor into the surgeon's calculations.

In the field of risk analysis, risks are described by measures of "likelihood" and "consequence." In this scenario, the combined patient susceptibility and procedural propensity scores describe the "likelihood" of potential complications occurring, and severity scores describe the "consequence." Thus, the surgeon

2

Table 2.4 Severity scores for potential complications and cumulative surgical risk level for the gastric bypass alternative

Complication	Severity score ("consequence")	Patient susceptibility score	Gastric bypass (Roux-en-Y)		
			Procedure propensity score	Susceptibility × propensity ("likelihood")	Complication risk level
Infection	2	4	2	8	16
Bleeding	3	4	1	4	12
Gallstones	1	5	3	15	15
Blood clot	4	6	2	12	48
Gastrointestinal obstruction	3	4	4	16	48
Gastrointestinal leak	2	3	3	9	18
			Cumulative surgical risk score:		157

Table 2.5 Cumulative surgical risk levels for the gastric band and gastric sleeve alternatives

Gastric band (Lap-Band)			Gastric sleeve (vertical sleeve gastrectomy)		
Procedure propensity score	Susceptibility × propensity ("likelihood")	Complication risk level	Procedure propensity score	Susceptibility × propensity ("likelihood")	Complication risk level
1	4	8	3	12	24
1	4	12	4	16	48
2	10	10	2	10	10
1	6	24	2	12	48
3	12	36	1	4	12
2	6	12	2	6	12
Cumulative surgical risk score:		102	*Cumulative surgical risk score*:		154

must first combine the susceptibility and propensity scores for each complication and then integrate these combined likelihood scores with their associated severity, or consequence, scores. Only then can cumulative risk levels be defined for the alternative surgeries.

Although these scores could be integrated in different ways, for the purpose of our hypothetical case study, we will simply take the product of each complication's likelihood score (which is itself a product of its susceptibility and propensity scores) and randomly assigned consequence score (1–5) to derive the risk score for the complication. We will then sum the risk scores across all complications to calculate the final, cumulative risk level for the surgical procedure. The results of these evaluations are shown below in Tables 2.4 and 2.5.

2.7 Discussion

It is important to note that the decision model and hypothetical scenario we present in this chapter are simplified examples meant only to demonstrate how MCDA can be applied in a difficult surgical situation. Our model's lists of complications, procedures, and patient characteristics are incomplete and are intended to be specific to the limited field of bariatric surgery. Realistically, the relevant factors and alternatives that must be considered when measuring risk and making decisions would be defined by the objective of the surgery. Additional patient characteristics, potential complications, and alternative procedures might need to be evaluated in order to fully comprehend associated risks and make a well-informed decision. Moreover, both the preferences of the patient and the surgical policies of the hospital must be taken into account.

Also worth noting is the fact that our model and scenario are specific to a preoperative surgical context, where risks can be evaluated before the operation takes place and the patient generally has a say in the decision that is made. MCDA can also be applied in an intraoperative context, when an unanticipated difficulty is encountered mid-procedure. In these scenarios, new risks can develop that often require a reassessment of the initial surgical strategy.

Ultimately, doctors and surgeons must be able to understand and evaluate risk in order to meet the needs of their patients. There are many ways to measure risk, and risk and decision analysis is just one way to facilitate comprehensive and efficient risk assessment. Medical MCDA could better inform patients and surgeons as to the potential risks of a procedure and could also improve surgical success rates through responsible mitigation of complications. Though decision analysis methods such as MCDA are no replacement for a skilled surgeon and the diagnostic abilities of medical professionals, they may act as tools to prioritize surgical procedures for a particular patient based upon cumulative measurements of relative risk.

In the field of surgery, decision models like the one described in this chapter would not replace, but rather support a surgeon's own expertise and intuition. With so many interrelated risk factors to consider in a difficult surgical situation, a structured approach to organizing, integrating, and interpreting these factors could help surgeons make better informed, risk-minimizing decisions.

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Deviation from Surgical Standards from a Viewpoint of Layers

Hermann Fenger

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3

3.1 Introduction

> The physician has only one task: to heal. If he succeeds, it doesn't matter how he does it (Hippocrates of Kos).

Today, this famous and at the same time understandable quote from the Greek doctor and philosopher no longer has unlimited validity. Medicine is now under the influence of the patient's legal rights; so that even successful medical treatments are put on the test bench.

Moreover, occasion gives the increased claim thinking of the patients. This development is supported by mostly one-sided reporting in the media and entails the relationship earlier stamped by trust has strongly chanced between doctor and patient. To observe an increased requirement of the judicature is in particular compared with the medical clarification duty.

Diminishing financial resources require medical services to be sufficient, effective, and economical. However, this efficiency principle is not medical practice. Rather, the physician owes the patient a professional, scientific standard treatment (BGH NJW 1975, 305; OLG Frankfurt NJW-RR 2005, 701f.; OLG Brandenburg OLGR 2005, 489ff.). Subsequently, the physician is obliged to treat the patient according to the recognized and secure standard of medical science (BGH VersR 1997, 770f.; OLG Karlsruhe OLGR 2006, 8; OLG Stuttgart VersR 2003, 253f.).

3.2 Legal Framework

As before, the agreement made between the patient and physician is regarded as a contractual service contract and not as a contract (BGHZ 63, 306/309; BGH NJW 1981, 2002; OLG Koblenz NJW-RR 1994, 52). Therefore, the physician does not owe the patient a specific result or outcome. This would be the essential content of a contract. Thus, the physician owes the patient a treatment *lege artis*.

This was followed by the new Patients' Rights Act. The treatment contract is now expressly regulated in the Civil Code (BGB) in § 630 a. After the treatment has been carried out according to the recognized standards existing at the time of treatment. Under this legislation, treatment must be provided in accordance with the recognised professional standards in place at the time it is provided.

Therefore, the physician must examine the patient according to the current standard of medical science and treatment. From the doctor, therefore, the necessary care under the prevailing circumstances is expected. He has to deal with treatment in the appropriate form. The scale of due diligence depends on how a conscientious doctor would have behaved in the situation. If the doctor violates this, it is at least negligent (BGH NJW 2000, 2737).

Contractor is therefore the medical doctor's standard. There, the doctor's duty of care is in accordance with the state of medical science at the time of implementation of the treatment assessed (BGH NJW 2004, 1452; OLG Saarbrücken NJW-RR 1999, 176).

Any critical engagement with a medical opinion of an expert as part of a contentious dispute because of alleged medical malpractice includes checking the literature cited by the expert. An expert's point of view backed up by references dating until after the disputed treatment is not uncommon. In such a case, the expert leaves his task that he an assessment of the treatment of the ex – ante demands.

The legislature has defined § 278 BGB, which represents a debtor in default events. According to § 278 Abs. 2 of this provision, any individual has been negligent, who makes the necessary care except in mind. The term "state of the science and technology" as a causative care feature previously used in this context implied something static. It referred to something given and fixed. Today the term "standard" is used. This concept points to what the legislature wants to areas with the necessary care, namely, a normative imposed ongoing to adapt to circumstances and dangers (Lauffs, Kern: Handbuch des Arztrechts, § 97 Rd. 3). The default plays an essential role in medical malpractice law. This is the crucial point of a warranty obligation for disappointment and a certain expectation (Katzenmeier: Arzthaftung, p. 278). The default is regularly described as the respective state of scientific knowledge and medical experience, which is necessary to achieve the objective of medical treatment and has been proven in testing (Carstensen DÄBl 1989, b – 1736). There is general agreement about the fact that the standard of good medical treatment should be guaranteed and must not be exceeded (BGH NJW

1999, 1778; BGH NJW 1995, 776f.; Steffen, Pauge: Arzthaftungsrecht Rd. 133). It is a comprehensive term of objective error.

It is not about penalizing personal debt, as is the case in criminal law. Rather, quality defects are pointed out. This standard of care may therefore heed the lack of training or experience. Nor does it depend on personal material shortages. The exhaustion of the budget is irrelevant. What is desired is that treatment that an average qualified physician, according to the state of medical science and practice of skill, knowledge, and attention to perform in a position (Katzenmeier a.a.O S. 279).

3.3 Importance of Policies and Guidelines

The provision of specialist standards consists of rich lines and guidelines. Rich lines are rules of the trade or omission of a legitimized institution that has failed to comply with the defined sanctions.

Guidelines are systematically developed, scientifically based, and contain practical recommendations about the appropriate medical procedure for specific health problems. A violation of a guideline is not indicated in the presence of a treatment error, let alone a rough treatment failure (OLG Hamm NJW 2000, 1801; OLG Stuttgart MedR 2002, 650; OLG Naumburg GesR 2002, 14f.).

However, guidelines and policies in particular can become the standard of care development (BGH NJW 2000, 1784f.). Then, when the doctor is different in each individual case of a guideline, the reason for this must be explained (OLG Düsseldorf VersR 2000, 1019f.). In individual cases, guidance may contain an indicative effect of the presence of compliance with care, such as the violation of S-3 guidelines (OLG Düsseldorf VersR 2000, 1019f.).

Overall, one must assume that a regular medical treatment is not only determined by rich lines. Rather, they are to be observed carefully and judged by the level of knowledge of medical science at the time of treatment. The guidelines and the guidelines shall otherwise – can these cognitive stood reflect only declaratory, not constitutive but justified. The physician must read regularly the relevant journals in the field in which he operates to achieve the necessary level of knowledge (OLG Hamm NJW 2000, 1801; BGH NJW 1991, 1535).

Thus, a medical treatment error may also be due to the fact that the delayed use of a non-approved indication for the necessary medication is wrong (OLG Köln VersR 1991, 186ff.). In this particular case, the court has even adapted a rough treatment failure with all its consequences. Ultimately, the Higher Regional Court of Cologne has even affirmed a duty to off-label use.

3.4 Freedom of Medical Therapy

At first glance, the previous explanations of medical therapy freedom seem too prejudiced. The choice of method is, however, still a matter for the doctor. It leaves him one of him are responsible, risk area under the rules of medical science (Ulsenheimer in Lauffs, Kern: Handbuch des Arztrecht, § 139 Rd. 33; BGHSt 37, 385ff.). This free space for the physician follows from the fact that the rapid advancement of medical technology and the associated extraction of ever new experiences and insights inevitably lead to differences in the quality of the individual treatments (BGH NJW 1993, 2989ff.). Therefore, the requirement of medical care must not be indiscriminately compared with the opportunities that prevail in university hospitals or specialized hospitals. Rather, the fact of the particular patient in a specific situation under achievable circumstance must be considered.

In any case, a more adequate medical standard must be achieved (BGH NJW 1994, 1597f.). That is why the application is not generally recognized forms of therapy generally allowed (BGH NJW 1991, 1536). The mere fact that a doctor leaves the field of medicine cannot be concluded from the outset after a treatment error (BGH NJW 1991, 1536).

With several recognized medical therapies to choose from, the physician must choose the one that on the one hand offers the best chance of recovery, but on the other hand brings the least risk to the patient and gives the patient the least pain. If the doctor decides on the greater risk or any related major pain treatment, although under all the circumstances a less hazardous procedure fulfills the purpose in the same way, he is violating his obligation to apply the optimal method of treatment (BGH NJW 1987, 2927; BGH NJW 1968, 1181f.).

The doctor may only take on more risk when the special circumstances of the case justify it (BGH MedR 2008, 87f.). By using a method of treatment outside the medical standards of the physician increased caution should be exercised. He must continuously monitor the course of treatment and should never observe from afar (BGH MedR 2008, 87ff. NB. Spickhoff).

Furthermore, the doctor also has to take into account which methods he personall thought were better and safer. It will be different according to the severity of the upcoming surgery. With technically simple operations, each operation method will be unproblematic and feasible. This ranges from simple information to the patient about the form in which the intervention is to be performed.

In a situation in which certain methods of operation can be more difficult than others, this must be discussed with the patient. With the patient the pros and cons of each method are discussed. This is especially true if some operation methods are more difficult than others. Every operational technical method is to be regarded as difficult and should be discussed with the patient in the same way. In all cases, documentation of the informed consent discussion is essential.

3.5 New Treatment or Outsider Methods

In a Berlin clinic, a novel method for lung patients was applied. The so-called Video-Assisted Thoracoscopic Surgery (VATS) lobectomy is carried out to remove lung cancer. Only two small incisions are created. A camera is inserted into the chest to transfer captured images to a high-resolution monitor. The operators only look at this monitor and operate using special instruments through a second section of about 6 cm. Approximately this amount is taken as the surgical specimen. The lymph nodes are removed to the same extent as in a conventional open surgery. The necessity of opening the chest with a large incision and spreading the ribs of conventional methods is removed using this technique. The clinic reported at the time that in five patients, this method was successfully used at an early stage of lung cancer.

This certainly could not be called a standard. However, in the interests of patients and the advancement of medical science this method has been allowed, even though some side effects and risks are initially present.

Upon application of a method, outsider jurisprudence requires the standard of care of a prudent physician. A decision of the Federal Court has expressly held that the application of a non-generally accepted method of treatment is generally allowed and not without more ado results in the liability of the practitioner (BGH MedR 2008, 87ff.). In this case, an orthopedist had treated intervertebral disk disorders using the Racz catheter. In this treatment, a cocktail of local anesthetics, a corticoid, an enzyme, and a salt solution, are injected into the area affected by a herniated disk segment over an epidural catheter in the spinal canal. This minimally invasive spinal epidural catheter technique has not been challenged. With the appropriate choice of treatment, no treatment failure was seen.

Rather, the Supreme Court decided on the basis of freedom of treatment that it is primarily responsible for the choice of therapy on the safest therapeutic route. However, a greater risk in the specific constraints of the case or in a more favorable prognosis healing must find an objective justification (BGHZ 168,103/105f.). In such a situation, all known and medically reasonable security measures must be applied to ensure successful and complication-free treatment. The more drastically a possible error affects the patient, the more seriously it must be taken (BGH VersR 1985, 969f.).

The application of an outside method differs from conventional, standard medical therapies, especially the degree to which hitherto unknown risks and side effects are to be expected. Therefore, a responsible medical assessment is required, in a particularly careful comparison between the expected benefits and their predicted, unknown or already occurring disadvantages must be made with special emphasis on patient welfare. Although the safest therapeutic route need not always be selected, when applying a higher-risk method for the patient be seen and be found in special dimensions is an objective justification in the constraints of the case or in a more favorable healing prognosis. The required consideration here is not a one-off process at the beginning of treatment. The balance must rather weighed up in each case once new information on the potential risks and side effects are available. The doctor must abide by immediate check-ups and continually be up to date.

3.6 Enlightenment

Of particular importance with regard to the pros and cons of the chosen method in all these situations is enlightenment, i.e., a special education of a maverick, not yet generally introduced new basic method with potential new and as yet unclarified risks (BGH NJW 2006, 2477f.; OLG Frankfurt NJW-RR 2005, 173/175; OLG Bremen GesR 2004, 238). The application of a computer-aided milling process ("Robodoc") at the coxal femur for the implantation of a hip joint prosthesis requires the patient to be informed of this fact in addition to the advantages and disadvantages of this method and also receives an explanation of the conventional manual method (BGH VersR 2006, 1073/1075).

Departing from an accepted standard method to apply a relatively new and not yet widely established method with new and as yet unclarified risks, the patient must also be informed that unknown risks cannot currently be ruled out (BGH NJW 2006, 2477f.).

Such an increased awareness obligation also applies to the intended application of a specific prostate laser procedure in a two-step operation, which had not yet been established at the time of surgery (OLG Bremen GesR 2004, 238). If serious medical science publications cannot be dismissed and unremarkably few outsiders who speak out against new techniques that have not been widely adopted or overweight against certain, previously normal operations or treatment concerns, the patient must also be informed about this (BGH VersR 2009, 1073; BGH NJW 1996, 776).

3.7 Documentation

Every medical intervention requires for its justification the effective consent of the patient. A patient may only provide this consent if it has been sufficiently elucidated. The burden of proof for the existence of an effective consent to the proposed procedure and the previously well-conducted reconnaissance are borne by the doctor (BGH VersR 2006, 838f.). To satisfy this burden of proof, the documentation requirement cannot be overstated.

The best and most extensive education will not help if it cannot be proven. Although it is possible to prove an explanation by witnesses, this is the least reliable evidence because witnesses often understandably cannot remember events in the distant past. This applies all the more if they are routinely carried out several times a day. Although it is recognized that in such cases it can be used that are regularly informed of the necessary shape patients (OLG Celle VersR 2004, 384f.; OLG Hamm GesR 2005, 401), but it is very risky to any deviation from the standard be limited to this type of evidence. The requirements of the case to the enlightenment in these cases is very high; thus anyone other than the default, both his reasons therefore and the extensive informed consent discussion must be documented.

3.8 Conclusion

A deviation from the standard is to be considered per se as a treatment failure. However, it must be ensured that the standard is not exceeded. The patient has a right to a nonstandard treatment. A concrete situation requires a departure from the standard; the patient must be fully informed about this and about the pros and cons of the method. The patient must know the dangers and the risks of failure of the intended intervention. He must be informed that the proposed intervention is not a medical standard and its effectiveness has not yet been secured. The patient must be able to consider whether he wants to take the risks of a possibly relatively indexed treatment and their chances of success with regard to its condition before the procedure.

Adequate documentation of both the assessment of the physician, which led to the departure from the standard, and the comprehensive informed consent discussion with the patient, is vital.

Surgeon in a Difficult Situation

Hans Troidl

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It was difficult, but could be done easily! (The "real" surgeon)
Diversity, individuality, contradiction and limitation are life, classification is including and excluding, it is simplification, it is reduction, is limited reality.
(Hans Troidl)

Frankly it is a little difficult for me to write down what I was asked to. In the usual case of the sole or co-authorship of a book, a lot of scientifically obtained data would be available for me to put up my text with.

In this matter I do need analyses and considerations that arise from my work experience, although I am aware of the limitations of my knowledge. I was at home in this surgical world for decades, operated thousands of patients, educated surgeons and went through difficult surgical situations. I interchanged with bright teachers and thoughtful, critical people ("soft data"; [2]) and finally wrote this contribution to find the definition of "difficult situation in surgery".

Can this be sufficient for the truth in the age of evidence and the dominance of "pure" science (measuring and counting – hard data [2])?

Thus we have arrived at the difficult questions: What is meant by "difficult surgery" and what does it give to a critical surgeon? Does the answer of these questions help to improve the treatment? At least, is there a benefit of the patient?

The ideasgiver on this, I think, interesting and overdue question is my former student Michael Korenkov, who at a symposium in Bad Soden [4] asked himself and the audience this question and then announced his conviction that this issue finally must be served. Of course, everyone in the hall knew immediately what he meant, only if you inquired, there was awkward silence – as always! I realised immediately that there was still an obligation to think about this issue but not only to understand the difficulties but also to look for solutions and even to ask for the purpose. Of course, this was all at once clear to everyone and you wondered: Why does this question come up just now – or so late?

4.1 Classifications and Stagings

Even medicine is covered with definitions and classifications in all directions and dimensions. Due to my experience, there was – after a long period of pure proliferation – a decade of orders and stagings that dominated the scene in medicine, and questions about causes and effects had almost been forgotten! The question about N1 and N2 with lung cancer was discussed, papers were published and congresses were organised. Even whole books have been filled with these questions.

A pioneer of this decidedly necessary, somehow overdue development was the Englishman Dukes, who in 1932 "staged" the rectal cancer by local expansion, infiltration and affected lymph nodes in so-called stadiums, even if he then could not realise the limits of his staging. He was in this respect a forerunner and pioneer as well as J. Goligher (Leeds) and the internist Visick of York, who defined and graduated the subjective "clinical" result in the stomach surgery ("soft data") which J. Goligher used to assess the effectiveness in the first randomised study on gastric-ulcus surgery that amounted to a paradigm shift in clinical research.

These persons owned the phase I of the stagings in medicine, which unfortunately today is often forgotten by the countless imitators. Gradually stagings and differentiated schemes of therapy depending on them became the usual conditions in virtually all surgical specialties.

In general surgery (gastric bleeding, Forest I–IV, gastric carcinoma histologically, etc.), the Child-Pugh score for liver cirrhosis, the severity classifications in the haemorrhoids and hernias, etc., etc., etc.! At first, pure X-ray images – only – were used. Laboratory data were added, which offered something being measured and counted. Finally, the supposedly objective histological findings. Sometimes the absurd controversy about the "correct" classification seemed to be more important than their actual clinical relevance!

The last and most important question was seldom or never asked.

Of course, the stagings were not accepted in the same way, which is an immanent problem of stagings, that is to say: definitions. Initially pure X-rays were used, but they soon realised that this isolated access was inadequate. Laboratory data were added offering details you could measure or count (objectivity). Finally, the supposedly objective histological findings. Not or not yet measurable factors of influence thus didn't find any attention, because only measurable data were relevant!

Sometimes the absurd controversy about the "correct" classification seemed to be more important than its actual clinical relevance! The final and decisive question of the benefit for the patient was rarely or never asked.

According to Sir Karl Popper, "the dispute about the typical/own definition" is a fundamental problem of the stagings. Your own favourite stage forces you to mere, blind defence soon losing sight of its real purpose. Such intensive efforts for the "correct" view were certainly very respectable, necessary and helpful, but these discussions were more and more dominated by theorists, who were experts (!) in their fields, but on the other hand had never seen an operating room from the inside and had never had to make a decision at the open abdomen. Rarely, the authors were those who used a classification in practice (apart from the great exceptions from the "pioneer days" I have mentioned).

The information obtained in this way, however, has also changed and clearly improved the medicine despite the limitations that I described and that cannot be excluded. Different therapeutic strategies depending on stages were fixed. The results of the treatments were given some degree of comparability and forecasts became more than just reading the coffee grounds. Other therapies were changed or even abolished. On this basis, even then studies (RCT) were possible at all.

These things work, especially in the statistics of large quantities, but not in the same way on the individual patient. Every doctor knows patients who are supposed to survive about 6 months after "stage III–IV", but years later they are still healthy. These are the "miracles". (Then I always checked the histology …)

By the way, the enthusiasm for the staging/scheduling was, for example, the reason for overlooking, that the penetration depth of a – still not fully understood – cancer or the isolatedly collected variables of the most surgical diseases are only partial aspects of the real individual diszease. In nature, the mono-causality is rather an exception! A tumour of a certain size (stage II or III) in the distal rectum of an older man with, e.g., heart attack, diabetes, pulmonary emphysema and severe nicotine abuse is, compared to a younger patient without comorbidity, a completely different disease/patient (!), although according to TNM the same staging should also mean the same disease. "This is certainly clear!" I hear them say.

The extreme way of thinking this way, however, is reflected in the systematic lymphadenectomy in Japanese medicine. My mockery until today: "Japanese lymph node hunting". There the surgeons for tumour surgery were more concerned with the removal and precise processing of lymph nodes than with the tumour-bearing organ – the sick man!

Rhetorically strong pathologists became famous and celebrated for their demand of a special preparation of the lymph nodes in the resect specimen with a special cut through the removed lymph node as well as for the counting (!) of the lymph nodes.

Although the breast cancer surgery questioned the radical lymph node dissection very early and then the so-called controlled studies on the stomach and the colon did not confirm the systematic lymphadenectomy in their effect (survival time), the staging with a particular lymph node number (!) and precise localization became standard.

The number and the standard became the golden calf – the phase II of the schedule lines/stagings. "I like numbers!"

This subject was often critically reviewed (e.g. [3]). By the way, this is different from the reaction of the gynaecologists, who never followed this mania, and now gave a strong reason for that: "Our results show no benefit in terms of overall or recurrence-free survival for pelvic lymphadenectomy in women with early endometrial cancer".

I myself considered the so-called lymphadenectomy with utmost scepticism, but I also was involved. I have always articulated my scepticism but not as consequently as today [5].

However, the discussion about the systematic lymphadenectomy refers directly to the subject of the book, because it makes the operation more difficult, more dangerous and with more serious consequences. But there is also the other truth, because a lymph node infiltration means a poor prognosis! However, this does not mean that now any further consideration should be stopped. It is important to think about it on the basis of these facts and in consideration of them! It's just research in biology based on the great Ernst Mayr.

"The surgeon in difficult situation" is our theme.

At first it should perhaps be helpful, how the surgeon reacts successfully in such a situation and how he manoeuvres out of it.

And most forgotten: "how competent is the anaesthesia"!?

All of these for more safety und better surgery!!

Therefore, first of all, we should become clear to some extent what we can or want to understand by this.

4.1.1 The Difficult Situation

Of course, every surgeon knows immediately what a "difficult situation" is – for some it does not exist at all.

Definitions as such are a bit of a problem – see Fig. 4.1! Socrates in Athens was said to lean at a pillar for days asking the passing Athenian for his profession, and he was not satisfied with the simple answer, e.g. "baker", but wanted to find it out more and more accurately by further questioning; it became not only recognisably difficult but also embarrassing and even annoying for the respondent. In the end he felt exposed and guilty. After this questioning the baker didn't even know who he was and what he did and ran away.

The exposed citizens of Athens' reaction were the many black stones in the urn: the death sentence for Socrates.

In my treatise on stealing intellectual property – plagiarism [6] – I have tried to resolve this problem with the ideas of Gerhard Vollmer, a physicist and philosopher, and of Sir Karl Popper (see below), with Gerhard Vollmer suggesting to complete the dominants of a definition, which are generally accepted at a time, with their own ideas.

Popper, who, by the way, thinks definitions to be fundamentally problematic, even though they are necessary for communication, proposes to list all the essential factors or dominants on the left (right to left) and to summarise them more like a hypothesis (!) on the right side "as an equation". The particular advantage of this


DIE EINHEIT DER GESELLSCHAFTSWISSENSCHAFTEN

Studien in den Grenzbereichen der Wirtschafts- und Sozialwissenschaften

Band 4

Unter Mitwirkung von

Hans Albert · Knut Borchardt · Hans K. Schneider

Rudolf Wildenmann · Eberhard Witte

herausgegeben

von

Erik Boettcher

Definitionen: links → rechts

Der Mensch =Def ein federloser Zweifuß

=Def rationale Wirbeltier

Recht → links: man beschreibt, hypothetisch, und gibt einen Namen.

Fig. 4.1 Sceptic thoughts of defining definitions by Sir Karl Popper. Original!

Okt. 1992

Fig. 4.2 These guidelines on "definitions" were written for me by Sir Karl Popper into his famous book *Logic of Scientific Discovery* when we were discussing about quality of life – a lecture I will never forget

approach is that it is open and flexible (Fig. 4.2).

Whether this has discouraged the surgeons from finding a definition of the "difficult situation" or whether it was simple negligence is not known. A further problem is connecting the subject with the question of the purpose. Therefore the question is if there are any ways of avoiding the difficult situation during surgery and to find the best possible solution to avoid negative consequences and thus to reduce the risk.

Closer to the questions about definition and purpose are the well-known ASA classifications (1963) with a similar intention at a different focus. They are about the functional limitations of organs as risk factors for anaesthesia. Here, a common problem can clearly be seen: A patient with ASA II in clinic A is different from such a patient in clinic B.

Also very close is the staging into so-called mild, moderate and severe operations. In Germany this classification has been agreed somehow. The purpose was probably to demand an objective basis for adequate financial resources, staff and authorization to educate. It is not an acceptable and meaningful classification of "difficult" operation. Amazingly enough I have not found anything else.

And "definitions" are time dependent!! Only recently, a paper (retrospective) very close to this issue was published [1]. In laparoscopic gallbladder surgery, the factors male gender and older age of the patients proved to be "difficult" but not the body weight, adhesions or the time of the surgery. Objective (!) criteria (criteria to be reached?) in this study were the surgical time and the conversion rate. Although of course the high-risk operations at the oesophagus, heart, pancreas, etc., are certainly more often charged with difficult situations, there are also difficult situations at the haemorrhoidectomy, however less frequently and with fewer consequences. That's what the following is about. On the other hand, it is abundantly clear that the development of surgery with services (achievements) that could hardly be thought of some time ago has increased the difficulty from itself enormously and this in a tremendous pace. This applies to both the technology and the necessary manual skills as well as particularly to make the right decisions with regard to risk assessment and risk minimization.

Increasing dependence on technology such as in endoscopic surgery, which reduces the cognitive and perceptual apparatus mainly on the visual, leads to completely new grades of difficulty. However, quite a few enthusiastically praised technical innovations have disappeared. I remember the high favourite lithotripter for gallstones, not to forget the myth laser and the "beams bomber" – devices that consumed so much energy that they could not be put into operation never having proven their effectiveness.

Difficulties in medicine are also economic difficulties (!), profit maximisation and financial objectives (guidelines). This topic affects into so many areas of medicine and has thereby replaced the ethos of medicine to a large extent. Additionally, the surgeon's self-selected difficulty looking upon the patient as a test subject to become famous with leads to difficult situations. The thyroid gland need not be approached from the axilla or from behind the ear.

The question is: why is it so hard for surgeons also to agree with a clear definition of "difficult situation"? Is it the real circumstances or negative experiences with definitions (e.g. acceptance) or the scientific and methodological difficulties or is such a definition not required at all?

Since 1984 (!) the mountaineers have divided their routes in degrees of difficulty, e.g. the so-called Benesch scale. This scale has seven levels of difficulty. With stage VII Benesch evaluated the easiest routes, with stage I the most difficult one. One can draw good inspiration from this if you try to find a classification of surgical severity (?). The method chosen by Benesch is simply a listing of facts, their number, intensity and specificity increasing with the difficulty of the routes. But even in this area, the classifications had to be changed. That means the most popular UIAA scale of Central Europe reversed the numerical weighting (evaluation) calling the easiest climbing route I. At level II, for example, the "three-point stance" (three limbs contact the rock) is necessary for the first time. In IV the force increases and the security cable is required. In addition, then physical fitness, experience and training are necessary, etc. You can, if you just want to, learn from similarities. Nevertheless, the question remains, why? For vanity, for teaching purposes, risk reduction!?

And, of course, there is not only one single classification. Thus the already branded primary problem of definitions is revealed. It goes without saying that the French have their own one. Moreover, there is another truth: In reality, none of the routes known for its difficulty has ever been tested by a study on effectiveness. Do you want to bet? And – it will probably never happen.

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Individual Surgery for Upside Down Stomach and Antireflux Surgery

Contents

Introduction

Michael Korenkov, Christoph-Thomas Germer, and Hauke Lang

M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations*,
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There are a lot of technical variants and modification in surgical treatment of gastroesophageal reflux diseases (GERD). The key phases in an operation are:

- Dissection of the phrenicoesophageal ligament and the angle of His
- Opening of pars flaccida and retrocardial mobilization with a loop around the esophagus
- Mobilization of the fundus and transection of the short gastric vessels (not obligate)
- Hiatoplasty
- Fundoplication

Contrary to the reconstruction of the cardioesophageal junction through the fundoplication, there are not so many technical variants for the first four steps. Establishing of laparoscopic techniques led to increasing rates of surgical treatment of GERD. Thereby it increases also the recurrence rates of GERD. The surgical treatment of GERD recurrence is much more difficult and connected often with technical problems and controversial decision situations.

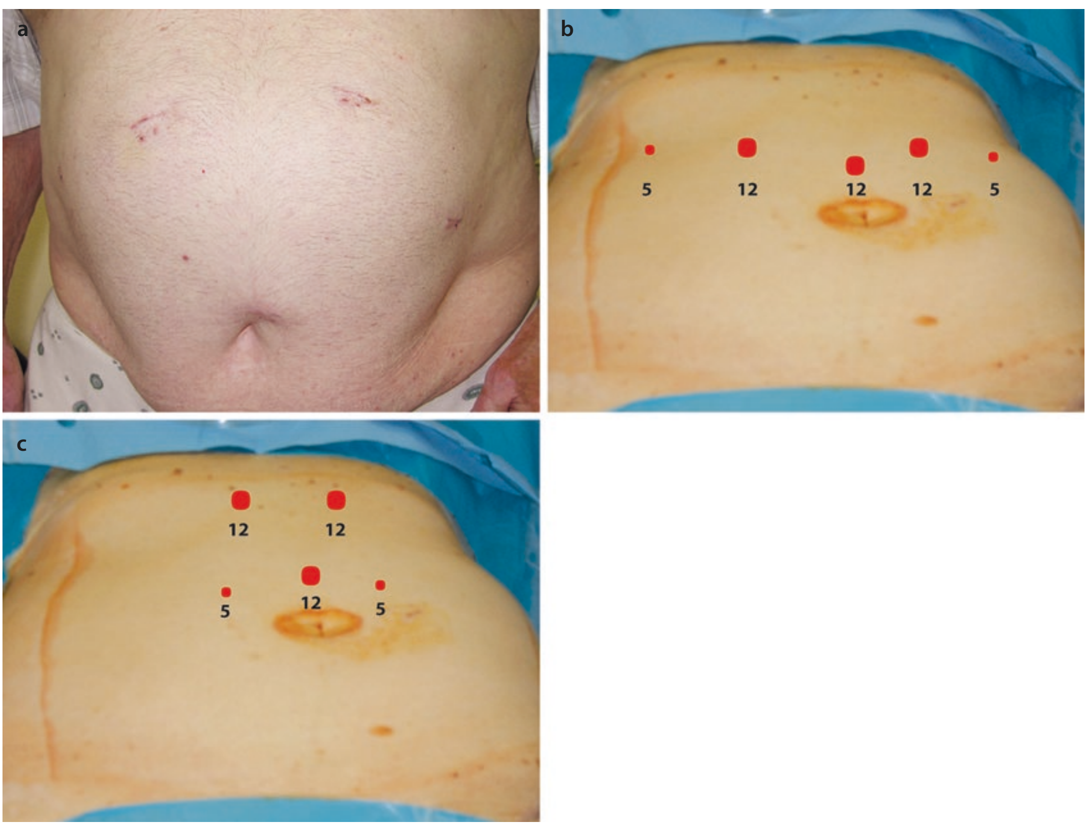
The topic upside-down stomach is closely connected with an antireflux surgery and is also presented in this chapter. Due to didactic reasons, we decided also to include in this chapter a contribution from Giovanni Dapri about single access surgery and a contribution from Dimitros Stefanidis about gastric bypass after failure fundoplication.

5.1 Laparoscopic Antireflux Surgery

5.1.1 Approach

The laparoscopic antireflux surgery is commonly performed with the use of four or five trocars.

Depending on the patient's constitution and surgical preference, trocar will be placed in a high, lower, or compact-pyramidal position (◘ Fig. 5.1). The specific features of SILS technique, which has been currently not considered as a standard therapy, will be presented in the contribution of Dapri.



◘ **Fig. 5.1** **a** "High" trocar placement, **b** "lower" trocar placement, **c** compact-pyramidal trocar position

First Step

Dissection of phrenicoesophageal ligament and the angle of His

Mostly this step is not considered to raise technical difficulties. By means of the caudal tension of the stomach, the phrenicoesophageal ligament will be gut perceivable. For the dissection can be used different instruments like hook with monopolar cautery, ultracision scissors, LigaSure, or Metzenbaum scissor. The technical problems and difficult decision can occur in the following situations:

Severely obese patient. It is sometimes difficult to view a His angle in severely obese patients with significantly enlarged left hepatic lobe. In such situation it is helpful to introduce an additional trocar.

Dissection of pericardiac fat deposits. During the dissection of the pericardiac fat deposits (so-called fat pad), diffuse bleeding especially in obese patients can occur. The excessive using of energy devices can lead to thermal injury of cardioesophageal junction with early postoperative perforation. To avoid such problems, the following steps might be useful:

1. To perform incomplete or no fat pad dissection.
2. The dissection of the fat pad should be beginning on the gastric wall (not on the esophagus or cardioesophageal junction!). The further dissection should be performed along the gastric wall toward the esophagus.

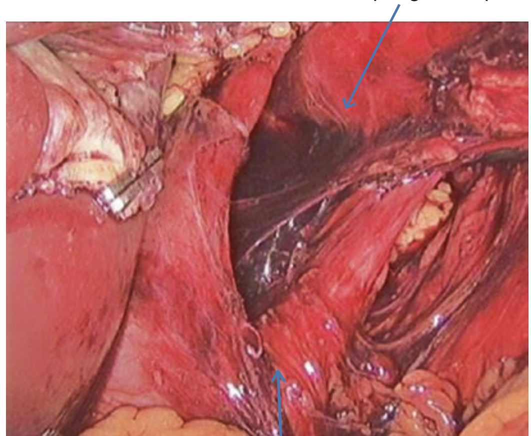
Second Step

Opening the pars flaccida and retrocardiac mobilization with encircle of the esophagus

Technical problems and difficult decision situations can be presented as follows:

Dissection in mediastinum. In case of unclear view, the dissection can be performed behind of the left diaphragmatic crus in mediastinum. In order to avoid it, we recommend dissecting at first the right diaphragmatic crus till to its base and identify the contact point (so-called v-point) with the left crus (◘ Fig. 5.2). Sometimes an additional distal dissection of the lesser curvature is necessary for this step. After the clear identification of the v-point is the further dissection between the posterior esophageal wall and v-point mostly unproblematic.

Severe bleeding. Predisposed for it is excess retrocardiac fat storage (retroesophageal fat pad), which is closely connected with the posterior esophageal wall (◘ Fig. 5.2). This fat tissue has good vascularization; that's why the dissection through the fat pad is almost always connected with the bleeding from the different intensity. In order to avoid this problem, it is helpful at first to identify the v-point clearly. After that a dissection should be performed between the v-point and the fad pad in the relative avascular plain.



◘ **Fig. 5.2** V-point and retroesophageal fat pad

Dissection of the retroesophageal fat pad. An excess retroesophageal fat pad should be removed as recurrence prevention, although there is no valid evidence for the effectivity of this step. Otherwise as a result of such dissection, the diffuse bleeding, esophageal injury, as well as the injury of the posterior vagal trunk can occur. This step is technically sophisticated and required high concentration and precision. The question "should you continue the fat pad removal in a difficult technical situation?" is not being cleared.

The injury of the posterior vagal trunk. During the retrocardiac dissection, the posterior vagal trunk will be often separated from the posterior esophageal wall. In case of the excess retroesophageal fat pad, the vagal nerve can be confused with the fat tissue and injured accidentally. In order to avoid this complication, no cable-like looking structures should be transected before the clear identification between the fat tissue, blood vessels, and posterior vagal trunk.

Third Step

Mobilization of the fundus with division of the short gastric vessels

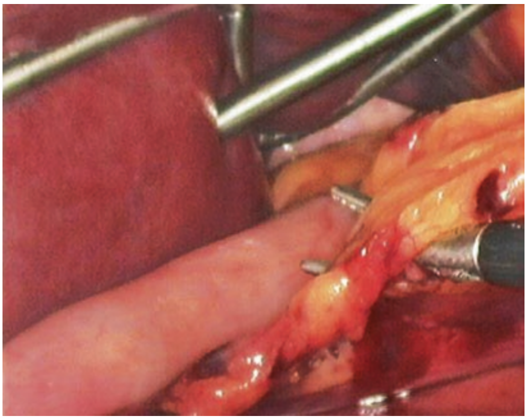


Fig. 5.3 "Bridging" the tissue portion before the transection with energy device (From M. Korenkov. Bariatric surgery. By courtesy of Hans Huber Publisher, Bern 2010)

This step is not obligatory and depends from the surgeon preference and mobility of the fundus. Thereby the technical difficulties occur seldom. Most common is diffuse bleeding or bleeding from the short gastric vessels, which occur mostly at the beginning of the dissection. It is recommendable to begin the dissection in an avascular zone close to gastric wall and perform the "tissue bridging" before the division (Fig. 5.3). An injury of the spleen capsule is not usual for the laparoscopic technique.

Fourth Step

Hiatoplasty

Posterior or anterior hiatoplasty as well a combination of both techniques will be used for the repair of hiatal hernia. Until now there is no valid data which of these techniques yield better results. In spite of the fact that the anterior hiatoplasty is technical more easily, most surgeons prefer a posterior repair. If the both cruses can be good identified is this step technical unproblematic. In case of confusion between the left crus and aorta, the last can be sticking accidentally. In such situation, a suture should be immediately removed without tying a knot. The bleeding can be managed by prolonged compression with a swab or gauze compress.

Fifth Step

Reconstruction of the cardioesophageal junction

The reconstruction of the cardioesophageal junction can be performed by 360°-, 270°-, or 180°-fundoplication. Any one of such procedures has their particular pitfalls, which will be discussed in the following chapters. Independent on the type of fundoplication, the intraoperative difficulties can occur in the following situations:

Small fundus. Some obese patients have a small fundus, so that the tension-free fundoplication independent from it type can be difficult. Also a division of the short gastric vessels cannot solve the problem always. In such situation, a complete retrogastric mobilization of the posterior gastric wall with the dissection of all adhesions in omental bursa can be helpful.

In this book, we didn't discuss deliberately the question if the short esophagus really exists, or this is only a matter of the sufficient mobilization.

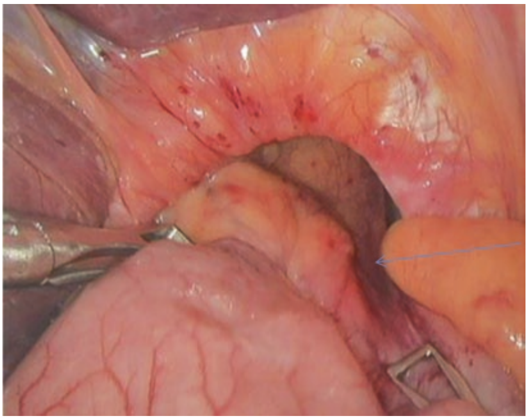
Short esophagus. Basically one can distinguish between a "real" short esophagus (long-segment Barrett esophagus), in which it is not possible despite on extended pericardiac dissection to replace the cardioesophageal junction in abdomen, and a so-called "pseudo"-short esophagus (short-segment Barrett esophagus), in which the desired reposition can be reached through an adequate mobilization. Accordingly the antireflux surgery for patients with a "real" short esophagus can be related with different difficult situations. In the literature the different technical variants from two basic procedures will be presented:

- Collis Plasty: Technical details of this procedure will be presented in chapters from Dallemagne (Chap. 6), Fuchs (Chap. 8), Mittal (Chap. 9), and Soper (Chap. 10).
- Fundoplication with the intrathoracal placement of the fundoplication cuff in combination with a distal gastric resection with Roux-en-Y loop anastomosis [1].

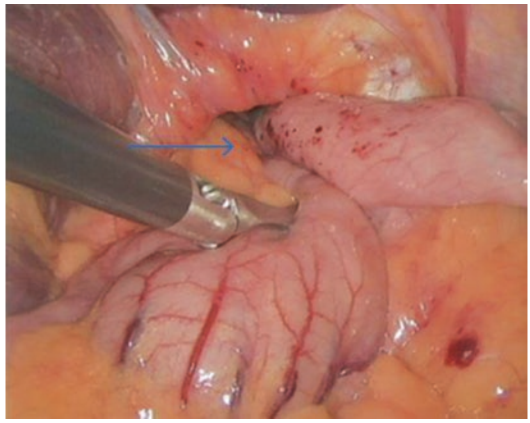
5.2 Laparoscopic Upside-Down Stomach Surgery

The technical steps of this procedure consist of:

- Repositioning of the stomach in the abdomen
- Opening and removing (partial removing) of hernia sac and mobilization of the cardio-esophageal junction with the placement of the traction band around it
- Hiatoplasty with mesh augmentation when indicated
- Fundopexy/fundoplication



■ **Fig. 5.4** Hernia sac tissue between the left diaphragmatic crus and stomach/esophagus (see *arrow*)



■ **Fig. 5.5** Hernia sac tissue with part of the greater omentum between the right crus and stomach/esophagus (see *arrow*)

■■ First Step

Repositioning of the stomach

This step is mostly unproblematic. All three editors have until now no especial difficulties with the repositioning of the stomach, although it is known both from the literature and from the personal communication about some cases of the failed gastric reposition or only partial gastric reposition. In the first situation, the different decisions from “not to do” till thoracotomy can be chosen. In the case of the partial reposition, some surgeons recommend the gastric fixation with the PEG tube.

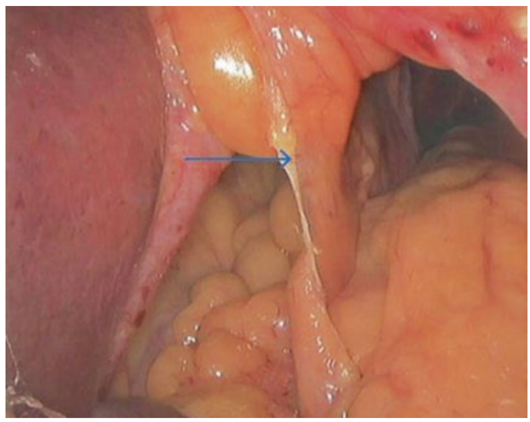
■■ Second Step

Opening and removing (partial removing) of hernia sac and mobilization of the cardioesophageal junction with the placement of the traction band around it

This step provides tremendous scope regarding the technical problems and difficult decision situation. One reason for this is a special anatomy of the hernia sac (very thick walls, sliding hernia). In this situation, it is sometimes difficult to distinguish between the hernia sac and esophageal or gastric wall. Also a good vascularization of the hernia sac can lead to severe bleeding in case of an accidental vessel injury.

When considering the surgical anatomy, following the structures of upside-down stomach should be considered:

- Hernia sac tissue between the left crus and stomach/esophagus (■ Fig. 5.4)
- Hernia sac tissue with part of the greater omentum between the right crus and stomach/esophagus (■ Fig. 5.5)



■ **Fig. 5.6** Sail-like sagittal fold form between the esophagus and mediastinal pleura (see *arrow*)

- Sail-like sagittal fold form between the esophagus and mediastinal pleura (■ Fig. 5.6)
- Retroesophageal fat pad

Different surgeons favor quite different ways in the dissection of the hernia sac (see chapters from Dallemagne (Chap. 6), Feussner (Chap. 7), Fuchs (Chap. 8), Mittal (Chap. 9), and Soper (Chap. 10). The most difficult situations occur in case of the limited view because of the enlarged left lobe of the liver, highly developed perivisceral fat deposits, as well as diffuse bleeding by an unlocated site of it.

■■ Third Step

Hiatoplasty

In case of adequate performed dissection of the hernia sac and mobilization of the cardioesophageal junction is hiatoplasty technical mostly unproblematic. Difficult decision situation occurs by:

- Excessive tension of the hiatoplasty sutures.
- "Thinned out" and denuded cruses (especially the right crus), which are not gut suitable for the hiatoplasty.
- In such situation, the following steps should be discussed:
- Indication for the hiatal mesh augmentation
- Combination from anterior and posterior hiatoplasty

5

Fourth Step

Fundopexy/fundoplication

This step is mostly unproblematic. In case of a "not ideal" hiatoplasty favor some surgeons the fundopexy. One of the editors performs additional to anterior semi-fundoplication, a gastropexy with the suturing of the stomach body to the abdominal wall (Fig. 5.7). The significance of this procedure is unclear.

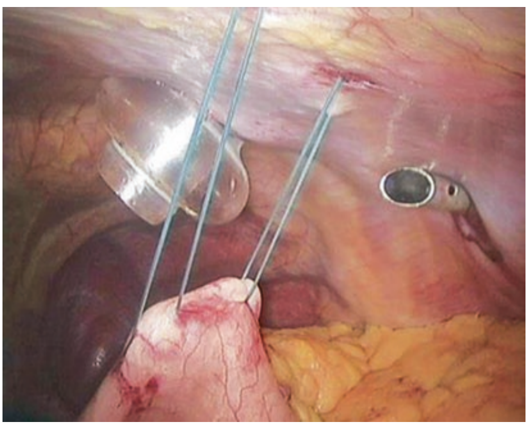


Fig. 5.7 Gastropexy with the suturing of stomach body to the abdominal wall

5.3 Classification of Intraoperative Difficulties

The operative difficulty for the antireflux surgery can be classified as summarized in a Table 5.1.

Table 5.1 Grading of operative difficulties for the antireflux surgery

Grading	Case type
I (ideal cases) It is easy to operate; every operative technique is technically unproblematic	Slender or normal weight patient No previous major abdominal surgery or minor upper abdominal surgery Clear exposition of the cardioesophageal junction Sufficient mobile and long enough fundus
II (not quite ideal) Some minor technical difficulties may occur; some operative techniques can be more difficult as other	Moderate obese patient (BMI around 30 kg/m^2) Otherwise similar to grade I
III (problematic) Difficult to operate, some operative techniques are considerably more difficult than others	Overweight patient (BMI > 35 kg/m^2) Enlarged left lobe of liver Highly developed perivisceral fat deposits Short not sufficient mobile fundus
IV (very problematic) Every operative step is very difficult	Extreme form of grade III factors

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Surgical Technique and Difficult Situations from Bernard Dallemagne

Bernard Dallemagne

Electronic supplementary material The online version of this chapter (doi:10.1007/978-3-662-49878-1_6) contains supplementary material, which is available to authorized users.

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6.1 Introduction

Large hiatal hernias may cause a large variety of symptoms and controversy still exists regarding the indication for surgical repair. Upside-down stomach represents a rare type of hiatal hernia with complete gastric herniation or herniation of most of the stomach into the thoracic cavity with organoaxial twist. This condition could potentially lead to gastric volvulus which carries the risk of life-threatening complications such as bleeding, strangulation, and perforation. Patients usually complain of mechanical symptoms such as dysphagia, chest pain, shortness of breath, and anemia rather than reflux symptoms. We support the idea that surgical management should be offered only to symptomatic patients bearing in mind that upon thorough questioning most patients will report some symptoms. Asymptomatic patients should be followed carefully and should be operated on if symptoms develop.

The main goal of the operation is to reduce the hernia and correct the anatomical defect. Consequently the surgical steps are (a) reduction of the stomach into the abdominal cavity and systematic dissection of the hernia sac and (b) extensive mobilization of the thoracic esophagus to deliver the gastroesophageal junction (GEJ) subdiaphragmatically in a tension-free manner and repair of the diaphragm hiatus. This method implies elimination of the axial tension caused by proximal migration of the gastroesophageal junction and radial tension exerted on the hiatal orifice as the hernia enlarges.

Today there is no doubt that laparoscopic repair offers reduced postoperative pain, with fewer overall complications and shorter hospital stay compared to open approach and will particularly benefit these patients who tend to be elderly and frail and often have significant comorbidities. We believe that laparoscopy repair is safe and effective, and it is our technique of choice in the management of paraesophageal hiatal hernia including upside-down stomach.

6.2 Patient Setup and Surgical Technique

The operation setup does not differ from our fundoplication technique. The patient is positioned in the lithotomy position, and the surgeon stands between the legs with the assistant on the left. Pneumoperitoneum is established and four 5 mm and one 10 mm ports are introduced in the upper abdomen. The 10 mm camera port is placed in the supraumbilical midline at the junction of the upper two-thirds and lower one-third between the umbilicus and the xiphoid process. This position of the optic above the umbilicus will allow a good visualization of the mediastinal structures during the intrathoracic mobilization of the esophagus. A 30° camera is recommended and can be of particular help while in the mediastinum. The other four 5 mm trocars are introduced under direct vision as shown. This port configuration allows for an ergonomic division of the working space with the surgeons' hands triangulating at the hiatus without crossing the operating field and no conflicts with the assisting lateral ports. The hiatus is exposed by retracting the left lever lobe via the right lateral trocar.

6.2.1 Reduction of the Stomach into the Abdominal Cavity

A straightforward reduction of the hernia structures is usually impossible in the beginning and of little use. Any direct manipulation of the stomach should be avoided especially in the case of acute gastric volvulus. The gastric wall can be edematous or ischemic and therefore more prone to perforate if placed under tension. It is important to work outside the hernia sac; this will allow correct and progressive identification of important landmarks such as the diaphragmatic right and left pillars, which will guide the initial dissection while providing a safe entrance in the inferior mediastinum. The first anatomical landmark is the right diaphragmatic pillar. The gastroesophageal junction (GEJ) is retracted using a grasper from the left lateral port. The lesser omentum is opened exposing the right crus while trying to preserve the hepatic branch of the vagus nerve and the left hepatic artery. The phrenoesophageal membrane is divided at the level of the attachment on the right crus. Then, working in the inner side of the right crus, a cleavage plane is identified between the sac of the hernia and the mediastinal structures. We recommend to work outside the hernia sac while proceeding with the intrathoracic dissection. If the cleavage plane is not easily found on the right side, the dissection can be alternatively carried out at the level of the left pillar or the superior aspect of the hiatal opening. Once the correct dissection plane is identified, the sac is securely grasped by an atraumatic grasper, pulled downward, and progressively reduced. At this stage the cleavage plane is virtually avascular and blunt dissection is very effective. The sac is progressively reduced from the right diaphragmatic pillar to the left crus or vice versa. A thickening of the phrenoesophageal ligament is typically found at the insertion of the left pillar and should be divided to allow a complete sac reduction and consequent exposure of the mediastinal structures such as the esophagus, the anterior and posterior vagus trunk, and the mediastinal pleura. Opening of the pleura is a frequent incident at this stage of the procedure. Pneumothorax does not require any particular treatment besides the increase of the positive end-expiratory pressure (PEEP) since the carbon dioxide will be promptly resorbed. The anesthesiologist should be informed and aware that no chest tube placement is needed when pneumothorax is secondary to passage of peritoneal CO2 into the interpleural space. Once the hernia is reduced and the sac dissected from the mediastinum, the esophagus can be clearly identified and mobilized. A retroesophageal window is created, and an umbilical tape is passed around the gastroesophageal junction to provide adequate traction. Intrathoracic dissection of the esophagus is a fundamental step of the operation that lengthens the abdominal portion of the esophagus. The vagi must systematically be identified and protected. This dissection is achieved by a combination of sharp and blunt dissection and can be extended to the pulmonary veins or higher if needed (Video 6.1.).

6.2.2 Esophageal Dissection: Short Esophagus Assessment

The gastroesophageal junction must lie, in a tension-free manner, below the diaphragm. Long-standing hernia and fibrotic changes within the esophageal wall may lead to shortening of the esophagus and make tension-free reduction of the gastroesophageal junction difficult or impossible. Intrathoracic migration of the anti-reflux valve and paraesophageal herniation are well-recognized complications after paraesophageal hernia repair and, among the possible cause, inadequate esophageal mobilization and shortening of the esophagus. Although there is a general agreement on the fact that an adequate mobilization should obtain an intra-abdominal position of at least 2–3 cm without tension, the surgeon is often left with the difficulty to properly assess the length and extent of esophageal mobilization. An additional confounding factor is the elevation of the diaphragm under the pneumoperitoneum responsible of a misleading impression of a longer intra-abdominal segment. The hernia sac should be completely excised to improve visualization of the GEJ. If a large fat pad is present anterior to the gastroesophageal junction, it should also be removed. Then, the assistant retracting the esophagus downward should release completely the traction in order to observe the position of the umbilical tape around the GE junction, with respect to the hiatus. If the tape is sucked back into the mediastinum, further dissection is needed. If available, intraoperative endoscopy is a valuable tool to objectively assess the location of the GEJ. If after aggressive mobilization of the intrathoracic esophagus, the GEJ still rests above the diaphragm, a Collis gastroplasty procedure is advisable, and a laparoscopic esophageal elongation is our technique of choice (Video 6.2). In this setting, the main 5 mm left subcostal working trocar is changed to a 12 mm port for the stapling device. A large bougie (50 Fr) is passed into the esophagus under laparoscopic control. The upper part of the fundus is stapled obliquely, with the tip of the stapler directed toward the bougie. The stapler is then reorientated parallel to the bougie, directed cephalad. This maneuver is useful to lengthen the esophagus by 2–3 cm. Sometimes repeated firings are necessary to create a suitable neo-esophageal conduit. A potential complication related to this technique is staple line leak. Today endoscopic esophageal stenting is our first-line treatment in the event of postoperative esophageal leak. It rapidly eliminates contamination of the mediastinum and peritoneum and it allows oral feeding and nutrition; adequate drainage of infected areas should also be simultaneously achieved if needed.

6.2.3 Crural Repair

Cruroplasty should be performed whenever possible without reinforcement keeping in mind that mesh reinforcement may reduce but does not suppress the risk of recurrence and that mesh-related complications are not rare. Crural closure should respect the anatomy of the esophageal inlet into the abdomen avoiding angulation and gently embrace the esophagus without compression on the esophageal wall. Typically interrupted nonabsorbable sutures are placed posterior to the esophagus. According to the anatomy and shape of the hiatus, anterior and lateral sutures can be added to avoid kinking of the esophagogastric junction or in case of a large defect. Primary indication for prosthetic hiatoplasty should be the size of the hiatal defect and the "texture of the crura." Pledgeted sutures are our first choice when the hiatal opening is large or if the crural bundles are thinned. A synthetic or biological mesh can be added to the cruroplasty only if the crura appear very poor or the hiatal opening too wide. Any contact between the mesh and the esophageal wall should be avoided to minimize the risk of stenosis, erosion, and scarring. A U-shaped prosthesis maintained in position by means of interrupted, nonabsorbable sutures is our recommended choice. A Vicryl mesh can be placed around the hiatus onto the diaphragm to temporarily reinforce the closure and help prevent early postoperative migration due to abrupt increase in intra-abdominal pressure, such as coughing at extubation and vomiting efforts (Video 6.3).

6.3 Should an Anti-reflux Procedure Be Performed Routinely?

A fundoplication (partial or total) is added routinely whenever possible. The additional role of gastric fundoplication in such a setting is not only that of reestablishing an appropriate anti-reflux barrier but also to anchor the stomach subdiaphragmatically since no gastropexy is performed. This involves mobilization of the gastric fundus with division of the gastrosplenic ligament and short gastric vessels and creation of a floppy antireflux valve, total or partial. The decision to add a total or partial wrap should depend on patient symptoms and on the anatomy of the stomach once the hernia has been reduced. If the patient has been complaining of typical GERD symptoms such as heartburn and regurgitation and the anatomy of the stomach is preserved, we favor a short floppy 360° Nissen fundoplication. It is obvious that a mobile fundus is necessary to build a floppy fundoplication. Size and shape of the fundus once the stomach is reduced should be taken into consideration. In long-standing hernia, the fundus can be "less pliable" and therefore unsuitable for a 360° wrap, even after short gastric mobilization. If this is the case, the preferred option after is a 270-degree posterior fundoplication, which will better put up with the anatomy of the stomach, avoiding twist and tension. If the patients' main complaints were dysphagia or non-GERD symptoms, a partial fundoplication is performed.

6.4 Postoperative Care and Investigations

Fluids are allowed the same day. Food intake begins on the first postoperative day after a gastrografin swallow has been performed. Patients are given a soft diet for 2 weeks and regular diet is typically resumed within a month. The patient is usually discharged on the second postoperative day. Postoperative follow-up is scheduled at 4 and 12 weeks.

Surgical Technique and Difficult Situations from Hubertus Feussner

Hubertus Feussner and Dirk Wilhelm

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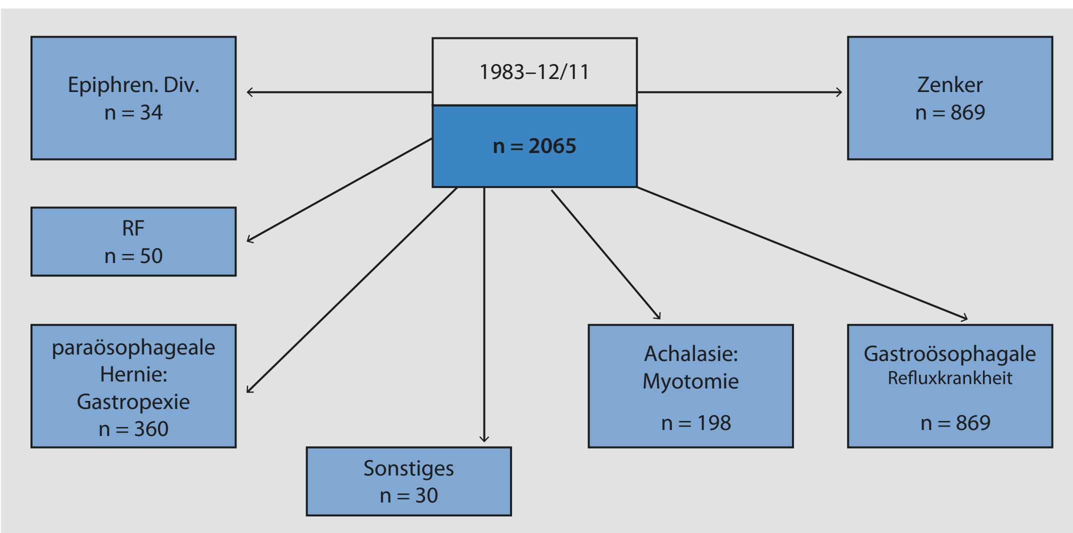
7.1 Introduction

Hiatal hernia is a common finding in almost all age groups with different anatomical variations and clinical appearance. From our point of view, a clear distinction between hernias requiring antireflux surgery and hernias with the need for anatomic repair (paraesophageal hernia, upside-down stomach) is mandatory, as they might differ in surgical indication as well as in terms of the applied surgical technique. It is paramount for antireflux surgery to augment the lower esophageal sphincter in order to eliminate reflux but also to repair an axial hernia if present. For paraesophageal hernia or for an upside-down stomach, the restoration of the normal anatomical conditions is the therapeutic goal to eliminate the symptoms associated with the malposition of the stomach (pain, postprandial retrosternal pressure, respiratory symptoms, anemia, in these cases). An antireflux procedure (fundoplication) can be omitted in most cases.

In clinical practice antireflux surgeries are by far more frequent than anatomical repairs (◘ Fig. 7.1).

7.1.1 Preoperative Diagnostic Workup

A sound indication is essential for the long-term success of antireflux surgery. Decision-making could be easy if one relies solely on the proton pump inhibitor test (relief of heart burn symptoms after administration of PPIs, recurrence of symptoms after suspension of medication). Patients with a positive PPI test in general are good candidates for surgery since acid reduction by proton pump inhibitors can simulate the effect surgery and therefore turned out to be one of the most reliable prognostic factors if antireflux surgery is considered. Even patients with a so-called volume reflux experience a reduction of the acidity of the refluate and will have at least a partial relief of their symptoms. Whether to recommend an operation or not, however, is most often difficult in patients with non-erosive gastroesophageal reflux disease or so-called atypical reflux disease, who will not respond to standard dosed proton inhibitors. Despite of normal long-term pH and impedance measurement, clinical symptoms are very suggestive for reflux disease, so that gastroenterologists



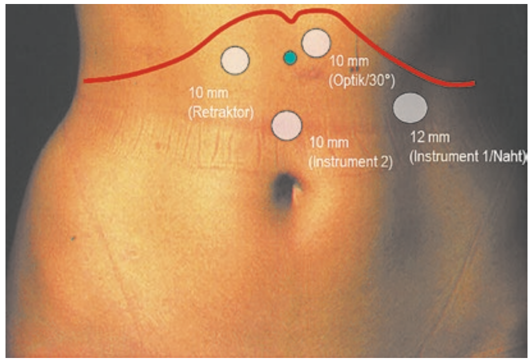
◘ **Fig. 7.1** Patient cohort operated on for benign gastroesophageal disorders between 1983 and 2011/Klinikum rechts der Isar, Technical University of Munich commonly double the dose of PPIs. If this again fails, the patients are motivated to see a surgeon and to receive antireflux surgery. Another patient cohort and increasingly often presented from ENT specialists are patients supposed for gastroesophageal reflux disease because of unspecific symptoms in the hypopharyngeal area which cannot be explained otherwise or in whom a laryngitis posterior has been found which is misinterpreted as a result of GERD.

Prior to any decision about the indication for surgery, a comprehensive diagnostic workup is mandatory including upper GI endoscopy, dynamic esophagography, manometry, and 24 h pH/impedance monitoring. In some rare cases, additional examinations, such as CT scans and assessment of the emptying of the stomach, have to be added. A review of all results of the examination by the surgeon himself is mandatory.

7.2 Surgical Technique: Laparoscopic Fundoplication

7.2.1 Access

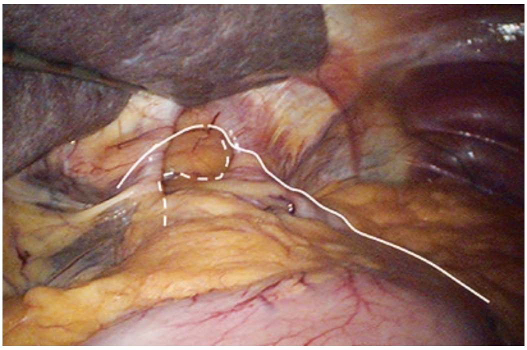
- We recommend splinting the esophagus from the inside by means of a large-bore bougie (more than 32 French) which has to be positioned into the esophagus, reaching to the stomach. In some cases a correct placement is possible only under laparoscopic supervision and by alignment of the esophagogastric junction.
- The operation starts with a small supraumbilical incision to generate the pneumoperitoneum. For an optimal access into the hiatus, this portside should be positioned at least 5 cm craniad to the umbilicus.
- The use of a Veress needle for establishment of the capnoperitoneum is the preferred option as only by this the incision can be set to the least size. The abdomen is then entered using a 10 mm 30° telescope (alternatively 5 mm 30° telescope) followed by a comprehensive visual exploration of the abdomen. Assessment of the hiatus at this stage is possible only in the minority of patients since it is usually covered by the left liver lobe. Visual exploration helps to detect concomitant diseases, adhesions, etc. and is recommend to rule out access-related injuries.
- In the next step, three additional trocars are inserted (◘ Fig. 7.2):
- The second trocar is positioned below the left costal arch and as proximately as possible to the xiphoid. This trocar is used later for insertion of the laparoscope, and its exact localization depends upon the size of the left liver lobe. The larger it extends to the left side, the more laterally the second trocar has to be placed to avoid collision between the telescope and the left liver lobe.
- The third trocar is required for the instrument to lift the left liver lobe and is usually inserted just below the right costal arch lateral to the falciform ligament.
- The final trocar (single-use trocar suitable for placing sutures, e.g., Ethicon® Tristar®) is inserted on the left side underneath the costal arch and in adequate distance lateral to the second trocar.



◘ **Fig. 7.2** Typical trocar position for laparoscopic fundoplication and reposition of paraesophageal hernia

7.2.2 Dissection

- Mobilization of the left liver lobe is the first operative step and sometimes requires incision of the left triangular ligament. The left liver lobe is then lifted up by means of a retractor device (e.g., Endo Retract® 10 mm, Covidien®) allowing for exploration of the hiatus. ◘ Figure 7.3 delineates the subsequent steps of the dissection.



■ **Fig. 7.3** Dissection line used for laparoscopic fundoplication starting from the great curvatur following the left and right diaphragmatic crurae. Finally, the gastroesophageal junction is dissected from behind (*dotted line*)

- Now the hiatus is dissected starting with the exposition of the left crus of the diaphragm. The gastrosplenic ligament is transected beginning at the base of the gastric dome (border between the upper and the middle part of the stomach). Following this dissection route, one ends up at the diaphragm where the posterior parts of the left crus become clearly identifiable. Separation of the esophagus and the left crus of the diaphragm is easily accomplished by blunt preparation as soon as the peritoneum is split.
- Following the opening of the hiatus in a counterclockwise direction in the next step, the preesophageal peritoneum is cut. Particular care is required in order to preserve the anterior trunk of the vagal nerve. The diaphragmatic musculature and its peritoneal cover layer deserve particular attention and have to be prevented from any damage. Otherwise, the sutures which, later on, are used to close the diaphragmatic hernia will not have the necessary grip and will get loose over time.
- Switching the preparation to the right side of the hiatus, the lesser curvature is pulled down to correct the sliding axial hernia completely. Otherwise, the upper branch of the left gastric artery may be injured accidently.
- The incision of the lesser sac is started just above of the hepatic branches of the vagal nerve which can be identified in their horizontal course. This operative step gives sight to the right crus of the diaphragm and again the esophagus is separated from the right crus by blunt dissection. The esophagus is deflected to the left side of the wide hiatus to achieve easy access to the retroesophageal space. The retroesophageal space is dissected, and the diaphragmatic commissure and the posterior part of the left crus are exposed.

■ **Fig. 7.4** Exposure of the gastroesophageal junction by means of an encompassing hook

- Frequently, a more or less large fat pad can be identified behind the esophagogastric junction. It can easily be pulled out to the right or to the left side followed by subsequent resection. This eases the retroesophageal preparation by far as it extends the available space.
- As soon as the distal crus on both sides of the hiatus are sufficiently exposed, a custom-made encompassing hook is introduced into the abdomen via an auxiliary tiny incision. This instrument was developed by us in the beginning of the 1990s and resembles a Deschamps hook – an instrument which was formally used in surgery more frequently. Following the bend on the tip of the hook, the instrument is placed around the posterior circumference of the esophagogastric junction facilitating its easy control and direction. While encompassing the cardiac region with the hook, particular care has to be spent to preserve the posterior branch of the vagal nerve (■ Fig. 7.4).
- By elevating the esophagogastric junction with the hook, the retroesophageal space is widened, and the posterior commissure of both crura becomes clearly visible.

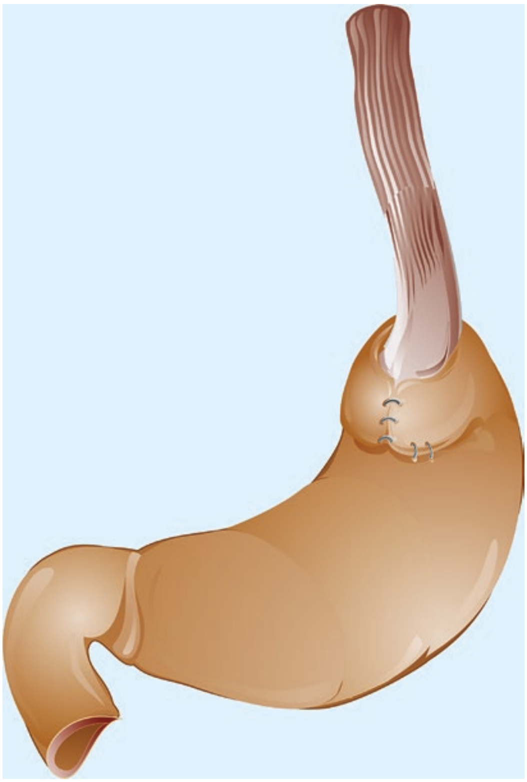
7.2.3 Closure of the Diaphragmatic Hernia

- In the next step, a posterior hiatoplasty is performed. Using Ethibond® sutures in size 2-0 (Ethicon, Johnson and Johnson), the posterior parts of the crura are proximated beginning at the level of the aorta proceeding toward the esophagus. Over-narrowing of the hiatus causing compression of the esophagus should be avoided by aid of the inserted gastric tube that is splinting the esophagus internally. The sutures have to be placed carefully to avoid accidental violation of the aorta.
- To close the hiatal gap, 2–3 interrupted sutures are adequate in most patients. We prefer tying the sutures extracorporeally. A distance of about 1 cm between the uppermost stitch and the esophagus is recommended to avoid compression of the esophagus which will cause dysphagia.

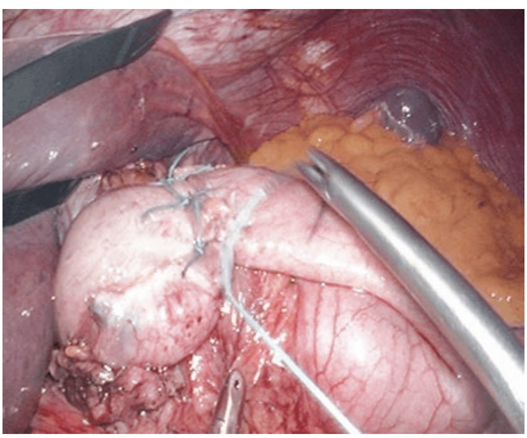
Dysphagia due to a diaphragmatic narrowing cannot be alleviated by bougienage – whereas a too narrow wrap which can be successfully widened by intraluminal dilatation.

7.2.4 Fundoplication

- In the last step, the gastric fundus is wrapped around the esophagogastric junction forming the fundoplication. We prefer the 360° cuff according to the technique of Nissen-Rossetti which should be as floppy and short as possible.
- Prior to the final closure of the cuff, the gastric fundus is checked for sufficient mobilization to allow creation of a tension-free cuff. In most cases division of the short gastric vessels is a precondition which has to be done straight along the greater curvature. With the advent of modern dissection devices (impedance-guided electrocoagulation, ultrasound dissection), this maneuver is no technical challenge any longer even if the spleen is situated close to the stomach. No additional treatment is required if division of the short gastric vessels is followed by local infarction of the apex of the spleen.
- The cuff is formed by passing the anterior aspect of the fundus through the retroesophageal window around the esophagogastric junction. Therefore, the so-called point of Rossetti is attached to the tip of the hook by suture (for this the custom-made hook possesses a small hole). By turning back the hook to the right side, the fundus is wrapped around the cardia. The right partnerfold of the cuff should stay in its position at the right side even if tension to the hook is suspended.
- Closure of the cuff is achieved by three interrupted sutures. We usually start with the upper end of the cuff. The uppermost part of the fundus which remained on the left side is grasped with the suture and attached to the right partnerfold by extracorporeal suturing. A second suture is added using the same technique and in distance of 1 cm caudal to the first stitch. Both sutures only grasp the opposing folds of the fundus without incorporating the anterior aspect of the cardia to allow later alignment of the wrap in a perfect position.
- After positioning of the cuff in an adequate height, the lowermost and third stitch is done which now includes the esophagogastric junction to prevent from slippage. Without this so-called three countries stitch, telescoping of the cuff along the esophagus is pending. However, the last stitch should not be placed before the cuff is checked for correct positioning. Otherwise, one can slide the wrap until it reaches its definitive position. In addition, special care has to be spent to the width of the cuff, which should be floppy without narrowing of the esophagus.
- Finally, the left edge of the cuff is additionally tied to the anterior gastric wall by two sutures. The idea is to gain a three-point stabilization of the position of the cuff: on the right side the hepatogastric ligament provides a pillar against slippage, in the middle the cuff is fixed by the lowermost suture of the cuff, and on the left side by these two last sutures (◘ Figs. 7.5 and 7.6).
- After creation of the wrap, the large bowel bougie is substituted by a normal gastric tube. The operative field is checked for hemostasis. Finally, a Robinson drainage with a diameter of 20 French is positioned in the left upper quadrant.
- Both gastric tube and drainage are removed on the morning of the first postoperative day.



■ **Fig. 7.5** The fundoplication is mainly hold by three sutures, while two additional sutures to the stomach support the plication



■ **Fig. 7.6** Intraoperative situation after formation of the fundoplication

Paraesophageal Hernia/Upside-Down Stomach

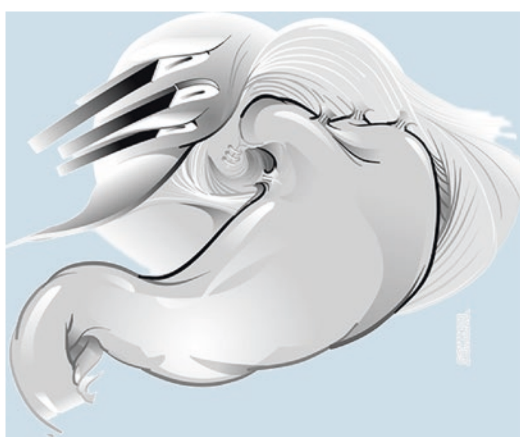
In case of a significant paraesophageal hernia or if even an upside-down stomach is diagnosed, surgery is indicated in almost all cases to relieve from associated characteristic symptoms and to prevent from typical complications.

General preparation for surgery is more or less identical to fundoplication. However, the transoral insertion of a large bowel bougie into the stomach is often difficult and most frequently requires detorquation and realignment of the stomach. The true extend of herniation becomes visible as soon as the left liver lobe is elevated:

- At first, the stomach has to be reduced. In general, this operative step is simple and easy to perform: Even with slight traction only, the stomach can be pulled back into the abdomen to expose the hernia and the diaphragmatic crura.
  - Occasionally, however, the stomach is firmly fixed within the mediastinum, and considerable force has to be exerted to reduce the herniated stomach into its proper position. In these special cases, careful retraction is necessary not to tear the stomach.
- In case of a type IV hernia, adjacent anatomical structures (greater omentum, transverse colon, occasionally the spleen) may be part of the hernia content. We would then recommend to start the reduction of the hernia by releasing the omentum from the mediastinum first. If the hiatus is too narrow, it can be widened by ventral incision using a GIA stapler to facilitate the repositioning of the hernia. In very rare cases, an assumed paraesophageal hernia emerges as a Bochdalek's hernia. Here, identification of the hernia ring is essential for correct diagnosis.
- Reduction of the stomach is facilitated by means of the large-bore bougie, which can be used to gently push back the stomach into the abdominal cavity. By this internal reposition, slipping back of the stomach into the intrathoracic position is prevented.
- After complete reposition of the herniated stomach, the reflection fold of the hernia sac is transected starting at the left diaphragmatic crus.
  - We recommend dissection of the hernia sac not straight on the left crus but somewhat medially, since this can cause fraying of the diaphragmatic muscle fibers. Ideally, the fibrotic parts of the hernia sac covering

the crura should be preserved as they will give a stable grip for the sutures when the hiatus is closed.

- More challenging for technical aspects and potentially dangerous is the dissection of the right crus of the diaphragm due of to the proximity of the left gastric artery. Before commencing the transection of the hernia sac, the complete reduction of the hernia is mandatory including exposure of the lesser curvature. Otherwise, a lesion to the left gastric artery is immanent. Again, a remnant of the hernia sac should be preserved to cover the weaker muscle of the right crus.
- Further dissection on the right aspect of the hiatus exposes the retroesophageal fat pad, which is easily pulled out and partially resected. Any lesion to the posterior trunk of the vagal nerve has to be avoided. Once the fat is removed, a clear overview upon the posterior commissure is achieved.
- As soon as the esophagogastric junction is repositioned and sight is given to the commissure of the crura by elevation of the cardia, just as described above, the hiatal gap is closed by suture. At this point, the stomach should remain within its original position in the abdomen without any tendency to reherniate into the mediastinum. Otherwise, reposition is incomplete and a more thorough mobilization of the esophagogastric junction and the esophagus is required. Again, a sound preservation of the pleura and the branches of the vagal nerve is mandatory.
- We prefer closure of the hiatus by suture only as we are firmly convinced that reinforcement of the hiatus by mesh application is dispensable in the majority of cases. According to literature mesh implantation in this hyperdynamic region is associated with mesh migration, perforation, and life-threatening complications. If the fibrotic tissue of the hernia sac that covers the crura is preserved during dissection, the sutures can be reliably anchored.
- Beginning at the posterior commissure, the hiatus is closed with single-button suture forming the posterior hiatoplasty. Again, narrowing of the hiatus by a too tight closure of the gap should be avoided.
- In addition, the anterior commissure is closed with a single suture which also integrates the anterior aspect of the esophagogastric junction (cave: anterior branch of the vagal nerve).
- Subsequently, the posterior aspect of the esophagogastric junction is anchored. This is achieved by suturing the posterior wall of the upper stomach to the posterior hiatoplasty.
- We renounce the formation of a fundoplication if the patient is not suffering from concomitant reflux disease (which may be the case in mixed hernia). It is our opinion that the fundoplication does not reduce the incidences of hernia recurrence but may lead to severe dysphagia. It is superior to fixate the fornix and the dome of the fundus to the left diaphragm with 3–4 nonabsorbable single-button sutures (gastrophrenic fixation). To prevent from injury to the lung or cardiac vessels, careful exposure of the anatomy and retraction of diaphragm is mandatory (◘ Fig. 7.7).
- The large-bore bougie is now replaced by a regular nasogastric tube which remains in place until the first postoperative day.
- The surgery is completed by careful hemostasis and rinsing of the abdomen. A Robinson drainage is placed with its tip to the hiatus. It will be removed on the third postoperative day. Optionally, the stomach can be filled with a diluted dye solution to rule out an accidental lesion in case of complicated repositioning of the hernia.



◘ **Fig. 7.7** Illustration showing the result after paraesophageal hernia repair

Surgical Technique and Difficult Situations from Karl-Hermann Fuchs

Karl-Hermann Fuchs, W. Breithaupt, G. Varga, T. Schulz, and B. Babic

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8.1 Introduction

The terms paraesophageal hernia, large hiatal hernia, upside-down stomach, and mixed hiatal hernia are used sometimes with a remarkable amount of confusion without a clear differentiation. However, these different entities are not only different anatomical situations, but they also do have a different pathophysiologic background with it is specific functional changes, which are important to differentiate in the surgical management.

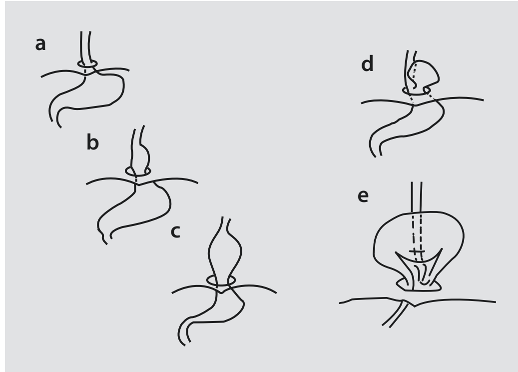
The *term large hiatal hernia* is used worldwide usually for a sliding or fixed hiatal hernia, which has developed to such an extent that the cardia and the hiatal opening is longer than 5 cm apart. This anatomical situation is very often associated with the gastroesophageal reflux disease (GERD).

8

The *term mixed hiatal hernia* describes a large axial hiatal hernia, in which the complete fundus including the angle of His is migrated into the lower mediastinum and one can find quite often the hiatal crura at the level of the gastric corpus. This anatomical situation is also very frequently associated with GERD. The size of the hiatal hernia, i.e., the portion of the stomach, migrated in the mediastinum, can be 50 % of the gastric volume and more. Quite frequently, these patients may have even decreasing reflux symptoms such as heartburn over the past years; however, the size of the hiatal hernia will increase their problems with massive regurgitation of fluid and food, respiratory symptoms, cardiac sensations in the postprandial phase, and other mechanical pressure symptoms due to the volume of the hernia.

The true *paraesophageal hernia* is a migration of part of the gastric fundus locally into the mediastinum. In this case, the defect in the phreno-esophageal ligament is limited to a small portion on the circumference of this ligament. Therefore, only a small portion of the gastric fundus migrates through this limited defect parallel to the esophagus into the mediastinum (◘ Fig. 8.1). These patients usually have no presence of a gastro-esophageal reflux problem.

An *upside-down stomach* can develop when through a limited defect in the circumference of the phreno-esophageal ligament over time the complete stomach migrates up into the lower mediastinum. In this situation, the cardia remains still fixed with its attachments of phreno-esophageal ligament at the hiatal level. The greater curvature of the stomach moves up into the chest, turning the stomach upside down. A very constant finding is a fibrous scar strand between the left crus and the gastric fundus near the angle of His.



◘ **Fig. 8.1** Axial hiatal hernias **a, b, c** and paraesophageal hernia **d**, **e**

The term *short esophagus* describes an anatomical situation, in which the esophagus is shortened and does not reach down to the intra-abdominal level with sufficient length of the lower esophageal sphincter. In these cases, the esophagus has shortened usually over time with a long-standing and persisting gastroesophageal reflux disease and esophagitis, causing inflammation and subsequent shrinkage and shortening. In addition, in these cases, it is not possible to mobilize the esophagus to re-create an intra-abdominal segment of the lower esophageal sphincter (Mattioli).

The most important indication for operative therapy of large hiatal hernias and its variations is the patients' reduced quality of life, due to massive fluid and food regurgitation, respiratory symptoms, heart sensations, and volume reflux. Especially in older patients, respiratory limitations can be devastating for the quality of life. Since most of these symptoms cannot be compensated by proton pump inhibitors, only surgical therapy can cure the problem.

One would think that the simple anatomical reconstruction of the hiatal region should be sufficient. However, clinical evidence and literature shows that often this is not enough. The necessity of a combination of anatomical reconstruction and an antireflux procedure are discussed controversially among surgeons. Therefore, it is important to differentiate in a preoperative diagnostic workup accurately what type of hiatal hernia is present in a given patient. Also a precise assessment of the anatomical situation must be performed, i.e., measurements of the length of the esophagus, the level of the cardia, and the level of the hiatal hernia, allowing for the determination of the size and the shape of the hernia. This can be done very preciously by endoscopy and radiography.

The question remains, whether an antireflux procedure is necessary after anatomical correction of a hernia and reconstruction of the hiatus. When a patient with an upside-down stomach is operated and its hiatal anatomy is dissected in order to reconstruct the altered anatomy, all anchoring structures of the cardia within the hiatal opening are disconnected. The probability of developing a postoperative reflux problem after taking down all these structures is substantial, and therefore, it is also recommended in literature that an anatomical reconstruction in a large hiatal hernia should be followed by some kind of fundoplication as antireflux procedure.

8.2 Preparation

The patient is prepared in a supine position with spread legs on the operation table and fixed. Then the whole body is brought into a 45° position after supporting the legs and the feet in order to use the gravity to pull the intra-abdominal organs down, resulting usually in a great view on the hiatal region. In total 5 ports in the upper two quadrants of the abdomen are needed to perform the operation.

8.3 Operative Technique

A complete dissection of the gastroesophageal junction with the careful identification and preservation of the vagal trunks and the integrity of the esophagus as well as the proximal stomach is absolutely important. This can be achieved without problems by focussing the dissection on the hiatal crura. It is important to find these anatomical landmarks of the right and left crus as well as the ventral hiatal arch and dissect them extensively. As a result of this dissection, the esophagus and the vagal trunks emerge in the middle of the dissection area. In large hiatal hernias, there is usually a large hiatal hernia sac, which also should be completely dissected first along the hiatal crura and arch. This technique will prevent the surgeon from creating accidental holes in the stomach or in the esophagus. The stomach and the esophagus should be kept under moderate tension with the strong grasper or by a loop to be able to dissect the circumference of the esophagus.

The technical principles of dissection are similar in all the abovementioned different anatomical variations and entities of large hiatal hernias. We start the dissection at the left crus by dividing the short gastric vessels between the upper pole of the spleen and the angle of His and the left crus. Then we drive the mobilization of the fundus and dissection of the gastroesophageal junction toward the left crus and stay with the dissection line at the borderline of the hiatus.

In the next step, all redundant tissue at the cardia including the anterior esophageal fat pad and the hiatal hernia sac must be removed. This includes also frequently positioned lipomas and/or fatty tissue in the mediastinum between aorta and esophagus. Before resecting the hernia sac and lipomas, it is absolutely important to make a precise identification of the vagal trunks in order to avoid damage.

The next step is the full mobilization of the esophagus. The aim of this mobilization is the positioning of a tension-free segment of the lower esophageal sphincter of 2–3 cm within the intra-abdominal pressure system of the cavity. This can be archieved by pulling on the gastroesophageal junction with a loop around the esophagus. The latter allows for stretching of the esophagus from the mediastinum to the abdomen. As a result, the esophagus can usually be mobilized with a long swap from the mid-mediastinum at the level of the pulmonary vessels.

If the preoperative diagnostic workup shows a large hiatal hernia exceeding the length from the cardia to hiatal level of more than 5 cm, the probability of a true short esophagus is higher, and the surgeon should be prepared to handle the special problems of a short esophagus during this operation.

Dissection of the hernia sac and esophagus in the mediastinum can increase the risk for pneumothorax during the operation. This is no problem for the experienced surgeon to deflate the pleural cavity via an external incision and a temporary drainage during the operation.

If all technical measures have been taken to mobilize the esophagus and it is impossible to create a tension-free segment of lower esophageal sphincter of 2–3 cm within in the abdominal cavity, a short esophagus is confirmed and the option of a Collis gastroplasty must be considered during the operation.

Once the situation is confirmed, a boogie is inserted into the esophagus and a marking stitch is set at the angle of His, which determines the segment that the esophagus should be lengthened. Then a rotatable linear stapling system is inserted through one trocar and a Collis gastroplasty is performed (◘ Fig. 8.6).

Using a 2-cm-long wedge-shaped resection of the subcardial stomach at the angle of His, the esophageal tube is lengthened for 2 cm. Thus, the enlarged fundic flaps have enough mobility to be used as fundoplication.

8.4 Division of the Short Gastric Vessels

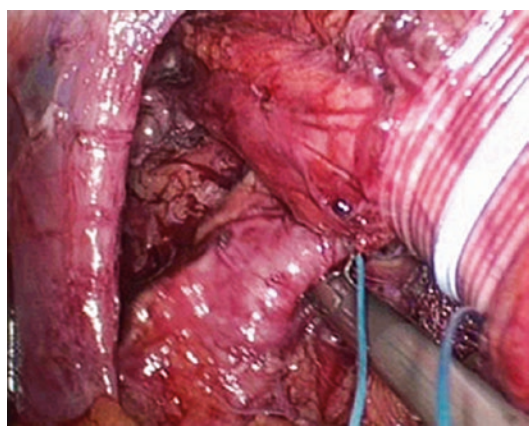
There is a controversial discussion about the benefit of this maneuver among surgeons. Several randomized trials have been performed to clarify this technical question. It is important to understand that a mobile fundus is important not only during the operation for a floppy fundoplication but postoperatively during eating. The filling of the gastric lumen with food and fluid must be possible to allow for a free accommodation of the fundus, since it is important for an appropriate postprandial physiologic filling and emptying function of the gastric fundus.

As a consequence, a symmetric fundoplication around the lower esophageal sphincter should be the aim, when the plication of the fundus is shaped. To reach this goal, the posterior detachments of the fundus must be divided, more than the short gastric vessels of the fundus. After fundoplication, it is important for gastric function that the fundus is mobile, when gastric filling occurs. Therefore, it is very important for postoperative eating function that the fundus is proximally mobilized and has the possibility of free movement around the gastroesophageal junction. If these posterior fundic attachments between the retroperitoneum and the fundus are seperated via the greater curvature, the short gastric vessels have to be divided to approach this region.

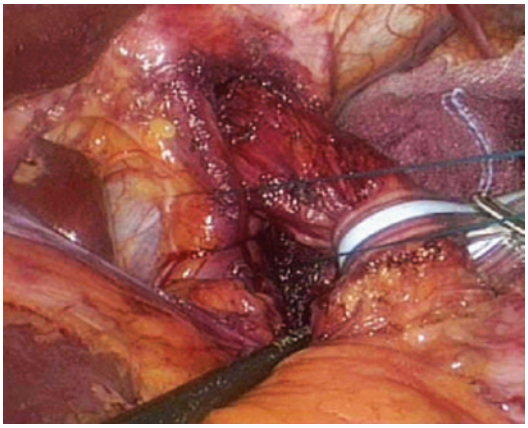
During redo-antireflux surgery, quite often these tissue connections at the posterior fundus are not divided, causing possible dysphagia or eating discomforts. In the randomized trials concerning the division of the short gastric vessels, different definitions of the mobilization of the fundus have been used. As a consequence, these results are not clinically relevant and cannot be compared. Today, it is left to the judgment of the individual surgeon to decide whether he or she can achieve a good functional postoperative result in the patients with or without fundic mobilization.

8.5 Hiatoplasty

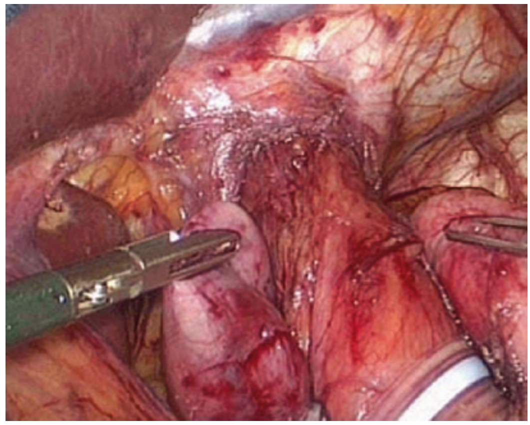
A hiatoplasty to approximate the hiatal opening during antireflux surgery is absolutely important. This should be performed with non-resorbable suture material (◘ Fig. 8.2). We prefer one or several "figure of 8" stitches, starting with the posterior aspect of the crura at the arcuate ligament.



◘ **Fig. 8.2** Posterior Hiatoplasty



■ **Fig. 8.3** Hiatoplasty



■ **Fig. 8.4** Shaping the fundoplication

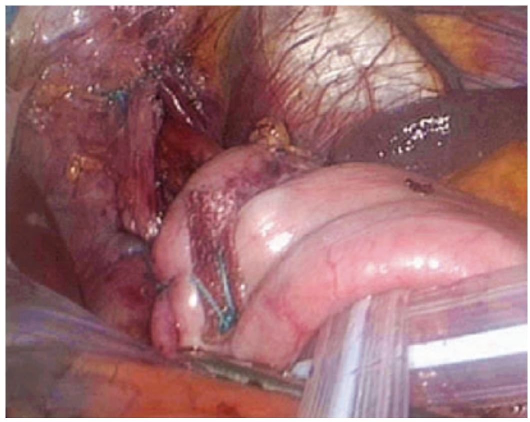
Quite often, we also use an anterior approximation of the hiatal arch or complete the downsizing of the hiatal opening (■ Fig. 8.3).

8.6 Fundoplication

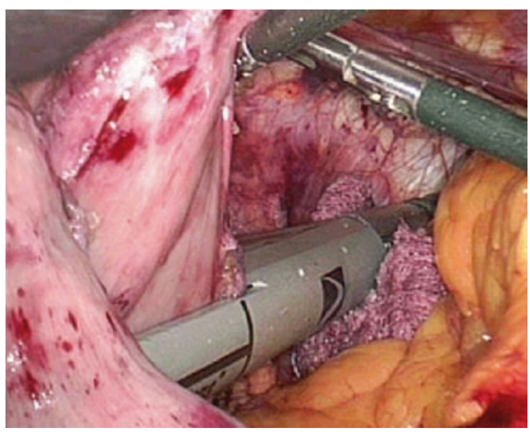
After hiatoplasty, a fundoplication should be performed. We use as a standard procedure the short floppy Nissen fundoplication in the DeMeester-sandwich technique. In severe esophageal motility disorders, we favor a posterior partial fundoplication in the Toupet technique.

The fundoplication is shaped by pulling with a loop the esophagus caudally and then moving the posterior funding flap through the retroesophageal window to the right side of the esophagus. Then a large-size bougie (54 French) is placed into the stomach, and a shaping of the fundus is completed to gain a floppy fundoplication (■ Fig. 8.4).

The anterior and the posterior fundic flaps are sutured together with one U-stitch in the DeMeester-sandwich technique, allowing for a continous identification of the anterior vagus during the stitch. It is important that the fundus is placed around the lower esophageal sphincter symmetrically and the fundoplication sutures are positioned on the right lateral side of the esophagus (■ Fig. 8.5).



■ **Fig. 8.5** Completed Nissen fundoplication



■ **Fig. 8.6** Placing of linear stapler at angle of His to complete Collis gastroplasty

8.7 Summary

The operative therapy of different entities of large hiatal hernias such as paraesophageal hernia, large mixed hernias, and upside-down stomachs should be performed after extensive diagnostic workup to make sure that the right anatomical situation is identified and also all functional parameters and defects are determined.

We think that not only an anatomical reconstruction in large hiatal hernias but also a fundoplication is necessary. Laparoscopic fundoplications as full wrap or partial wrap are the standard procedures in the operative treatment of gastroesophageal reflux disease. These procedures can be done in experienced hands with a very low morbidity and a short postoperative hospitalization. The functional results in experience centers are excellent. Especially redo surgery should be performed in such centers.

Surgical Technique and Difficult Situations from Sumeet K. Mittal

Pradeep Pallati and Sumeet K. Mittal

M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations*,
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9.1 Introduction

Intrathoracic stomach represents herniation of greater than 75 % of the stomach through the esophageal hiatus into the thoracic cavity. The most common symptoms include intermittent dysphagia for solids, abdominal and chest pain secondary to visceral torsion, gastrointestinal bleeding from mucosal ischemia resulting in iron deficiency anemia, and heartburn. A high incidence of acute volvulus with possible gangrene, perforation, or hemorrhage requiring emergent surgery has been reported, and elective repair has been recommended [1] though not universally accepted for asymptomatic patients. All symptomatic PEH should be repaired especially if they have symptoms suggesting incarceration. The operative repair was traditionally via left thoracotomy and subsequently via laparotomy though laparoscopic repair is feasible in nearly all patients. Cuscheri first reported laparoscopic repair of paraesophageal hernia in 1992 [2]. Operative strategy includes sac and hernia reduction with hiatus closure along with or without fundoplication.

9.2 Preoperative Workup

Preoperatively, all patients undergo esophageal studies including esophagogram, upper endoscopy, and manometry. Esophagogram determines the extent of herniation along with any evidence of volvulus. There is a high probability of short esophagus if the GEJ is >5 cm above the hiatus. Upper endoscopy is used to rule out ischemia in acute setting and identify Cameron's ulcers, reflux esophagitis, and Barrett's esophagus (BE) in the chronic setting. Peptic stricture, BE, and endoscopic esophageal length index are predictors of a short esophagus [3]. Manometry may be difficult in these patients due to the angulation of the gastroesophageal junction, and we prefer to place the catheter under endoscopic guidance. Manometry identifies any extent of esophageal dysmotility and helps in decision-making with regard to anti-reflux procedure. General preoperative evaluation should include cardiorespiratory risk assessment in these often elderly and frail patients. Laparoscopy is associated with greater intraoperative cardiopulmonary compromise than open procedures.

Thorough evaluation is needed prior to surgical intervention.

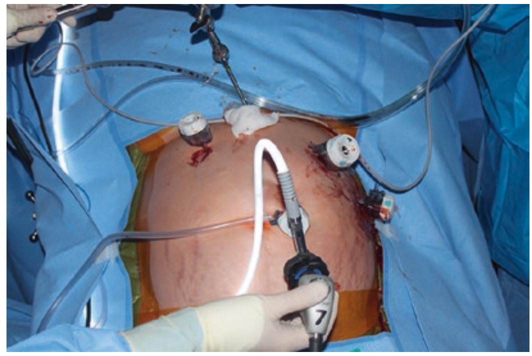


Fig. 9.1 Showing the usual trocar placements. The camera port is above and left of the umbilicus. Assistant port is below the costal margin in the anterior axillary l ine and the liver retractor is near the xyphoid. The surgeons working ports are a 12 mm trocar in left mid clavicular line 1-2 cm below the costal margin and a 55 mm trocar just right of the midline in the epigastrium

9.3 Preparation

The patient is placed in an inverted Y supine position (Alphamaxx, Maquet Inc., Germany). The operating surgeon stands in between the legs, the first assistant on the left side of the patient, and the camera operator on the right side of the patient.

Port placement is as shown in Fig 9.1. We place a larger 12 mm cannula for the operating port (surgeon's right hand) for ease of needle insertion at the time of suturing. The port is also placed close to the left subcostal region in such a manner that it could be used for placement of gastrostomy tube at the end of the procedure (if needed). If there is a high degree of suspicion for short esophagus based on preop assessment, the left arm is extended on the arm board, and the left chest is prepped in the field for Collis gastroplasty.

9.4 Surgical Technique

This operation can be divided into five steps:
1. Reduction of hernia sac
2. Mediastinal dissection and assessment of esophageal length
3. Crus closure
4. Anti-reflux procedure
5. Gastrostomy tube placement – selectively

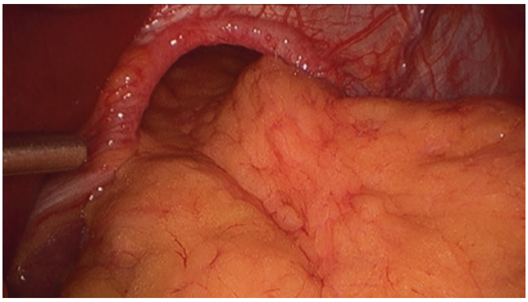


Fig. 9.2 Initial laparoscopic view showing majority of stomach and omentum herniating thru a gigantic hiatal defect

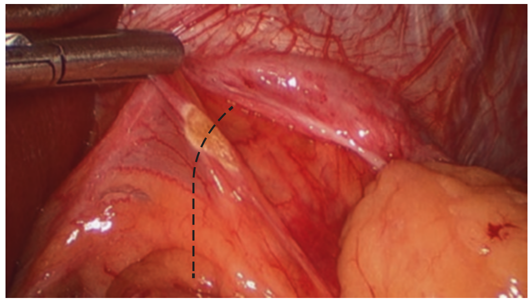


Fig. 9.3 Initial line of dissection. The assistant (not shown) grabs the hernia sac and everts it out of the mediastinum

9.4.1 Reduction of Hernia Sac

After initial laparoscopy, the liver is retracted with the use of a Nathanson® liver retractor (Cook Surgical, Bloomington, Indianapolis, USA) with a table-mounted Iron Intern® (Automated Medical Products Corp., New York, NY). We use a 30° angled lens during the procedure. Occasionally 0° lens is used for mediastinal dissection. The patient is placed in a steep reverse Trendelenburg position to bring the bowel contents away from the esophageal hiatus. The hernia, with its contents, is identified (Fig. 9.2). If the colon is herniated, it is reduced with the use of blunt graspers using hand-over-hand technique.

We do not attempt to reduce the stomach as it obstructs proper visualization. Rather the sac is retracted caudally bringing its edge of the anterior most portion in clear view. We start the dissection just inside the arch of the crus with electrocautery. It is imperative that we enter the correct plane outside the hernia sac. It is important to preserve the peritoneal lining of the crus. The cut edge of the sac is grabbed by the assistant and pulled in the caudal direction. With further countertraction with the surgeon's left hand, the cautery is used to continue dividing the sac at the level of the hiatus. One must continuously reposition the assistant's and the surgeon's left-hand instruments to provide traction at the leading edge of the sac dissection. One can identify the correct plane by the fact that it almost lends itself to dissection and there is no bleeding.

It is important to enter the correct plane outside the hernia sac. The correct plane is avascular and dissects readily.

On extending over the right crus, the gastrohepatic ligament is divided. In patients with aberrant left hepatic artery, we preserve only if it is larger than 4 mm. While extending onto the left crus, the division of the short gastric vessels facilitates the exposure (Fig. 9.3). The dissection along the left crus is technically challenging, as the exposure can be difficult especially for the novice. The inverted hernia sac is grasped and pulled caudad and to the patient's right to allow for better traction. The sac is bluntly dissected and pulled into the abdominal cavity. In obese patients, if needed, an additional 5 mm trocar can be placed on the left side for the assistant's second hand to retract the bulky omentum that usually obscures the view at this point.

The peritoneal lining on the undersurface of the diaphragm is preserved at all times as this is incorporated in the sutures for the crural closure at the end.

Once the dissection reaches the junction of the right and left crus, a 6-inch-long 1/2-inch Penrose drain is passed from right to left below the esophagus and then secured with Endoloop® (Ethicon Endo-Surgery Inc., Cincinnati, Ohio). It is important to place the retracting Penrose drain at the gastroesophageal junction (GEJ) after the hernia sac has been reduced. If the hernia sac is not below the retracting Penrose, the sac and the accompanying fat are pulled through the loop to appropriately position the Penrose. The retraction with Penrose drain is safe and avoids inadvertent injury to the GEJ.

We do not excise the hernia sac off the viscera, though the sac is dissected off the greater curvature and the angle of His to correctly identify the GEJ. It also allows for proper positioning of the fundoplication over the distal esophagus.

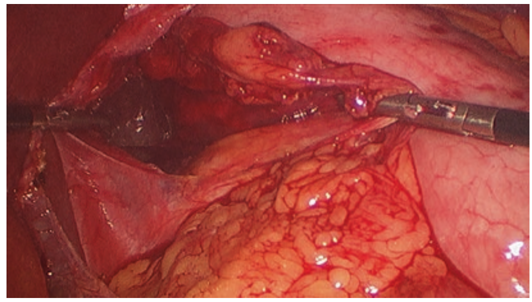
9.4.2 Mediastinal Dissection

With adequate traction on the Penrose drain by the assistant, the esophagus is stretched out. Generous dissection of the mediastinum is performed with alternating blunt and sharp dissection (◘ Fig. 9.4). Using the two instruments in the surgeon's hand, the dissection is carried with chopstick-like motion parallel to the esophagus. Care is taken that the tip of the instruments does not push in to the esophagus. Dissection between the esophagus and the aorta is performed meticulously with harmonic scalpel, as there are direct blood vessels to the esophagus from the aorta.

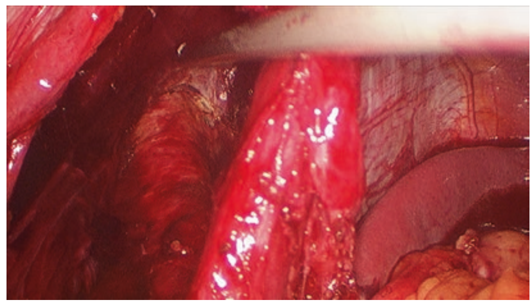
Mediastinal dissection is to be carried as high as possible up usually up to the inferior pulmonary veins (◘ Fig. 9.5).

Inadvertent pneumothorax is encountered occasionally. This needs to be conveyed to the anesthesiologist and intra-abdominal pressure may need to be decreased if any difficulties arise. Rarely, a temporary chest tube may need to be inserted to continue with the procedure.

The bleeding is minimal in this dissection if performed meticulously. A gauze piece can be inserted through the large port to absorb any blood and to increase visibility. In obese patients and when dissection is carried too high, we sometimes switch to zero-degree lens for better visualization.



◘ **Fig. 9.4** An avascular plane has been made between the hernia sac and the crus and dissected into the mediastinum. Fascia/ peritoneum has been preserved on the crus

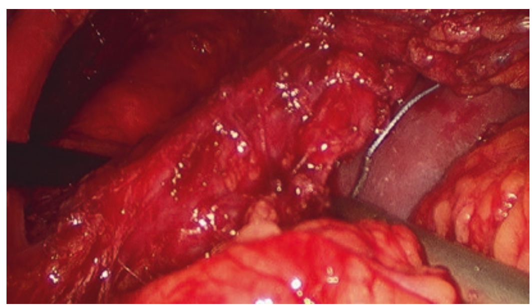


◘ **Fig. 9.5** Extensive mediastinal dissection is done usually above the inferior pulmonary veins. Care is taken to avoid injury to the perforators and the aorta

9

9.4.3 Crural Closure

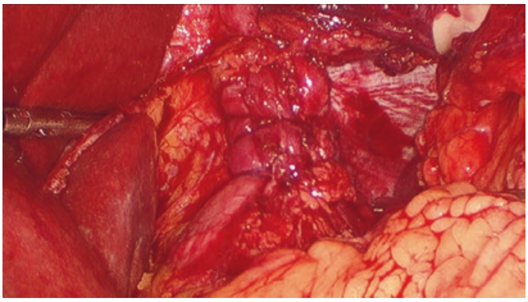
The crus closure is achieved with 0 Ethibond® (Ethicon LLC, San Lorenzo, Puerto Rico) figure-of-eight suture tied with the use of a Ti-Knot device® (LSI Surgical Procedure Solutions, Victor, NY). The first stitch is crucial and placed as posteriorly as possible. To aid in this, the left-hand grasper of the surgeon is placed between the aorta and the left limb of the crus (◘ Fig. 9.6). This allows the surgeon to feel the grasper with the needle and avoid aortic injury while allowing for the deepest possible suture in the left crus. Starting the suturing posteriorly decreases the tension as the crus is progressively closed anteriorly. We avoid using any prosthetic material at the hiatus and only rarely do we use a U-shaped



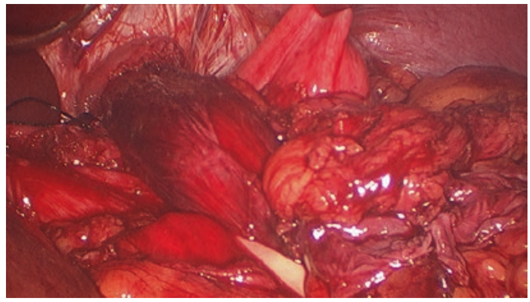
◘ **Fig. 9.6** Crus closure is started as posteriorly as possible. Left hand gasper (shown) of the surgeon is placed between the aorta and the left limb of curz. This grasper is 'felt' with the needle as it is skived over it to the deepest and most posterior cruz bite possible

bioprosthetic mesh Veritas® (Synovis Surgical Innovations, St. Paul, MN).

A series of figure of eight sutures are placed and serially tied (◘ Fig. 9.7). Occasionally, we



■ **Fig. 9.7** Series of figure of eight sutures are placed posterior to anterior



■ **Fig. 9.8** "Shoe shine"maneuver after hernia sac has been dissected of the angle of his and posterior fundoplication limb delivered to the right of the patient

place a single figure of eight suture anterior to the esophagus. The last crus closure suture is placed after bougie removal and after completion of fundoplication.

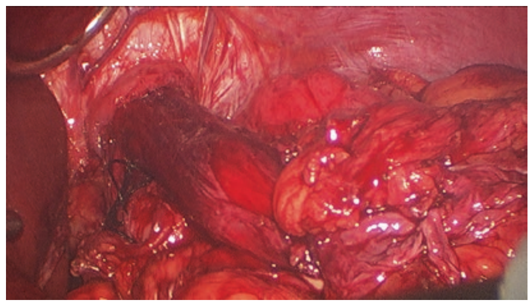
The usual size of the mesh if used is 6×8 cm^2 with a 3 cm U-shaped defect to accommodate the esophagus. The mesh is secured at three locations to the hiatal opening with sutures (3, 6, and 9 o' clock) and lateral edges secured with tacking device (AbsorbaTack®; Covidien Corp, Mansfield, MA, USA). Care is taken to avoid direct contact of the mesh to the esophagus.

Mesh is rarely required for crus closure even in the large intrathoracic stomach, and when required, a biological mesh is used.

9.4.4 Anti-reflux Procedure

The anti-reflux procedure of choice depends on the preoperative symptoms, manometry, and the patient's general health. In cases of elderly people with history of no or minimal reflux symptoms, we do not perform an anti-reflux procedure. The type of fundoplication is decided based on preoperative manometry, and for patients with ineffective motility, a partial posterior or anterior fundoplication is done if we do decide to proceed with a fundoplication.

When decided to perform a reflux procedure, the posterior vagus nerve is dissected off the esophagus with a blunt grasper in the surgeon's left hand. The fundus of the stomach is measured to a length of 5 cm from the angle of His and a 00 silk suture is placed approximately 2 cm behind the line of divided short gastric vessels at this



■ **Fig. 9.9** "Drop test" allows to make sure that there is no tension on the proposed limbs of the fundoplication

point. With the help of the suture, the fundus is delivered behind the esophagus in front of the posterior vagus nerve.

A drop test and a shoeshine maneuver are performed to create a proper tension-free fundoplication (■ Figs. 9.8 and 9.9). At this point, a 60 Fr bougie is placed and fundoplication is sized for 1 cm overlap. A single 00 Prolene test suture is placed incorporating the anterior and posterior fundoplication limbs. The orientation of the fundoplication, the location of the divided short gastric vessels, and tightness of the fundoplication are assessed. We believe that an appropriately placed fundoplication lies at 9 o' clock position, divided short gastric vessels are in their native position facing the spleen, and a 5 mm instrument can be placed between the fundoplication and the esophagus with 60 Fr bougie in place. After being satisfied with the test stitch position, the test stitch is replaced with a pledgeted 2-0 Prolene (Ethicon Endo-Surgery Inc., Cincinnati, Ohio) horizontal mattress suture

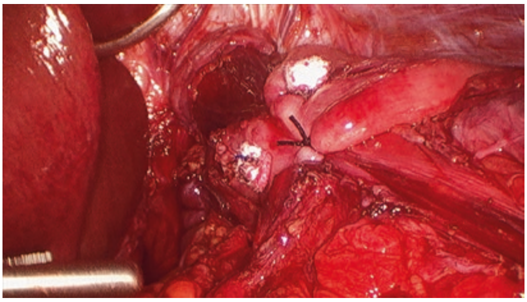


Fig. 9.10 Completed fundoplication

incorporating the anterior and fundoplication limb along with the esophagus at 9 o' clock position 2 cm above the GEJ (Fig. 9.10). The suture is secured with a Ti-Knot device® (LSI Surgical Procedure Solutions, Victor, NY).

The fundoplication is completed with a single 00 silk suture incorporating just anterior and posterior fundoplication limbs below the pledgeted stitch.

9.4.5 Gastrostomy Tube Placement with Endoscopy

We place endoscopic-guided percutaneous gastrostomy tube, not infrequently especially in elderly and frail patients. This allows it to be used as decompression tube and for hydration or medication use in the perioperative period. In our experience, this allows an easier postoperative convalescence in these patients.

9.5 Difficult Situations

9.5.1 Short Esophagus

Due to the long-standing nature of paraesophageal hernia, these patients are at high risk of having a short esophagus. Usually, with extensive mediastinal dissection, one is able to get adequate intra-abdominal esophageal length (>2 cm). After maximal mediastinal dissection, the gastric fat pad is dissected of the angle of His to accurately identify the GEJ and measure the intra-abdominal esophageal length from the arch of the crus to the GEJ. If there is less than 2 cm of subdiaphragmatic esophageal length, we proceed with Collis gastroplasty via left thoracic route. These cases are suspected on routine preoperative evaluation based on endoscopy, contrast study, and manometry.

Though several methods have been described for minimally invasive Collis gastroplasty, we use a technique developed at our institution [4]. A 3 cm incision is made in the left third intercostal space in the anterior axillary line. A tentative path of stapler is assessed with a blunt probe, which also makes a defect in the left mediastinal pleura. For this the probe "is walked" over the diaphragm under laparoscopic guidance from lateral to medial. A 46 Fr bougie is placed in the esophagus. A 45-mm-long blue load endoscopic stapler is passed through the hiatus and placed parallel to the lesser curvature snug against the bougie. The stapler is fired to create a neo-esophagus. Fundoplication is performed over the neo-esophagus after crural closure. Alternatively in elderly patients with no history of significant reflux symptoms, we proceed only with hiatus repair without fundoplication [5].

9.5.2 Inability to Reduce the Stomach

In rare circumstances, the contents of the sac may not be reducible as there are significant adhesions of the sac to the mediastinum. This is usually avoided by complete and meticulous dissection of the hernia sac by adhering in the right plane. If one cannot identify the right plane at the start of the dissection, we recommend trying at a different point along the crus to start the dissection. Though we have not encountered such a situation, we would anticipate proceeding with repair via left thoracotomy, as in our experience laparotomy offers no advantage over laparoscopy in mediastinal dissection.

9.5.3 Bleeding

If meticulous attention is not paid to dissection in the mediastinum, one can run into significant bleeding especially from perforating esophageal branches from the aorta. If bleeding is encountered, a sponge is placed and pressure held for 5 min while preparation is made for possible open procedure. Usually this suffices or a clip can be placed on the stump. Holding pressure with thrombin-soaked Gelfoam and Surgicel is also helpful.

9.5.4 Visceral Injury

Mediastinal dissection if not performed in correct plane can result in injury to the esophagus and/or GEJ. It is important to be aware of this possibility. If an injury is suspected, an endoscopy is done to confirm and clearly delineate the injury. We had one case of 1 cm longitudinal full thickness injury at the GEJ. We repaired the mucosa with 4.0 Vicryl interrupted sutures. The muscle was then re-approximated over, with interrupted 3.0 Vicryl sutures. An endoscopy was done for leak test and followed with an anterior fundoplication (as the patient had poor motility).

9.5.5 Tearing of the Crus with Primary Closure

In our experience primary closure can be performed in nearly all cases. We do not routinely use mesh for hiatus reinforcement. In a subset of patients, there may be too much tension at the sutures and cause crus tearing. In these patients we use a biosynthetic mesh. We had one patient in whom the right limb of the crus tore with suture placement. In this case, we dissected the falciform ligament and secured it to the edges of the crus. This was followed with placing a U-shaped mesh. We use Veritas® (Synovis Surgical Innovations, St. Paul, MN).

9.6 Classification of the Difficult Situations

The guarding is based on a personal perception of anticipated difficulty during dissection:

Grade 1 - Only stomach and omentum in the chest

Grade 2 - Colon herniated in addition to upside-down stomach

Grade 3 - Duodenum herniated in addition to upside-down stomach

Grade 4 - Pancreatic tail/spleen herniated in addition to upside-down stomach

The upside-down stomach grade should be based on the highest level, i.e., a patient with duodenum herniated along with colon would be grade 3. Similarly, patient with pancreatic tail/spleen herniated with or without duodenum and/or colon would be grade 4.

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Surgical Technique and Difficult Situations from Nathaniel J. Soper

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10.1 Background

The upside-down stomach (UDS) is a rare presentation of a Type III paraesophageal hernia with organo-axial rotation. Symptoms typically manifest as postprandial chest pain or dysphagia. Laparoscopic paraesophageal hernia repair is indicated in operable patients with symptomatic paraesophageal hernias.

10.2 Evaluation

Prior to surgery, patients should be fully evaluated by esophagogastroduodenoscopy (EGD), esophageal manometry, and barium swallow. Blind placement of the manometry catheter can be difficult and potentially dangerous, thus EGD placement may be required. Some argue that manometry is unnecessary and that all patients can tolerate a Nissen fundoplication, or vice versa, that all patient should be repaired with a partial fundoplication. We feel that a tailored approach is better for long-term patient function and that a Nissen fundoplication should be performed when severe esophageal dysmotility has been ruled out.

10.3 Procedure

We perform laparoscopic repair of UDS in a typical fashion to that of other Type III paraesophageal hernia repairs.

Step 1 - The patient is positioned supine on a bean bag with split legs. The surgeon stands between the patient's legs and the assistant stands at the left side.

Step 2 - After prepping and draping, CO_2 pneumoperitoneum is established after placing a 10 mm port 12 cm below the xiphoid process just to the left of midline. A 30°-angled high-definition laparoscope is inserted, and the patient is placed in steep heads-up position. A 5 mm liver retractor port is placed at least 15 cm from the xiphoid process, 2 fingerbreadths below the right costal margin. The assistant's 5 mm port is then placed halfway between these two ports. The surgeon's 10 mm right hand port (to allow for intracorporeal suturing with an SH needle) is placed 10 cm from the xiphoid 2 fingerbreadths below the left costal margin.

Step 3 - A 5 mm "snake" liver retractor is placed through the right lateral port, elevating the left hepatic lobe, thereby exposing the esophageal hiatus. The retractor is secured to a table-mounted Bookwalter retractor holder. The surgeon's 5 mm left-hand port is then placed to the right of midline just below the inferior edge of the retracted left lobe of the liver. A Veress needle is used to "sound out" potential sites for this port.

Step 4 - An orogastric (OG) tube is positioned in the mid-stomach for decompression, although the hernia may make this difficult. EGD is sometimes required to adequately decompress the stomach.

Step 5 - The stomach is then carefully reduced as much as possible with downward manual traction using atraumatic graspers.

Step 6 - The upper portion of the gastrohepatic omentum is divided, and the hernia sac is opened along the superior medial aspect of the right crus. The leading edge of hernia sac is retracted inferiorly to the patient's left and the entire hernia sac is carefully reduced with blunt and ultrasonic shear dissection dividing the hernia sac around the anterior circumference of the hiatus until the base of the left crus is reached. Care must be taken to avoid injuring the left gastric artery (LGA) at the base of the right crus, as this artery may de superiorly displaced due to the UDS (see Pitfall 1).

Step 7 - The gastrocolic and gastrosplenic omentums are divided along the greater curvature from the mid-stomach up to the angle of His with an ultrasonic scalpel, mobilizing the fundus off the left half of the diaphragmatic crus and opening the retroperitoneum behind and at the left side of the gastric cardia. The posterior sac (corresponding to the lesser sac peritoneum) is then divided completely and the remaining sac reduced into the abdomen.

Step 8 - The esophageal hiatus is then meticulously dissected, identifying the anterior and posterior vagus nerves. Laterally, the pleura may be densely adherent to the hernia sac. Small tears in the pleura usually are inconsequential.

Step 9 - The distal esophagus is mobilized out of the posterior mediastinum off the preaortic and prevertebral fascia in an orad direction as far as possible. At least 3–4 cm of intra-abdominal length of the esophagus is needed to adequately construct a Nissen fundoplication. Downward traction at the gastroesophageal junction using a half-inch Penrose drain is sometimes helpful. Upper endoscopy should be performed when GEJ location is uncertain. A Collis gastroplasty is needed when inadequate esophageal mobilization is encountered despite maximal cephalad dissection (see Pitfall 2).

Step 10 - The hernia sac is resected to facilitate fundoplication and to ensure adequate esophageal mobilization. Care must be taken to avoid vagus injury and inadvertent gastrotomy. Distinguishing chronically thickened hernia sac from the gastric wall is sometimes quite difficult (see Pitfall 3).

Step 11 - The gastric fundus is passed from left to right behind the EGJ and used to retract the esophagus and expose the enlarged hiatal defect.

Step 12 - The crura are reapproximated with interrupted 0 or 2-0 braided polyester sutures. Large crural defect closures should be buttressed with a bioabsorbable mesh

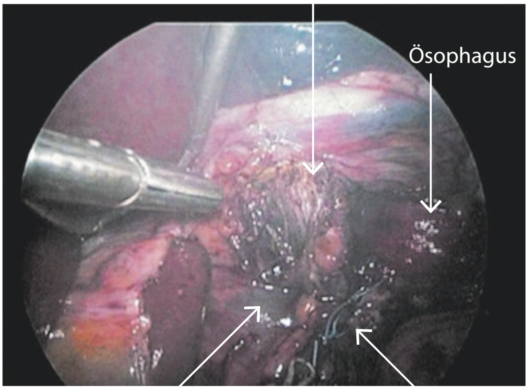

Fig. 10.1 Relaxing incision of the right crus

either carefully sutured or "glued" in place with fibrin sealant. The addition of a right crus "relaxing incision" prior to mesh placement should be considered (see Pitfall 4, Fig. 10.1, and Video).

Step 13 - At this point, an assistant with experience of passing esophageal dilators should remove the OG tube and gently pass a 50 Fr followed by a 60 Fr esophageal dilator down the esophagus through the EGJ into the stomach under direct laparoscopic visualization to avoid inadvertent esophageal perforation.

Step 14 - The gastric fundus is checked for rotational tension and torsion with the "shoe-shine" maneuver, and the stomach is circumferentially plicated around the EGJ with three anteriorly placed interrupted 2-0 braided polyester sutures, grasping the esophagus to the right of the anterior vagus nerve between bites of fundus. The length of the "short, floppy" fundoplication should be approximately 2 cm. Patients with severe esophageal dysmotility should undergo a partial fundoplication.

Step 15 - The esophageal dilator is removed and the abdomen is irrigated with warm saline, inspecting the subphrenic space and spleen for bleeding, and then aspirating all saline irrigation.

Step 16 - The liver retractor, the table-mounted retractor holder, and all laparoscopic ports are removed. The fascia at sites of 10 mm ports is closed. Skin incisions are closed with subcuticular sutures.

Pitfalls and Recovery

1. *Left gastric artery injury:* The LGA may be superiorly displaced in the setting of a UDS. As a result, care must be taken during the initial medial dissection. Standard hemostatic surgical principles are employed including conversion to an open operation if needed.
2. *Inadequate esophageal length:* If adequate esophageal length is not obtained despite maximal esophageal mobilization in Step 9 and the EGJ cannot be returned to an intra-abdominal position, a Collis gastroplasty may be indicated. With a 60F dilator in place, a wedge fundectomy is performed with multiple firings of laparoscopic staplers. The remaining fundus is then plicated around the neoesophagus.
3. *Vagus nerve or gastrotomy during hernia sac resection:* The hernia sac may be chronically thickened which may increase the risk of vagus nerve injury during sac resection. Likewise, an inadvertent gastrotomy or thermal injury from the ultrasonic dissector may be created. Any obvious gastrotomy should be closed in one or two layers as appropriate. Areas suspicious for thermal injury should be oversewn.
4. *Large crural defect:* Closure of a large crural defect without excessive tension may be challenging. We now employ a right crural "relaxing incision" to allow for reduced tension with crural closure. The vertical fascial incision is made using the ultrasonic shears on the very lateral aspect of the right crus, but well to the left of the inferior vena cava. Approximation of the crura then takes place in the usual fashion. We use a bioabsorbable mesh (Bio-A, Gore Medical), to reinforce the crural repair (see Video).

10.4 Post-op Regimen

An NG or OG tube is usually not necessary. Oral intake of liquids and soft foods is begun as soon as the patient has no nausea, usually on the day of surgery. Red meat and dry bread are avoided for 4 weeks. Pain and nausea are controlled with injectable narcotics, ketorolac, and ondansetron for 6–12 h and then with oral analgesics.

10.5 Complications

Complications of laparoscopic paraesophageal hernia repair include vagus nerve injury, esophageal perforation, gastric perforation, splenic laceration and hemorrhage, gastroparesis, gastric bloating, esophageal dysmotility (dysphagia), excess flatulence, and fundoplication dehiscence with recurrent GERD.

10.6 Follow-Up

A barium swallow and/or esophagogastroduodenoscopy (EGD) should be performed in patients with persistent dysphagia after 4–8 weeks. A follow-up barium swallow is suggested at 6 months and if symptoms recur.

Surgical Technique and Difficult Situations from David I. Watson

David I. Watson

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11.1 Technique for Laparoscopic Antireflux Surgery

11.1.1 Preoperative Workup

A careful history of the patients' symptoms is taken, with emphasis on heartburn and regurgitation, and response to proton pump inhibitor therapy. Upper gastrointestinal endoscopy, oesophageal manometry and 24-h pH monitoring are routinely performed to confirm gastro-oesophageal reflux and identify motility disorders where a Nissen fundoplication should be avoided.

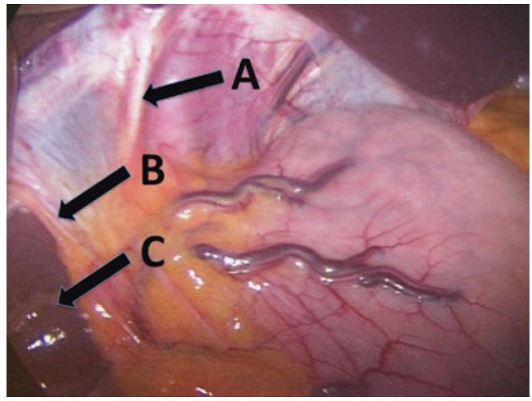


Fig. 11.1 Undissected hiatus exposed after insertion of the liver retractor. *A* edge of right hiatal pillar, *B* hepatic branch vagus nerve, *C* caudate lobe of the liver seen through avascular window in the lesser omentum

11.1.2 Operating Room Setup

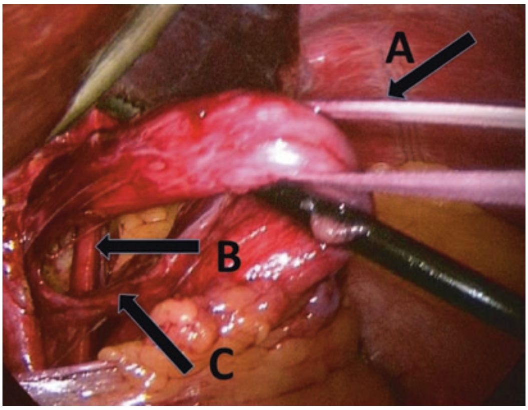
The patient is positioned with the legs extended in stirrups and 20–30° head up (reverse Trendelenburg). The video monitor is placed at the patient's eye level and in line with the operating surgeon who stands between the patient's legs. The assistant stands at the patient's left. The instrumentation is simple. Two 11-mm and two 5-mm trocars are used, along with two atraumatic grasping instruments, a diathermy hook and a needle holder for the operating surgeon. The assistant also controls a 30° laparoscope and uses an atraumatic grasper for retraction. A pair of scissors is used for cutting sutures. A Nathanson liver retractor (Cook Medical Technology, Eight Mile Plains, Queensland, Australia) is used to provide excellent and stable elevation of the left lobe of the liver. The Harmonic scalpel, or similar technology, is never used.

11.1.3 Operative Technique

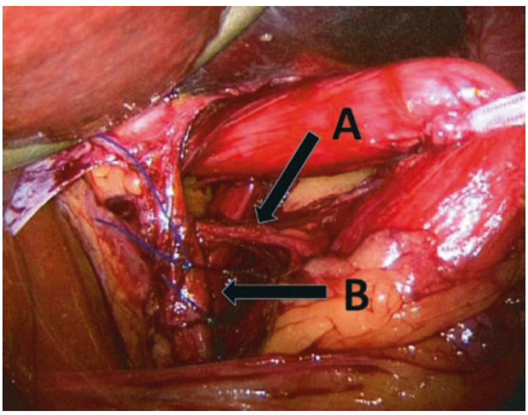
An 11-mm port is introduced supraumbilically by open insertion to establish pneumoperitoneum. The liver retractor is introduced via a 5-mm stab wound, placed as high as possible between the xiphoid and the apex of the left costal margin, and the left lobe of the liver is lifted to expose the hiatus. The Nathanson liver retractor provides good exposure even in patients with a fatty liver. Three further ports are placed, a 5-mm port immediately subcostal in the right midclavicular line, an 11-mm trocar immediately subcostal in the left midclavicular line and a 5-mm port in the anterior left axillary line 3–4 cm below the costal margin.

The first step is to open the lesser omentum above and below the hepatic branch of the vagus nerve to expose the right hiatal pillar within the lesser sac (Fig. 11.1). The hepatic branch is protected and spared. Hiatal dissection commences anteriorly on the right side, using blunt dissection (minimal diathermy and no ultrasonic shears!), with the dissection maintained approximately 5 mm inside the hiatal rim to avoid removing the fascial coverings which cover and protect the muscle fibres at the hiatal rim. Cutting instruments and energy sources are not used, and dissection is bloodless if in the correct plane. The right pillar is dissected first, and then the dissection is extended across the front of the hiatus to the left pillar, and posteriorly along the edge of the left pillar. Once the pillars are dissected, any remaining attachments to the distal oesophagus can be bluntly dissected before developing a plane behind the oesophagus from the right side.

Next, an atraumatic grasping instrument is passed from right to left behind the oesophagus. A long linen tape is passed through the 11-mm left upper abdominal port to this instrument, pulled behind the oesophagus and then passed back to the instrument passing through the left upper abdominal port. Both ends of the tape are removed through the left upper abdominal port; the port is removed over the tape and then resited so that the two ends of the tape pass through the wound, but not through the port. The ends of the



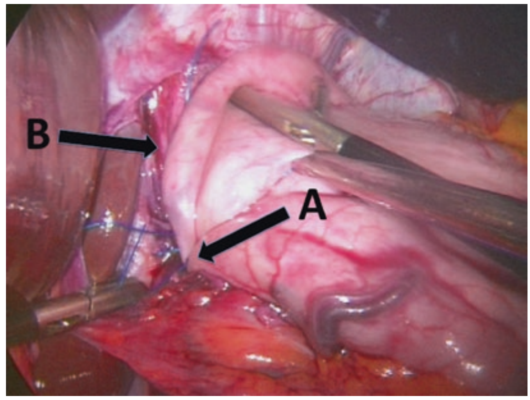
■ **Fig. 11.2** Dissected hiatus. *A* tape around oesophagus, *B* left hiatal pillar, *C* posterior vagus nerve



■ **Fig. 11.3** Repaired hiatus. *A* posterior vagus nerve, *B* repaired hiatus

tape are secured at the level of the skin with a clamp, and traction is applied as necessary. The oesophagus is elevated anteriorly to better view the posterior hiatus, facilitating completion of the dissection of the posterior aspects of both hiatal pillars and the posterior oesophagus. The posterior vagus nerve is displaced posteriorly, away from the oesophagus (■ Fig. 11.2).

The hiatus is then repaired posteriorly by approximating the left and right pillars using 1 or 2 non-resorbable, monofilament sutures, and the diameter of the hiatus is reduced to approximately 30 mm (■ Fig. 11.3). An intra-oesophageal bougie is not needed for calibration of the hiatal repair. An anterior 180° fundoplication or a Nissen fundoplication is then constructed to complete the procedure. The choice of fundoplication type is based on preoperative oesophageal motility testing and patient preference.



■ **Fig. 11.4** Completed first suture for anterior 180° partial fundoplication. *A* first suture, *B* edge of fundus which will be sutured to the oesophagus and right hiatal pillar

11.1.4 Fundoplication Construction

The operative technique for laparoscopic anterior 180° partial fundoplication has been described in detail [1]. The anterior wall of the gastric fundus is manipulated until a loose piece is identified which can easily be placed across the front of the oesophagus for suturing without tension. The fundus is first sutured to the right lateral wall of the distal oesophagus and to the right hiatal pillar with three sutures (■ Fig. 11.4). This stabilises a 3–4 cm length of intra-abdominal oesophagus against the hiatal rim. All sutures include substantial “bites” of the oesophageal wall. The fundoplication is constructed to fully cover the anterior aspect of the intra-abdominal oesophagus. The fundus is also sutured to the apex of the oesophageal hiatus with two additional interrupted stitches, to close the space anterior to the oesophagus and to reduce the risk of postoperative herniation (■ Fig. 11.5).

If a Nissen fundoplication is added, a loose 360° fundoplication is constructed, again using the anterior wall of the gastric fundus [2]. It is important to select the anterior fundus approximately halfway between the cardia and the short gastric blood vessels. This piece is pulled around behind the oesophagus (■ Fig. 11.6). If it does not sit loosely, the fundus is repeatedly manipulated until the loosest piece is identified, and this piece is then used to construct the fundoplication. The piece of the stomach that comes across the left side of the oesophagus is selected after this, in such a way that a very loose 360° wrap is facilitated. The wrap is secured with three non-absorbable sutures

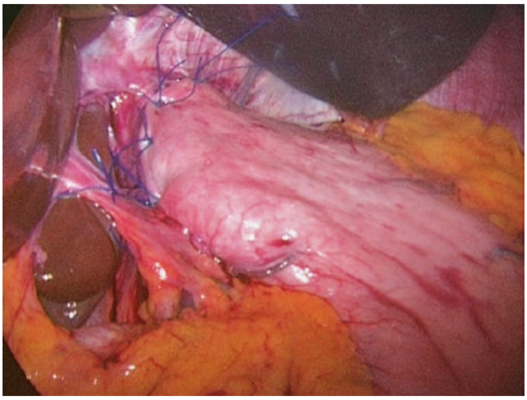


Fig. 11.5 Completed anterior 180° partial fundoplication. The fundus sits loosely across the oesophagus and anterior hiatus

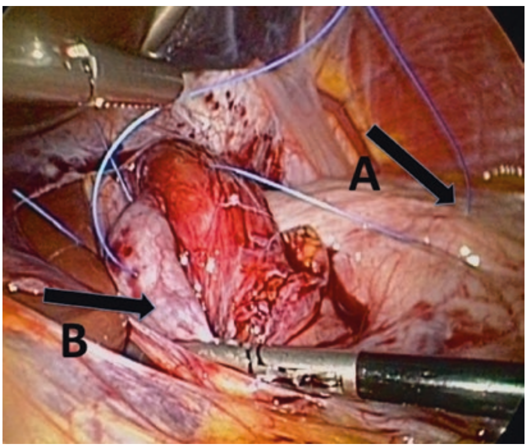


Fig. 11.6 Construction of a Nissen fundoplication. The fundus sits loosely behind the oesophagus. *A* piece of the fundus which will form anterior component of the wrap, *B* piece of the fundus which will form posterior component of the wrap

(1 or 2 also including the anterior oesophageal wall) and calibrated using a 52-Fr intra-oesophageal bougie (Fig. 11.7). When care is taken to select the most appropriate piece of the anterior fundus, the short gastric vessels almost never need to be divided. The fundoplication is not sutured to the diaphragm.

11.2 Difficult and Unusual Intraoperative Situations

A systematic and consistent approach to hiatal dissection minimises the risk of problems during laparoscopic fundoplication. A "defensive" approach which expects problems at every operation, and anticipates abnormal anatomy and other difficulties, will minimise the risk of serious difficulties.

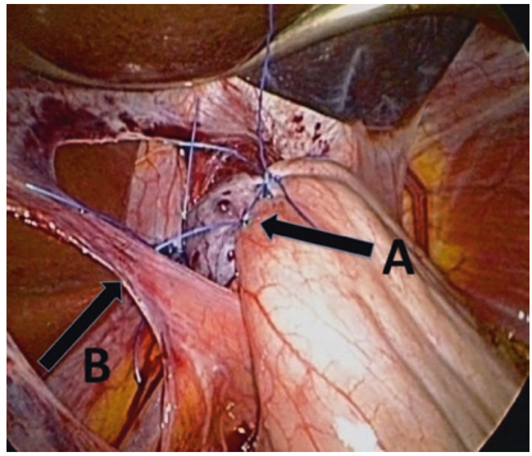


Fig. 11.7 Completed Nissen fundoplication (*A*), sitting above the preserved hepatic branch of the vagus nerve (*B*)

11.2.1 Abnormal Vascular Anatomy

Failure to recognise aberrant vascular anatomy in the region of the oesophageal hiatus can lead to vascular injury and bleeding, necessitating conversion to open surgery to control haemorrhage, and in rare situations bleeding can be life threatening. Awareness of anatomical variations, and a strategy during dissection which avoids injury, is the best approach to this problem. To do this, the use of energy sources such as diathermy or ultrasonic shears should be minimised. Ultrasonic shears have an active blade, which can press against other structures when dividing tissue. This has led to inadvertent injury to the inferior vena cava (IVC) or aorta at the level of the oesophageal hiatus, or immediately inferior [3]. IVC injury is more likely when a large hiatus hernia is present, as the space between the edge of the right hiatal pillar and the IVC can be less than 10 mm. Opening the avascular part of the lesser omentum below the hepatic branch of the vagus nerve using a blunt dissection technique allows early identification of this vessel, and dissection can then be directed away from the IVC.

The aorta is at risk in a small number of individuals when it lies more anteriorly, posterolaterally on the left side of the oesophagus. In these individuals, the muscle of the left hiatal pillar can be thinner and merge into the anterior aspect of the aorta. In such individuals, the use of energy sources posterolateral to the oesophagus, in the vicinity of the angle of His, can result in inadvertent injury. Blunt dissection in this region minimises risk. Care also needs to be taken to not place posterior hiatal repair sutures through the wall of the aorta when repairing the hiatus.

The left inferior phrenic artery arises from the left gastric artery and runs along the edge of the right hiatal pillar in 5–10 % of individuals. When located in this position, this vessel should be ligated or clipped and then divided to allow the right anterolateral aspect of the oesophageal hiatus to open adequately. Care should be taken to look for this vessel before hiatal dissection commences. The vessel is easily seen, but will be injured if not ligated at an early stage.

An aberrant left hepatic artery can arise from the left gastric artery, and run through the upper aspect of the lesser omentum, adjacent to the hepatic branch of the vagus nerve. In the absence of a large hiatus hernia, this vessel can usually be preserved, with dissection occurring above and below the vessel. When a very large hiatus hernia is present, however, preservation of this vessel is more difficult, and it will usually need to be ligated and divided to open up space on the right side of the oesophageal hiatus.

11.2.2 Adipose Tissue

Excessive amounts of adipose tissue in the region of the oesophageal hiatus make dissection difficult, and this is more common in males than females. Some perivisceral and omental adipose tissue can be displaced away from the operative field by tilting the operating table head up, with 25–30° head-up tilt often needed to achieve adequate exposure. An enlarged fatty liver in combination with intra-abdominal obesity restricts surgical access further, and this type of liver is fragile and easily damaged by hand-held liver retractors. The use of a “fixed” Nathanson liver retractor usually solves this problem, provides better and more stable exposure of the oesophageal hiatus and also minimises the risk of liver injury. When using this device, adequate exposure is usually obtained.

Occasionally a “lipoma” or extension of fatty tissue from the posterior aspect of pericardial fat pad is present, particularly in obese males. This extends through the oesophageal hiatus, posterior to the oesophagus, into the mediastinum, and it can fill the hiatus and make dissection of the posterior hiatus difficult. A posterior hiatal “lipoma” should be pulled fully downwards into the abdomen and retracted by a grasping instrument held by the assistant, whilst posterior hiatal dissection and repair is completed. Once the hiatus is repaired with posterior sutures, the “lipoma” sits below the diaphragm and the operation can be completed in the usual manner.

11.2.3 Adhesions

Upper abdominal adhesions following previous open surgery can limit access and port placement, particularly if previous upper midline or right upper quadrant subcostal abdominal incisions have been used. Much time can be spent dividing adhesions to gain sufficient access for conventional laparoscopic port placement in the midline and right upper quadrant. An optical entry technique can be used in the left subcostal region for rapid placement of the first port, instead of entry via the midline. To place the right upper quadrant port, the avascular area of the falciform ligament can be opened to visualise and enter an adhesions free space anterior to the right lobe of the liver. Under vision, the right upper quadrant port can then be placed above any adhesions, and the operation will subsequently proceed in a conventional fashion. If these techniques are not feasible, all ports can be moved further to the left to create enough room and triangulation to allow the procedure to be completed laparoscopically.

11.2.4 “Small Gastric” Fundus

A small gastric fundus may occasionally limit mobility when forming a Nissen fundoplication without dividing the short gastric vessels. If this is encountered, the short gastric vessels can be divided to fully mobilise the fundus, or alternatively a partial fundoplication can be constructed. This situation is encountered in less than 2 % of cases.

11.2.5 Intrathoracic Stomach

Most Western series now report an increasing proportion of patients presenting with a giant hiatus hernia, including intrathoracic stomach [4]. If encountered, the stomach can consistently be reduced into the abdomen, by first focusing on dissection of the sac, rather than the stomach from the mediastinum. Full reduction of the hiatal sac progressively delivers the stomach into the abdomen, and the problem of oesophageal shortening is rarely encountered. When dissecting the sac, care must be taken to protect the fascia covering the muscle at the edge of the hiatal defect. This is achieved by dissecting 5–10 mm inside the edge of the hiatal defect. If dissection is at the muscle edge, bare muscle will be exposed and the hiatal defect will be larger and more difficult to close than if the fascial covering is protected.

Table 11.1 Operative difficulty for surgery for intrathoracic stomach

Grading	Case type
I (ideal cases)	Thin patient, normal-size liver, less than 50 % of the stomach in hernia sac
II (not quite ideal)	Thin patient, normal-size liver, most of the stomach in hernia sac
III (problematic)	Overweight patient, enlarged fatty liver, most of the stomach in hernia sac Or thin patient undergoing revision surgery with less than 50 % of the stomach in hernia sac
IV (very problematic)	Overweight patient, enlarged fatty liver, more than 50 % of the stomach in hernia sac and undergoing revision surgery

The operative difficulty for surgery for intrathoracic stomach can be classified as summarised in Table 11.1.

11.3 Personal Experiences

Case 1

Situation

An 88-year-old woman underwent laparoscopic repair of a giant hiatus hernia with an intrathoracic stomach. Presurgery symptoms were consistent with intermittent episodes of gastric volvulus, and no reflux symptoms were present. The hernia sac is reduced from the chest, but the gastroesophageal junction can only be brought to the level of the diaphragm, but not below without tension. A short oesophagus is thought to be the problem.

Dilemma

(1) Perform a Collis gastroplasty to get the "gastroesophageal junction" into the abdomen, or (2) allow the gastroesophageal junction to be anchored at the level of the diaphragm with some tension?

Solution

Do not add a Collis gastroplasty. Just repair the hernia and anchor the stomach using a partial fundoplication.

Outcome

Good clinical outcome and no symptoms. Radiological follow-up at 6 months shows a 3-cm sliding hiatus hernia.

Analysis

This is an elderly patient who does not have gastroesophageal reflux. A Collis gastroplasty adds a risk of leakage from the staple line used to create the neo-oesophagus, and if leakage occurs, the morbidity and mortality risk in this patient will be substantial. A small recurrent hiatus hernia which is fixed by adhesions at the level of the diaphragm will be asymptomatic, and cannot rotate and twist, or cause any significant problem. The risk of a symptomatic recurrent hernia is less than 3 %, probably less than the risk of an adverse outcome from performing a Collis gastroplasty in an elderly patient.

Case 2

Situation

An 82-year-old woman underwent laparoscopic repair of a very large hiatus hernia. The hernia sac was dissected and removed from the mediastinum, and the hernia was repaired with posterior sutures placed between the right and left hiatal pillars. After placing four sutures, it became apparent that the repair was under tension, and when tightening the fourth suture, the right hiatal pillar started to split.

Dilemma

How can the hernia be repaired satisfactorily?

Solution

Options are

1. Reduce the insufflation pressure from 12 to 15 mmHg to approximately 8 mmHg. This reduces the tension on the diaphragm and often allows the pillars to be approximated without significant tension.
2. Supplement the posterior hiatal repair with additional anterior sutures, as this area will usually be under less tension.
3. Reinforce the hiatal repair with a piece of mesh.

Outcome

Use these three strategies as a series of escalating steps. If the first fails, move to the second option. If all else fails, reinforce with a piece of mesh placed across the posterior hiatal repair.

Analysis

Although randomised trials suggest a lower risk of barium meal-detected recurrent hiatus hernia at short-term follow-up following mesh repair of large hiatus hernia, the only trial reporting longer-term outcomes failed to show any longer-term benefit following mesh repair. When dissecting the hernia sac, care should be taken to preserve the fascial coverings over both hiatal pillars. If this is achieved, suture repair can almost always be completed using steps (1) and (2). If mesh is used, it is best placed posterior to the oesophagus, aiming only to reinforce the suture repair. Mesh should not encircle the oesophagus as this can erode into the lumen of the oesophagus or lead to dense scarring and narrowing of the gastroesophageal junction.

Case 3

Situation

A 52-year-old man underwent laparoscopic fundoplication for gastroesophageal reflux. After dissecting the hiatus, a suture was placed posterior to the oesophagus to repair the hiatus. The suture was placed first through the left hiatal pillar. Next, as it was placed through the right hiatal pillar, bright red bleeding occurred with blood gradually filling the operative field.

Dilemma

The aorta lies behind the dissected oesophageal hiatus, close to the junction of the right and left hiatal pillars, and it is likely that the suture needle has been placed through the aorta.

Solution

Carefully withdraw the suture needle when bleeding of this type occurs, aspirate the blood and then use a blunt-ended grasping instrument to place gentle pressure over the bleeding site.

Outcome

Bleeding stops and the operation proceeds satisfactorily

Analysis

A needle puncture of the aorta can occur when placing the first posterior hiatal repair suture. If the needle is withdrawn, the bleeding will stop. Care must be taken to avoid tearing the aorta, as this will precipitate more profuse bleeding, with the need for formal vascular repair. If this type of bleeding occurs, never tie the suture knot as doing this will tear a larger hole in the side of the aorta.

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Single-Access-Laparoscopy and Foregut-Surgery from Giovanni Dapri

Giovanni Dapri

M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations*,
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12.1 Introduction

Laparoscopic surgery is considered to be among the most significant surgical advances of the twentieth century. The benefits of laparoscopic surgery over open surgery include fewer adhesions, reduced postoperative pain, a shorter length of stay, faster return to daily activities, and improved cosmesis [1, 2]. Recently, the natural orifice transluminal endoscopic surgery (NOTES) further enhanced the cosmetic benefits of minimally invasive surgery – while minimizing potential morbidity that is associated with multiple incisions – by introducing single (S)-incision, single-port, single-access laparoscopy (SAL). Studies investigating the efficacy of SAL have demonstrated the safety and feasibility of this technique [3]. However, other potential advantages such as reduced pain and a reduction in access-invasivity require further investigation.

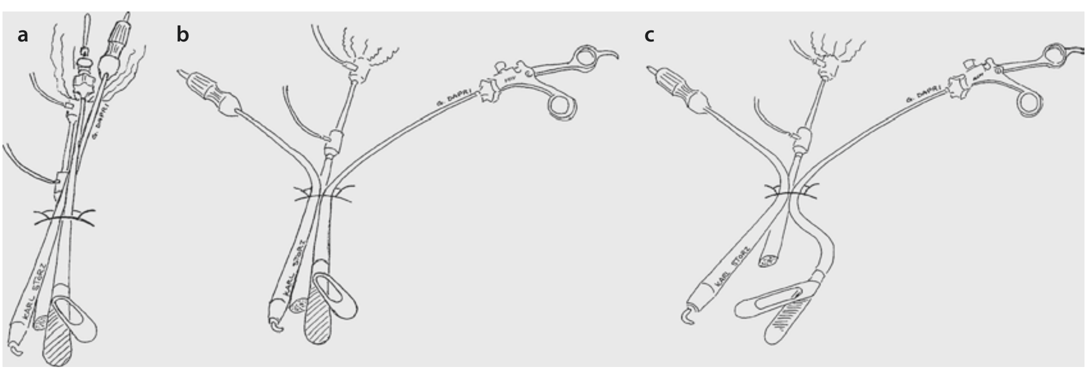
One of the challenges during SAL, in which only a single access is used, is the conflict between the surgeon's hands and the camera assistant. In addition, instruments can clash, and their tips can cross. Moreover, the procedure is more costly, due to the disposable materials that are used [4, 5]. Other challenges include patient selection for the procedure in terms of body mass index (BMI), previous abdominal surgery, the surgeon's learning curve, and the exposure of the operative field [6, 7].

In this chapter, some of the foregut laparoscopic procedures (e.g., S-Nissen Fundoplication, S-Gastric Resection, and S-Gastric Ulcer Repair) performed through SAL are described. The technique that is reported here was developed while considering the primary role of laparoscopy being the optical system as the bisector of working triangulation [8]. Therefore, the classic straight laparoscopic instruments (◘ Fig. 12.1a) have been curved outside the umbilicus (◘ Fig. 12.1b), thereby providing improved working ergonomics, and inside the access (◘ Fig. 12.1c), thus establishing the classic laparoscopic working triangulation. The technique that is described uses curved reusable instruments that are inserted transumbilically into the abdomen without the use of a trocar, together with an 11-mm reusable trocar for a regular 10-mm optical system, which keeps the cost of the procedure similar to the multi-trocar laparoscopy, due to the reusable materials that are employed.

12.2 Technique

12.2.1 S-Foregut Surgery: Patient Position, Umbilical Access, and Instruments

The patient is placed in the supine position with the arms alongside the body and the legs abducted. The surgeon stands between the patient's legs, the camera assistant stands at the patient's right, and the scrub nurse stands at the patient's left (◘ Fig. 12.2). The umbilicus is incised, and the peritoneal cavity is entered using the Hasson technique. A purse-string suture using 1 polydiaxone (PDS) is placed in the umbilical fascia at the 2, 4, 6, 8, 10, and 12 o'clock positions. A reusable 11-mm trocar and a 10-mm, 30°-angled, rigid, standard-length scope (Karl Storz Endoskope, Tuttlingen, Germany) are used. Once the pneumoperitoneum is established, curved



◘ **Fig. 12.1** The concept of the curved instruments is based on the straight classic instruments **a** of the triangulation angle, both externally **b** and inside the abdominal cavity **c**

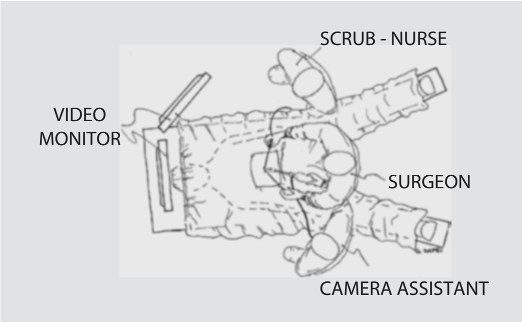


Fig. 12.2 The patient and team positionings

reusable instruments according to DAPRI (Karl Storz Endoskope, Tuttlingen, Germany) are inserted transumbilically without trocars. Curved grasping forceps I (Fig. 12.3a, S-Gastric Ulcer Repair) and curved grasping forceps III (Fig. 12.3b, S-Nissen Fundoplication, S-Gastric Resection) are used in the surgeon's nondominant hand and are inserted through the umbilical fascia using a separate opening that is outside of the purse-string suture at the 10 o'clock position. The instruments for the surgeon's dominant hand include a curved coagulating hook (Fig. 12.3c), a curved scissors (Fig. 12.3d), a curved bipolar scissors (Fig. 12.3e), a curved needle holder I (Fig. 12.3f, S-Gastric Ulcer Repair), a curved needle holder II (Fig. 12.3g, S-Nissen Fundoplication, S-Gastric Resection), and a curved suction device, all of which are introduced alongside the 11-mm trocar inside the purse-string suture (Fig. 12.4).

Once the 11-mm trocar and the curved instruments have been inserted in the umbilicus, the purse-string suture is adjusted to maintain a tight seal around the 5-mm instruments and the 11-mm trocar, and the suture is opened only to

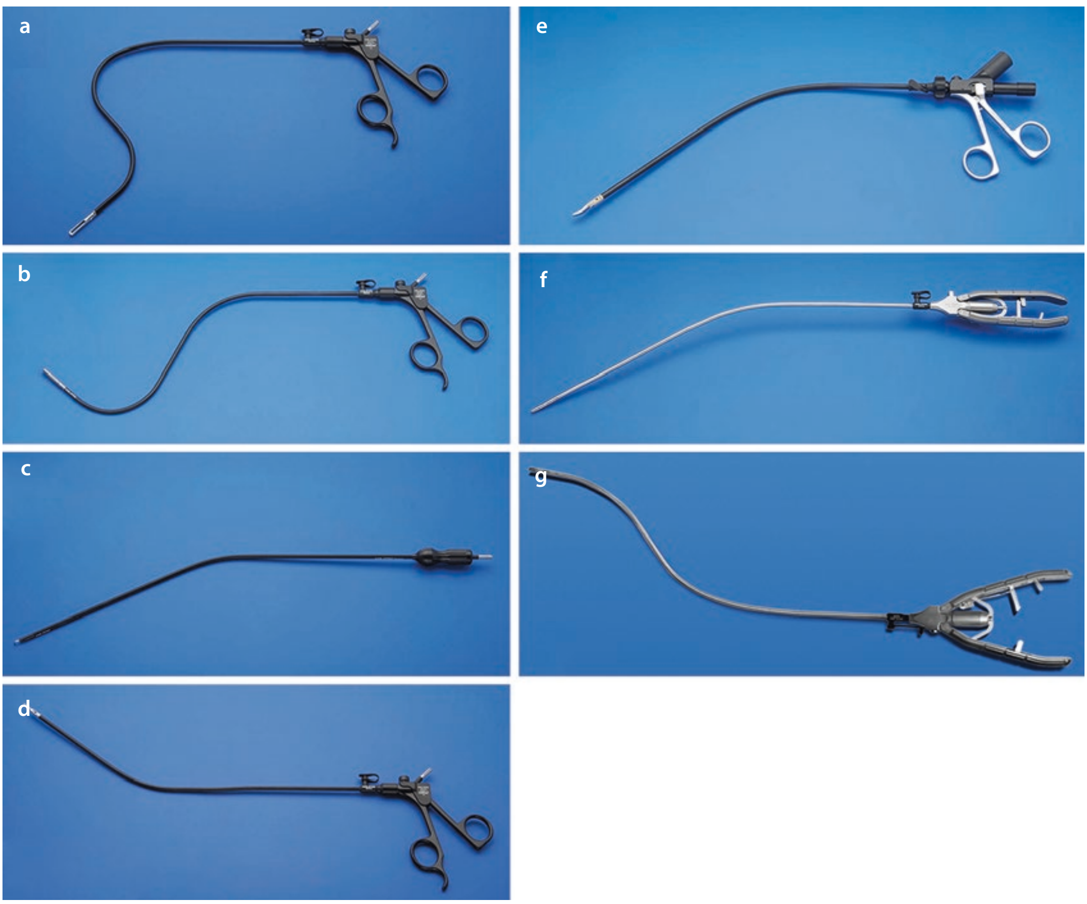


Fig. 12.3 Curved reusable instruments according to DAPRI (Courtesy of Karl Storz – Endoskope, Tuttlingen, Germany): **a** grasping forceps I, **b** grasping forceps III, **c** coagulating hook, **d** scissors, **e** bipolar scissors, **f** needle holder I, **g** needle holder II

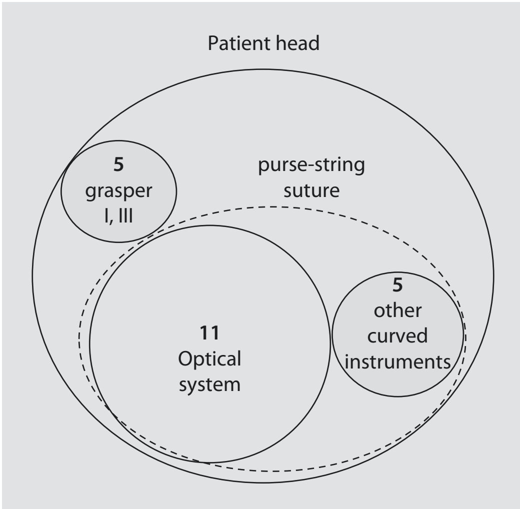


Fig. 12.4 Placement of the curved instruments, optical system, and purse-string suture through the umbilicus

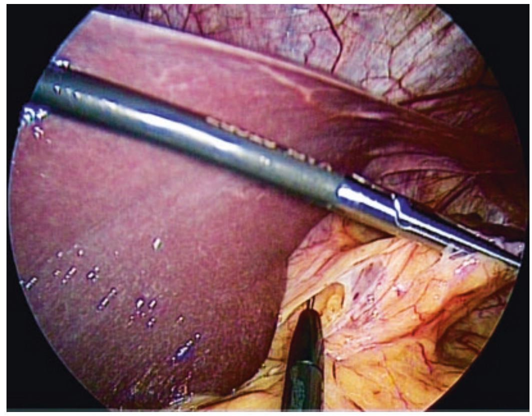


Fig. 12.5 The distal curve of the grasping forceps III permits the retraction of the left liver lobe simultaneously to the exposure of the hepatogastric ligament for the dissection

permit the change of tools to the surgeon's dominant hand, or for the evacuation of smoke that is created during the dissection.

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12.2.2 S-Nissen Fundoplication

The curved grasping forceps III keeps the distal curve to retract the left liver lobe and expose the hiatal region simultaneously to the dissection of the hepatogastric ligament by the coagulating hook (Fig. 12.5). Both the phrenogastric ligaments and the diaphragmatic crura are freed to expose the lower esophagus (Fig. 12.6). A piece of umbilical tape is inserted in the abdomen through the 11-mm trocar using a straight grasper, and is used to encircle the gastroesophageal junction, thereby increasing the exposure of the hiatus (Fig. 12.7). Tension is maintained on the umbilical tape, thus permitting the complete preparation of both of the crura for plasty. Stitches using 2/0 silk are introduced in the abdomen through the 11-mm trocar using a straight grasper. Cruraplasty is performed using figure of 8 sutures with intracorporeal knots (Fig. 12.8). The gastric fundus is moved behind the lower esophagus, and the short gastric vessels are dissected "à la demande" by a medial-to-lateral

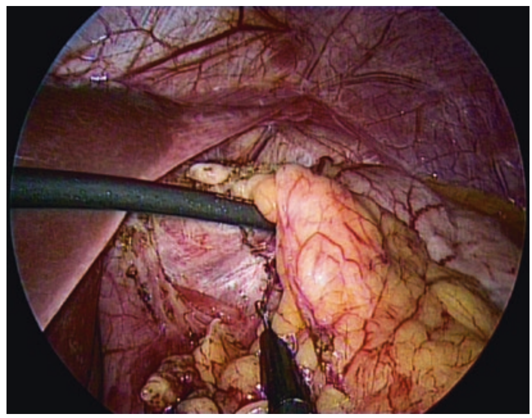


Fig. 12.6 Both of the diaphragmatic crura are freed until to expose the lower esophagus

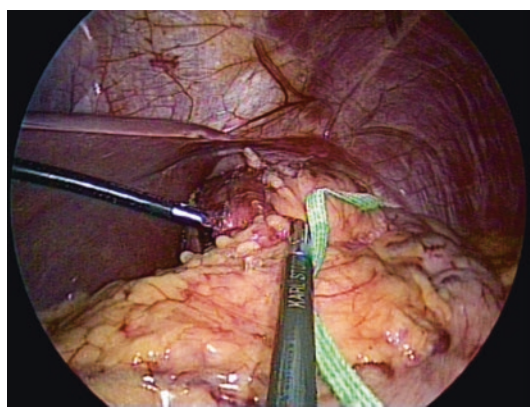
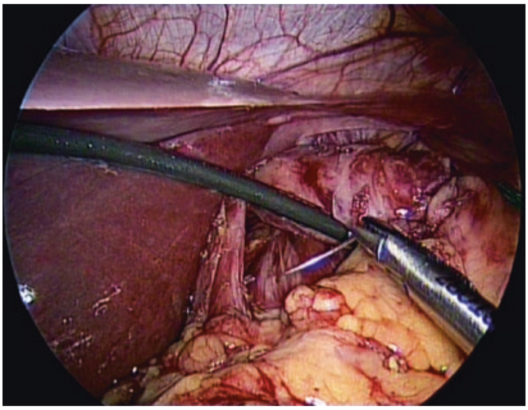
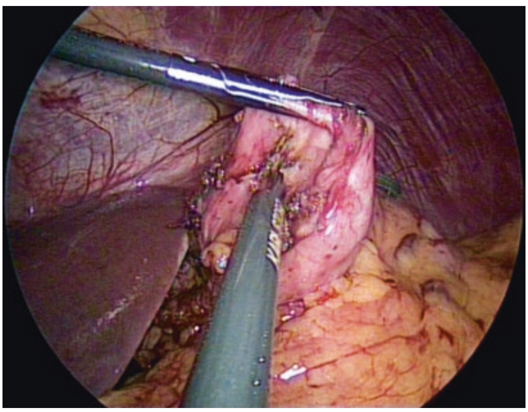


Fig. 12.7 The lower esophagus is encircled by a piece of umbilical tape

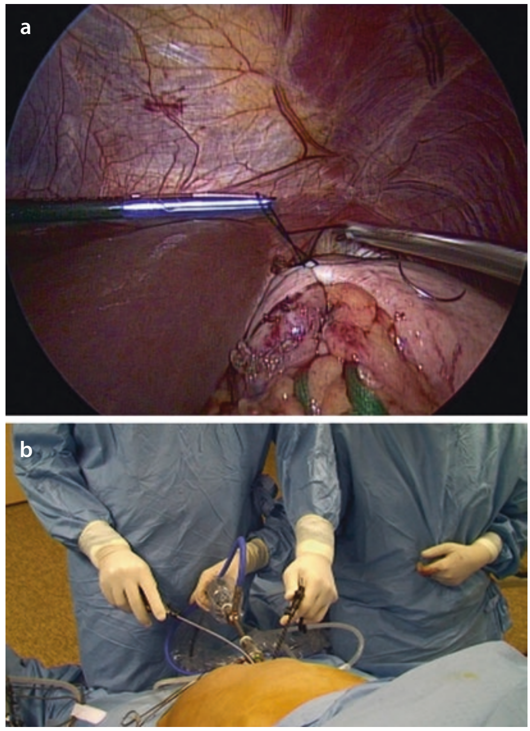


◘ **Fig. 12.8** The cruraplasty is performed easily due to the opening jaw position of the curved needle holder II (45° angle with respect to the main shaft)

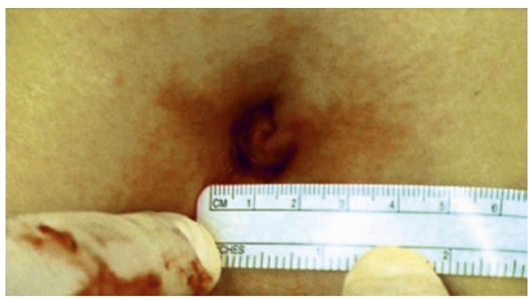


◘ **Fig. 12.9** The short gastric vessels are freed "à la demande" after they pass the gastric fundus behind the lower esophagus (using a medial-to-lateral approach)

approach using a coagulating hook or bipolar scissors (◘ Fig. 12.9). A 34-Fr orogastric bougie is inserted transorally by the anesthesiologist. A floppy 360° fundoplication is performed using intracorporeal knots (◘ Fig. 12.10a), and thanks to the curvature of the instruments, the surgeon can perform the entire procedure in an ergonomic position with flexed arms (◘ Fig. 12.10b). At the end of the procedure, the orogastric bougie, umbilical tape, stitches, and curved instruments are removed under control. Absorbable sutures are used to close both the umbilical fascia and the separate opening that was used for the grasper. The final scar length is approximately 15 mm (◘ Fig. 12.11).



◘ **Fig. 12.10** Because of the curvature of the instruments, a working triangulation is established inside the abdomen **a**, and the surgeon can work ergonomically with flexed arms **b**



◘ **Fig. 12.11** The final scar length

12.2.3 S-Gastric Resection

(The resection of benign or borderline lesions such as gastrointestinal stromal tumor (GIST), carcinoid, and others can be performed using SAL [9]).

Perioperative gastroscopy is used to locate the endoluminal gastric lesion (e.g., in the case of a smaller gastric curvature, 1 cm down to the gastroesophageal junction). A stitch using 2-0 Vicryl

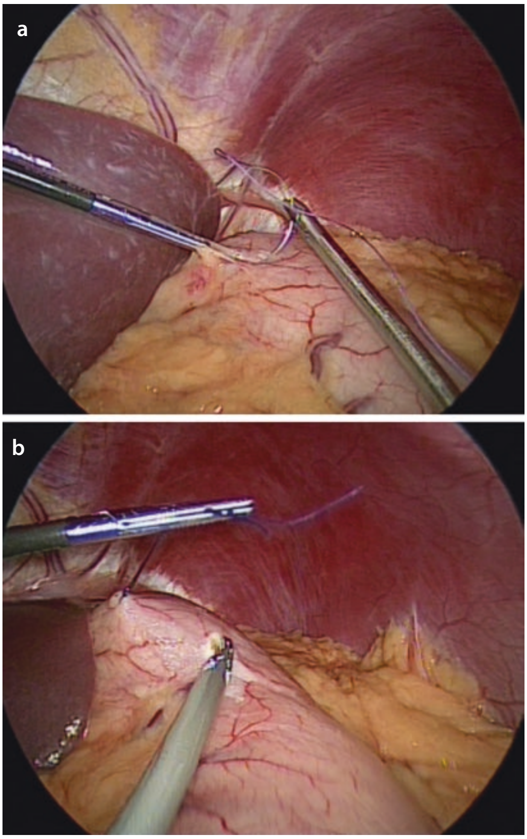


Fig. 12.12 A superficial simple suture is placed in the center of the lesion under endoscopic control **a** to retract the lesion for dissection **b**

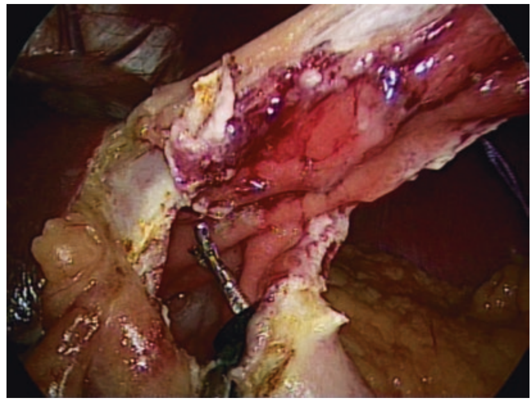


Fig. 12.13 A gastroscopic grasper is used to delineate the edges of the resection

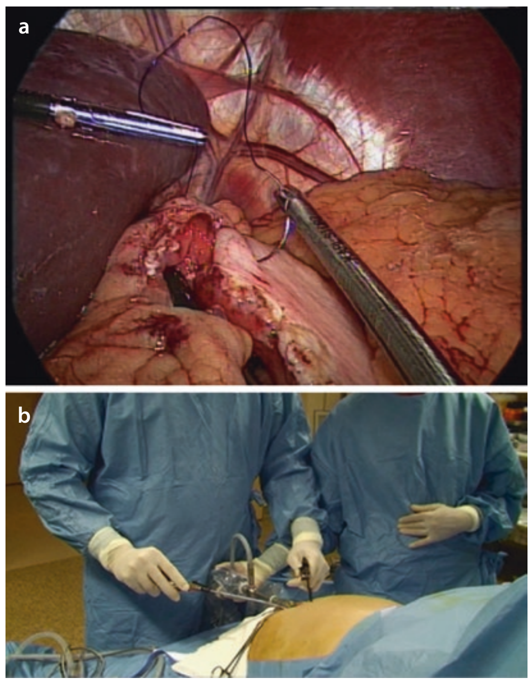


Fig. 12.14 Because of the curvature of the instruments, no conflict exists between the instrument tips within the abdomen **a**, or between the surgeon's hands outside of the abdomen **b**

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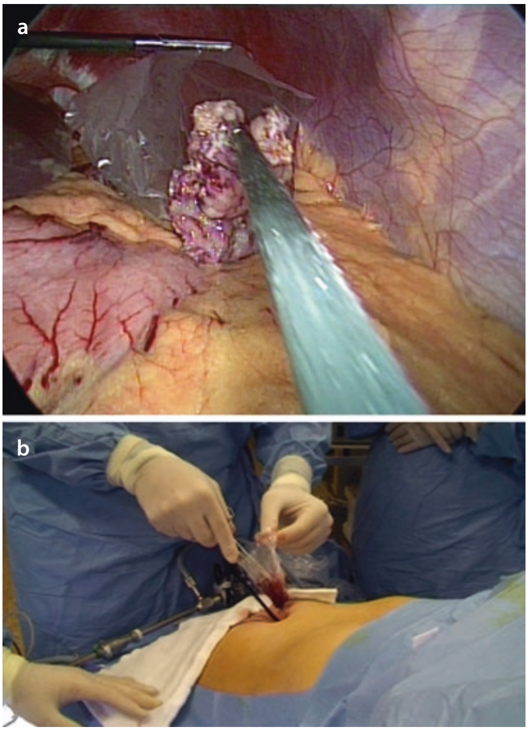
is introduced in the abdomen through the 11-mm trocar using a straight grasper, and a superficial simple suture is placed in the center of the lesion under endoscopic control (Fig. 12.12a) to retract the lesion for dissection (Fig. 12.12b). Harmonic shears (Ethicon Endo-surgery, Cincinnati, OH, US) are introduced together with the other curved instruments for the surgeon's dominant hand (alongside the 11-mm trocar and inside the purse-string suture), and the lesion is full-thickness resected; a gastroscopic grasper is used to help delineate the edges of the resection (Fig. 12.13). The gastrostomy can be closed using a stapler line; however, to avoid potential stricture, two converting absorbable 2/0 PDS running sutures are inserted in the abdomen via the 11-mm trocar and implanted. Because of the curvature of the instruments, there is no conflict between the tips of the instruments inside the abdomen (Fig. 12.14a) or between the surgeon's hands outside the abdomen (Fig. 12.14b). Finally, a leak-test using the gastroscope is performed to test the integrity of the suture. A custom-made plastic bag is introduced through the 11-mm trocar using a straight grasper (Fig. 12.15a), and the specimen is retrieved through the umbilicus (Fig. 12.15b). At the end of the procedure, the stitches and curved instruments are removed under control. Both the umbilical fascia and the separate opening that was used for the grasper are



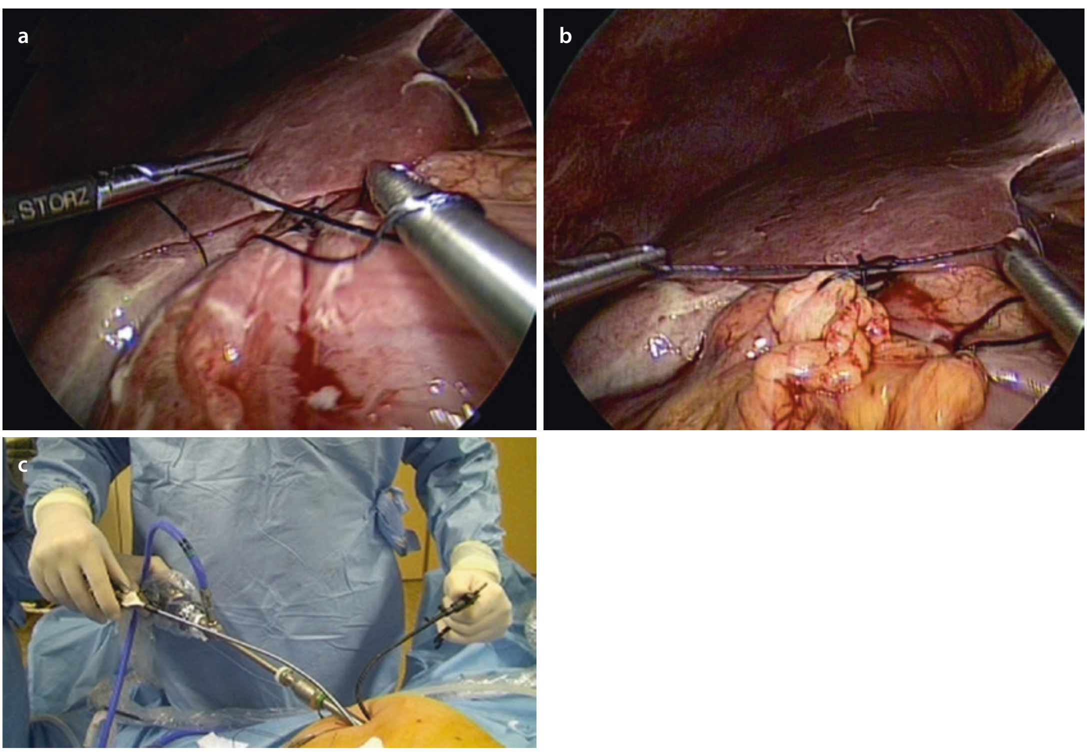
◘ **Fig. 12.15** A custom-made plastic bag **a** is used to remove the specimen through the umbilicus **b**

closed using absorbable sutures. The final scar length is approximately 15 mm.

12.2.4 S-Gastric Ulcer Repair

(In patients who present with peritonitis, laparoscopy allows the diagnosis and in most cases the treatment. A simple exploration of the abdominal cavity can reveal the presence of a perforated gastric ulcer, and in early diagnosis, SAL is feasible [10]).

The procedure begins with the localization of the perforation after using a curved suction device to obtain a bacteriological sample of the free liquid that is usually located in the hepatorenal (Morison's) pouch or in the pelvic (Douglas') pouch. A percutaneous stitch is passed from the left hypochondrium into the falciform ligament to improve exposure of the gastric antrum, the pylorus, and the first duodenum. 2/0 silk stitches are inserted in the abdomen through the 11-mm trocar using a straight grasper. The gastric ulcer is repaired using one or two figures of 8 sutures (◘ Fig. 12.16a) and is covered using simple stitches for omentoplasty (◘ Fig. 12.16b) with an ergonomic position that is



◘ **Fig. 12.16** Repair of the gastric ulcer using figures of 8 sutures **a**, omentoplasty **b**, and in an ergonomic position that is similar to multi-trocar laparoscopy **c**

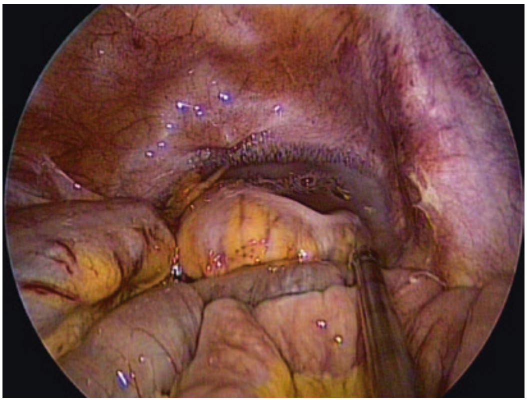


Fig. 12.17 Final lavage of the cavity

similar to multi-trocar laparoscopy (Fig. 12.16c). The procedure is completed with irrigation of the abdominal cavity with saline solution (Fig. 12.17). The nasogastric tube (which was inserted at the beginning of the laparoscopy) is kept in place under smooth suction. The instruments and stitches are removed under view, and both the umbilical fascia and the separate window that was used for the grasper are meticulously closed. The final scar length is approximately 15 mm.

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12.3 Discussion

In the S-Foregut Surgery technique that has been described here, the curved grasping forceps I and III are introduced into the abdomen through a separate opening in the umbilical fascia. This is a specific trick to prevent leakage of the pneumoperitoneum throughout the entire S-procedure. The grasper in the surgeon's nondominant hand (e.g., the left hand) is not changed throughout the S-procedure, which is in contrast to the other curved instruments in the surgeon's dominant hand (e.g., the right hand), which are repeatedly changed during the various steps of the procedure. Thus, placement of a purse-string suture in the umbilical fascia at the beginning of the procedure is essential for maintaining a sufficient pneumoperitoneum. This suture is opened only to permit changing the instruments in the surgeon's dominant hand or to evacuate the smoke that is created during the dissection. A thick sliding stitch such as a 1 PDS stitch is suggested for the umbilical purse-string suture.

The curved grasping forceps I and III and the curved needle holder II mainly provide two curves. One curve is at the umbilicus, thus preventing a conflict between the surgeon's hands and the optical system outside the access area, and the other curve is between the umbilicus and the instrument's tip, thereby establishing the internal working triangulation. Furthermore, the distal curve of the grasper III has been drawn to retract the left liver lobe superiorly, thereby increasing the exposure of the hiatal region. Other valid alternatives that can be used to increase the exposure of the hiatus are the placement of a Penrose drain under the left liver lobe [11, 12], percutaneous stitches at the crura junction [13], percutaneous stitches through the liver [14], the suspension of the liver using an EndoCinch [15], or the insertion of a millimetric wire such as Veress needle [16]. In addition, in the case of a gastric lesion or perforation in the antrum, pylorus, or first duodenum, placing percutaneous stitches from the left hypochondrium into the falciform ligament can improve the exposure of the operating field.

The curved coagulating hook, the curved scissors, the curved bipolar scissors, the curved needle holder I, and the curved suction device have a similar shape and create only one curve, thus preventing a collision between the surgeon's and the assistant's hands outside of the umbilicus. Moreover, the open jaws of the curved needle holders I and II are placed at a 45° angle with respect to the main shaft; this position permits only a quarter rotation of the surgeon's wrist to pass or remove the needle in the tissue, thereby preventing potential damage by the curves in the internal viscera.

All of the curved instruments must be inserted into and removed from the abdomen following their curves while maintaining a 45° angle with respect to the abdominal wall.

Because of the curved shape of the instruments, the surgeon can perform the entire procedure in an ergonomic position that is similar to a multi-trocar laparoscopy, as clashing of the instrument tips or crossing of the surgeon's hands rarely occurs during the SAL procedure [4, 5]. Clearly, however, a learning curve is needed to understand the manner in which the curved instruments should be maneuvered, and in which way the sutures should be placed. Hence, the selection of patients to undergo to S-Foregut Surgery remains an important challenge [6, 7], and the surgeon should exclude patients whose BMI exceeds 35–40 kg/m^2 or who are taller than 1.80 m. In addition, giant hiatal hernia, the difficult localization of benign gastric lesions, diffuse peritonitis and the difficult localization of a perforated gastric ulcer are all contraindicated for S-Foregut Surgery. Using this procedure in the above cases increases the difficulty of the transumbilical approach, increases the duration of the S-procedure, and increases the risk of peri- and postoperative complications.

Finally, because of this technique, the umbilical scar length is similar to the scar that results in multi-trocar laparoscopy using a 12-mm trocar, as only one reusable 11-mm trocar is inserted in the umbilicus, and the curved instruments are advanced in the abdomen without trocars. This feature, combined with the fact that all of the materials that are used are reusable, keeps the cost of S-Foregut Surgery similar to the cost of multi-trocar laparoscopy.

I.	Ideal cases (i.e., easy to operate, no problems)
II.	Not quite ideal cases (some minor difficulties may occur)
III.	Problematic cases (difficult to operate, some operative techniques are considerably more difficult than others)
IV.	Very problematic ("horrible") cases (every operative step is difficult)

Classification of patients according to intraoperative difficulty (I to IV) for single-incision laparoscopy and foregut surgery:

I. Female patients, not tall, BMI <25 kg/m^2, no giant hernia (if hiatal), no peritonitis (if perforated ulcer), small tumor (if gastric resection), no previous abdominal surgery
II. Male patients, quite tall, BMI >30 kg/m^2, previous abdominal surgery
III. Male and tall patients, BMI >40 kg/m^2, large hepatomegaly, giant hernia (if hiatal), diffuse peritonitis (if perforated ulcer), huge tumor (if resection), previous major abdominal surgery with adhesions
IV. Male patients, high BMI, large hepatomegaly, intrathoracic giant hernia (if hiatal), late diagnosis and diffuse peritonitis (if perforated ulcer), advanced tumor (if resection), previous major abdominal surgery with adhesions

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Gastric Bypass After Failed Fundoplication from Dimitrios Stefanidis

Dimitrios Stefanidis

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13.1 Introduction

Gastroesophageal reflux disease (GERD) affects 40 % of the American population and has a clear association with obesity. With the incidence of obesity rising at alarming rates in the USA, the prevalence of GERD is also increasing [1, 2]. Some studies have even described a dose–response relationship between obesity and GERD [2]. Even though the mainstay of GERD treatment is pharmacologic, select patients may benefit from surgery [3]. Laparoscopic gastric fundoplication is considered the gold standard for the surgical management of GERD, as it is associated with low morbidity, early recovery, and excellent outcomes [3]. Nevertheless, long-term patient follow-up data have cast doubts about the long-term efficacy of the procedure as a considerable percentage of patients have symptom relapse and restart acid-reducing treatment [4]. Importantly, evidence suggests that fundoplications are associated with a higher incidence of failure in the obese compared with the nonobese [5].

Patients who fail their initial fundoplication present a considerable challenge for the surgeon. While redo fundoplication has been shown in a recent review of the literature to be effective in 81.5 % (65–100 %) of patients at a median of 18 months after surgery, success rates are lower than after primary fundoplication [6]. Importantly, recent longer-term evidence suggests that treatment failures even for experienced surgeons increase over time with an estimated 50–63 % failure rate at 10 years [7]. Moreover, redo fundoplication is associated with a higher incidence of intraoperative and postoperative complications compared with primary fundoplication [6]. Since obesity is associated with higher failure rates, and laparoscopic Roux-en-Y gastric bypass (LRYGB) induces profound weight loss with comorbidity improvement including GERD resolution [8], when considering a redo operation in the obese population, a LRYGB appears to be a better alternative than redo fundoplication [9, 10]. Moreover, given the high long-term failure rates of redo fundoplication, a LRYGB may be a better alternative for GERD relapse in general. In this chapter, the author will describe his experience with laparoscopic revision of failed fundoplication to Roux-en-Y gastric bypass (RYGB).

13.2 Preoperative Assessment

All patients undergo extensive workup before surgery that includes a detailed history and physical examination, an upper gastrointestinal series (UGI), upper endoscopy, gastric emptying study, and pH testing and/or manometry if the origin of the patient's symptoms is not evident on endoscopy or UGI. In addition, they undergo preoperative risk assessment and medical clearance in anticipation of a prolonged procedure and a consultation with a nutritionist with experience with gastric bypass surgery.

13.3 Operative Technique

All patients receive preoperative antibiotics (cefazolin 2 g IV and metronidazole 500 mg IV) and deep venous thrombosis prophylaxis (5,000 U subcutaneous Heparin or 30 mg of Lovenox and sequential compression devices). A Foley catheter is placed and, depending on the age and comorbidities of the patient, invasive monitoring may be instituted. The patient is positioned supine with both arms out. A footboard is placed, and the patient is attached securely to the bed to allow steep reverse Trendelenburg position. Two monitors are placed at either side of the patient's head at the eye level of the surgeon and assistant. The surgeon stands on the right side of the table and the assistant on the left; a camera operator is also required to drive a 30° 10-mm scope. A five-trocar technique (three 12-mm and two 5-mm disposable trocars) is used, and a Nathanson liver retractor is placed in the subxiphoid position to retract the left lobe of the liver up to expose the hiatus (often this retractor is not needed, as the left lobe of the liver is adherent to the diaphragm and is self retracted) (Fig. 13.1).

The peritoneal cavity is accessed using the Optiview technique (5-mm noncutting trocar) in a lateral location of the left or right upper quadrants away from previous scars to avoid intra-abdominal injuries. Pneumoperitoneum to 15 mmHg is established, and the remaining trocars are introduced under direct visualization. If needed, the Nathanson retractor is placed later during the case. The initial step of the procedure is to divide any adhesions between the omentum and/or bowel and the abdominal wall to gain access to the upper abdomen and the hiatus and to be able to introduce all trocars. Such adhesions are

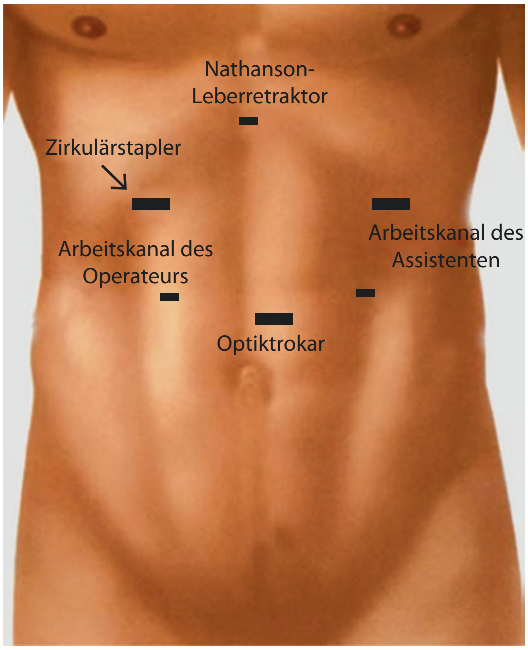

Fig. 13.1 Trocar positioning

common after previous open fundoplication. My preference is then to dissect the left lobe of the liver off the stomach (usually densely adherent) until the caudate lobe and the right crus are seen. I find that there usually is an unscarred plane between the caudate lobe and the right crus, which when entered allows the surgeon to more easily define the anatomy in an otherwise scarred and anatomically obscure hiatus. An accessory left hepatic artery can often be found in this plane and should be anticipated; if small, I usually take it but otherwise preserve it. The surgeon needs to be very careful not to injure the vena cava, which is close to the right crus. During this dissection, the surgeon uses his left hand to retract the liver away from the stomach and harmonic scalpel or cold scissors in the right for safe dissection, while the assistant uses his right hand to retract the stomach toward the spleen and the left hand to provide counter traction to the surgeon. A suction device in the left hand of the assistant may be very useful to remove blood from the operating field.

The dissection then continues between the right crus and the stomach/ esophagus and is carried anteriorly toward the left crus. The anterior vagus should be identified during this step, but it is often impossible due to dense scar tissue. Once the limits of this dissection are reached, the dissection is shifted to the left side of the stomach and the greater curve. Any remaining short gastric vessels are taken safely with the harmonic scalpel, and the dissection continues cephalad until the left crus is encountered. The two planes of dissection are connected, and the stomach and esophagus are separated carefully from the crura. Scar tissue can be dense in this area due to previous crural stitches. Given that anatomic planes can be very obscure, dissecting near any identified stitches can minimize the risk for gastric or esophageal injuries. A Penrose drain should be passed behind and wrapped around the esophagus to act as a handle for the assistant to retract the esophagus and stomach outside the mediastinum and facilitate esophageal dissection high into the mediastinum. This dissection can be challenging due to scarring from the previous operation(s) and the presence of a herniated wrap which is not uncommon. The posterior vagus should be identified and preserved during this step if possible.

Once an adequate length of esophagus (>2–3 cm) is restored intra-abdominally, the most tedious part of this procedure begins which is taking down the previous fundoplication. The surgeon's patience is tested during this step and slow, very careful dissection is key to avoid enterotomies, as planes are usually obscured. In general, it is easier to start the dissection at the lowest aspect of the fundoplication and develop the plane between the stomach and the fundoplication. This plane is often less scared and, once developed, allows lifting the wrap up from the esophagus making its separation easier and safer. The sutures of the previous fundoplication are very helpful in orienting the surgeon to the area where he/she needs to divide the fundoplication but are not always visible immediately. Some surgeons divide the fundoplication with a stapler but this is not my preference. In the case of a posterior partial fundoplication, each side needs to be separated from the stomach and esophagus carefully. Once the wrap is undone, the stomach should be returned back to its anatomic position by dissecting the wrap off its posterior attachments to the stomach. Occasionally, a previously undissected hiatal hernia sac may be encountered during this dissection making recognition of anatomic planes even more challenging. Complete takedown of the fundoplication should be guided and confirmed by intraoperative endoscopy.

The last part of the procedure is the creation of the gastric bypass, which tends to be the easiest and most straightforward part of the operation. A gastric pouch is created using a linear stapling device and thicker than usual staple loads (green), often with staple line reinforcement. Unlike a regular RYGB where pouch creation is started at the lesser curvature, these cases often require that the division of the stomach starts at the greater curvature and progresses toward the lesser. This approach is aided by the previous division of the short gastric vessels, minimizes bleeding at the usually scarred lesser curvature, and avoids disrupting blood supply to the pouch. When this horizontal transection is completed, the fundus that was wrapped around the esophagus is divided vertically and removed leaving a small lesser curve-based pouch for anastomosis with the jejunum. The removed fundus is often the area where enterotomies occur and often appears ischemic at the end of the dissection. The size of the pouch is tailored to the patient's BMI. In obese patients, a small 30-cc pouch is created, whereas in normal weight patients, a slightly larger pouch is created. A very large pouch should be avoided as it may predispose patients to future anastomotic ulcerations as a result of acid secretion. If patients have preoperative evidence of gastroparesis, however, the pouch is created small independent of the BMI to avoid bezoar formation in the future. Gastroparesis is not uncommon in this patient population and should be looked for preoperatively. The anvil of a 25-mm circular stapler is then introduced via the mouth at the end of an orogastric tube DST Series™ EEA™ OrVil™ Device, Medtronic, MInneapolis, MN and exteriorized and left in place at the most dependent and mobile portion of the pouch. The jejunum is then divided approximately 50 cm from the ligament of Treitz or at an area that allows the bowel to easily reach the hiatus. A 100-cm Roux limb is measured. A jejunojejunostomy is then created between that point of the Roux and the cut end of the biliopancreatic limb using 60-mm linear staple loads (white) fired in opposite directions to minimize narrowing of this anastomosis during closure of the enterotomies. The enterotomies are closed with another firing of the same stapler. The 25-mm EEA stapler is then introduced via the right upper quadrant trocar site inside the cut end of the Roux; its spike exteriorized through the antimesenteric border of the Roux and connected to the anvil in the pouch. An antecolic antegastric circular-stapled gastrojejunostomy is then performed. The anastomosis is checked by endoscopy for leaks or bleeding, which is addressed if present. The quality of the resected "tissue donuts" is also examined. Finally, both mesenteric defects (jejunojejunostomy and Peterson's) are closed with a running permanent suture to avoid postoperative internal hernias.

Before leaving the operating room, a decision is made about whether to place a gastrostomy tube in the gastric remnant. While leaving a gastrostomy tube can prove invaluable in the postoperative course of some patients, it can also lead to significant complaints by patients that do not need it. The tube is placed laparoscopically using either a Stamm technique, if the remnant can easily reach the abdominal wall, or a Witzel technique, if remnant mobility is limited. In general, I prefer to leave a gastrostomy tube in patients after a very difficult procedure, in patients who are normal weight or had significant weight loss before the surgery to support their nutrition and minimize weight loss after surgery, or in any high-risk patient. A drain is not routinely left under the anastomosis unless specific concerns about the anastomosis exist.

13.4 Special/Unusual Situations

As previously mentioned, patients with previous open procedures usually have incisional hernias at their upper midline incision. These hernias need to be repaired, ideally with a biologic mesh, during the procedure. If the hernia is not repaired or individual defects are closed primarily with suture (the surgeon may be tempted to do this at the end of a very long and difficult laparoscopic case), the risk of postoperative bowel obstructions may be significant. The author has encountered most postoperative problems in this patient subgroup, and therefore an open procedure may be advisable.

Most enterotomies occur at the gastric fundus that was wrapped around the esophagus. Often, that part of the stomach also appears to have compromised blood supply. By removing it, the chance for postoperative leaks from a recognized and repaired or a missed enterotomy is likely decreased.

Holes in the esophagus represent a more difficult challenge for the surgeon. In one case, the author encountered a hole in the anterior esophagus after dissection of the esophagus and stomach from the left lobe of the liver in a patient with a history of multiple prior antireflux procedures including a prior Angelchik procedure and later removal of the device. To address this issue, the author created a longer pouch in the horizontal axis, folded the extra fundus over and sutured it to the anterior esophagus to cover the esophageal hole similar to a Dor fundoplication. This patient did not have to be converted to an open procedure but took considerably longer to complete. The patient did very well.

Another very important aspect is the use of appropriate size staplers. Tissues are scarred and staple formations are more likely to fail if the increased thickness of the tissues is not accounted for by the surgeon. In addition, while the author usually creates his gastrojejunostomy in an antecolic antegastric fashion with a transoral circular stapler, he uses a hand-sewn anastomosis and/or a retrocolic Roux limb if tissue mobility, thickness, and the presence of anastomotic tension dictate. Moreover, in exceptionally difficult cases if the dissection in the hiatus is unsafe due to very dense scar tissue, it may be prudent to create a longer transverse gastric pouch without taking the fundoplication down and the anastomosis in an area of the pouch where the tissue quality is better. This approach is suboptimal but may need to be adopted for patient safety. The author has had to adopt this approach in a patient after a previous Collis–Nissen procedure complicated by a postoperative leak. The tissues at the time of surgery were extremely scarred and dissection unsafe in the hiatus. On the other hand, the author also had to revise a patient 5 years after she had this approach at another facility. While the patient's reflux symptoms had initially resolved for 3–4 years, they became severe again necessitating taking down the fundoplication and making the pouch small by the author.

13.5 Postoperative Course

All patients are monitored closely postoperatively using continuous pulse oximetry and heart rate monitoring in the appropriate hospital setting. Older and sicker patients may be kept intubated overnight in the intensive care unit. A swallow study is obtained selectively the day after surgery, and the patients are started on a liquid diet. They are discharged home 2–4 days later when they can tolerate their diet, are comfortable moving, and have no other concerning issues. The author has performed over 70 of these procedures in the last 7 years with good results. All procedures have been completed laparoscopically without conversions; however, three patients required a laparotomy and two a laparoscopy in the early postoperative period due to bowel obstruction. No mortalities have been encountered, and one leak at the gastrojejunal anastomosis occurred. All patients have had resolution of their preoperative symptoms and excellent reflux control immediately after surgery. Adjustment to the eating limitations of RYGB has been challenging for a small proportion of patients early after surgery, but overall patient satisfaction has been excellent. It should be noted that these patients should be investigated aggressively after surgery if any concerning symptoms/signs occur to allow for early reintervention if needed.

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Individual Surgery for Gastric Gastrointestinal Stromal Tumors

Contents

Introduction

Michael Korenkov, Christoph-Thomas Germer, and Hauke Lang

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Compared with stomach cancer, gastric gastrointestinal stromal tumors (GIST) are much better suitable for laparoscopic techniques. An opportunity to perform a local tumour resection without lymphadenectomy as well as a good response of GISTs to chemotherapy all these factors may favour choosing of laparoscopic approaches.

When planning of the surgical procedure, the following factors should take into account:

- Tumor position (lesser or greater curvature, anterior or posterior gastric wall)
- Tumor growth (exophytic or endophytic)
- Distance from gastroesophageal junction (enough (>2 cm) or not enough)
- Distance from the pylorus (enough (>2 cm) or not enough)
- Local tumor proliferation (local limited or local advanced with the contact to surrounding structures)
- Risk of violation of the GIST pseudocapsule
- Distant metastases (available or not available)
- Depending on these factors, different surgical techniques can be used:
- Laparoscopic wedge resection, in some cases – sleeve gastric resection (see contribution from M. Gagner)
- Intragastric resection (via trocars)
- Transgastric resection (via gastrotomy)
- Partial or total gastrectomy
- Multivisceral resection

Laparoscopic gastric wedge resection (GWR) is the treatment of choice for a tumor located in most of the body of the stomach, along the greater or lesser curvature, and involving the anterior or posterior wall. Tumors positioned at or near the EGJ or pylorus, large intraluminal tumors, or tumor adherence to surrounding structures often create significant challenges for a laparoscopic approach due to poor visualization and/or inability to reliably achieve tumor-free margins.

Resection of tumors located on the posterior gastric wall or on the lesser curvature can be difficult laparoscopically but may be safely completed in appropriate circumstances. The influence of tumor size on the appropriateness of laparoscopic GWR remains an area of debate.

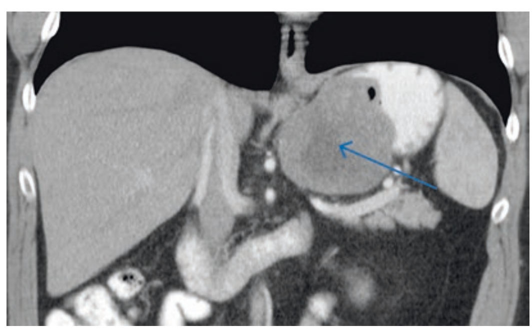
For tumors with endophytic growth, an intraoperative gastroscopy is sometimes necessary for the better tumor identification and occasionally for the definition of resection borders. When indication to laparoscopic GWR is justified, the intraoperative difficulties are not to expect.

14.1 Laparoscopic Transgastric Resection

In cases where laparoscopic GWR may be challenging (large intraluminal tumors, located at the posterior gastric wall or near the EGJ), a laparoscopic transgastric resection may be considered as an alternative. The access to the tumor will be achieved via anterior gastrotomy.

For this step, intraoperative gastroscopy is absolutely necessary. For patients with large intraluminal tumors with the base located >2 cm from the Esophagogastric Junction (EGJ), gastrotomy should be performed longitudinally on the anterior gastric wall. After visualization of the tumor and its base, laparoscopic traction sutures will be placed and the linear stapler resection will be performed.

Before firing the stapler, the posterior gastric wall should be lifted off the underlying structures, including the splenic vessels, celiac axis, and pancreas, to avoid injury. The gastrotomy incision can be closed hand sewn or stapled. The technical difficulties occur most as a consequence of the wrong choosing of this technique. Large exophytic tumors with adherence to surrounding structures provide bad conditions for using laparoscopic transgastric resection (◘ Fig. 14.1, exophytic gastric GIST located on the posterior gastric wall with contact to splenic artery and pancreatic capsule. CT scan courtesy of Dr. Ingrid



◘ **Fig. 14.1** Exophytic gastric GIST located on the posterior gastric wall with contact to splenic artery and pancreatic capsule

Harth, Institute of Radiology, Klinikum Werra-Meissner).

14.2 Combined Laparoscopic/Endoscopic Resection (Intragastric Resection)

Indications for a combined laparoscopic/endoscopic resection are similar to transgastric resection. Instead of gastrotomy, all trocars will be placed intragastric via abdominal and gastric walls. The stapler is introduced via the trocar. The portion of the gastric wall containing the base of the intraluminal tumor is invaginated into the gastric lumen, potentially with traction sutures. Unlike in the more common laparoscopic approach, the resected gastric segment is removed via gastroscopy from the mouth using standard oncologic techniques. The authors have little personal experience with this technique; on this ground we write no comment about technical steps and difficult situation by using this technique.

14.3 Distal Gastrectomy

Indication for a distal gastric resection is usually proximity to the pylorus, such that wedge resection is not possible without narrowing the pylorus. The resection technique is performed according to principles of a “benign” gastric resection, whether open or laparoscopic, with care to achieve a negative margin around the tumor. Technical steps and difficult situations are similar to those encountered in a typical distal gastrectomy, including division of the stomach and proximal duodenal bulb and Billroth I or II reconstruction.

14.4 Subtotal Gastrectomy and Total Gastrectomy

Indication for subtotal or total gastrectomy is a large tumor at or near the EGJ (total) or body/antrum (subtotal) which does not shrink with neoadjuvant imatinib enough to allow a less extensive operation. The resection technique is performed according to principles of gastric resections for benign conditions or other neoplasms, whether open or laparoscopically. Technical steps and difficult situations are similar to those encountered in a typical subtotal or total gastrectomy. Of note, we prefer to avoid a proximal gastrectomy; removing the proximal stomach including the EGJ usually requires transecting the vagus nerves and often leads to profound reflux even after pyloromyotomy or pyloroplasty.

14.5 Multivisceral Resection

The main indication for multivisceral resection is an exophytic tumor growing with adherence to surrounding structures. Although GISTs tend not to directly invade other structures, they may be intimately adherent to adjacent organs (e.g., pancreas, liver, colon, spleen, diaphragm, retroperitoneum) and dissociation without violating tumor margins may be a challenge. If such close proximity has been identified preoperatively, these patients may be treated with neoadjuvant imatinib in order to promote tumor shrinkage prior to resection. If neoadjuvant treatment is unsuccessful, or if adherence is detected intraoperatively, en bloc resection of the GIST with any attached organs or portions thereof is required to minimize tumor spillage and achieve oncologic clearance.

Technical steps and difficult situations are similar to other oncological multivisceral en bloc resections.

14.6 Classification of Intraoperative Difficulties

The operative difficulty for gastric GIST surgery can be classified as summarized in ◘ Table 14.1.

Table 14.1 Grading of operative difficulties for gastric GIST surgery

I.	The ideal case. Surgery is straightforward, and every operative technique is relatively routine	Small to moderate (≤5 cm) tumor size Location on greater curvature or anterior wall of the stomach ≥5 cm far from EGJ or pylorus Typically easy to resect laparoscopically BMI <25
II.	The less-than-ideal case. Some minor technical difficulties may occur; some operative techniques can be more difficult than others	Larger tumors (>5 cm) with location on greater curvature or anterior wall of stomach ≥5 cm far from EGJ or pylorus Small to moderate (≤5 cm) tumor size, location on greater curvature or anterior wall of stomach ≤2 cm far from EGJ or pylorus Small size (<2 cm) with location at lesser curvature of stomach or at the EGJ or pylorus BMI 25–30
III.	The problematic case. Difficult, with some operative techniques considerably more difficult than others	Large (>5 cm) tumor size with location on posterior abdominal wall or at lesser curvature Tumor location or size requiring total gastrectomy and reconstruction Locally advanced GIST requiring concurrent multivisceral resection Re-operative gastric resection with *limited* adhesions BMI >40
IV.	The very difficult case. Every operative step is very difficult	Extreme forms of III

Surgical Technique and Difficult Situations During the Gastric Sleeve Resection from Michel Gagner

Michel Gagner

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15.1 Introduction

Laparoscopic sleeve gastrectomy (LSG) was performed for the first time in July 1999 as part of laparoscopic biliopancreatic diversion with duodenal switch (LBPD/DS) [2]. By serendipity, LSG alone was started as part of a two-stage operation for super-super obese patients, trying to avoid morbidity, which then led to a stand-alone operation for smaller patients [3]. Indications for this procedure have expanded over a decade to high-risk patients: the usual body mass index (BMI) indications for weight loss surgery, extreme ages (adolescent and elderly), low BMI, diabetes type 2, transplantation candidates, cirrhotic with or without portal hypertension, etc [1–4]. It also has been used for the reversal and revision of gastric bypass in patients who present with severe hypoglycemia syndromes, weight regain, severe micronutrient deficiencies, and old jejunoileal bypass or failed gastric band. Contraindications are just a few, and I would reconsider a patient with severe reflux disease on long-term medication, with an incompetent sphincter and/or Barrett's esophagus. This in my view is better treated with a Roux-en-Y gastric bypass. The sleeve gastrectomy may compromise the use for stomach pull-up replacement in the future. Another could be a complicated duodenal ulcer history with perhaps a pyloric stenosis, with altered emptying (although it could theoretically be solved with a pyloroplasty).

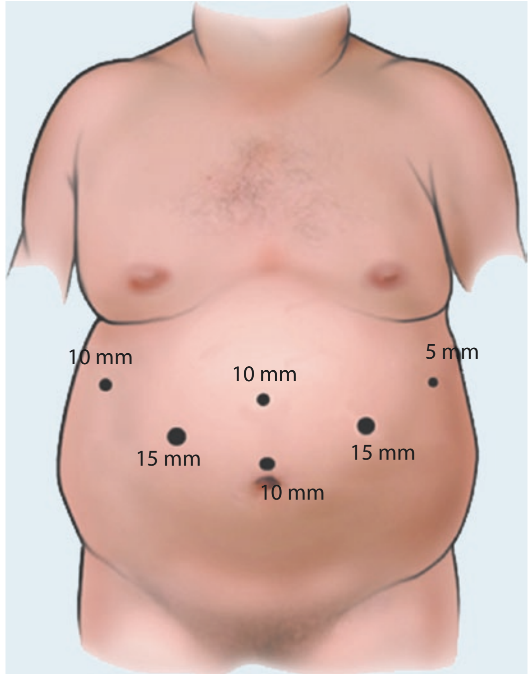

Fig. 15.1 Trocar position. The Nathanson retractor is inserted in the epigastrium. Two working ports of 12 mm are inserted on each side of the upper abdomen, midway between the umbilicus and subcostal area. An open laparoscopy was performed and a 10-mm reusable trocar is placed in the umbilicus. For an upper view, in large patients, an additional 10 mm is placed midway between the Nathanson retractor and the umbilicus. Finally, a 5-mm trocar is placed in the lateral left for perigastric tractions

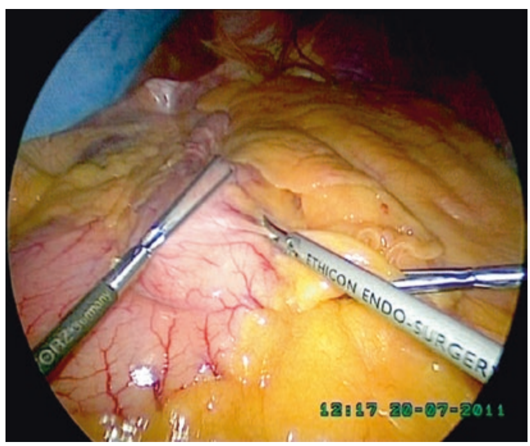

Fig. 15.2 Mobilization of the greater curvature

15

15.2 How I Do Laparoscopic Sleeve Gastrectomy?

Although this procedure is simpler than laparoscopic gastric bypass and can be performed with single trocar techniques in the umbilicus, I still prefer to use several trocars in the upper abdomen, to get the best triangulation and exposure (Fig. 15.1). Therefore, after an initial open laparoscopy in the upper umbilicus, a 12-mm trocar is introduced in the umbilicus for insufflations of CO_2 at 15–20 mmHg (a higher pressure than usual laparoscopy, in order to push the left diaphragm further up). Liver retraction is next with either a Nathanson liver retractor position in the epigastrium or a 12-mm trocar for a fan-like retractor from the extreme right subcostal area. The operation is commenced by mobilizing the greater curvature of the stomach with ultrasonic shears (Fig. 15.2). Operating trocars are a right paramedian and a left paramedian (left is positioned higher that the right to reach the upper fundus

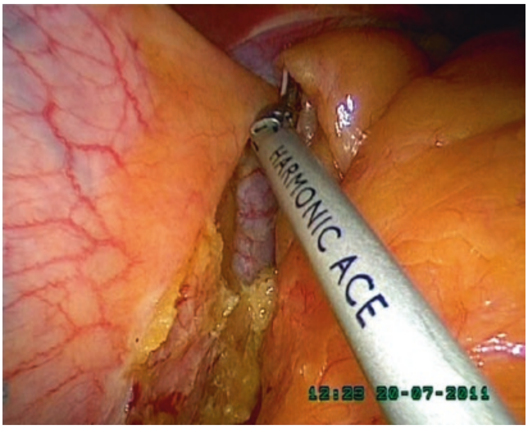

Fig. 15.3 Left crus exposure and dissection

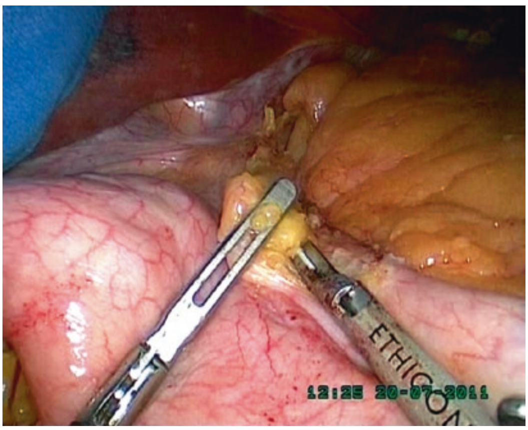

Fig. 15.4 Anterior left fat pad dissected

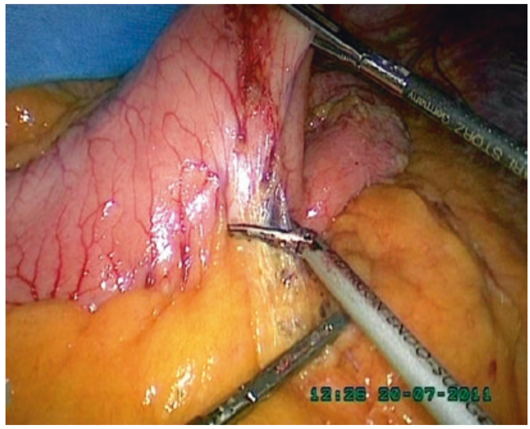

Fig. 15.5 Distal antral mobilization

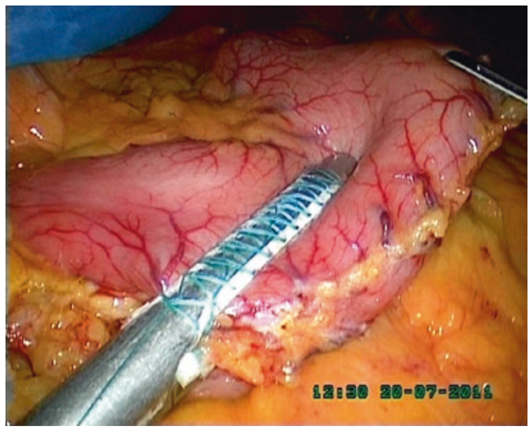

Fig. 15.6 Stapling with green cartridges and bioabsorbable Seamguards, from the right

area for stapling). A lateral left 5-mm trocar is used for omental retraction and gastric traction. The mobilization is continued upward to the left crus. The left crus itself is exposed from 12 to 6 o'clock; (Fig. 15.3) this permits the evaluation of a hiatal hernia and if the stomach has migrated upward through the chest. The next maneuver is to dissect very well the perigastric fat overlying the esophagogastric junction from the left toward the anterior midline (not crossing it to avoid any vagus nerve injury) (Fig. 15.4). Mobilization of the antrum is commenced where we have started on the greater curvature, with again using a Harmonic scalpel, and it stops near the pylorus (Fig. 15.5). Nowadays, the stapling is performed at 4 cm from the pylorus (previously 6 cm) in order to make a smaller tube; however, the bougie size has increased from a 32 Fr to a 36–40 Fr, in order to avoid any stenosis at the incisura. The stapling is always done with a linear stapler, flexible, using green cartridges, and bioabsorbable buttress material (Bioabsorbable Seamguard, Gore, Flagstaff, Arizona), with adequate tissue compression (Fig. 15.6). The stapling requires 4–6 firings with adequate lateral traction by the assistant using a laparoscopic Dorsey bowel clamp exactly on the greater curvature moving upward (Fig. 15.7). Oversewing of key points is done with a 3-0 PDS with an SH needle at the top (Fig. 15.8) and bottom (Figs. 15.9, and 15.10) centimeter and at each crossings of staple line. A methylene blue test is completed with an orogastric tube 18 Fr which also permits the assessment of strictures (Fig. 15.11). The stomach is extracted from the umbilicus. Trocars greater than 10 mm are closed with a suture passer using Vicryl 0 or #1 and similarly for the umbilical fascia using a J needle.

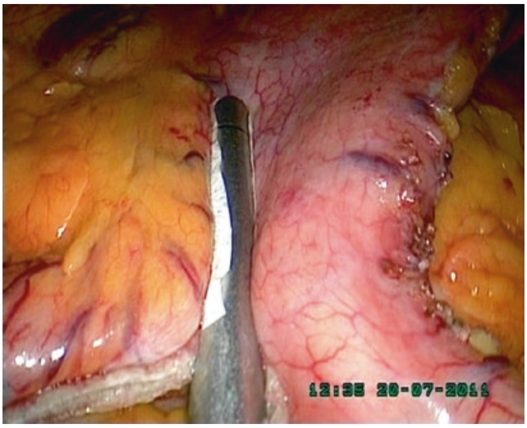

Fig. 15.7 Stapling with green cartridges and bioabsorbable Seamguards, from the left

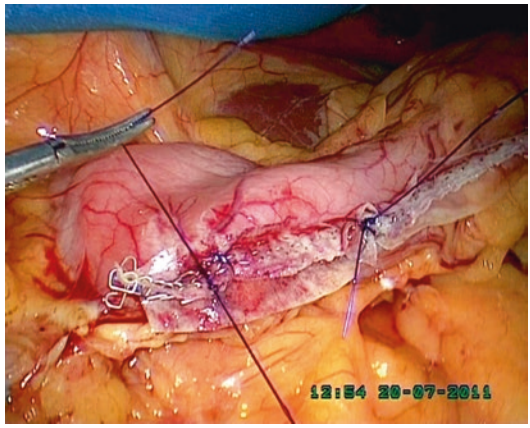

Fig. 15.10 Oversewing the distal staple line

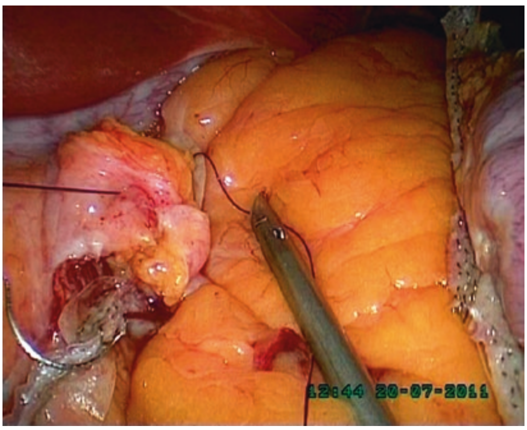

Fig. 15.8 Oversewing of the proximal stomach with the fat pad covering the staple line

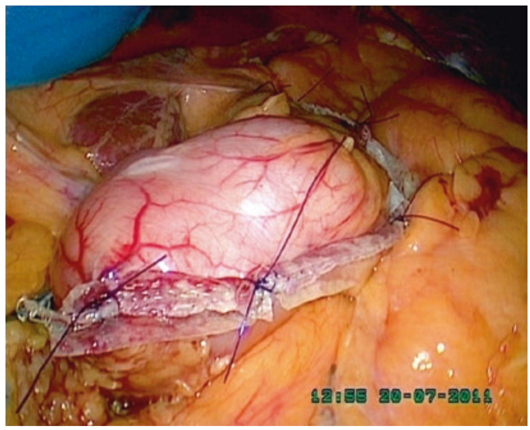

Fig. 15.11 Methylene blue test

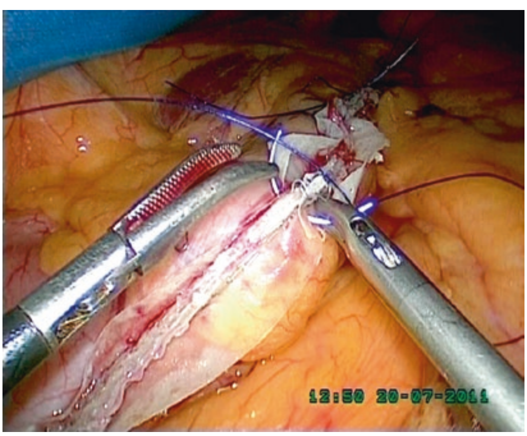

Fig. 15.9 Oversewing the intersections

15.3 Difficult/Unusual Intraoperative Situations

I want to discuss four problematic situations encountered intraoperatively: the problematic liver, problematic spleen, problematic diagram, and stapler misfiring. Recently, I encountered a very large liver, an unforeseen situation, which compromised the exposure of the upper half, during mobilization of the greater curvature. I used two liver retractors, the usual epigastric Nathanson liver retractor, for the lower half of the left lobe of the liver, and a disposable paddle (Covidien, Norwalk, Connecticut) inserted via a trocar from the right lateral area (12 mm) which pulls the upper and most lateral part of the liver from the spleen. Still the space was very small and the window just a few centimeters. In this situation, you really have to go very slow and avoid any bleeding at all costs. Mobilization of the stomach can be done posterior as much as one can, reaching the base of the left crus and then turning toward the spleen to finish the top short gastric vessels. If all retraction efforts fail, a stapling first technique can be done with a larger sleeve in the upper part and joining where you have stopped on the greater curvature mobilization. You can always come back.

Bleeding has been reported on average to be about 1 % in laparoscopic sleeve gastrectomy. Most beginners get in trouble in their first 100 cases with severe bleeding from the upper hilum of the spleen. A laparoscopic clip applier (repetitive firings) has to be readily available next to the table just in case; also a laparoscopic aspiration/irrigation cannula has to be of the best standard to be able to aspirate quickly bleeding that would come from a branch of the splenic artery or vein. It can quickly fill the space over the pancreas and obscure any effort to close the vessels. I find that pressure in the area is best at the beginning with a bowel clamp, or insert 1–2 4 × 4 gauzes and press, wait, and get organized. This means call for help, get an extra trocar in the left subtotal area for clipping, and get better retraction of the stomach rightward. Clips are often the best way to control vessels, aside from the application of Surgicel^{TM} and compression. Clamping the hilum of the spleen is rarely necessary, a maneuver that can be done coming inferiorly, since the gastrosplenic ligament has been opened.

The capsule of the spleen can be torn by the assistant pulling too hard from the gastrosplenic fat retraction or during the last centimeters dissecting a very close spleen from the greater curvature. The latter is easily dealt by avoiding getting into the spleen and choosing to get in the wall of the stomach and by separating the serosa from the submucosa. This will be resected afterward. Surgicel and pressure is the best way to deal with oozing from the capsule; if one possesses an argon beam coagulator (with a 5-mm laparoscopic probe) in the operating room, this can be used directly on the spleen.

Significant hiatal hernias should be assessed at the time you have reached the base of the left crus [6]. A repair can be performed from the left side (as opposed to classically from the right), using interrupted 2-0 Ethibond sutures. The bougie should be able to pass after the repair. I like to do it after the sleeve gastrectomy; this is easier with a wide space and avoids pulling on the stomach. In fact, I started to do sleeve gastrectomy for large type III hiatal hernias in the elderly more than 8 years ago, and avoid doing a fundoplication. Avoid using mesh material in combination with a sleeve gastrectomy with a stapled line, as this can erode and increase the risk of fistula formation. Avoid trying to fix the sleeve to the crus, as this can also erode and lead to leaks.

The misfiring of staplers is always a possibility, especially in a thick stomach, when one has started the stapling closer to the pylorus. Male gender and previous gastritis may increase the risk of misfiring (this is why I try to treat *H. pylori* infection preoperatively). I have pretty much encountered all situations with misfiring or stapling tubes (nasogastric tubes, temperature probes, and bougie). Everything can be repaired, so don't panic. I advocate not using temperature probes in the patients (at least not nasally or orally), as they can be carried down the esophagus inadvertently during the insertion of bougies. The area where the tube has been transected has to be cored out and a hand-sewn closure should transversely be done. I do not advocate refiring over a bougie as this will certainly lead to a severe stenosis with resultant increase risk of leakage above. If this occurs very high, one can transform this into a gastric bypass (loop or Roux-en-Y jejunostomy), without gastrectomy, leaving both the sleeve and jejunal pathway (as the jejunal anastomosis may close prematurely). Avoidance of nasogastric tube with a routine removal of the tube when one initiates the mobilization of the greater curvature is best. Concerning the bougie, I ask the anesthesiologist to hold manually the bougie once it is in proper place with the tip in the duodenum or distal antrum and hold it until all the stapling is done and some sewing in the upper part is completed. If misfiring of the stapler is encountered, try to look for all pieces of the stapler, because a small plastic or metal part could have been broken and will be left in the patient; sometimes it has fired only one centimeter and the stapler cannot progress. It is best to use a new stapler and allow a long time for tissue compression. I use a tissue compression between each firing with my hand of at least 15 s for the first one and 10 s for the subsequent ones; the times are doubled for thick tissue. If one row of the staples appears twisted or incomplete in their B formation, a complete running suture of monofilament absorbable 3-0 suture is done. I have seen blades from the stapler break in the middle of stapling and result in incomplete stapling. Buttress material may need to be avoided if the situation is reappearing itself. A rare situation is to find the stapler stuck in the tissue, with inability to open it. This can be tough, and all secondary maneuvers recommended from the manufacturer have to be performed. Rarely, a hard pulling tearing downward may need to be done with countertraction (in one instance, I had to saw the shaft of the stapler in order to release the jaws!) .

15.4 Postoperative Problems

The most common serious problem is a drop of hemoglobin after sleeve gastrectomy. This in my view is due to a too aggressive protocol of anticoagulation. I have ceased to use routine anticoagulation in low-risk patients, with a short anesthesia; these patients have bilateral lower limb compressive devices and are on early ambulation protocol a few hours after sleeve gastrectomy. The use of buttress material (the absorbable one) has demonstrated a decrease in intraoperative and postoperative bleeding [14]. Rarely, if this persists and a patient starts to show tachycardia and decrease in blood pressure, transfusions are initiated. A gastroscopy would be the first maneuver if this is associated with melena or hematemesis, to see if bleeding vessels from the lesser curvature can be stopped. Re-exploration in the operating room can be necessary, to look for bleeding in the greater curvature; a hematoma will often be localized between the sleeve and the spleen. Potential sites are the gastroepiploic arcade, short vessels from the gastrosplenic ligament, the splenic capsule or a splenic branch, the liver capsule (from liver retractor or instruments used close to the stomach during gastric exposure), mesenteric, omental, or retroperitoneal hematomas (from optical trocars), and also abdominal wall vessels (branch of the epigastric artery). Sometimes laparoscopic evacuation of the clots is all that is necessary, which entertained a coagulopathy.

Leaks can be avoided and are now lower than 1 % in large series; even certain recent series have been published with no leaks [5]. The recent meta-analysis on this particular and important subject shows that a small bougie leads to leaks (thicker tissue more medial, more prone to stenosis, and hematomas in the wall) [12]. A bougie of 40 Fr is adequate enough for the purpose of a good sleeve gastrectomy, and 32 Fr or smaller is too small [13]. Stapling alone appears to be associated with higher risk of leaks, and adding a suture decreases this rate by an additional 1 % (3-0, not large needles puncturing the sleeve and just oversewing not invaginating, with absorbable suture monofilament, not permanent material). The addition of absorbable buttress material (not the permanent ones) confers a risk reduction by threefold. Once a leak occurs, it has to be categorized between an early leak (48 h during the admission), a late leak (3–7 days), and very late leak(more than 1 week). Most very late leaks do not need acute intervention and will require antibiotics (as they present usually with fever); a CAT scan with contrast to evaluate closed contained leaks. If the collection is very small, it can be treated with antibiotics alone; however, a large one will need percutaneous drainage. They usually close after diet, rest, and time [10]. The acute ones require intraoperative management; a return to the operating room may permit closure by laparoscopy and insertion of large drains, with a stent placed gastroscopically with fluoroscopy. Two stents may be necessary if a stenosis is associated in the mid position of the sleeve. Stents are placed for a minimum of 4–6 weeks to allow complete healing around the leak. A gastrografin study is done once a week, to assess patency and migration of stents (which means that they may be replaced or new ones inserted). A feeding jejunostomy is very important as adequate nutritional intake may take several weeks and may avoid the use of TPN for months [11]. Late leaks are treated with percutaneous drainage and stent insertion. If nothing works, a gastrojejunostomy at the sleeve's point of leakage (now a gastrocutaneous fistula), with a Roux-en-Y is performed.

A stenotic area on the midportion of the sleeve (or at the incisura) may compromise the nutritional intake and decrease the quality of life in these patients. This incidence is less than 0.5 %. Thiamine deficiency may happen with neurologic impairment (and with other hydrosoluble vitamins). In the early

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weeks following a sleeve, a gastroscopy with balloon dilatation is useful and can be repeated up to three times [7]. A stent can also be placed afterward. And if this fails, reintervention is proposed; Himpens suggested the use of a seromyotomy, but I prefer a gastroplasty, by doing a longitudinal opening adjacent and parallel to the staple line and closing it transversely (like a pyloroplasty) with monofilament absorbable suture of 3-0 [9]. One can transect the gastric pouch and do a gastric bypass (making sure that the intermediate gastric space is indeed draining distally), or just do a Roux-en-Y gastrojejunostomy without transection.

Severe GERD may persist in the first year and is present in 5–15 % of patients. Most respond to Proton Pump Inhibitor (PPI) (or now I prefer to revert back to H2-blockers to decrease the calcium and vitamin D deficiency associated with chronic use of PPI). It is also associated with intrathoracic migration to the upper part of the sleeve, a situation where a significant hiatal hernia was not recognized intraoperatively (or ignored!). A CAT scan with contrast of the chest and upper abdomen is realized to assess the problem. Ultimately, a reoperation has to be done to move the stomach back in the abdomen with closure of the hiatal hernia. If none of this is present, and we are facing LES incompetence, confirmed by manometry, then a Roux-en-Y gastric bypass should be preformed, as a revision. I usually will not do a revision for GERD in the first 12 months following the sleeve operation, as many patients improved with weight loss.

Weight regain by dilatation of the sleeve is a chapter on its own. Suffice to say that if the posterior fundus mobilization was insufficient at the primary operation, dilatation of the upper half will be seen 3 years after, with slow weight regain [8]. These patients respond to a re-sleeve gastrectomy [15]. Dilatation of the antrum is not as responsive, and in my view, these patients are best candidate of a secondary duodenal switch (short or classic). A Roux-en-Y on top of a sleeve is not as restrictive as one would like, and the patient has had mixed results with this approach, with minimal malabsorption. Adding a band should not be realized as there is very little place for gastro-gastric sutures, and bands are more likely to erode than in a virgin stomach (◘ Fig. 15.11).

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Surgical Technique and Difficult Situations from Chandrajit Raut

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16.1 Introduction

- Gastrointestinal stromal tumors (GISTs) are the most common mesenchymal neoplasms of the gastrointestinal tract.
- They are submucosal lesions that are thought to arise from intestinal pacemaker cells known as interstitial cells of Cajal [1].
- They are characterized immunohistochemically in 95 % of cases by a mutation in the *c-kit* proto-oncogene or the platelet-derived growth receptor alpha (*PDGRFA*) gene [2].
- The stomach is the most common primary site (50–70 %) for GISTs.

16.2 Prognostic Factors

- The behavior of GISTs is based on three major prognostic factors: tumor size, mitotic rate, and site of origin, as shown in ◘ Table 16.1.
- GISTs arising in the stomach have a better prognosis than those of comparable size and mitotic count arising in the small intestine, colon, or rectum.
- Prognostic factors correlate with potential for recurrence [3–5].

16.3 Preoperative Considerations

16.3.1 Presentation

- Gastric GISTs may present:
  1. As an incidental and/or asymptomatic mass noted on physical exam or seen on endoscopic or radiologic evaluation
  2. Emergently with free rupture, obstruction, or hemorrhage
- While patients with life-threatening or emergent presentations may require immediate surgery, most can be treated with a carefully planned elective resection.

16.3.2 Selecting Patients for Surgery

- All patients with nonmetastatic GISTs at least 2 cm in size should undergo surgery.
- More uncertain is the role of surgery in asymptomatic patients with GISTs less than 2 cm in size.
- A strategy of endoscopic surveillance with esophagogastroduodenoscopy (EGD) +/− endoscopic ultrasound (EUS) at 6- to 12-month intervals is reasonable.

◘ Table 16.1 Risk stratification of primary GIST by mitotic index, size and site [4]

Tumor parameters		Characterization of risk for metastasis (% of patients with progressive disease)			
Mitotic index	**Size (cm)**	**Gastric**	**Duodenum**	**Jejunum/ileum**	**Rectum**
<5/50 HPF	≤2	None (0 %)	None (0 %)	None (0 %)	None (0 %)
	>2 and ≤5	Very low (1.9 %)	Low (8.3 %)	Low (4.3 %)	Low (8.5 %)
	>5 and ≤10	Low (3.6 %)	High (34 %)	Moderate (24 %)	High (57 %)
	>10	Moderate (10 %)	High (34 %)	High (52 %)	High (57 %)
>5/50 HPF	≤2	None (0 %)[a]	Insufficient data	High (50 %)[a]	High (54 %)
	>2 and ≤5	Moderate (16 %)	High (50 %)	High (73 %)	High (52 %)
	>5 and ≤10	High (55 %)	High (86 %)	High (85 %)	High (71 %)
	>10	High (86 %)	High (86 %)	High (90 %)	High (71 %)

HPF high power fields
[a]Small numbers of cases

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- It is important to recognize that while tumors less than 2 cm in size are associated with good prognosis, most experts consider all GISTs to harbor metastatic potential, and thus, none should be considered truly benign.

16.3.3 Staging and Medical Clearance

- Staging for GISTs should include chest X-ray and an abdominopelvic contrast-enhanced computed tomography (CT) scan; given the rarity of extra-abdominal metastases, chest or head CTs are unnecessary.
- Biopsy is not routinely required if the patient is proceeding directly to surgery and the diagnosis is suggestive on endoscopy and/or imaging.
- If the patient is being considered for neoadjuvant therapy as described below, endoscopic ultrasound-guided fine needle aspiration should be considered to confirm the diagnosis and immunohistochemical profile; given the friable nature of these tumors, transperitoneal biopsies of primary lesions should be avoided if alternatives exist.
- Patients should undergo appropriate preoperative testing to optimize medical comorbidities prior to surgery.

16.3.4 Neoadjuvant Therapy

- Many gastric GISTs may be resected laparoscopically.
- Therefore, in evaluating a patient with a primary gastric GIST, the surgeon should determine if the tumor can be resected using a laparoscopic or laparoscopic-assisted approach.
- If so, then neoadjuvant therapy is usually not necessary.
- If not, then neoadjuvant therapy with tyrosine kinase inhibitor imatinib mesylate (Glivec, Novartis Pharmaceuticals, Basel, Switzerland) should be considered.
- While neoadjuvant therapy will not usually change the extent of gastric resection required, it may convert an operation requiring an open laparotomy to one feasible laparoscopically.
- The response to therapy may be assessed by PET scan in 2–4 weeks or by CT scan in 4–6 weeks; a joint decision whether or not to continue neoadjuvant therapy or proceed to surgery should be made jointly by the medical oncologist and surgical oncologist.
- In general, we prefer to continue neoadjuvant therapy for at least 6 months; little incremental benefit is seen after 9 months.

16.4 Surgical Technique

16.4.1 Goals of Surgery

- Surgery is the definitive and only potentially curative therapy for primary GISTs.
- The goal of surgery is a macroscopically complete resection with negative microscopic margins, a so-called “R0” resection.
- Tumors should be handled gently, preferably using a “no-touch” technique, as they are typically friable.
- Segmental or wedge resections are appropriate if anatomically feasible.
- The extent of gastric resection is based on (a) the size of the tumor and (b) maintenance of gastrointestinal continuity postoperatively (including preserving gastroesophageal and pyloric sphincter integrity, if possible).
- Unlike adenocarcinomas, GISTs tend not to infiltrate through the submucosa, and thus the 5-cm margins sought during gastrectomies for gastric adenocarcinoma are not necessary for gastric resections for GIST.
- Furthermore, GISTs do not typically metastasize to lymph nodes, and therefore lymphadenectomy is not indicated.
- Locally advanced gastric GISTs should be approached with an en bloc resection of adjacent organs in order to minimize potential violation of the tumor. In such cases, surgical resection is often preceded by medical therapy to promote tumor shrinkage and minimize the extent of resection.

16.4.2 Laparoscopic Approach

Patient Selection

- A laparoscopic approach is generally easiest for tumors located along the greater curvature or anterior gastric wall. These cases are classified as Group I (ideal cases).

   - Tumors at the gastroesophageal junction (GEJ), pyloric channel, lesser curvature, or posterior wall may still be resected laparoscopically but require more experience and should be approached with a lower threshold for open conversion. These cases are classified as Group II (minor difficulties possible).
   - Patients who cannot tolerate pneumoperitoneum (e.g., severe lung disease) should be offered an open approach.
   - At no time should the surgeon compromise the extent of resection simply to persevere with a laparoscopic approach.

Preparation

- The patient is placed supine on the operating table with arms abducted or tucked to the sides.
- Legs may be either placed in a modified lithotomy position or separated on a split leg table, allowing the surgeon to stand between the legs, facing the epigastrium for an optimal working position.
- Monitors should be placed over the patient's shoulders.
- The first-assistant stands on the patient's right, and the scrub nurse or technician may stand either on the patient's left or near the left leg.
- A nasogastric tube is placed to decompress the stomach.
- Intraoperative EGD may be helpful to localize small, intraluminal tumors; preoperative EGD with tattooing may also be helpful but is not routinely necessary.

Technique

- Pneumoperitoneum is established via Veress needle or open technique at the level of the umbilicus. This port is used for the laparoscopic 10 mm, 30° angled camera. If the tumor is at the GEJ or lesser curvature, the camera port may be moved cephalad (1/4–1/3 of the distance between the umbilicus and xiphoid) to enable better visualization.
- Additional ports are placed as follows:
   - 5-mm port at the right subcostal margin for a liver retractor, if necessary
   - 5-mm port in the left upper quadrant at the anterior axillary line for retraction or dissection, depending on the location of the tumor
   - 5-mm and 12-mm ports in the left upper quadrant or toward the midline for primary dissection and stapler insertion, depending on the location of the tumor (if the tumor is close to the pylorus, then one of the ports may be placed in the right upper quadrant)
- The abdomen is inspected carefully for evidence of metastatic disease
- The patient is placed in steep reverse Trendelenburg position.
- The lesser sac is entered by incising the gastrocolic omentum, avoiding injury to the gastroepiploic vessels.
- The extent of the tumor base is evaluated, and assessment is made if it is feasible to achieve safe laparoscopic resection with adequate remaining gastric lumen.
- Concomitant intraoperative EGD for localization may be used if the lesion is small and intraluminal.
- Incision of the gastrocolic omentum is extended leftward, with division of the short gastric vessels as needed to achieve resection with negative margins.
- Incision of the gastrohepatic omentum may be needed if the tumor is located on the lesser curvature or at the GEJ.
- If the tumor is located on the greater curvature, ligation of the gastroepiploic vessels may be necessary, with application of laparoscopic clips or the use of a coagulating or sealing energy device.
- If the tumor is located on the lesser curvature, care should be taken to avoid transecting branches of the vagus nerve, if possible; ligation of the left gastric artery and/or coronary vein may be necessary.
- Once the uninvolved surrounding fatty tissue and vessels are cleared, a wedge resection may be performed using sequential firings of a laparoscopic linear stapling device, ensuring that the tumor pseudocapsule is not transected (see ◘ Fig. 16.1).
   - A roticulating stapler head greatly facilitates precise angular firing of the stapler.
   - The 3.5-mm staple cartridge is typically safe to accommodate the thickness of the stomach, but a 4.5-mm staple cartridge may be considered if the stomach is thickened.

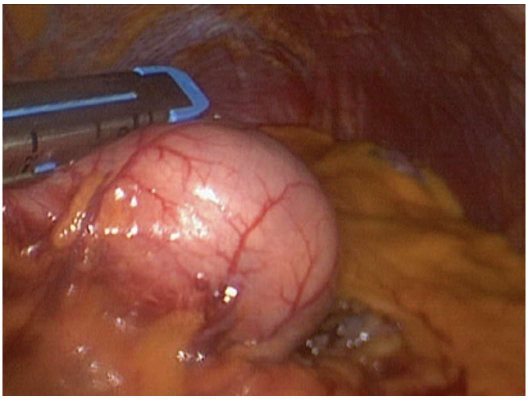

Fig. 16.1 Wedge resection for gastric GIST using a linear stapler

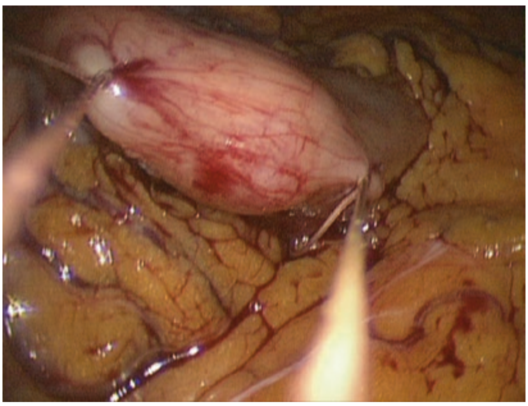

Fig. 16.2 Gastric traction sutures

- 1–2 laparoscopic sutures with long tails placed 1–2 cm beyond the proximal and distal edges of the tumor may serve as useful leverage points to assist with insertion of the stomach into the stapler jaws (see Fig. 16.2).
- The nasogastric tube should be retracted into the esophagus prior to stapling.
- If the extent of tumor is unclear, EGD should be performed intraoperatively by the assisting surgeon to identify the intraluminal extent of the tumor.
  - In such cases, the transillumination provided by the endoscope will allow the surgeon holding the laparoscope to visualize the submucosal extent of the stomach.
  - While air insufflated through the endoscope may fill the proximal small bowel, clamping the bowel is generally not necessary.
- Alternatively, if the tumor base extent is unclear, a gastrotomy may be made at a known tumor-free location and the tumor excised under direct intraluminal visualization using electrocautery or an energy device.
  - The gastrotomy can then be closed intracorporeally using absorbable sutures (e.g., 3-0 Vicryl).
- Once the tumor, with a rim of normal tissue, is detached, it is placed into an impervious retrieval bag and removed from the 10-mm or 12-mm port.
- The specimen should be oriented, if possible, and may be opened ex vivo to ensure that the GIST was removed in its entirety.
- The nasogastric tube is again extended into the gastric lumen beyond the staple lines.
- The abdomen and the staple lines are inspected for hemostasis.
- Routine drains are not required.
- Once the abdomen is desufflated, the 10-mm and 12-mm port sites are closed at the fascial and skin levels, and the 5-mm port sites are closed at the skin level alone.
- We typically send the tumor to pathology for a macroscopic evaluation of the margins.
  - Any positive margins should be re-excised, either laparoscopically or via conversion to a laparotomy.

16.4.3 Open Approach

Patient Selection

- Patients with locally advanced, recurrent, metastatic, or persistently large (>8 cm) tumors (despite neoadjuvant therapy) should be offered an open approach [6].
- These patients may be classified as Group III or IV (intermittently or persistently difficult), depending on the size and location of the tumor, the degree of adherence to adjacent organs, and the presence of adhesions.
- An open approach may be considered for tumors on the posterior gastric wall or near the GEJ.

Preparation

- The patient is placed in the supine position with arms abducted or tucked.
- Nasogastric tube is inserted.

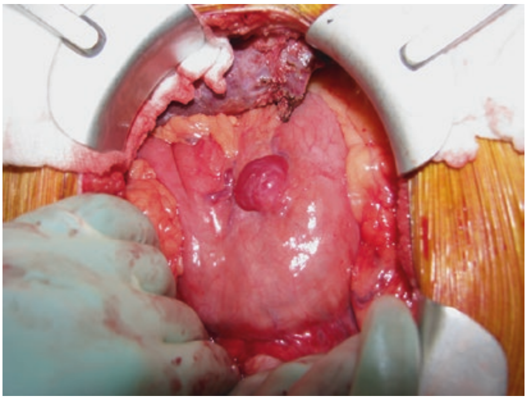

Fig. 16.3 GIST on the lesser curvature of the stomach

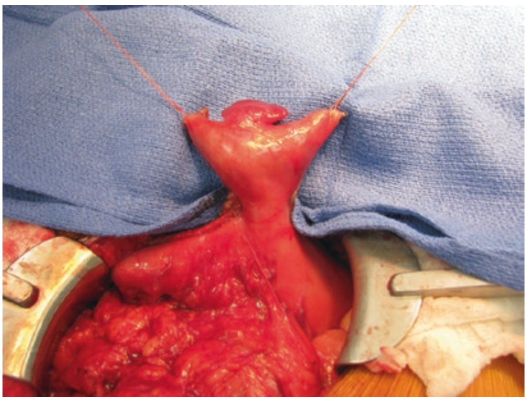

Fig. 16.4 Wedge resection of the GIST on the lesser curvature of the stomach

Technique

- An upper midline incision is made.
- Careful inspection is completed for metastatic disease.
- An abdominal retractor is placed (e.g., Bookwalter, Omni, Balfour).
- Identification, isolation, and excision of the tumor are done as described in the laparoscopic approach (see Figs. 16.3 and 16.4).

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16.5 Intraoperative Complications

16.5.1 Pneumothorax

- This situation may be encountered when dissection is required close to the GEJ, or if the patient has a concurrent hiatal hernia requiring reduction of the stomach from the chest prior to tumor excision.
- These cases are typically classified as Group II or III (possibly or intermittently difficult).
- If pleural violation is encountered, conversion to open operation is typically necessary to assess the extent of the injury and to avoid ongoing insufflation of the chest with CO_2.
- If a small defect is made, suction of the pleural cavity with a red rubber catheter in parallel with Valsalva maneuver from the anesthesiologist, followed by quick removal of the catheter and closure with a purse-string suture, may be all that is required.
- If the defect is more extensive, primary repair with nonabsorbable braided suture may be required.
- Placement of a small bore chest tube (e.g., 18 F or 20 F) or closed suction drain is prudent in the latter scenario and may be removed on postoperative day 1 or 2, once the pneumothorax has radiographically resolved.

16.5.2 Violation of the GIST Pseudocapsule

- This complication can occur during manipulation of this often friable tumor or by inadvertent stapling through the tumor edge.
- If the latter occurs, and is detected while the patient is still under anesthesia, additional gastric margins should be resected.
- If tumor spillage during manipulation occurs in a laparoscopic procedure, careful judgment should be made whether the surgeon is able to safely and reliably amass the tumor fragments, or whether conversion to an open procedure is required to inspect the abdomen for rogue pieces of tumor.
- In either case, thorough irrigation of the abdomen with sterile water and/or saline should be done prior to closing.

16.6 Difficult Scenarios

16.6.1 Adherence to the Surrounding Structures

- If the tumor is adherent to an adjacent organ (e.g., pancreas, liver, colon, spleen), it may be difficult to ascertain whether true invasion exists.

- If suspected preoperatively, these patients should be treated with neoadjuvant tyrosine kinase inhibition.
- These cases are usually classified as Group III (intermittently difficult).
- If detected intraoperatively, an en bloc resection principle should be followed.
  - In general, primary GISTs rarely “invade” additional organs beyond their site of origin, but may be tightly adherent to other organs such that en bloc resection is required to minimize tumor spillage.
  - These procedures typically require an open approach.
- The most common organs to be affected in locally advanced cases are the pancreas and colon.
  - Segmental resection of the colon can usually be safely and easily accomplished en bloc with the gastric resection.
  - If the pancreas is involved, an appropriate en bloc resection (e.g., pancreaticoduodenectomy or distal pancreatectomy) may be required, depending on the location of the GIST.
  - We typically favor leaving a drain in the pancreatic bed after any pancreatic resection to evaluate for a pancreatic leak once the patient resumes eating postoperatively; this is controversial and may be omitted at the discretion of the surgeon.

16.6.2 Reoperative Gastric Surgery

- Intra-abdominal surgery in patients who have undergone prior surgical procedures is always challenging.
- In patients who have undergone previous gastric resection, care must be taken to avoid severe gastric luminal narrowing when completing a wedge resection for GIST.
- Luckily, even in patients with multiple gastric surgeries, ischemia of the stomach is rare due to its redundant vascular supply.
- These cases can be classified as Group II to IV (possibly to persistently difficult), depending on the presence of adhesions in relation to the tumor.

16.6.3 GISTs at or Near the Gastroesophageal Junction (GEJ) or Pylorus

- Tumor location near the GEJ is challenging for several reasons:
  - Laparoscopic isolation and excision of the tumor may be difficult or impossible due to awkward angles required for stapler application.
  - Identification and preservation of the vagus nerve is paramount.
  - Wedge resection with preservation of adequate gastric lumen is difficult.
  - Tumors may be located inside the chest if the patient has a concurrent sliding or paraesophageal hernia.
- For patients with GEJ tumors, preoperative consultation with a thoracic surgeon may be advisable, particularly if a minimally invasive esophagogastrectomy is required.
  - Such patients should always be advised of the potential for an esophagogastrectomy well in advance.
- Visualization may be facilitated by complete incision of the gastrohepatic omentum and rotation of the tumor anteriorly.
- Once the vagus nerve is carefully identified and the tumor isolated, two options can be used to maintain gastric luminal patency.
  - A bougie (48–54 F for females, 50–56 F for males) may be inserted prior to laparoscopic stapling.
  - A gastrotomy may be performed to enable tumor resection under direct vision and with a more modest and precise excision of normal tissue at the margins; reconstruction can then take place over a bougie.
- If the GIST frankly involves the GEJ complex, open or laparoscopic resection with esophagogastrostomy can be performed.
- Tumors located near or involving the pylorus may require a distal gastrectomy with a Billroth I or Billroth II or Roux-en-Y reconstruction, at the discretion of the surgeon.
- These cases are classified as Group II or III (possibly or intermittently difficult).

16.6.4 Positive Margins on Final Pathology

- Complete tumor excision with negative margins is the goal of surgical intervention for GISTs.
- We check margins macroscopically by gross sectioning (but not necessarily by microscopic frozen section analysis) intraoperatively with the pathologist.
- Rarely, margins on final analysis may be positive; however, reoperation for positive margins is rarely necessary.
- Adjuvant imatinib mesylate has been shown to improve both recurrence-free and overall survival rates in patients with higher risks for recurrence [7].
- The efficacy of adjuvant therapy solely for positive margins is impossible to assess, as true local recurrences of GISTs in the adult population are exceedingly rare, even with microscopically positive margins.
- All patients with positive resection margins on final pathology should be seen by a medical oncologist to assess the role of adjuvant imatinib mesylate therapy.

16.7 Classification of Intraoperative Difficulties

The operative difficulty for gastric GIST surgery can be classified as summarized in ◘ Table 16.2.

◘ Table 16.2 Categorization of patients with gastric GIST according to the classification of intraoperative complexity

I.	The ideal case. Surgery is straightforward, and every operative technique is relatively routine	Small to moderate (≤ 5 cm) tumor size
		Location on greater curvature or anterior wall of the stomach
		≥5 cm far from the EGJ or pylorus
		Typically easy to resect laparoscopically
		BMI <25
II.	The less-than-ideal case. Some minor technical difficulties may occur; some operative techniques can be more difficult than others	Larger tumors >5 cm with location on greater curvature or anterior wall of stomach ≥5 cm far from the EGJ or pylorus
		Small to moderate (≤5 cm) tumor size, location on greater curvature or anterior wall of the stomach ≤2 cm far from the EGJ or pylorus
		Small size (<2 cm) with location at lesser curvature of the stomach or at the EGJ or pylorus
		BMI 25 – 30
III.	The problematic case. Difficult, with some operative techniques considerably more difficult than others	Large (>5 cm) tumor size with location on posterior abdominal wall or at lesser curvature
		Tumor location or size requiring total gastrectomy and reconstruction
		Locally advanced GIST requiring concurrent multivisceral resection Reoperative gastric resection with *limited* adhesions
		BMI >40
IV.	The very difficult case. Every operative step is very difficult	Extreme forms of III

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Individual Surgery for Gastric Cancer

Contents

Introduction

Michael Korenkov, Christoph-Thomas Germer, and Hauke Lang

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The surgical treatment of gastric cancer consists of ablative and reconstructive phases. The key steps of the operation are the following:
1. Complete detachment of greater omentum from the transverse mesocolon and opening the bursa omentalis
2. Mobilisation and transection of duodenum
3. Gastric mobilisation along the greater curvature
4. Gastric mobilisation along the lesser curvature
5. Retrogastric mobilisation and isolation and section of left gastric vessels
6. Transection of stomach or oesophagus, respectively
7. Lymphadenectomy (in combination with above-mentioned steps
8. Reconstruction of food passage

The order of operating steps can vary depending on the intraoperative situation. The laparoscopic approach by gastric cancer has not been established as a standard procedure at least in Europe, so we will discuss in our introduction only the problems of conventional gastric surgery. Nevertheless, the technique of F. Corcione will be presented in this chapter. The difficult surgical situations can occur at every key step.

17.1 Approach

Median laparotomy from the xiphoid process to below the umbilicus or transversal upper abdomen laparotomy with the option of widening to form a Mercedes-star incision is the most common approach. In some cases, abdominothoracic or separate abdominal and thoracic approaches can be used. We prefer the median laparotomy especially in underweight patients with a sharp thoracic aperture. Normal-weight or obese patients will be decided for median or transversal upper abdomen laparotomy individually. For the exposition of the operative field, different wound retractor systems will be used.

17.2 First Step: Detachment of Greater Omentum from the Transverse Mesocolon and Opening the Bursa Omentalis

This step is technically most unproblematic. The transparent avascular field will be presented by traction of the transverse colon and greater omentum. Scissors will be used for the detachment.

Bipolar coagulation, UltraCision scissors, LigaSure as well as a classic ligation will be used for the dissection of vascularised portions. Technical difficulties can occur in the following situations:

Very slim patient without previous operations If patients are very slim is possible to get a wrong plain with injuring of the transverse mesocolon. The transection of mesocolon vessels can lead to ischemia of the transverse colon.

Obese patient without previous operations Diffuse bleeding during the preparation can occur and will be however in most cases not problematic. Otherwise, the preparation "above" of the bursa omentalis can take place. This situation is mostly also unproblematic.

Patient with chronic pancreatitis and portal hypertension without previous operations These constellations can be connected with heavy bleeding especially during periduodenal dissection and the preparation in the "right" bursa omentalis. In cases of anastomoses between right gastroepiploic vein and right colic vein or superior mesenteric vein (so-called Henle's gastrocolic trunk) the usual traction of transverse colon and stomach can lead to vein disruption with difficult-to-control bleeding. Uncontrolled stitching in such situations can be used in segmental ischemia of the transverse colon. In case of portal hypertension, we recommend to operate cautiously and slow.

Patient with previous operations Previous right hemicolectomy, gastric and pancreatic surgery, and rare open cholecystectomy can have special significance for intraoperative difficulties. In such cases, it is not always possible to perform an appropriate preparation because of changes in anatomy. Heavy blood loss and prolonged duration of operation must be taken into account. To avoid difficult intraoperative decision situations, all lacks of certainty concerning the operability should be clear before the operation. In case of suspicion of metastasis in distant lymph nodes, all diagnostic procedures (inter alia PET-CT) should be considered.

17.3 Second Step: Mobilisation and Transection of the Duodenum

The key points in the duodenal mobilisation are transection of right gastric artery and right gastroepiploic artery. For oncological reasons, the transection of the right gastric artery should be performed near the hepatic artery proper. The right gastroepiploic artery will be divided in the projection of pancreatic head near the lower part of the descending portion of the duodenum. The duodenum will be transected about 2 cm distal to the pylorus. The transection line can run along the lateral margin of hepatoduodenal ligament. A linear stapler will be used for this step. A staple line can be peritonised with single button serosal sutures depending on surgeon preference. Thereby, a pancreatic capsule should stay intact.

■ **Difficult Situations**

The duodenal transection in gastric resection/gastrectomy is mostly not problematic. The intraoperative difficulties can occur in the following situations:

Distal stomach cancer with intrapyloric growth In order to reach an adequate distance from the tumour margin, the duodenal bulb will be maximally mobilised. Such mobilisation can lead to increase of perifocal haematomas which can negatively influence duodenal leak tightness (empiric presumption, no valid data). Also the "ultralow" duodenal transection can lead to tension of the medial duodenal wall with increased burden for the staple line. In order to avoid such tension, using the arsenal of duodenal ulcer surgery (Roux-en-Y duodenojejunal anastomosis) can be helpful. In case of tumour infiltration of pancreatic head or duodenal bulb, gastric resection will be combined with the resection of pancreatic head.

Thickened duodenal wand in patient with chronic pancreatitis A thickened duodenal wall can lead to uncertain stapler clamp closure that can increase the risk of a leakage. Using the special cartridges with extra-long clamps (e.g. Echelon Flex 60 with a black cartridge (4.4 mm open clamps, 2.3 mm closed)) cannot always solve this problem. In such situation, it is important to transect the duodenum close to the pylorus (cave: adequate distance from tumour margin) in order to have additional tissue for the suturing of the staple line.

17.4 Third Step: Stomach Mobilisation Along the Greater Curvature

This step is mostly technically unproblematic. Dissection of colicosplenic or gastrosplenic ligaments can lead to accidental injury of the spleen capsule with diffuse bleeding and sometimes with splenectomy as a result. Also an accidental injury of splenic vessels during the transection of the left gastroepiploic vessels (mostly mix up of splenic and gastroepiploic vessels) can lead to splenectomy.

17.5 Fourth Step: Stomach Mobilisation Along the Lesser Curvature

Thereby, the lesser omentum will be transected close to the liver. En bloc lymph node dissection from this side is easier than from the side of greater curvature because of the better identification of common hepatic and splenic arteries. Dissection will be performed along the common hepatic artery towards the celiac trunk as well as along the splenic artery towards the splenic hilum. For the better exploration of the retrogastric space, it is helpful to transect a duodenum at first.

The most common technique of the lymph node dissection is from the periphery to the centre. The implementation of this technique in practice is sometimes difficult. Some surgeons prefer a dissection technique "en bloc right to left" towards the splenic hilum with continuation along the greater curvature. Other surgeons perform the lymph node dissection separately after removing the stomach.

17.6 Fifth Step: Retrogastric Mobilisation and Transection of the Left Gastric Artery

The key step of this procedure is the identification and dissection of the left gastric pedicle (gastropancreatic ligament or plica) with central dividing of left gastric artery and vein.

■ **Difficult Situations**

In case of adhesions between the tumour and the pancreatic capsule, the last should be removed.

For patients with the firm connective tissue and pericapsule oedema, this step is mostly nonproblematic. The dissection can begin with the removal of the ventral mesocolic sheet and will be exchanged on the anterior pancreatic surface. If good preparation conditions are missing, the indication for the simultaneous pancreatic resection should be discussed.

17.7 Sixth Step: Gastric or Oesophageal Transection

In case of the subtotal gastric resection, a transection will be started between first and second vessel branches of the lesser curvature towards the greater curvature in projection on the upper spleen third. This step is technically unproblematic. In case of the total gastrectomy, the line of transection goes at the cardio-oesophageal junction. Thereby, a mobilisation of the cardio-oesophageal junction with dissection of the paracardiac lymph nodes will be performed. The key steps of such mobilisation are dissection of the phrenico-oesophageal ligament and cutting both vagus nerves.

Difficult Situations

During the surgery of the locally advanced subcardiac (Siewert type III) and cardiac tumours (Siewert type II), a problem of not adequate circumferential margin can occur. In case of dorsolateral adhesions between the tumour and diaphragm, en bloc resection of the affected part of diaphragm should be performed.

In patients with tumours of the cardio-oesophageal junction (Siewert type II), a distal oesophagus should be removed. If the proximal resection margin in the quick section is tumour positive, technical difficulties in some cases can occur:

- Limited approach (transhiatal) for the oesophageal resection and intrathoracic lymphadenectomy
- Problematic tension-free traction of Roux-en-Y loop for the intrathoracic anastomosis. In such a situation, using colonic interponat for the coloesophageal or colojejunal Roux-en-Y loop anastomosis can be helpful.

17.8 Seventh Step: Passage Reconstruction

Oesophago-enteric or gastro-enteric anastomosis with entero-enteric anastomosis will be created during the reconstructive phase. Creating a gastro-enteric anastomosis after subtotal gastric resection is independent from the three techniques (handsewn, circular stapler, linear stapler) is usually unproblematic. Oesophago-enteric anastomosis can be created as a "simple" Roux-en-Y loop anastomosis or as a pouch anastomosis. A staple anastomosis with 25-mm circular stapler is widespread.

Difficult Situations

Obese patient with a narrow and "deep" oesophageal lumen In such a situation, it can be difficult to introduce a stapler anvil into the oesophageal lumen. We recommend to make at least four stay sutures before the introduction of anvil.

Very thin and fragile oesophageal wall In such a situation, additional sewing over the oesophago-enteric anastomosis with single button sutures (e.g. Vicryl 2-0) can be recommended. The leakage control with methylene blue or oesophagoscopy is obligatory.

17.9 Classification of Intraoperative Difficulties

The operative difficulty in the surgery for gastric cancer can be classified as summarised in Table 17.1.

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Table 17.1 Grading of operative difficulties in the surgery for gastric cancer

Grading	Case type
I (ideal cases) It is easy to operate; every operative technique is technically unproblematic	Slender or normal-weight patient
	No previous major abdominal surgery
	Distal gastric cancer without serosa penetration and without intrapyloric involvement
	No surgical relevant comorbidities (liver cirrhosis, pancreatitis, etc.)
II (not quite ideal) Some minor technical difficulties may occur; some operative techniques can be more difficult as others	Moderate obese patient (BMI around 30 kg/m^2)
	Otherwise similar to grade I
III (problematic) Difficult to operate, some operative techniques are considerably more difficult than others	Overweight patient (BMI >35 kg/m^2) Intrapyloric tumour localisation with infiltration of the duodenal bulb
	Tumour adhesions to neighbouring organs and tissues
	Locally advanced cardiac cancer (Siewert type II)
	Surgical relevant comorbidities (liver cirrhosis, pancreatitis, etc.)
	Previous major abdominal surgery
IV (very problematic) Every operative step is very difficult	Extreme form of grade III factors

Surgical Technique and Difficult Situations from Francesco Corcione (Laparoscopic)

Francesco Corcione and Pierluigi Angelini

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Oncologic gastric surgery frequently causes different kinds of difficulties to the surgeon, principally because of the frequent evidence of particularly aggressive neoplasm and also because of the complex vascularization and lymphatic drainage makes it difficult to perform the total or partial resection of the stomach with preservation of sufficient free margins and with correct lymphadenectomy [1]. In the reconstructive phase, special skills are required to solve some of the problems deriving, especially during total gastrectomy, from the necessity of performing a well-vascularized tension-free anastomosis that is wide enough and correctly oriented to ensure good transit.

With this in mind, we recommend that sufficient training is given for less challenging open and laparoscopic gastric surgeries, such as those for GIST, benign lesions, and early distal gastric cancer, before the surgeon goes on to perform gastric oncologic surgery with D2 lymphadenectomy and total gastrectomy for advanced cancers [2].

Currently, a laparoscopic approach to gastric cancer is also rapidly increasing in popularity as the curability of both early and advanced gastric cancer using a minimally invasive technique has been generally confirmed by favorable long-term follow-up data, which demonstrate the feasibility and validity of laparoscopic gastric surgery compared with the codified fundamentals of oncologic surgery with regard to open procedures [3–16]. Further results from prospective randomized studies in larger series of patients carried out at multiple centers also give hope for the future. The specific difficulties of hemostasis and dissection encountered in laparoscopic gastric surgery can be dealt with by utilizing advanced technology such as ultrasonic or radiofrequency scalpels, which are helpful for lymphadenectomies, and bipolar forceps, which enable optimal exposure of the vascular and biliary structures with minimal occurrence of lesions to these structures at a rate that overlaps that of open surgery. Thus, we think it is possible to face even the most complex intraoperative situations using minimally invasive techniques in centers that are widely equipped with the most advanced technology.

18.1 Personal Experience in Difficult Situations: Suggested Technique (Tips and Tricks)

In this section we summarize some suggestions deriving from our experience in gastric oncologic surgery with regard to facing the most frequently occurring difficulties during open or minimally invasive procedures.

- In some cases, it may not be easy to perform the en bloc dissection of the distal lymph nodes of station 4 (between the omentum and the stomach) and lymphadenectomy of group 6 (infra-pyloric lymph nodes) because of the possible fusion between the right side of the transverse mesocolon and the overlying gastrocolic ligament. The best way to avoid errors and colic and mesocolic lesions or, on the other hand, incomplete lymphadenectomy, is to have a correct vascular approach to the gastroepiploic pedicle. The right gastroepiploic vein is dissected at the confluence in the trunk of Henle, spearing the confluent right branch of the middle colic vein, and the right gastroepiploic artery is dissected at the origin from the gastroduodenal artery along the upper part of the pancreatic head. All the fat and lymphatic tissue over this vascular dissection can and must be dissected for a complete and safe lymphadenectomy without lymphatic spread. The clear visualization of the gastroduodenal artery below the duodenum also constitutes the best landmark for the level of the next duodenal resection after freeing it from pancreatic adhesions and the opening of the hepatoduodenal ligament.
- Some difficulties may be encountered in performing a D2 lymphadenectomy. The correct and complete lymphadenectomy of station 8 can be better achieved by opening the hepatoduodenal ligament near the liver and dissecting the lymph node group 12 by lowering the loose connective tissue of the ligament towards the stomach, also dissecting the right gastric artery at the origin of the hepatic artery, and the supra-pyloric lymph nodes of group 5. In dissecting the right gastric artery, the trick is not to clip it, at least

on the duodenal side, by using ultrasound or radiofrequency dissection, thus avoiding subsequent conflict with the clip during duodenal resection with use of a stapler. Lymphadenectomy of station 8 (hepatic artery) can be completed from the right to the left or can alternatively be performed with a left to right progression starting from the celiac trunk after the next step.

- We suggest a retrogastric approach with stomach and omentum lifting for the dissection of the left gastric vein and artery and associated lymphadenectomy of group 7 (left gastric lymph nodes), of station 9 (celiac trunk) and 11p (proximal splenic artery). Dangerous bleeding that cannot be controlled by ultrasonic, bipolar, or radiofrequency may occur during this dissection. In these cases, the best way to control hemorrhage is to compress the damaged vessel and to provide a proximal isolation by clipping or suturing.
- In completing the lymphadenectomy along the vertical portion of the lesser curvature (group 3), with the opening of the pars condensa of the hepatogastric ligament, special attention must be given to preserving any additional left hepatic artery still present, with surgical exposure and dissection of the left gastric artery distally with regard to its origin where necessary, continuing the dissection upward along the lesser curvature until arriving at and dissecting the right pericardial lymph nodes of group 1.
- Not rarely, infiltrations of the liver, pancreas, and spleen, especially from wide tumors of the posterior gastric wall, cause many difficulties when performing an R0 gastrectomy, usually inducing a more limited palliative surgery with gastroenteroanastomosis. Our experience of good outcomes in some cases of enlarged procedures induce us, in selected cases, to extend the surgery to the structures involved (spleen, pancreas, colon, liver) where possible, to obtain a macroscopic complete resection of the neoplasm, in the open as in the laparoscopic approach, with the recommendation that, if possible, the tumor is removed en bloc with all the organs involved.

A preliminary intraoperative ultrasound [17] is necessary to define the operability. Splenectomy or splenopancreasectomy is sometimes necessary even in patients with lesions of the upper two-thirds along the greater curvature pre- and intraoperatively staged as higher than T1 N0, in which a correct D2 lymphadenectomy including station 10 (splenic hilum) cannot be performed in a conservative way every time, also in open surgery with the help of Jinnai maneuver.

- With regard to the reconstructive phases, it is indubitable that especially in total gastrectomy different kinds of difficulties could be encountered. We have a large body of favorable experience of the Roux-en-Y transmesocolic side-to-side esophagojejunal anastomosis according to Orringer's technique [18, 19], which enabled extensive anastomosis that is never under stress and provides sufficient distance between the esophagojejunal anastomosis and the jejunojejunal anastomosis at the base of the transmesocolic Roux-en-Y loop. The functional results of this anastomosis proved to be satisfactory with regard to postoperative complications, which were minimal. In laparoscopic surgery, particular attention has to be dedicated to the preparation and dissection with a 45- or 60-mm white load endo-stapler of the third jejunal loop that cannot make use of transillumination, which is helpful in the open technique. Despite this, careful opening of the peritoneal serosa of the mesentery allows the vascular arches to be identified, isolated, and, when indicated, dissected with a harmonic scalpel between clips or using ultrasonic or radiofrequency energy. To avoid troublesome bleeding, the prepared loop is conducted to the esophagus via the transverse mesocolon through a tunnel opened in the avascular area slightly to the left and cranial to the ligament of Treitz.
- If the loop is too short to reach the esophagus without tension, it can be elongated by selective section of a vascular segment of the proximal arcades of the mesentery. After adequate experience is acquired, this step requires

slightly longer operative times than with the open procedure, and any possible ischemic lesions to the loop require resection and another preparation. The jejunojejunal anastomosis at the base of the Roux-en-Y loop can be performed both laparoscopically and through an extractive periumbilical mini-laparotomy. No specific advantages in favor of one method or the other were perceived, other than the few minutes saved with the open technique, which on the other side is exposed to a higher percentage of incisional hernia in respect of the suprapubic extractive incision in the laparoscopic option for this anastomosis.

- Some difficulties in the esophagojejunal anastomosis usually derive from the tendency of the esophagus to retract into the mediastinum, especially in high resections, due to cardiac neoplasm. To avoid the retraction, which could also determine the necessity of thoracic access that has not been previously programmed, with prolonged operative time and increased risks, we usually first provide good mobilization of the distal mediastinal esophageal segment that can be easily isolated from the vagus nerves, which are dissected. Then, after the retraction of the nasogastric probe, we perform a subtotal resection of the esophageal–cardiac junction with a 45- or 60-mm green or gold load stapler. This is carefully moved from the right to the left to achieve a subtotal resection. The residual continuity on the left side will ensure the support in situ of the esophageal stump, avoiding inconvenient retractions from taking place, which can easily occur during the Trendeleburg phases performed in the anastomotic step. In fact, only after the side-to-side esophagojejunal anastomosis, similar to that Orringer described for cervical esophagogastroplasty [13, 14], with a 45- or 60-mm green load stapler applied between the posterior wall of the esophagus and the anterior wall of the Roux-en-Y loop, the transection of the gastroesophageal junction is completed with the second application of the stapler.
- Closure of the access route of the stapler with manual interrupted 3–0 polyglycolic acid sutures (best with intracorporal suturing in laparoscopic procedures), and with intraoperative hydropneumatic anastomosis testing via the injection of methylene blue solution and air through a nasojejunal tube repositioned at the anastomosis site that is left in situ for 3 or 4 days until the routine water-soluble radiographic test.

18.2 Remnant Gastrectomy

- Remnant gastrectomy (RG) procedures [20, 21], or primary gastrectomy in patients previously operated on in the upper abdomen, usually require a preliminary extensive adhesiolysis. In this instance, both in open and in laparoscopic operations, it is helpful to preliminarily create a pneumoperitoneum using the open Veress-assisted technique. It consists of needle insertion under the left costal margin, an operating pressure of 12 mmHg, aspiration tests of CO_2 by a syringe with a physiological solution, and an incision in the wall with a surgical scalpel blade no. 11 and positioning of a 10- to 12-mm optical trocar (T1) on the linea alba or more often on the left or right flank in the frequent case of middle line adhesions. After this, the preliminary positioning of an additional 5-mm trocar (T5), preferably on the left side allows adhesiolysis to be achieved, preferably with a cold knife.
- After this, in remnant gastrectomy a wide dissection of the afferent and efferent loops of the gastrojejunal anastomosis is needed, at a sufficient distance from the anastomosis, with two applications of a white load stapler, while performing an en bloc resection of the entire mesentery of the jejunal portion of the anastomosis. The cautious and necessary extensive mobilization of the jejunal trunks can often present great difficulties, particularly in patients who had undergone a previous anastomosis performed using the transmesocolic technique. Thus, particular attention is required to avoid colic or mesocolic lesions that may occur during the laparoscopic approach, almost always requiring a conversion to open surgery for a colonic resection–anastomosis with or without protective ileostomy, usually in patients without bowel preparation.
- In cases of remnant gastrectomy after previous subtotal gastrectomy for cancer metastatic lymphadenopathies can be incurred in which

resection is usually very difficult for fibrosis determined from the previous incomplete procedures. In cases of remnant cancer after previous limited antrectomy for a benign ulcer, the adhesions to the pancreas and to the retroperitoneal space, often increase the difficulty in the execution of a complete D2 lymphadenectomy that also involves the left gastric pedicle if pierced during the previous operation.

18.3 Conclusion

As for any other field, surgery for gastric cancer requires special care to be taken with planning and technique to achieve good results in terms of oncologic radicality and a low rate of intraoperative complications, such as low perioperative morbidity and mortality. The very complex vascular and lymphatic systems of the stomach pose some problems that have still not been completely solved to decide on the most correct form of lymphadenectomy to perform. In any case, many common surgical difficulties are encountered by during any operation. By proposing the crucial points of a standardized technique, both in the open and laparoscopic approaches, to improve performance of some of the critical steps of total, subtotal and remnant gastrectomy, we hope to have made our contribution to improving results in this challenging surgical field.

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Surgical Technique and Difficult Situations from Arnulf H. Hoelscher (Conventional)

Arnulf H. Hoelscher

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19.1 Introduction

19.1.1 Classification and Staging

For the planning and performance of surgical treatment, the exact topographic assignment of carcinomas of the stomach and the esophagogastric junction is of central importance. In distal gastric adenocarcinoma of the antrum or the pylorus especially of category cT1 or cT2 with intestinal type of Lauren, a subtotal gastric resection can be performed. However in more proximally located carcinomas of the corpus or fundus especially those of the diffuse type, a total gastrectomy is necessary.

In adenocarcinomas of the esophagogastric junction, it is decisive if the carcinoma can be completely resected via an abdominal and transhiatal approach or if an extended resection of the thoracic esophagus is necessary. Further the main lymphatic draining area is important for the planning of surgical resection.

For the description of adenocarcinomas of the esophagogastric junction, the classification of 1987 with type I, type II, and type III is most appropriate (Siewert et al. 1987). This therapeutically relevant classification is currently internationally applied under the name "adenocarcinoma of the esophagogastric junction" (AEG):

- AEG type I: Barrett carcinoma of the distal esophagus which cannot be completely resected via an abdomino-transhiatal approach and which has a lymphatic drainage area to the mediastinum as well as along the lesser curvature in direction to the left gastric artery and celiac trunk.
- AEG type II: real cardia cancer in the narrower sense
- AEG type III: subcardial gastric cancer

The lymphatic drainage of type II and type III carcinoma is mainly directed into the abdomen like a gastric cancer but also in the lower mediastinum. These lymph nodes can be completely resected via abdomino-transhiatal approach.

For the pre-therapeutic classification of the tumor according to the AEG classification, the following diagnostics are necessary:

- Esophagogastroscopy with biopsy, endosonography, and spiral CT scan of the abdomen and thorax. The sagittal reconstruction for the CT data and in some cases also an esophagogram by barium swallow show the extent of the carcinoma in relation to the esophagogastric junction. This is especially important in case of a large hiatal hernia. The endoscopic and radiologic examinations are also the basis of a clinical TNM staging.
- Malignant tumor is proved and classified via an endoscopic biopsy. An experienced endoscopist can evaluate the T category with a high accuracy. The accuracy of the T category by endosonography however varies between 65 and 92 % (Hoelscher a. Fetzner 2012). Limited accuracy exists concerning the extent of invasion of early cancer into the mucosa or submucosa. The clinical N category by endosonography or CT scan is only based on the measurement of the lymph node diameter less or more than 1 cm. Therefore the N category remains unsafe (Hoelscher a. Fetzner 2012).
- The cytological approval of lymph node metastasis by transmural puncture does not influence the surgical procedure as the lymph nodes directly adjacent to the esophagus are anyhow removed during the operation. The contrast-enhanced spiral CT scan is mainly used to exclude distant metastases and the infiltration into neighboring organs (cT4 category). Magnetic resonance imaging (MRI) does not gain significant further advantages compared to a technically good CT scan with evaluation by an experienced radiologist. A PET-CT should only be used in cases of special questions.

If there is any clinical or radiological suspicion of peritoneal carcinomatosis, e.g., in case of ascites, a diagnostic laparoscopy should be performed. This is especially indicated in type II and III carcinomas prior to neoadjuvant therapy. The preoperative diagnostics comprise also the functional risk assessment of the patient because the procedure is extended, and therefore the functional load-bearing capacity is very important.

19.1.2 Therapeutic Strategies

In cT1 carcinomas, it has to be decided whether an endoscopic or surgical resection is appropriate. Criteria for this decision are the diameter of the tumor and the possibility of a complete endoscopic en bloc resection as well as the depth of

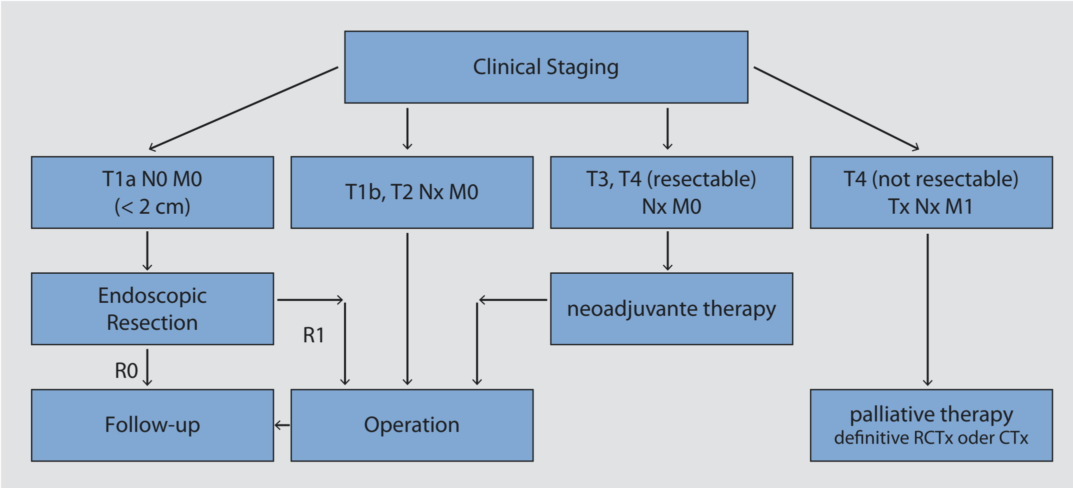


Fig. 19.1 Gastric carcinoma and adenocarcinoma of the esophagogastric junction: Multimodal therapeutic strategies according to the clinical staging

infiltration in the mucosa or submucosa (Hoelscher 2012, Annals of Surgery, Hoelscher a. Fetzner 2012). Mucosal carcinomas of less than 2 cm in diameter can be resected after submucosal injection either in the cap technique or more safe with the so-called endoscopic submucosal dissection (ESD). Carcinomas with these kinds of characteristics never had lymph node metastases in the own case material (Hoelscher 2012). This supports the possibility of endoscopic resection (Pech, Annals of surgery). In mucosal cancer of less than 2 cm in diameter especially those with infiltration of the deepest third of the mucosa (m3), lymph node metastases can already be present in 10 % of the cases. Therefore the indication for local resection should be established very carefully in these cases.

In submucosal cancer of the stomach and esophagogastric junction, the percentage of lymph node metastasis is 15–20 % in case of infiltration of the upper third (sm1), 20 % in case of infiltration of the middle third (sm2), and 40–55 % in case of infiltration of the lowest third (sm3) (Hoelscher 2012). Therefore submucosal cancer is not appropriate for endoscopic resection (Fig. 19.1). This recommendation is in accordance with the current German S3-guideline for gastric cancer (Möhler 2011). As indicated in Fig. 19.1, gastric cancer and adenocarcinoma of the esophagogastric junction in the categories cT1b and cT2 NX M0 should directly be operated. In advanced carcinomas, i.e., cT3 and resectable cT4 carcinoma, a neoadjuvant therapy followed by surgery is recommended (Fig. 19.2). In gastric carcinoma and type II and III AEG carcinomas, neoadjuvant therapy comprises especially chemotherapy like FLOT followed by operation after an interval of about 4 weeks.

In AEG type I carcinoma and also in some cases of type II which extend into the distal esophagus, neoadjuvant radiochemotherapy is favored, especially with the CROSS regimen.

Nonresectable T4 carcinomas and all gastric carcinomas of category M1 should be treated by definite chemotherapy or definite radiochemotherapy (type I) with an appropriate palliative therapy.

19.1.3 Extent of Resection

According to the German S3-guideline of gastric cancer of 2011, the aim of curative surgery of gastric cancer is the complete resection of the primary tumor and the regional lymph nodes with histological approval of tumor-free proximal, distal, and circumferential resection margins (R0 resection) (Möhler 2011).

In distal tumors of the stomach, i.e., antrum and pylorus, the proximal stomach can be preserved without negative effect on the prognosis. This is especially true for T1 and T2 carcinomas of the antrum and pylorus. In case of intestinal type of Lauren, a sufficient oral resection margin of 5 cm should be achieved and 8 cm in case of diffuse type of Lauren (Fig. 19.2).

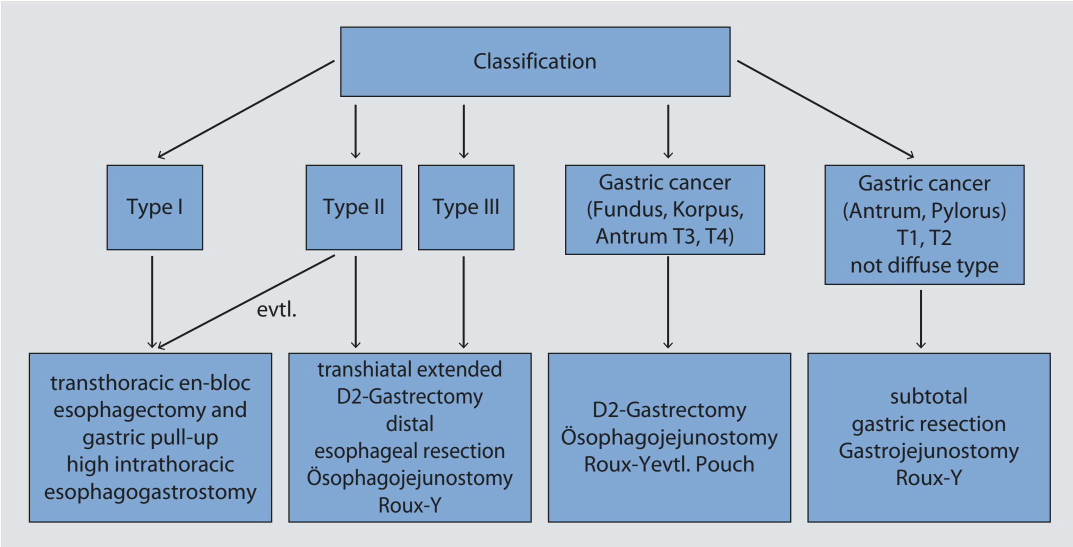


Fig. 19.2 Gastric carcinoma and adenocarcinoma of the esophagogastric junction (AEG): surgical procedures according to the classification

In more proximally located carcinoma, usually a total gastrectomy is necessary. In adenocarcinoma of the esophagogastric junction of types II and III additionally to the gastrectomy, a distal esophageal resection is necessary. In some cases of AEG type II carcinomas with a luminal extent into the distal esophagus, an esophagectomy with proximal gastric resection and reconstruction by a narrow gastric conduit can also be necessary in order to achieve an R0 resection at the esophageal resection margin.

In some cases of far advanced tumors which infiltrate the stomach as well as the esophagus, an R0 resection can only be achieved by total esophagogastrectomy with reconstruction by colon interposition. If possible also in T4 carcinomas, an R0 resection should be achieved by multivisceral resection of adherent structures to the tumor like the diaphragm, left liver lobe, pancreas, or transverse colon en bloc with the primary cancer.

Multivisceral R0 resections have a decisive advantage in comparison to R1 resections. A routine splenectomy should be avoided. Laparoscopic resections of gastric cancer are possible, but the experiences especially in the western world are limited. Most reports about this minimal invasive technique come from Asia and are especially concerning Billroth I resections of small distal carcinomas.

The standard of lymphadenectomy in case of subtotal resection as well as gastrectomy or transhiatal extended total gastrectomy is D2 lymphadenectomy, i.e., compartment one with the lymph node areas 1–6 and compartment two with the lymph node areas 7–11. In AEG type II and III carcinoma in addition, the lymph nodes of the lower mediastinum are resected. In case of suspicious lymph nodes of the splenic hilum or direct infiltration of the tumor into the spleen, the so-called pancreatic preserving zone splenectomy should be performed. An extension of lymphadenectomy to the para-aortic lymph nodes is not improving the prognosis (Sasako).

In AEG carcinomas type I, the transthoracic en bloc esophagectomy with radical mediastinal lymphadenectomy and abdominal D2 lymphadenectomy is performed with reconstruction by gastric pull-up and high intrathoracic esophagogastrostomy. The abdominal part of the procedure can mostly be done by a minimal invasive approach.

The operation of Merendino, i.e., limited distal esophageal and proximal gastric resection with the reconstruction by isoperistaltic jejunum interposition between the esophagus and stomach, is a very rare indication. This procedure has especially an indication in case of mucosal carcinoma which can today mostly be resected by endoscopic means.

In submucosal carcinomas, the limited lymphadenectomy with preservation of both vagus trunks has disadvantages of radicality if the Merendino operation is applied. Further the functional long-term results with substantial percentage of dysphagia, gastroesophageal reflux, or gastric emptying disturbances are dismal (Zapletal).

19.2 Preparation

The patient is placed in supine position. In order to expose the upper abdomen, it is appropriate to lift the thorax up by a soft towel in the back.

19.3 Surgical Technique

Gastrectomy comprises a resection of the whole stomach, pylorus, and cardia.

- The standard approach is median laparotomy of the upper abdomen left of the umbilicus.
- A very good overview can be achieved by an approach via a combination of median upper abdominal laparotomy and transverse incision (turned around T shape).
- The upper abdominal cavity can be approached very easily by a self-holding retractor.
- The first step after opening of the abdominal cavity is the evaluation of the oncologic situation, especially the exclusion of peritoneal carcinomatosis or liver metastasis and the localization and extension of the primary tumor. In adenocarcinoma type II or III, it is most appropriate first to dissect the distal esophagus in order to decide if the procedure can be done from an abdominal approach. The left lobe of the liver has to be dissected from the diaphragm and should be retracted to the right side. The peritoneum on the distal esophagus should be incised and the right and the left diaphragmatic crus have to be dissected.
- The esophageal hiatus is opened, and the esophagus which is secured by a large gastric tube is bluntly dissected between the index finger and the thumb and taped. If necessary, the esophagus can further be dissected in the lower mediastinum by an anterior incision of diaphragm in front of the pericardium.
- The next step is a dissection of the greater omentum from the transverse colon and the opening of the bursa omentalis. The gastrosplenic ligament is severed close to the spleen by conventional technique or a dissection device. The left gastroepiploic artery and vein are dissected between ligations and suture ligations.
- The gastric fundus is freed from retroperitoneal adhesions and completely mobilized by reaching the primary area of dissection at the left diaphragmatic crus.
- The right colonic flexure is freed and the postpyloric duodenum is dissected. The dissection of the gastroduodenal artery and the identification of the origin of the right gastroepiploic artery and vein are performed. Both vessels are suture ligated at their origin with complete removal of lymph node area 6, the so-called infrapyloric lymph nodes. These remain at the gastric specimen.
- At the lesser curvature, the right gastric artery is suture ligated and the postpyloric duodenum is dissected on a length of about 3 cm. About 2 cm distal to the pylorus, the duodenum is closed and cut with a stapler, e.g., GIA 60 blue. The stapler line at the duodenal stump is oversewn with 3–0 seromuscular single stitches.
- Along the gastroduodenal artery, the lymphadenectomy of compartment two is started, i.e., lymph node areas 6–12. Along the gastroduodenal artery, the common hepatic artery and the proper hepatic artery are prepared and the lymph nodes from these arteries are removed.
- The lymphadenectomy of the hepatoduodenal ligament with lymph node area 12 is performed. During this lymphatic dissection along the proper hepatic artery and the left hepatic artery, the right gastric artery can be dissected again at its origin und should be suture ligated. The lymph nodes are removed from the upper edge of the portal vein which runs dorsal in the hepatoduodenal ligament.
- The small omentum is dissected close to the liver. A small left hepatic artery in the small omentum can be closed and cut without any severe sequelae. A larger artery which mostly carries also the origin of the left gastric artery and which is coming from the celiac trunk should be dissected from the lymph nodes and preserved. In this case, the left gastric artery is cut after suture ligation directly at its origin from the left hepatic artery.
- Lymphadenectomy now runs along the common hepatic artery in median direction with resection of the lymph nodes at the upper

edge of the pancreas and the anterior surface and behind this artery. In some cases, it is appropriate to tape the artery in order to complete the resected lymph nodes behind this vessel.

In order to dissect the portal vein more clearly and avoid injuries, this vessel should be pushed with the index finger of the left hand through the foramen of Winslow in medial and anterior direction. This allows a clear view of the upper edge of the portal vein and a very radical lymphadenectomy. This maneuver also facilitates the preparation of the origin of the left gastric vein into the portal vein.

- At this area, the left gastric vein is suture ligated and cut. Further dissection is along the common hepatic artery in the direction of the celiac trunk. The splenic artery is dissected and the left gastric artery is cut and suture ligated at its origin.

In the case of a large left-sided hepatic artery originating together with the left gastric artery from the celiac trunk, the left hepatic artery must be preserved, and the left gastric artery has to be dissected and cut after suture ligation at its origin.

- After freeing the celiac trunk, the left and right diaphragmatic crus is dissected. The lymph node dissection is further extended to the splenic artery with resection of lymph nodes of station 11.
- After dissection of further retrogastric connective tissue, the stomach is completely free together with the lymph node compartments one and two, and it only remains connected to the esophagus. If the lymph node 13 in the dorsal part of the hepatoduodenal ligament is obviously infiltrated, this can be resected behind the pancreatic head after mobilization of the duodenum according to Kocher.
- Now the anterior and the posterior vagus trunk of the distal esophagus is dissected and cut after coagulation. This gives further length of the abdominal esophagus. The esophagus is cut above the cardia and the specimen is delivered for histological examination. At the esophageal stump, a purse-string suture with monofilament thread size 0 is placed, and the 28 head of a circular stapler is inserted and purse-string suture is tied. In some cases of a very small diameter of the esophagus or the upper jejunum, the 25 stapler can also be used.
- The spleen is preserved in the standard gastrectomy. Only if lymph nodes are suspicious of metastasis in the hilum of the spleen, a so-called pancreas-preserving splenectomy (zone splenectomy) should be performed. This affords a mobilization of the spleen and the pancreatic tail after dissecting the retroperitoneal connective tissue. After careful elevation of spleen and pancreatic tail in anterior direction, the splenic artery and the splenic vein can be dissected in the splenic hilum and suture ligated and cut. The pancreatic tail has to be dissected from the splenic hilum under preservation of the pancreatic capsule. The spleen together with the lymph nodes at the upper edge of the pancreas and from the splenic hilum is removed. Splenectomy can also be performed en bloc with the gastrectomy.

In resectable T4 carcinomas of the stomach, adherent structures to the tumor, like the diaphragm, spleen, left lobe of the liver, pancreatic tail, or transverse colon, should be resected en bloc with the primary carcinoma. In case of the left regional extended gastrectomy with resection of the celiac trunk because of large lymph node metastasis (Appleby operation), the vascularization of the liver is preserved by the gastroduodenal artery as well as the proper hepatic artery. The common hepatic artery is suture ligated and cut proximal of the origin of the gastroduodenal artery. This operation is completed by cutting the pancreas above the portal vein and extirpation of the pancreas and the stomach in the left direction. The celiac trunk is suture ligated or sutured at the origin of the aorta. The stomach is resected together with the left pancreas and the spleen en bloc. In case of this operation, it has to be assured that the vascularization of the liver via the gastroduodenal artery is sufficient. In the same manner, a right regional gastrectomy with en bloc resection of the pancreatic head and the duodenum can be performed like in Whipple's operation.

- In case of a transhiatal extended gastrectomy (▪ Fig. 19.3), a preparation of the abdominal esophagus is performed, and the diaphragm is cut in anterior direction after suture ligation of both sides of the diaphragmatic

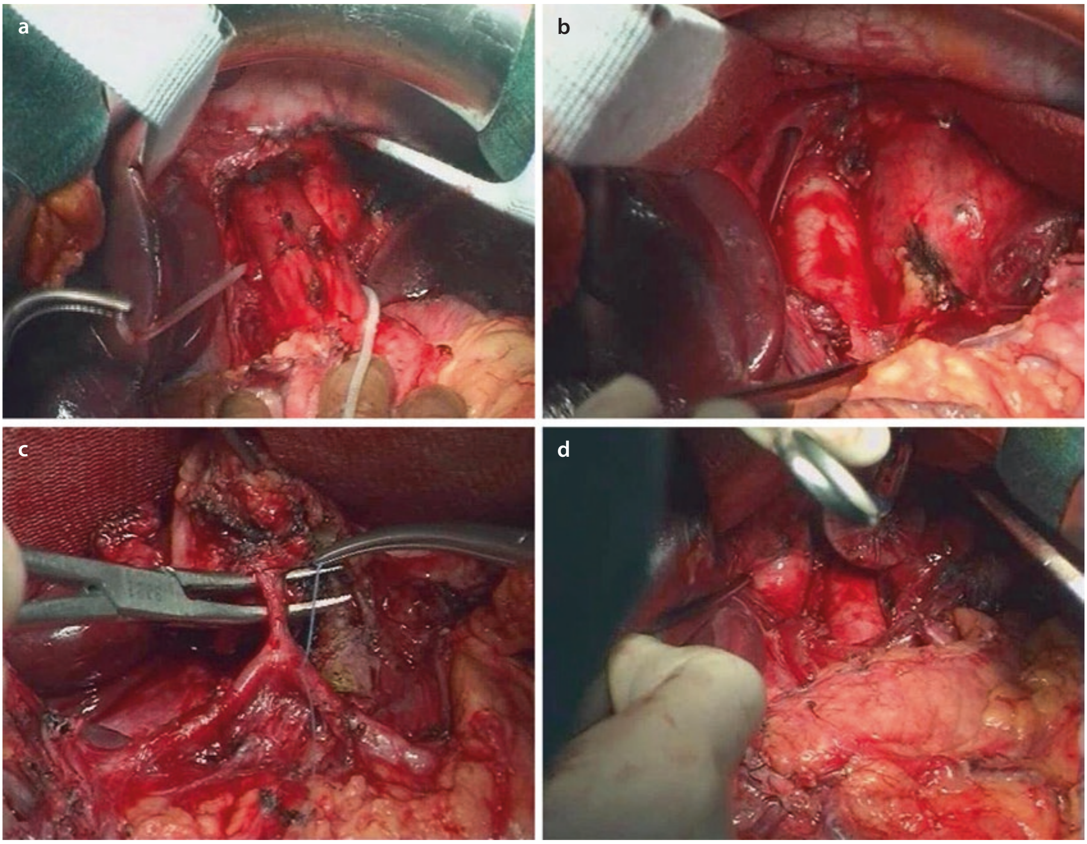


Fig. 19.3 **a–d** Surgical technique of transhiatal extended gastrectomy. **a** Taped esophagus with exposition of the lower mediastinum after suture ligation of the phrenic vein, median incision of the diaphragm, and dissection of the right and left diaphragmatic crus. **b** Situs after lymphadenectomy in the lower mediastinum with dissected aorta and both lungs. **c** Situs after suprapancreatic en bloc lymphadenectomy before suture ligation and cutting of the left gastric artery. **d** Inserted removable device of the stapler via a purse-string suture in the lower esophagus and in the lower mediastinum after gastrectomy and distal esophageal resection

vein. This allows wide exposure of the esophagus and the lower mediastinum.
- The lymph nodes between the pericardium and aorta are excised with pleural stripes at both sides. The right and the left pleural cavity are drained with thoracic drainages. After insertion of two long Brunner hooks, the esophagus can be dissected very high in the lower mediastinum with resection well above the tumor. To assure the complete resection of the carcinoma at the esophageal resection line, an intraoperative frozen section of the resection margin of the esophagus should be performed.

In this case, cutting of the vagus nerve is also important as this gets more mobility to the esophagus.

- In the same manner as in case of abdominal gastrectomy, a purse-string suture is placed at the esophageal stump.

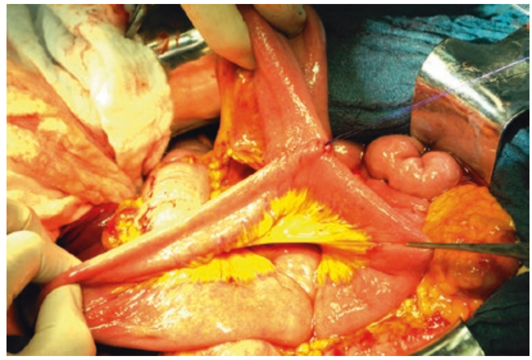
19.3.1 Reconstruction After Gastrectomy and Transhiatal Extended Gastrectomy

The standard reconstruction after gastrectomy is a Roux-en-Y esophagojejunostomy.
- For preparation of this construction, the vascularization of the upper jejunum is exposed by diaphany with a light on the opposite side of the small bowel mesentery. This allows a very clear recognition of the mesenteric vascular arcade of the upper jejunum.

◘ **Fig. 19.4** Insertion of the stapler and antimesenteric jejunal perforation of the central rod

- The length of the chosen jejunal loop must be enough for easily reaching the esophagus. The fatty tissue between the mesenteric arteries and veins is cut and the vessels are suture ligated. The aim is a formation of a long, well-vascularized aboral jejunal loop.
- After cutting the continuity of the jejunum, the aboral jejunal loop is moved via a retrocolic route into the upper abdomen. During this maneuver however, the integrity of the mesenteric vessels is of utmost importance. At the edge of the jejunal loop, the stapler is inserted and the central rod is perforated in aboral direction antimesenteric and connected with the removable part of the stapler in the esophagus (◘ Fig. 19.4).

After closure of the stapler, it is very important to prove that only the antimesenteric wall is around the central rod of the stapler and not the mesenteric wall. If the mesenteric wall of the jejunum is completely or partially pulled into the stapler anastomosis, a closure or a stenosis of the lumen is the consequence. After closure of the stapler and firing of the anastomosis, the rings of both sides, esophageal and jejunal, should be



◘ **Fig. 19.5** Completed Roux-en-Y anastomosis as an end-to-side jejunojejunostomy

controlled for completeness. Further, the consistency of the lumen of the end-to-side esophagojejunostomy should be approved by a thick gastric tube.

- Finally the redundant part of the jejunal loop should be removed 2–3 cm left of the esophagojejunostomy with a linear stapler. This stapler line should be oversewn by 3–0 single stitches. Oversewing of the esophagojejunostomy can be performed with 4–0 monofilament PDS sutures.
- 50 cm distal to the esophagojejunostomy, a Roux-en-Y anastomosis is performed (◘ Fig. 19.5) with extramucosal single-row stitches or continuous suturing. The mesenteric gap is closed and the retrocolic gap of the jejunum is also adapted to the jejunum with single-row stitches. In case of a transhiatal extended gastrectomy, the jejunal loop should be mobile enough to ensure a tension-free anastomosis. The mobility of the jejunal limb can be improved by loosening the root of the whole small bowl mesentery and the cecum from the retroperitoneal connective tissue. If the diaphragm has been incised in anterior direction for exposure of the lower mediastinum, an anterior hiatoplasty with non-resorbable 1–0 stitches should be performed. However, a narrowing of the jejunal loop which leads to the lower mediastinum should be avoided.

If in transhiatal extended gastrectomy with distal esophageal resection the anastomosis high in the lower mediastinum is technically too difficult, the anastomosis can also be performed via a right lateral thoracotomy in the sixth intercostal space.

- A drainage of the operative area is usually not necessary. Only if there is suspicion of a pancreatic lesion or a certain tendency to bleed especially in patients with a necessity to have medication against thrombocyte aggregation, a drainage in the left subphrenic space or below the left lobe of the liver should be performed.

19.3.2 Pouch Formation in Case of Abdominal Gastrectomy

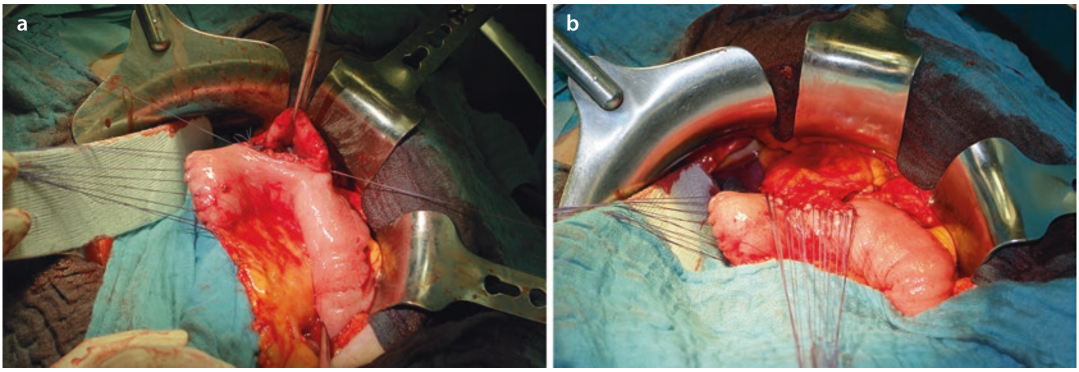
Especially when the patient has a very favorable tumor stage and good prognosis, a gastric substitute with a pouch can be created. Most appropriate is a turned J-pouch of a Roux-en-Y loop.

- This affords a formation of a long Roux-en-Y loop. Both jejunal loops are placed parallel to each other at a length of 15 cm. At the upper edge of the pouch, a ring of about 5 cm in length remains open.
- The side-to-side anastomosis of the jejunum is planned for 8–10 cm and prepared by stay sutures.
- At the lower edge of the pouch, an antimesenteric incision is performed on both limbs of 1.5 cm and the 8 cm long linear stapler (e.g., GIA 80) is inserted. After insertion of the two branches of the stapler, it is very important that they are placed in the antimesenteric part of both limbs; otherwise, parts of the mesentery can be cut. The anastomosis is fired and it is necessary to avoid intraluminal bleeding of the long linear anastomosis inside. If necessary, a compress can be introduced into the pouch for a short time in order to perform a compression.
- Via the open end of the jejunal limb, the circular stapler is inserted. During this procedure, a too intense stretching of the jejunal wall should be avoided. If the introduction of the stapler, e.g., a 28 head, via this side is not possible, it can also be introduced over an enlargement of the introduction side of the linear stapler.
- The circular stapler is now proceeded in the direction of the upper edge of the pouch, and the central rod is perforated at the antimesenteric side. After connection of the stapler device with the removable part in the esophagus, the anastomosis is fired as has been described above for the end-to-side esophagojejunostomy.
- Finally the insertion area of the linear stapler at the lower edge of the anterior wall of the pouch is closed with 3-O extramucosal single-row stitches. The open blind loop of the jejunal limb is closed with a TA 55 linear stapler, and the staple line is oversewn. The so-called esophagojejunoplication which comprises the coverage of the anastomotic anterior wall by a ring of the upper part of the pouch is rarely performed today (◘ Fig. 19.6).

◘ **Fig. 19.6** Preparation of the J-pouch

19.3.3 Subtotal Gastric Resection

In case of the subtotal gastric resection, about 4/5 of the stomach is resected and 1/5 of the proximal stomach is preserved. A preparation is formed quite similar to total gastrectomy. However, during the



■ **Fig. 19.7** **a** Exposed completed posterior wall of the gastrojejunostomy after subtotal gastric resection. **b** Completed suture of the anterior wall of the gastrojejunostomy

mobilization of the abdominal esophagus, the integrity of the esophagogastric junction and the esophagus has to be guaranteed. As the vascularization of the gastric remnant after preparation of the whole lesser curvature is only maintained by the upper short gastric arteries and veins, the integrity of the spleen and the mentioned vessels is very important.

- The greater omentum of the greater curvature is dissected and cut according to a 4/5 resection of the stomach.
- On the minor side, the lymphadenectomy is the same as in total gastrectomy. The lymph nodes at the esophagogastric junction are resected from the esophagus in direction to the stomach up to 3 cm below the cardia. The integrity of the esophageal and gastric wall in this area is very important.
- This procedure is followed by closing and cutting of the stomach with a linear stapler from about 2 cm below the cardia transverse to the side of the greater curvature, e.g.,. with a TA 90. The consistency of the distal esophagus must be assured.
- The lymphadenectomy along the vessels of the upper abdomen is performed as has been described for total gastrectomy. The lymph nodes are removed en bloc with the gastric specimen. In comparison to the gastrectomy only the lymph node area 2 subcardial at the major side of the gastric fundus is preserved.
- The reconstruction is done by a Roux-en-Y jejunal loop. A Billroth II reconstruction is not appropriate because of the small gastric remnant which would provoke a very intense bile reflux. The Roux-en-Y loop is performed in the typical manner like in total gastrectomy and closed with a linear stapler at the blind edge which is placed at the lesser curvature of the gastric remnant. The jejunal loop is also moved into the upper abdomen retrocolic.
- The stapler line at the gastric remnant is oversewn at the minor side until an area of 3 cm at the major side. This part of the stapler line is resected and the jejunal loop is opened at the antimesenteric side also at 3 cm in length.

As the jejunum is more easy to stretch than the stomach, it is suggested to open the jejunum a bit less than the opposite side of the stomach.

- The anastomosis is performed with 3-0 mattress sutures at the posterior wall and extramucosal single wall stitches at the anterior wall (■ Fig. 19.7). In the same manner, the anastomosis can be performed in continuous suturing technique.

The so-called “Jammerecke” is closed with a 3-stitch technique which comprises the anterior wall of the stomach, the posterior gastric wall at the lesser curvature and the jejunum. This ensures a good coverage of this sensitive area of the anastomosis.

- The Roux-en-Y anastomosis is performed in a typical manner as has been described above.

19.4 Difficult Situations

A Case Example

Situation

The case comprises a AEG type II tumor with a large part of this tumor in the distal esophagus. Because of the preoperative diagnostic (endoscopy, CT scan), it seems to be possible to remove the tumor via an abdomino-transhiatal approach. After transhiatal exposure and palpation as well as intraoperative esophagogastroscopy, it is clear that the tumor cannot be removed completely at the esophagus via a transhiatal approach.

Problem

There is the danger that the stomach is completely dissected and removed at the duodenum. If it is not possible to remove the tumor at the esophagus with a tumor-free margin via the transhiatal approach, the stomach can no more be used for a reconstruction. The only alternative then would be reconstruction via colon interposition. The patient however has not been prepared for this procedure. A colonoscopy and an anterograde lavage of the bowel have not been performed. According to the experience of the surgeon, perhaps he is not able to perform a reconstruction via a colon interposition.

Solution

Because of this potential situation, it is suggested in cases which are difficult to judge preoperatively first to dissect the distal esophagus by transhiatal approach in the lower mediastinum. The esophagus can be cut and the frozen section can be performed. If the cutting section is infiltrated, another segment of the esophagus can be resected in order to achieve a tumor-free resection margin.

Analysis

If the frozen section shows a tumor-free resection margin, a transhiatal extended gastrectomy with D2 lymphadenectomy is completed and reconstruction according to Roux-en-Y. If the frozen section shows an infiltrated resection margin, still the decision can be taken to perform a reconstruction with a gastric pull-up after extended esophagectomy. The reconstruction is then performed by gastric pull-up with a narrow gastric conduit. However at the aboral resection margin of the stomach, a tumor-free resection also has to be guaranteed. If the stomach is infiltrated widely by the subcardial part of the tumor and if it is not appropriate for formation of a gastric tube, a total esophagogastrectomy and a colon interposition with proximal esophagocolostomy and distal colojejunostomy have to be performed.

19.4.1 Classification of the Intraoperative Difficulties

We classify the intraoperative difficulties in patients which have to be operated for gastric cancer as mentioned in ◘ Table 19.1.

◘ **Table 19.1** Grade of intraoperative difficulties in gastrectomy for carcinoma

Grade I: ideal patient	Technically simple to operate, each surgical method can be performed without problems	Small gastric cancer in the antrum or corpus in patients without abdominal surgery before and without neoadjuvant treatment
		Treatment by subtotal gastric resection, modified D2 lymphadenectomy, and reconstruction after Roux-en-Y with gastric jejunostomy or treatment by gastrectomy with D2 lymphadenectomy with reconstruction after Roux-en-Y esophagojejunostomy

(continued)

Table 19.1 (continued)

Grade II: not a very ideal patient	Moderate technical difficulties, some surgical methods can be more difficult than others	AEG type II or type III tumor: treatment by transhiatal extended gastrectomy with distal esophageal resection, D2 lymphadenectomy in the lower mediastinum
		Advanced carcinoma of the gastric antrum with infiltration of the pylorus: treatment by gastrectomy, D2 lymphadenectomy, more extended duodenal resection
		Patient after neoadjuvant therapy and reasonable scaring of the lymph nodes along the suprapancreatic vessels and at the upper edge of the pancreas: exact dissection of this vessels during lymphadenectomy and preservation of the pancreas
		Patient with abdominal surgery before: abdominal adhesiolysis
Grade III: problematic patient	Difficult to operate, some surgical methods significantly more difficult than others	AEG type II tumor with significant infiltration of the esophagus: Very high esophagojejunostomy with transhiatal or by right transthoracic approach if necessary, intraoperative decision to perform esophagectomy and reconstruction by gastric pull-up, mediastinal lymphadenectomy, abdominal modified D2 lymphadenectomy
		Intense intraabdominal adhesions: very difficult adhesiolysis
		Patients with a gastric stump cancer or Billroth I or Billroth II resection before, especially after retrocolic reconstruction
		Patients after neoadjuvant therapy and intense scaring of the lymph nodes along the suprapancreatic vessels: exact dissection of these vessels during lymphadenectomy and preservation of the pancreas
Grade IV: very difficult patient	Each step of the operation is difficult	Extended AEG type II tumor with very large infiltration of the esophagus and stomach: esophagogastrectomy, mediastinal and abdominal D2 lymphadenectomy, reconstruction by colon interposition with esophagocolostomy and colojejunostomy
		Extended T4 gastric cancer: multivisceral resection with extended gastrectomy and en bloc resection of the liver, spleen, colon, duodenum, pancreas, and necessary intestinal or biliary reconstruction, Appleby operation in case of infiltration of the celiac trunk

Operative Technique and Difficult Situations by Joachim Jähne (Conventional)

Joachim Jähne

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20.1 Introduction

With respect to the actual guidelines for the diagnostic and therapeutic approach to gastric carcinoma and due to the generally accepted histology-, stage-, and localization-oriented surgical therapy, the intra- and extraluminal extent of gastric resection can be well defined in order to achieve a R0 resection [3]. For oncological reasons, approximately 80 % of all gastric carcinomas require a total gastrectomy – eventually transhiatal or abdomino-thoracic – while in about 20 % of all patients, a subtotal, distal gastrectomy is adequate. Irrespective of the intraluminal extent of resection, a D2 lymph node dissection should be an integral part of surgery.

The following description for both procedures reflects the author's experience. Multivisceral resections as "left upper quadrant evisceration" with en bloc left pancreatic resection, splenectomy and resection of the left colonic flexure, as well as gastrectomy with simultaneous resection of the head of the pancreas are not described herein.

20.2 Pre- and Intraoperative Setting

- All patients are discussed in the daily indication's conference. At the day before surgery, all patients' charts are intensively reviewed. During rounds in the morning before surgery, the incision is marked.
- In the OR patients' charts are again reviewed by the anesthesiologists. Following intubation and in general anesthesia, the intraoperative checklist is reviewed and team time-out is performed.
- During the operation, the surgeon uses a headlight to avoid recurrent manipulation at the OR light and to get a good view in particular in deeper areas of the situs.
- Resection is performed by the use of bipolar scissors and bipolar coagulation. Opening of the abdomen and transection of the bowl is performed by monopolar coagulation.
- For ligations 3-0 Vicryl is used. Hemostasis by sewing is done by 5-0 or 4-0 Prolene.

20.3 Operative Technique

20.3.1 Resection

- The abdomen is opened by a transverse laparotomy with upper extension to the xiphoid in the midline (Fig. 20.1). Skin incision is done with a scalpel and further tissue separation by monopolar coagulation. The wound edges are covered by laparotomy sponges. For retraction an Ulrich retractor is placed.
- The intraoperative findings are documented and technical as well as prognostic resectability is clarified. In case of resectability, the left lobe of the liver is mobilized in order to get good access to the esophagogastric junction (Fig. 20.2). Prior to that, the spleen is covered in a laparotomy sponge to avoid iatrogenic lesions.

Fig. 20.1 Preoperative mark of skin incision and transverse laparotomy

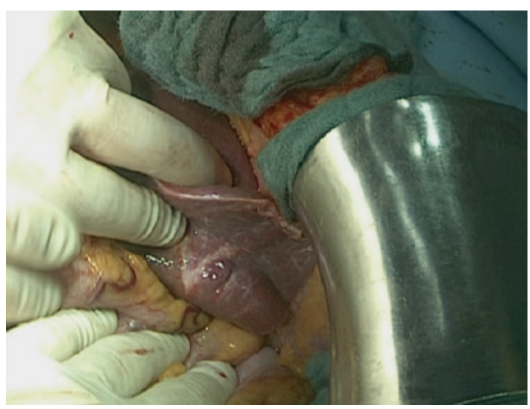
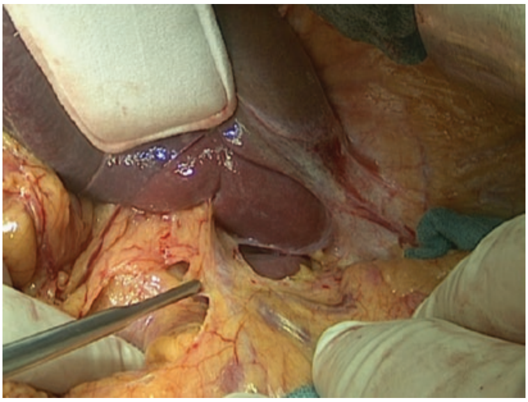
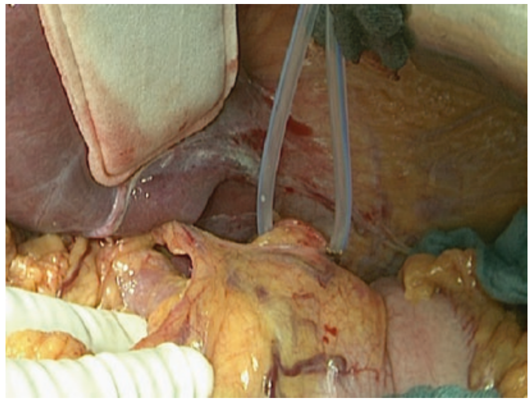


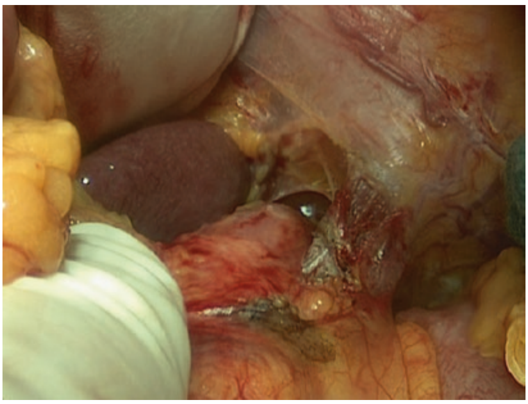
Fig. 20.2 Mobilization of the left lobe of the liver



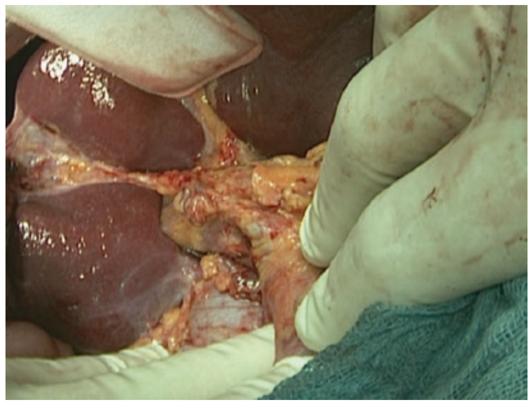
■ **Fig. 20.3** Incision of the small omentum close to the liver toward the esophagogastric junction; accessory left liver artery originating from the left gastric artery



■ **Fig. 20.5** Embracement of the esophagus including the vagal nerves



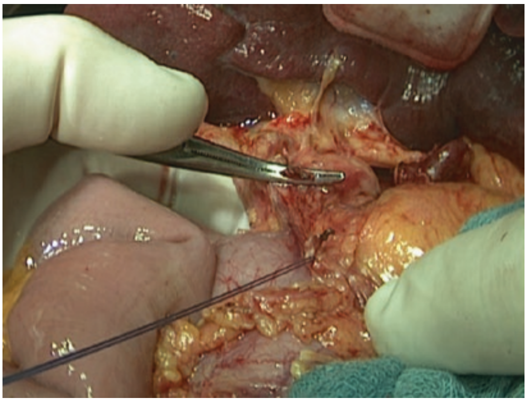
■ **Fig. 20.4** Incision of the peritoneum at the esophagogastric junction and exposure of the esophagus



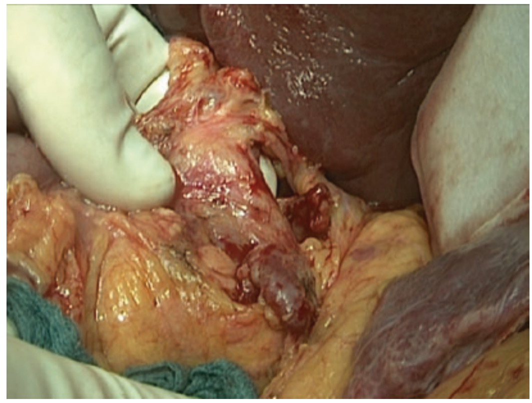
■ **Fig. 20.6** Mobilization of the duodenum, lymph node dissection at stations 13 and 16

Routine en bloc splenectomy is no longer performed. Only in case of locally advanced proximal gastric cancer that splenectomy is carried out by a ventral approach.

- The small omentum is incised close to the liver and in direction toward the esophageal hiatus. An eventually occurring accessory left liver artery originating from the left gastric artery needs to be preserved (■ Fig. 20.3). If this is not feasible, it usually does not cause harm to liver perfusion (■ Fig. 20.3).
- The peritoneum at the esophagogastric junction is incised (■ Fig. 20.4). Both branches of the diaphragm are exposed and the esophagus including the vagal branches is embraced (■ Fig. 20.5). In particular in carcinomas of the esophagogastric junction, this is important to clarify resectability. Additionally, it enables significantly the retroperitoneal lymph node dissection during further resection.
- Subsequently the duodenum is mobilized according to Kocher. During the mobilization of the duodenum, lymph node dissection at the right edge of the hepatoduodenal ligament starts and the identification of lymph node station 13 is possible. Additionally, lymph node station 16 (right of the vena cava and aorta) is dissected (■ Fig. 20.6).
- Due to the increased incidence of cholecystolithiasis following gastrectomy, we routinely perform cholecystectomy [2], although hard evidence for this approach is lacking.



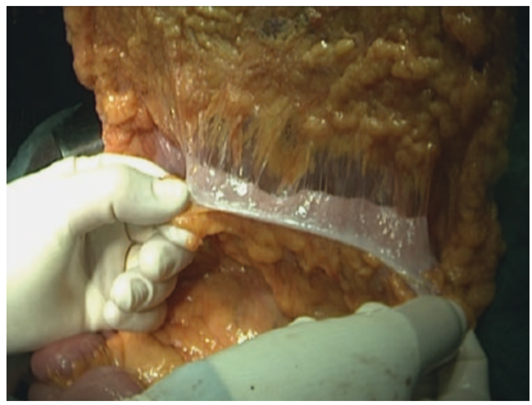
■ **Fig. 20.7** Lymphadenectomy at the hepatoduodenal ligament with ligation of the right gastric artery



■ **Fig. 20.8** Lymphadenectomy at the hepatoduodenal ligament and at the portal vein

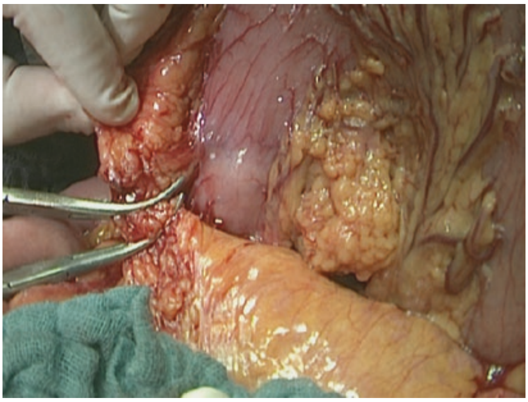
- Subsequently, lymphadenectomy at the hepatoduodenal ligament is performed. To identify anatomical variations of the right hepatic artery, e.g., origin from the mesenteric artery, lymph node dissection should start at the right edge of the choledochal duct. During lymph node dissection, the hepatic artery and the right gastric artery are identified, the latter one being dissected (■ Fig. 20.7). In obese patients the initial preparation at the hepatoduodenal ligament is avoided, and instead the common hepatic artery at the upper border of the pancreas and the branch of the gastroduodenal artery are identified. The common hepatic artery is then used as a live rail for lymph node dissection at the hepatoduodenal ligament.
- The lymph nodes behind the hepatoduodenal ligament and along the portal vein are dissected. This is achieved while the tip finger of the surgeon pushes the tissue behind the ligament from right to left (■ Fig. 20.8). The result is a compression of the portal vein, which is completely dissected of all lymphatic tissue.
- Lymph node dissection, always en bloc, is then continued along the common hepatic artery down to the celiac trunk. Small bleeding during the dissection is stopped by bipolar coagulation.

> **Particular attention is paid to the upper border of the pancreas. Injuries and necrosis due to coagulation must be avoided to prevent postoperative pancreatitis.**

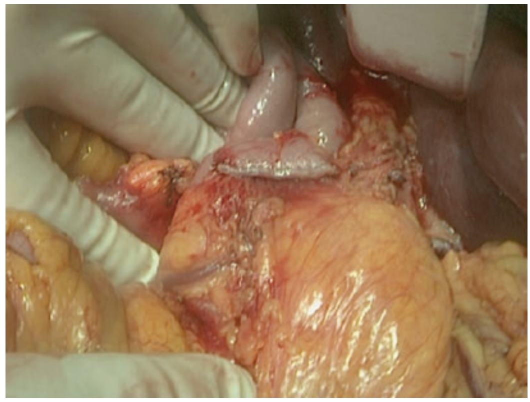


■ **Fig. 20.9** Omentectomy including excision of the anterior layer of the mesocolon

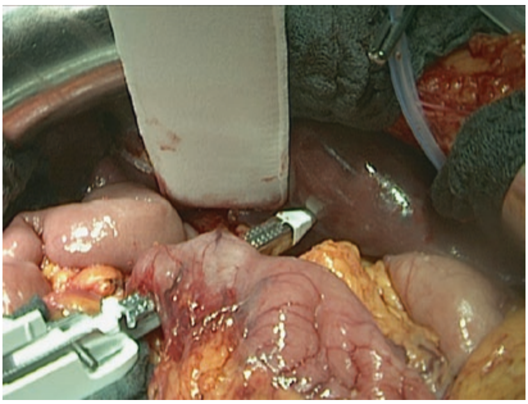
- Extensive coagulation is not necessary. Most of the bleeding will stop automatically.
- Complete omentectomy is performed by simultaneous excision of the anterior sheet of the mesocolon (■ Fig. 20.9). If the preparation is done in the correct layer, this can be performed without any bleeding. Blunt dissection by the first assistant supports this step. Omentectomy is performed down to the left colonic flexure.
- The bursa omentalis is divided, omentectomy is completed, lymph node dissection is performed below the pylorus, and the right gastroepiploic vessels are taken off. This procedure can be easily performed by palpation of the vessels between the thumb and tip finger. It also helps to avoid damage to the head of the pancreas (■ Fig. 20.10).



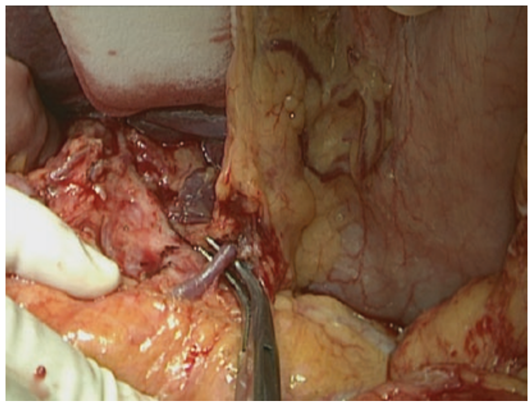
■ **Fig. 20.10** Lymphadenectomy below the pylorus and take-off of the right gastroepiploic vessels



■ **Fig. 20.12** Closure of the duodenal stump



■ **Fig. 20.11** Transection of the duodenum with a linear stapling device

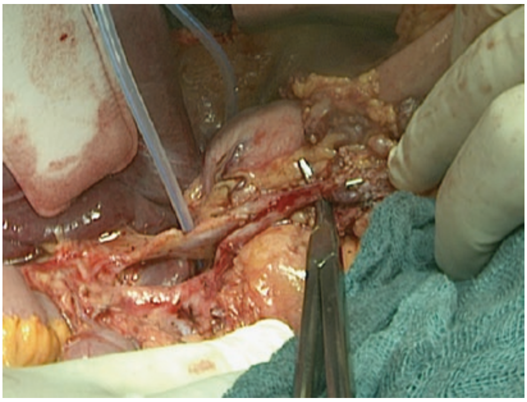


■ **Fig. 20.13** Lymphadenectomy at the celiac trunk. Dissection of the left gastric artery

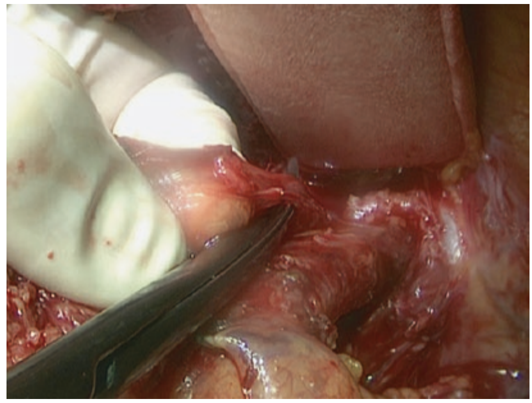
- Transection of the duodenum is done by use of a linear stapling device (■ Fig. 20.11). Until a couple of years ago, the stapler line was oversewn with single stitches. This was abandoned (■ Fig. 20.12).

> **In order to avoid thermic damage, hemostasis at the stapler line is never done by coagulation. Significant bleeding is managed by single stitches with 4–0 Vicryl.**

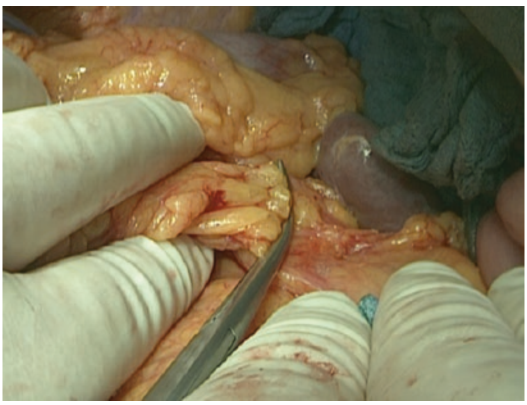
- In case of distal gastric cancer, the closure of the duodenal stump may be difficult. In these instances, a closure with a second Roux-en-Y loop should be considered. Additionally, intraoperative frozen section of the distal resection margin appears to be necessary to establish a tumor-free margin. In all other cases, frozen section of the distal resection margin does not appear to be necessary.
- If there remains uncertainty regarding an intact papilla of Vater following transection of the duodenum, cannulation of the choledochal duct is advised. In case of an injury to the papilla of Vater, partial duodenopancreatectomy is unavoidable for a safe solution of that intraoperative challenge.
- By lifting-up of the stomach, lymphadenectomy at the common hepatic artery to the celiac trunk is completed. The left gastric vein is taken off (■ Fig. 20.13). Lymph node dissection at the celiac trunk includes radicular dissection of the left gastric artery. In case of an accessory left hepatic artery, the left gastric artery is preserved, and only the ascending branches to the stomach of this artery are



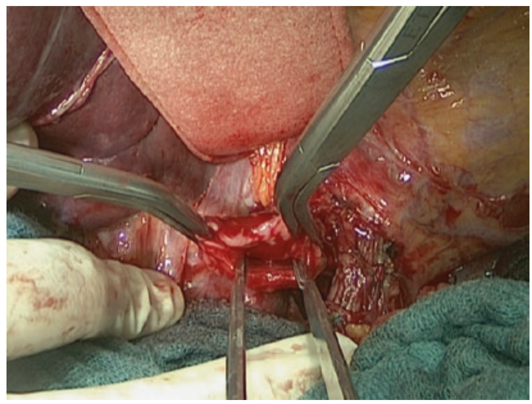
■ **Fig. 20.14** Dissection of the ascending branches of the left gastric artery in order to preserve an accessory left liver artery



■ **Fig. 20.16** Truncal vagotomy



■ **Fig. 20.15** Transection of the gastrosplenic ligament



■ **Fig. 20.17** Transected esophagus which is hold with two Ellis clamps

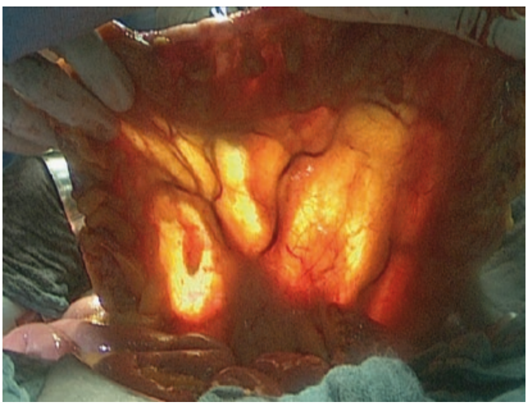
dissected (■ Fig. 20.14). In obese patients this may be very difficult.

- After completing the lymph node dissection at the celiac axis, it is further performed at the splenic artery. During this part of the resection, the short gastric vessels are divided. Later on, the gastrosplenic ligament is transected and the spleen is preserved (■ Fig. 20.15).
- Subsequently, lymph node dissection is performed in the retroperitoneum up to the esophagogastric junction. Both branches of the diaphragm are exposed, and in case of carcinomas at the esophagogastric junction, both branches of the diaphragm are partially transected for better exposure of the esophagus. Following truncal vagotomy (■ Fig. 20.16) and paraesophageal lymphadenectomy, in case of a transhiatal approach combined with lymphadenectomy in the posterior mediastinum, the esophagus is distally closed with a Satinsky clamp and proximal transected. Frozen section of the proximal resection margin is routinely performed (■ Fig. 20.17).
- Following the resection, the abdominal cavity is rinsed with distilled water, which enables the detection of even the smallest bleeding. If the proximal resection margin is free of tumor, reconstruction starts.

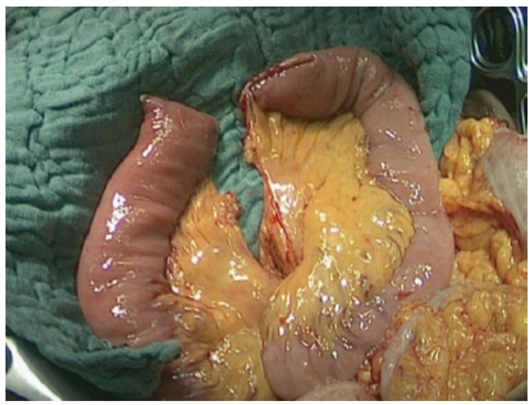
20.3.2 Reconstruction

Among all available reconstruction methods, Roux-en-Y reconstruction is the preferred type. Reconstruction according to Longmire is only applied in early tumor stages and in carcinomas located in the proximal and middle third of the stomach.

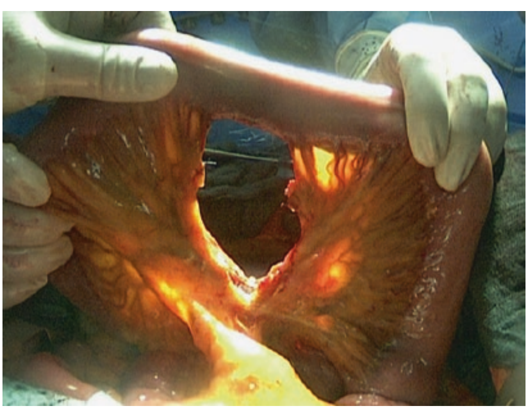
- To establish the Roux-en-Y reconstruction, the second jejunal loop is identified using diaphanoscopy, and the vessels within the mesenterium are evaluated (◘ Fig. 20.18).
- Following an asymmetric transection of the mesenterium, the jejunum is divided by a linear stapler (◘ Fig. 20.19). Oversewing of the stapler line is abandoned (◘ Fig. 20.20).
- The isoperistaltic Roux-en-Y loop is relocated in the upper abdomen through an incision in the mesocolon. The blind end of the loop always is on the right side to avoid a twisting of the mesenterium. Only in Longmire reconstruction the blind end is on the left side.
- Following an antimesenteric incision 2–3 cm proximal of the stapler line, a hand-sewn end-to-side esophagojejunostomy is performed. The anastomosis is performed with single stitches, at the seromuscular jejunum and at the transmural esophagus. The rear wall of the anastomosis is knotted inside (◘ Fig. 20.21, 20.22, 20.23, 20.24, 20.25, 20.26, and 20.27).
- The endoluminal tube is removed within 12–24 h after surgery. Patients are allowed to drink water on the first day postoperatively. A fluid diet is given on the second postoperative day.



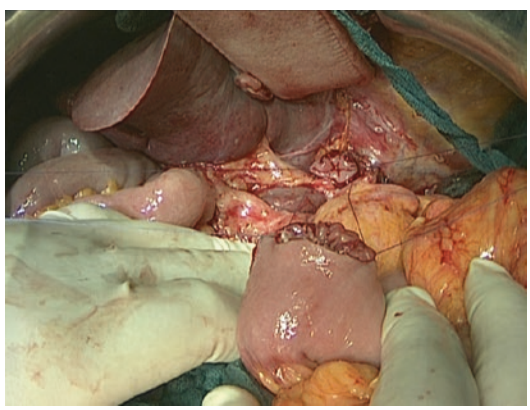
◘ **Fig. 20.18** Evaluation of the vessel architecture of the mesenterium of the small bowl



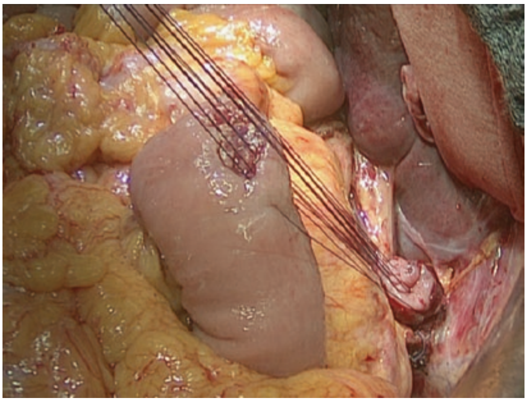
◘ **Fig. 20.20** Transection of the jejunum



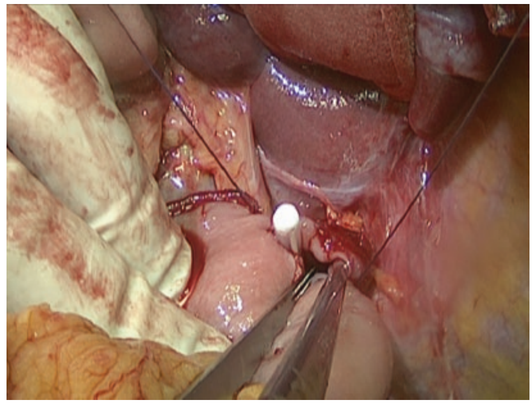
◘ **Fig. 20.19** Transection of the mesenteric vessels to establish the Roux-en-Y loop



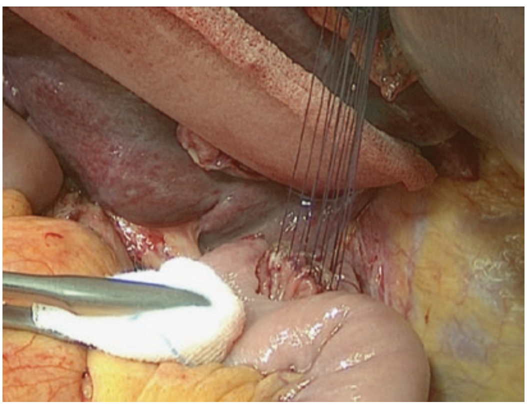
◘ **Fig. 20.21** Hand-sewn esophagojejunostomy, stitches at the edges



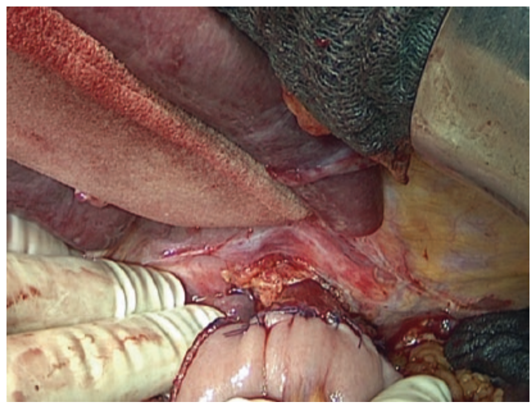
◘ **Fig. 20.22** Sutures at the rear wall of the esophagojejunostomy



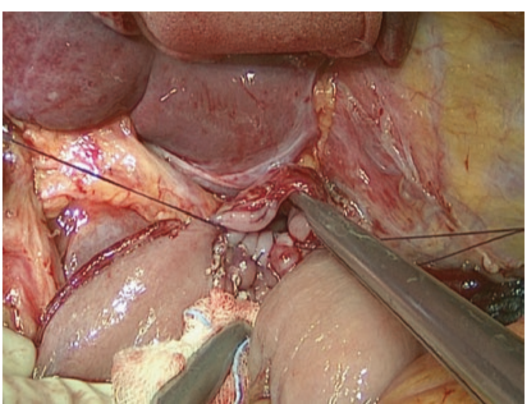
◘ **Fig. 20.25** Insertion of an endoluminal tube



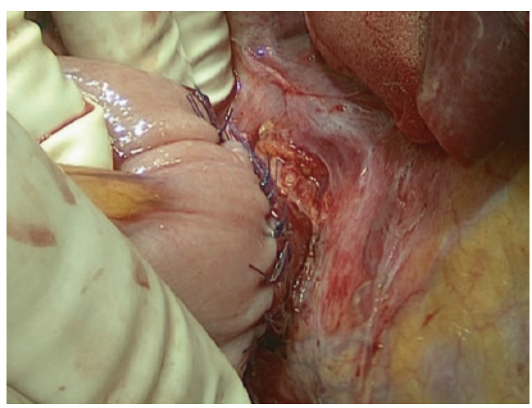
◘ **Fig. 20.23** Approximation of jejunum and esophagus



◘ **Fig. 20.26** Completion of the anastomosis by suturing the front wall



◘ **Fig. 20.24** Knotted sutures at the rear wall of the esophagojejunostomy



◘ **Fig. 20.27** End-to-side esophagojejunostomy, view from the left side

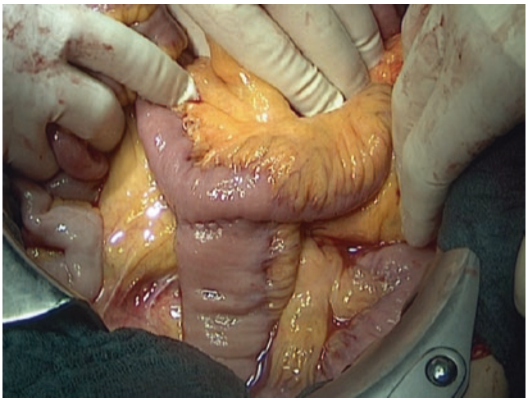


Fig. 20.28 Hand-sewn end-to-side jejuno-jejunostomy

- A stapler anastomosis is basically performed in the same fashion. For technical reasons, the esophagus is transected by a purse-string clamp and the purse-string suture is placed. At the esophagus the head of the stapler is placed, usually with a diameter of 21–25 mm. To establish the anastomosis, a jejunostomy is performed 20 cm distal to the blind end of the loop and the stapler is inserted. In contrast to a hand-sewn anastomosis, the stapled anastomosis is exposed to methylene blue to check for sufficiency. In case of leaks, single 4-0 Vicryl sutures are placed.
- The end-to-side jejuno-jejunostomy is placed 50–60 cm distal to the esophagojejunostomy to avoid bile reflux. It is sutured in a running seromuscular fashion with 4-0 Monocryl (Fig. 20.28). In Longmire reconstruction, the jejuno-duodenostomy is also sutured in that fashion. At the jejuno-jejunostomy as well as at the mesocolon, the mesenterial defects are closed by single sutures.
- A drainage catheter is placed behind the hepatoduodenal ligament to drain the esophagojejunostomy as well as the duodenal stump. Following team time-out and instrument and sponge count, the abdomen is closed in a running fashion.
- Patients do not get a suprapubic catheter. Extubation is performed in the operating room and the patients are transferred for one night to the ICU.
- During the postoperative course, a couple of complications may occur despite a perfect technique. In most cases, they can be managed conservatively and/or interventionally. In general, morbidity may be between 20 and 30 % and mortality should be below 5 % [1].

20.3.3 Specifics of Gastrectomy for Proximal Cancers

For carcinomas at the esophagogastric junction, the preoperative classification according to Siewert may be difficult. Additionally, many pathologists do not apply the Lauren classification when describing the preoperative biopsies. For these reasons, difficulties arise when determining the extent of intraluminal resection.

While carcinomas of Siewert type I are best treated by subtotal esophagectomy with reconstruction by a gastric tube, eventually colonic interposition, Siewert type II or III carcinomas require either a transhiatal or abdomino-thoracic total gastrectomy. In these cases it may be helpful to evaluate the mesenteric vessel arcades initially to assure that the Roux-en-Y loop will be long enough for reconstruction. A good arterial and venous blood supply is essential in these cases. Therefore, the Roux-en-Y loop is created prior to resection. If a jejunal reconstruction is not feasible, type II and III cancer are resected by subtotal esophagectomy and gastric tube reconstruction.

If an abdomino-thoracic resection is necessary, it needs to be considered that an intrathoracic resection of the esophagus is usually only possible with a 3–5 cm distance. To assure an intrathoracic anastomosis without tension, the Roux-en-Y loop is first transposed into the chest before the esophagus is finally transected. Additionally, it is necessary that the blind end of the jejunal loop is rectified toward the surgeon. Intrathoracic anastomosis is performed in the same fashion as an intra-abdominal esophagojejunostomy.

20.3.4 Subtotal Distal Gastrectomy

The operative principles are almost identical to total gastrectomy. The embracement of the esophagus is not performed. Lymphadenectomy includes the paracardiac lymph node station 1. The stomach is transected above the arcades of the right and left gastroepiploic vessels by means of a Payr clamp. The lesser curvature is transected with a TA 55/90 or the Contour stapler. The resection margin at the lesser curvature is about 2 cm below the esophagogastric junction. In order to avoid an intraoperative injury to that region, a gastric tube is inserted. The stapler line at the lesser curvature is oversewn by 4–0 Vicryl.

Reconstruction is performed by a retrocolic and isoperistaltic 50 cm Roux-en-Y loop. The gastrojejunostomy is hand-sewn with 4-0 Monocryl in a running seromuscular technique. Jejunojejunostomy completes the reconstruction.

20.4 Difficult Situations

Case 1

Situation

A 68-year-old patient with a distal carcinoma in the pretherapeutic uT3 uN0 stage denies the proposed neoadjuvant chemotherapy. During the operation the carcinoma shows extension well below the pylorus. Intraoperative frozen section of the duodenal resection margin shows a R1 situation.

Problem

Acceptance of a R1 resection or extension of the resection, e.g., Whipple's procedure?

Solution

Whipple's operation to achieve a R0 resection

Analysis

Careful evaluation of the prognostic benefits versus the possible increase of perioperative morbidity and mortality

Case 2

Situation

A 78-year-old female patient with bleeding distal gastric carcinoma, ASA-3 classification. Following subtotal distal gastrectomy without intraoperative complication, postoperative recovery was prolonged. Initially, laboratory values returned to normal. On postoperative day 7, fever and a CRP increase were noted. Drainage tubes were already removed, and on clinical examination, the abdomen was distended with slight pain. Due to meteorism, ultrasonography was difficult. On postoperative day 9, computed tomography showed a right subhepatic fluid collection with signs of air bubbles.

Problem

Reoperation yes or no?

Solution

Reoperation with signs of a small insufficiency of the duodenal stump, oversewing, alternative: Roux-en-Y loop for closure of the defect

Result

The patient recovered slowly and discharged on postoperative day 21.

Case 3

Situation

A 58-year-old patient with locally advanced carcinoma of the esophagogastric junction, type Siewert II, intestinal type according to Lauren, status post neoadjuvant chemotherapy with clinically partial remission, and significant morbid obesity (BMI 31) showed during the operation tumor growth into the esophagus of 4 cm length. Furthermore, the jejunal mesenterium was obese, so that a precise evaluation of the vessel arcades was limited.

Problem

Transhiatal gastrectomy versus abdomino-thoracic gastrectomy versus (as alternative) subtotal esophagectomy with gastric tube reconstruction?

Solution

Subtotal esophagectomy with gastric tube reconstruction to achieve a R0 resection. The extraluminal resection included a D2 lymphadenectomy, but the infrapyloric lymph nodes in the region of the right gastroepiploic vessels were not dissected.

Result

Pathology confirmed the R0 resection with only limited nodal involvement.

Analysis

Particular intraoperative situations may require alternative resection strategies without impairment of the aim of R0 resection.

Table 20.1 Level of intraoperative challenges in patients with gastric carcinoma

Level I: ideal patient	Technically easy to operate on, every resection is possible without problems	Intraoperative tumor stage T1–T3, tumor localization in the middle third of the stomach, limited nodal involvement
		Normal BMI
		No comorbidities
		No neoadjuvant treatment
Level II: patient with slight challenges	Moderate technical challenges, some resection strategies may be more difficult than others	Like level I, but obesity with a BMI of 25–30
		Neoadjuvant treatment
Grad III: problematic patient	Difficult to operate on, some methods are significantly more challenging than others	Like level II, but comorbidities (e.g., diabetes, coronary artery disease), prior surgery
		Additionally tumor in the distal third of the stomach with extension to the duodenum
		Tumor at the esophagogastric junction
Level IV: very problematic patient	Each operative step is difficult	Like level III, additionally BMI >30 and, for example, COLD
		Tumor at the esophagogastric junction

20.4.1 Classification of Intraoperative Challenges

We classify intraoperative challenges in patients with gastric carcinoma as shown in Table 20.1.

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Surgical Technique and Difficult Situations from Giovanni de Manzoni (Conventional)

Giovanni de Manzoni, Simone Giacopuzzi, Maria Bencivenga, and Enhao Zhao

M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations*,
DOI 10.1007/978-3-662-49878-1_21

21.1 Introduction

We consider a total or subtotal gastrectomy with a clear proximal resection margin of 5 cm and a D2 lymphadenectomy as surgical standard for gastric cancer treatment.

In this chapter, we report a detailed description of our surgical technique and some deviations from usual procedure depending on tumor characteristics.

21.2 How We Do Total Gastrectomy

Median laparotomy from the xiphoid process to below the umbilicus; opened the peritoneal cavity, we resect round and falciform ligaments.

- At this point, a complete exploration of the abdominal cavity is needed as the retrieval of peritoneal or liver metastases could modify surgical indication; washings for peritoneal cytology are always performed.
- We proceed with resection of the left triangular ligament to mobilize liver segments II and III medially and expose cardiac region [1].
- The next step is the complete detachment of greater omentum from the transverse mesocolon: it is performed along an avascular plane that is easier to find starting close to transverse colon wall [1, 2]. Dissection includes removal of the serous layer from the superior surface of the mesocolon up to the front face of the pancreas. For tumors of the posterior gastric wall penetrating the serosa, a bursectomy with complete removal of the inner peritoneal surface of the bursa omentalis is performed [3]. Detachment is continued to the right and left, and it is completed with mobilization of the hepatic and splenic flexure of the colon. At this point, after opening the lesser omentum, a tape is placed around the gastric body; in this way, the second assistant can pull up the stomach, while the first assistant can traction the transverse colon to allow a good exposure of the origin of the right gastroepiploic vessels [1, 2].
- Hence, we first proceed to isolation and section of the right gastroepiploic vein proximal to its confluence with the middle colic vein, and then we perform the resection of the right gastroepiploic artery [2]; at this time, lymphadenectomy of nodes at station n. 6 is performed, removing the adipose tissue located between the trunk of Henle and the antero-superior pancreaticoduodenal vein together with dissection of corresponding portion of the front face pancreatic serosa (Fig. 21.1).

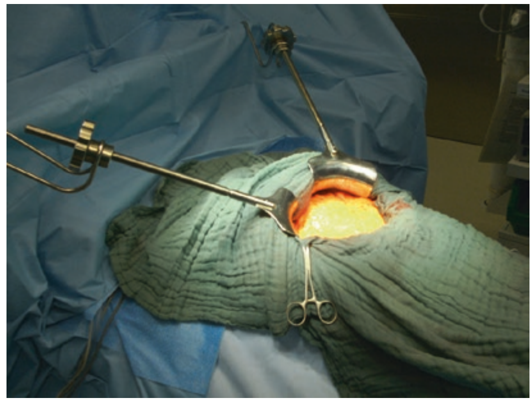


Fig. 21.1 Transverse upper abdominal laparotomy with the use of two Stuhler's retractors

At this point, the dissection of the right gastric vessels together with removal of suprapyloric nodes (n. 5 nodes) allows complete mobilization of the pylorus and the duodenal bulb.

- The transection of the duodenum is done with a mechanical linear stapler placed 2–3 cm below the pylorus. An oversewing of stapler line of the duodenal stump with seromuscular suture is always performed [1, 2].
- We proceed with a complete division of the lesser omentum; retrieval of an accessory left hepatic artery is not uncommon; it can be sectioned without problems [2].
- Gastric mobilization continues with resection of the gastrosplenic ligament carefully ligating the left gastroepiploic vessels and then short gastric vessels next to the splenic hilum to ensure correct lymphadenectomy at station 4sa.
- Now the stomach is tractioned upward and medially to permit isolation and section of the left gastric vessels. First, we identify and ligate the vein just above upper pancreatic margin, and then we isolate and dissect the artery. Removal of the adipose tissue surrounding the left gastric vein from the level of the upper pancreatic border to the origin of the left gastric artery allows correct dissection of n. 7 nodes (Fig. 21.2).
- Division of the phrenoesophageal membrane (Laimer-Bertelli membrane) leads to the release of cardia and anterior surface of the abdominal esophagus together with nodes at

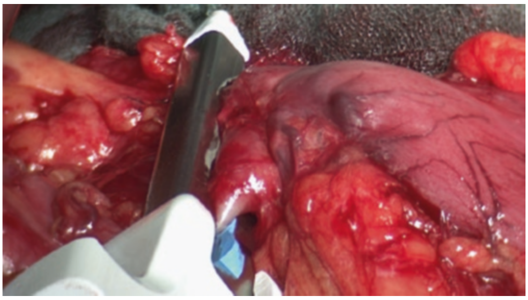


Fig. 21.2 Transection of duodenum

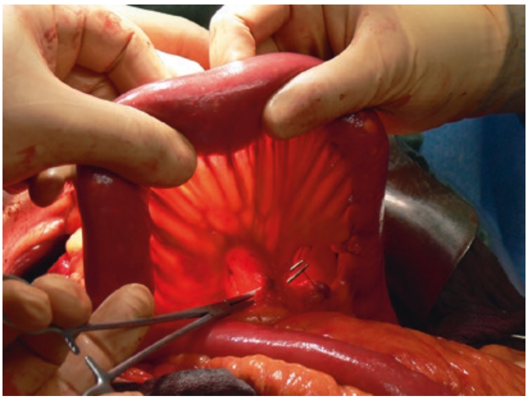


Fig. 21.3 Thinning the second loop of jejunum

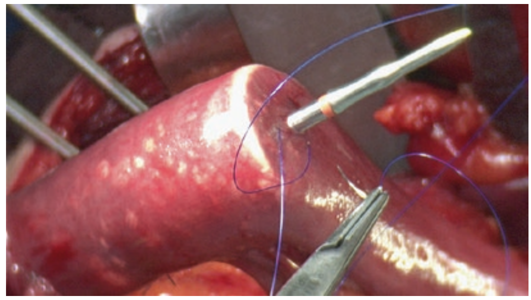


Fig. 21.4 Safeguarding of the pin penetration with u-suture

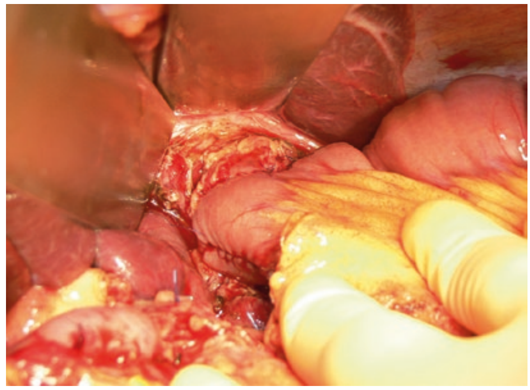
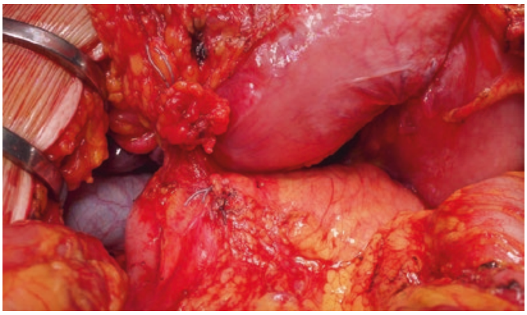


Fig. 21.5 Over-suturing of the stapler line

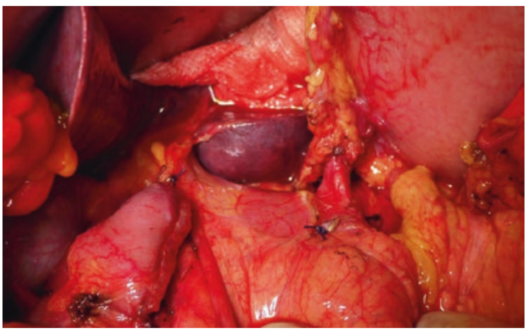
station n. 1; after a careful posterior detachment of the esophageal wall with ligation of vascular cardiac branches, we execute the section of the two vagus nerves [1].

At this point, we are ready for esophageal section. We consider a safe proximal resection margin of 5 cm; if it is respected, the section can be done just above the EGJ carefully removing the left and right paracardiac nodes. In this way, we have completed gastrectomy and D1 lymphadenectomy. If a higher anastomosis is needed, the diaphragmatic hiatus must be opened, and, with the help of two retractors, the mediastinal esophagus is detached from the pericardium (Pinotti maneuver). Esophageal section is performed using a rake clamp with the insertion of a 25 mm circular stapler anvil in the distal esophagus [1, 2] (Fig. 21.3).

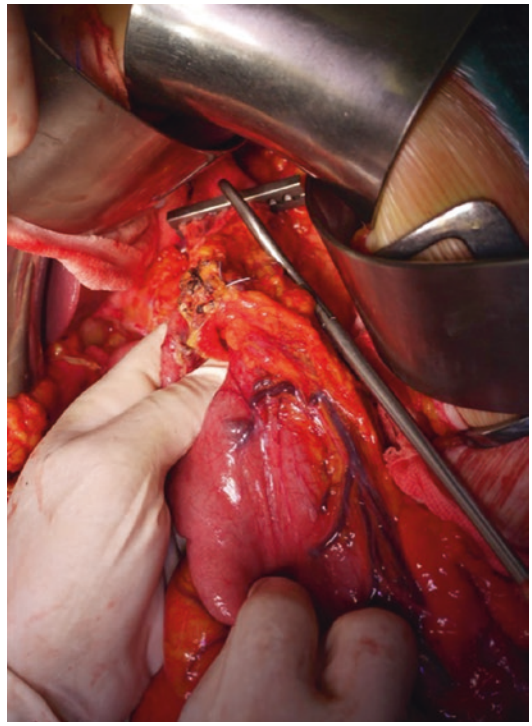
- If a standard D2 lymphadenectomy is indicated, prior to reconstruction, node dissection along the common hepatic artery, the celiac trunk, and the splenic artery is performed; anterior lymph nodes of the hepatoduodenal ligament are also removed [1]. The line of dissection follows the perivascular autonomic nerve branches to avoid devascularization of structures especially for biliary ducts in case of posterior hepatoduodenal lymphadenectomy (Fig. 21.4).
- If a super-extended lymphadenectomy has to be done, we gain the access to the aortic plane with duodenopancreatic kocherization, and then we proceed to complete removal of para-aortic lymphatic tissue between the left renal vein and the origin of the inferior mesenteric artery [1].
- Reconstruction is usually achieved with a Roux-en-Y anastomosis.
- This phase starts with the preparation of the jejunal loop: anatomy of the arterial arcades is examined by transillumination (Fig. 21.5); we usually preserve the arcades at the base of the mesentery to ensure a good blood supply. First, we do the jejuno-jejunal anastomosis at about 20 cm from the ligament of Treitz. It is a mechanical end-to-side anastomosis, and it is obtained by creating a purse-string suture on the proximal end of the divided jejunum in



■ **Fig. 21.6** Lymphadenectomy of infrapyloric lymph nodes



■ **Fig. 21.7** Lymph node dissection along of left gastric artery



■ **Fig. 21.8** Dissection of esophagus

which we insert a 21 mm anvil, and then a circular stapler is inserted for about 40 cm through the distal end of the divided jejunum; at this level, the jejunal limb is perforated with spike and the anastomosis is completed (■ Fig. 21.6). A seromuscular oversewing is always performed.

- We proceed with the transposition of the efferent jejunal loop to supramesocolic compartment through an avascular area of the transverse mesocolon.

The last step is esophagojejunostomy: we introduce the 25 mm circular stapler through the proximal entrance of transposed loop, the spike is brought out after 5–6 cm on the antimesenteric side, the anvil on the distal esophageal stump is joined to the stapler, and the end-to-side esophagojejunostomy is performed (■ Figs. 21.7 and 21.8).

Finally, we use a linear stapler to close the jejunal stump and make a reinforcement of the esophagojejunal anastomosis with seromuscular 4–0 suture with absorbable thread [1, 2].

In case of necessity, we can perform an intrathoracic esophagojejunostomy with a right anterolateral thoracotomy approach at the fifth or sixth intercostal spaces. It is made possible by Kasai's technique: the resection of 5–6 cm of the jejunum keeping intact the mesentery allows the realization of a tension-free intrathoracic anastomosis as tensions are discharged on the portion of the mesentery without the jejunum [2].

21.3 Subtotal Gastrectomy

- If a subtotal gastrectomy is indicated, the ablative phase differs from that previously described for total gastrectomy. In these cases, the omentectomy starts proximally to insertion of the left gastroepiploic artery, and just one or two short gastric vessels are sectioned. Gastric section is performed along a line extending from the greater curvature 2 cm below the lower splenic pole up to the right margin of the heart in order to completely remove the right paracardiac lymph nodes.
- Reconstruction is usually obtained performing a Roux-en-Y end-to-side gastrojejunal anastomosis.

21.4 Deviations from Standard Procedure

1. In case of upper third tumors or of macroscopic metastasis at the splenic hilum, it is possible to perform a spleen-preserving dissection of lymph nodes at n. 10 and n. 11 stations by Jinnai's maneuver.
   - First step is section of posterior parietal peritoneum from the right to left starting from the left margin of the upper mesenteric vein along the lower margin of the pancreas and posterior margin of the spleen up to the superior splenic pole.
   - Then, after a careful detachment from posterior structures, the splenopancreatic block is turned, and the dissection of lymph nodes along the splenic artery and at splenic hilum can be performed.
   - At the end, splenopancreatic block is replaced in the left hypochondrium being careful not to twist the vascular axis [2].
2. In case of demonstrated or suspected duodenal invasion, the section of duodenum has to be done more than 3 cm from the pylorus.

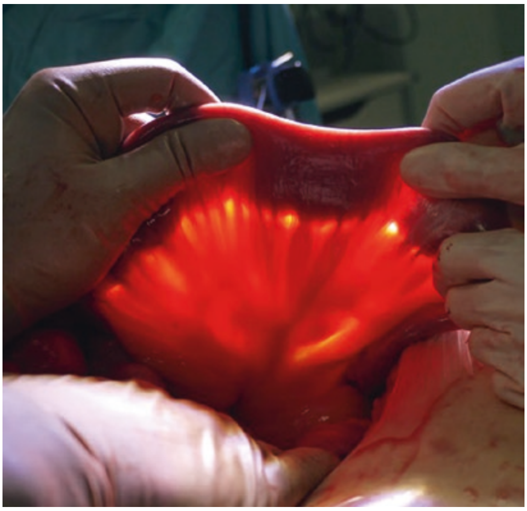
   Gastric adenocarcinoma with duodenal invasion has been reported with an incidence of 12–24 % for antral tumors. It is more frequent in cases of large >6 cm AGC of the lower third with infiltrative grow pattern (Bormann 3 or 4) and infiltration of the serosa layer. The invasion is generally through the submucosa or subserosa and its identification is not simple. Duodenal invasion is rare but reported also in EGC (0.5–1.8 %).

   In most of cases (>80 %), the extension of duodenal invasion is <3 cm [4].

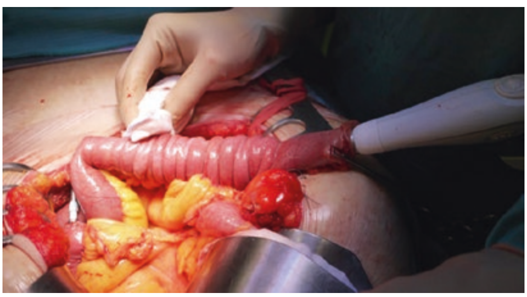
   In these cases, before duodenal resection, we perform a complete kocherization with medial rotation of the first and second portion of the duodenum and pancreatic head. In this way, we can detach the duodenum from the pancreatic head and execute the resection at more of 3 cm from the pylorus with the possibility of a safe oversewing. We usually perform a frozen section of resection line.
3. In cases of early gastric cancer of the upper third of the stomach or of EGJ (Siewert II with <2 cm of esophageal invasion), a proximal gastrectomy using a gastric conduit with personal technique is feasible.

Fig. 21.9 Intraoperative view after D2 lymph node dissection

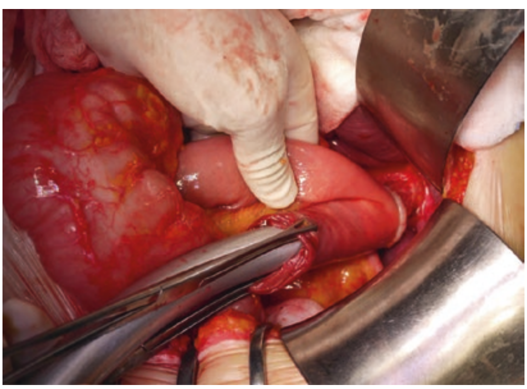
   - We start, as already described for total gastrectomy, with detachment of the greater omentum from the transverse mesocolon and mobilization of the right and left colon flexures, and then we kocherize the duodenum to provide a good mobility of gastric tube. The left gastroepiploic and short gastric vessels are ligated. The lesser omentum is divided and left gastric artery and vein are divided and tied. Section of the two vagus nerves allows a complete exposition of the abdominal portion of the esophagus; at this point, the esophagus is divided using a GIA 60 linear stapler above the level of EGJ or at least 2 cm above the tumor for EGC of EGJ (Fig. 21.9).
   - We create a gastric conduit along the greater curvature using multiple firings of linear staplers: we start from the fundus first for 5–6 cm parallel to the greater curvature and then in the direction of the lesser curvature (Fig. 21.10). In the second step, we excise the distal part of the lesser curvature starting just above the pylorus up to 5 cm away from the upper section to complete the gastric conduit and create an access pouch for circular stapler (Fig. 21.11). After sectioning the esophageal hiatus, we free the lower esophagus and complete node dissection by removal of lower mediastinal nodes. Then a 25 mm anvil is placed in the esophageal stump, and a purse-string suture is created at the top of the gastric conduit (Fig. 21.12).
   - At this point, a circular stapler is inserted through the gastric access pouch (Fig. 21.13), and a stapled end-to-end anastomosis is created; finally, gastric



■ **Fig. 21.10** Transillumination of the jejunal vessels

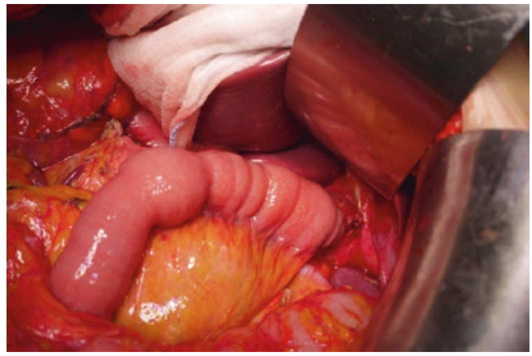


■ **Fig. 21.11** Creation of jejuno-jejunal



■ **Fig. 21.12** Creation of a 25-mm circular stapler esophago-jejunal end-to-side anastomosis

pouch is closed with a linear stapler and the anastomosis is overswen [1]. This technique has been developed considering the vascular anatomy of gastric tube as it is the only possible way to perform anastomosis without interruption of vascularity along the entire circumference of the suture line.



■ **Fig. 21.13** completion of esophago-jejunal end-to-side anastomosis

4. In case of advanced cardiac adenocarcinoma, intrathoracic anastomosis has to be performed.

   The creation of gastric tube follows the procedure described previously for proximal gastrectomy; in this case, gastric tube creation starts at the angle of His. Diaphragmatic hiatus is opened and a lower mediastinal node dissection is performed, and then the gastric tube is attached to the esophageal stump before closing the abdominal cavity.

   At this point, the patient is repositioned in left lateral decubitus and a right anterolateral thoracotomy at fourth or fifth intercostal space is performed. The mediastinal pleura is incised and the azygos vein is isolated and divided. The esophagus is isolated and an extended lymph node dissection is performed. Then the esophagus is divided 2–3 cm above the azygos vein. The gastric conduit is transposed in the chest cavity, and after the insertion of a circular stapler through the gastric pouch, a circular stapled end-to-end anastomosis is created [5] (■ Fig. 21.14).
5. In case of positive peritoneal washing, we can complete radical surgery with a hyperthermic intraperitoneal chemotherapy (HIPEC).

   We usually perform HIPEC with the closed technique. After completing anastomoses, two inflow and two outflow drains are inserted in the peritoneal cavity, and then the abdominal wall is closed. Drains are connected to an external circuit including a pumping system and a heat exchanger. When the abdominal temperature reaches 41.5–42.5° C, infusion of chemotherapeutic agents starts for the duration of an hour. The drugs we usually use are mitomycin C and cisplatin. At the end of perfusion, the

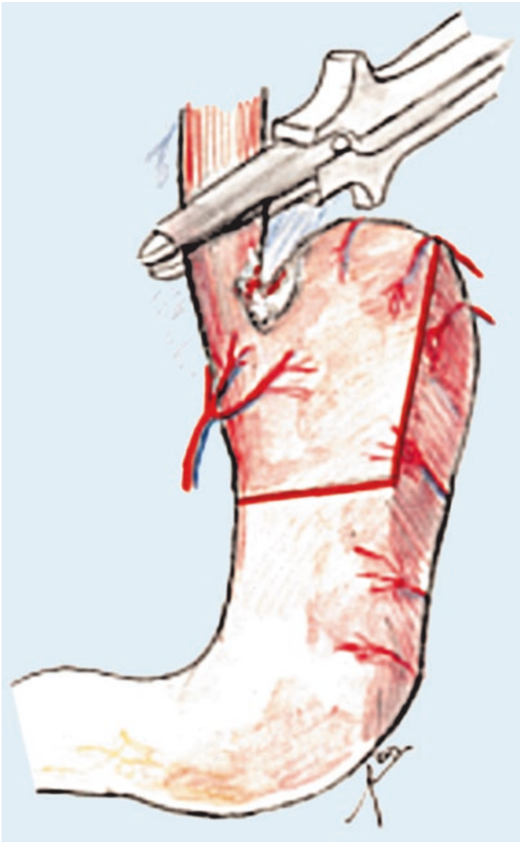


Fig. 21.14 transection of esophagus 2 cm above of the visible tumor margin

abdominal wall is reopened; after a careful inspection, two of the four drain tubes are removed and the laparotomy is closed [1].

21.5 Classification of Patients According to Intraoperative Difficulty

1. Ideal cases: if all these characteristics are present
   - Young patient (<50 years old)
   - Normal BMI
   - No previous major abdominal operations
   - Early tumor
2. Not quite ideal cases: if at least one of these characteristics is present
   - Obese patient
   - Previous upper mesocolic abdominal surgery
   - Voluminous tumor of the medium or lower third
3. Problematic cases: if at least one of these characteristics is present
   - Voluminous tumors of the upper third
   - Bulky lymph nodes especially at station n. 10
   - Previous chemotherapy
   - Cirrhotic patient with periesophageal/perigastric varices
4. Very problematic cases: if one of the following characteristics is present
   - Tumors invading adjacent organs T4b
   - Esophageal or duodenal invasion
     i. Especially if also other previous characteristics are present (BMI >35; cirrhosis; preoperative chemotherapy)

21.6 Difficult Situations: Personal Experience

Case 1

Situation

A 71-year-old male patient with cT1sm N0 cardiac adenocarcinoma on Barrett's esophagus and subrenal aortic aneurysm of 5.5 cm.

Dilemma

What is the appropriate surgical strategy for this patient?

Solution

A simultaneous surgical approach has been chosen performing EVAR as the first step and then Ivor Lewis esophagectomy.

Outcome

Postoperative course was uneventful; the patient has been discharged on the 14th postoperative day. At 1-month follow-up, angio-TC showed a type 2a endoleak that has been managed conservatively.

Case 2

Situation

A 72-year-old female patient with cT3N+ adenocarcinoma of the gastric body underwent total gastrectomy and D2 lymphadenectomy at another hospital. Lymphadenectomy of the hepatoduodenal ligament was complicated by an ischemic injury of the common bile duct with the result of a biliary leakage. At the admission to our unit, the patient was septic and the CT scan showed an intra-abdominal abscess.

Dilemma

Reoperation with hepaticojejunostomy or conservative management?

Solution

A fistuloscopy was performed and a drainage tube was left in the intra-abdominal abscess. Then a percutaneous transhepatic biliary drainage was placed and a systemic antibiotic therapy was started.

Outcome

The result was the closure of the biliary fistula with a residual stricture of the common bile duct. Serial endoscopic treatments with balloon dilatations and stent insertions are needed.

Case 3

Situation

A 51-year-old male patient with cT3 N+ adenocarcinoma of gastric fundus with cardiac invasion managed by total gastrectomy and a D2 lymphadenectomy.

A transabdominal intramediastinal Roux-en-Y esophagojejunostomy was performed; intraoperative methylene blue test was positive. It was not possible for an intra-abdominal oversewing.

Dilemma

Anastomosis takedown or left thoracotomy with oversewing?

Solution

We performed a left thoracotomy and oversewing of the anastomosis that was incomplete for one third of its circumference. We also placed a nasogastric tube in suction for 1 week.

Outcome

No anastomosis leakage, no complications but refeeding was started later than usual.

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Individual Surgery for Benign Gallbladder and Bile Ducts Diseases

Contents

Introduction

Michael Korenkov, Christoph-Thomas Germer, and Hauke Lang

M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations*,
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A surgery of gallstone disease is indicated by the following patient groups:
1. Patients with symptomatic cholecystolithiasis
2. Patients with acute cholecystitis
3. Patients with chronic cholecystitis, "shrinking" and porcelain gallbladder
4. Patients with failed endoscopic extraction of bile duct stones ("unusual" anatomy of the papilla vateri, previous B-II surgery, "fixed" common bile duct stone, etc.)
5. Patients with biliodigestive or cholecystohepatic fistulas (Mirizzi II)

Unfavourable background for surgery is liver cirrhosis, severe obesity, extended previous abdominal surgery, acquired or congenital body deformities as well as a third trimester of pregnancy.

22.1 Patients with Symptomatic Cholecystolithiasis

Laparoscopic cholecystectomy is considered as a gold standard for the surgical treatment of patients with symptomatic cholecystolithiasis. The difficult-decision situations occur by unusual anatomy of Calot's triangle especially in combination with the above-mentioned unfavourable background.

An ideal technical performance of laparoscopic cholecystectomy aims a separate preparation of cystic artery and cystic duct and their transection after unequivocal identification of both structures. Before the transection, a terminal connection of both tubular structures with a gallbladder wall should be identified. The following situations can make an intraoperative orientation difficult:
- Very short and dilated cystic duct
- Very short cystic artery in combination with an arch-shaped right hepatic artery curve (the so-called caterpillar hump of right hepatic artery)
- Combination of 1 and 2 (especial unfortunate)

Patients with Morbus Bechterew deformities and gibbus formation or patients in the third trimester of pregnancy require a special placement of trocars (◘ Fig. 22.1).

In case of difficult presentation of surgical situs or problematic triangulation, additional trocars should be placed.

◘ **Fig. 22.1** Patient with severe gibbus formation by Morbus Bechterew. In this case, a standard patient positioning and usual trocar placement were not possible

22.2 Patients with Acute Cholecystitis

The technical difficulties occur most often in the following situations:
- *A gallbladder is difficult to grasp*. In spite of puncture and aspiration of gallbladder content, it is not possible to grasp a gallbladder wall with a standard 5 mm grasper. Recommendable is to change the 5-mm trocar to 10/12-mm trocar with the use of a 10-mm Babcock grasper.
- *Severe infiltrating of the gallbladder neck*. In this situation, a usual dissection of the Calot's triangle is not possible. Recommendable is an anterograde preparation of the gallbladder from the apex to the neck. Such preparation is most often related with diffuse bleeding from liver bed, which can be sometimes very intensive. Using of argon beamer or bipolar coagulation can be necessary. Recommendable is a "small step dissection" with meticulous haemostasis after each step. Aspects of the subtotal cholecys-

tectomy and using of linear stapler are discussed in detail in the chapter of Crafa et al. (► Chap. 23).
- *Combination from the acute cholecystitis and intrahepatic gallbladder*. In such case for the planning of further surgical procedure, accessibility of the gallbladder neck for the dissection should be evaluated. If a safe exposition and transection of cystic artery and cystic duct are possible, the following options are available:
- Step-by-step gallbladder preparation from the liver bed according to the following pattern: “dissection of the small gallbladder segment – assured haemostasis – next step”.
- Resection of liver bed in apex area.
- Transvesical approach with opening of the gallbladder, removing of stones and gallbladder wall resection with mucosa destruction on the posterior wall (argon beamer, mono- and bipolar coagulation). Before the destruction of the mucosa, a meticulous examination and biopsy if necessary should be performed.

If the gallbladder neck is not suitable for dissection, the following options should be discussed:
- Anterograde preparation
- Conversion to an open approach
- Break the operation (estimation the risk of perforation!)

22.3 Patients with Chronic Cholecystitis, “Shrinking” of the Gallbladder and Porcelain Gallbladder

Technical difficulties by surgical treatment of patients of this group are similar dependes on anatomical specifics to difficulties by patients with acute cholecystitis or biliodigestive/cholecystohepatic fistulas.

22.4 Patients with Failed Endoscopic Extraction of Bile Duct Stones

On this occasion, the problem is that in a lot of clinics the laparoscopic bile duct exploration is not a routine surgical procedure. In such situation, every surgeon should decide if his surgical expertise and technical know-how in his clinic are sufficient for the assured performance of this procedure. If such is not the case, a conventional technique of bile duct revision should be used.

22.5 Patients with Biliodigestive or Cholecystohepatic Fistulas

Patients of this group will be operated mostly conventional, although there is a positive experience with the use of endoscopic technique. Patients with cholecystohepatic fistulas (Mirizzi II) mostly have severe adhesive process in a cholecystohepatic junction. Thereby there is a considerable inflammatory contraction of the gallbladder neck and a hepatoduodenal ligament and absence of Hartmann’s pouch. A consequent dissection in this area can lead to long segment bile duct injury. In the case of suspected cholecystohepatic fistulas, a subtotal cholecystectomy is recommendable.

22.5.1 Classification of Intraoperative Difficulties

The operative difficulties for surgery of benign gallbladder and biliary tract diseases can be classified as summarised in ◘ Table 22.1.

Table 22.1 Grading of operative difficulties for benign gallbladder and biliary tract diseases

Grading	Case type
I (ideal cases) It is easy to operate; every operative technique is technically unproblematic	Slender or normal-weight patient without body abnormalities No previous major abdominal surgery No perivesical inflammatory or fibrotic changes Usual anatomy of Calot's triangle Orthotopic gallbladder position
II (not quite ideal) Some minor technical difficulties may occur; some operative techniques can be more difficult as others	Moderate obese patient (BMI around 30 kg/m^2) Otherwise similar to grade I
III (problematic) Difficult to operate; some operative techniques are considerably more difficult than others	Overweight patient (BMI > 35 kg/m^2) Previous major abdominal surgery Acute or chronic cholecystitis Liver cirrhosis Biliodigestive or cholecystohepatic fistulas Acquired or congenital body deformities Third trimester of pregnancy
IV (very problematic) Every operative step is very difficult	Extreme form of grade III factors

Surgical Technique and Difficult Situations from Francesco Crafa

Francesco Paolo Prete, Mario Baiamonte, Francesco Ruotolo, Francesco Bavetta, and Francesco Crafa

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The most common biliary tract procedure currently performed is the laparoscopic cholecystectomy. Laparoscopic cholecystectomy (LC) is the current standard treatment of symptomatic gallstones and one of the most common procedures being performed by the general surgeons all over the world for cholelithiasis and acute cholecystitis. A number of diverse factors including biliary anatomy and disease severity may render LC challenging, especially to the surgeon ascending the learning curve. Difficult cholecystectomy may be associated with serious complications and a high conversion rate, and no consensus is found among surgeons on how to manage difficult laparoscopic cholecystectomy. We present our current strategies to manage difficult cholecystectomy, classifying the difficulty of the cases we discuss by intraoperative difficulty as:

I	Ideal cases (i.e. easy to operate, no problems)
II	Not quite ideal cases (some minor difficulties may occur)
III	Problematic cases (difficult to operate, some operative techniques are considerably more difficult than others)
IV	Very problematic (“horrible”) cases (every operative step is difficult)

23.1 Safe Steps in Laparoscopic Cholecystectomy

Before facing a difficult LC, it is important to have a baseline structured surgical strategy in mind.

Our standard approach to cholecystectomy applies to both technically easy and difficult LC and follows the same key steps:

- *Access and identification* of structures (creation of pneumoperitoneum, insertion of trocars, first exploration)
- *Exposure* (with separation of all eventual adhesions limiting correct visualisation of the area containing cystic duct and artery)
- *Isolation* of the cystic duct and cystic artery followed by their closure and division
- *Dissection* of the gallbladder
- *Extraction*
- *Check* of haemostasis, biliostasis and closure of the surgical accesses

The patient is in lithotomy position (supine, with legs spread) and is prepared as per eventual cholangiography. Three 5 mm trocars and one 10 mm trocar are inserted; if a common bile duct exploration is planned, two 5 mm trocars and two 10 mm trocars are used.

The first trocar is always inserted using a modified “open” technique: a transverse 10–15 mm long infra-umbilical incision is performed for camera introduction, with exposure of the fascial layer, longitudinal incision along the “linea alba” below the umbilicus and direct visualisation of the peritoneum prior to insertion of the first 10 mm port, to induce pneumoperitoneum.

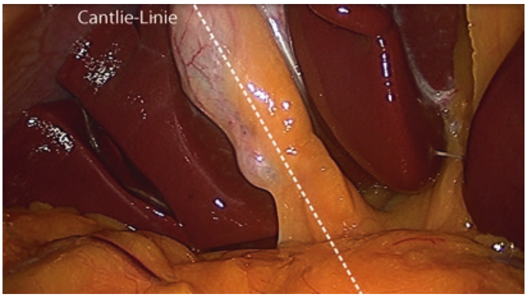
A second 5 mm incision is performed in the right hypochondrium, over the mid-clavicular line about 5–8 cm below the rib margin.

A third 5 mm incision is placed at the same level in the left hypochondrium.

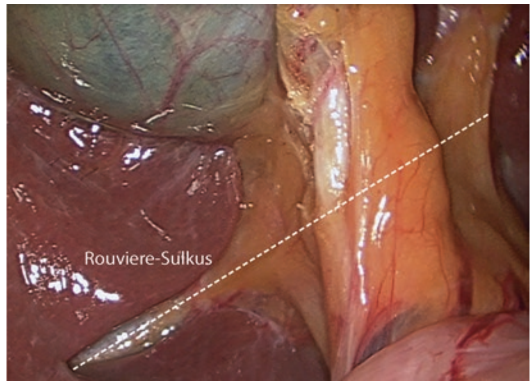
A 5 mm incision approximately at the junction of the upper third and lower 2/3 of a line between the xiphoid and umbilicus completes the access (◘ Fig. 23.1). This access can be of 10 mm in case of CBD exploration.

The surgeon stands between the patient’s legs, with the assistant on the patient’s right side. The following instruments are used: a 30° 10 mm laparoscope, a harmonic scalpel and two reusable grasping forceps.

◘ **Fig. 23.1** Trocar placement for laparoscopic cholecystectomy



■ Fig. 23.2 Cantlie-Line

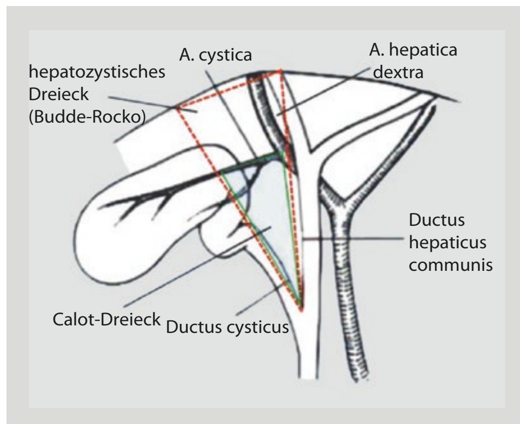


■ Fig. 23.3 Rouviere-Sulcus

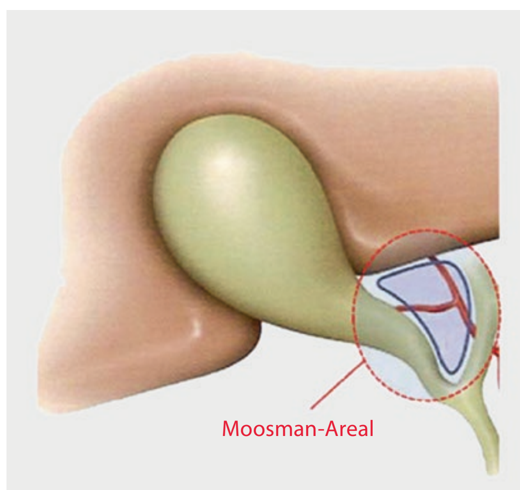
The two grasping forceps are introduced, the first through the 5 mm port in the xiphoid process and then the second through the 10 mm port placed in the right flank. The left instrument elevates the fundus of the gallbladder (along with the IV liver segment), while the right hand provides a counter-traction on the infundibulum of the gallbladder towards the right, obtaining a view of "Cantlie's line" (a straight line running along the gallbladder long axis to the inferior vena cava – ■ Fig. 23.2). This manoeuvre avoids both angling of the common hepatic duct(CHD)/common bile duct (CBD) and aligning with the cystic duct. At the same time, it opens the space of the liver/gallbladder/CBD triangle, facilitating dissection. Traction has to be moderate, as excessive tension on a thin walled gallbladder with thin hepatic pedicle tends to stretch the CHD/CBD and aligns it with the cystic duct, allowing confusion between the two structures with risk of damage to the CHD/CBD.

After introducing the harmonic scalpel from the 5 mm port positioned in the left hypochondrium, we proceed to identify the Gans scissure, an area situated to the right of the liver hilar plate, containing the right hepatic duct, and Rouviere's sulcus, a 3–4 cm sulcus running to the right of the liver hilum anterior to the caudate process, which indicates the plane of CBD accurately (■ Fig. 23.3).

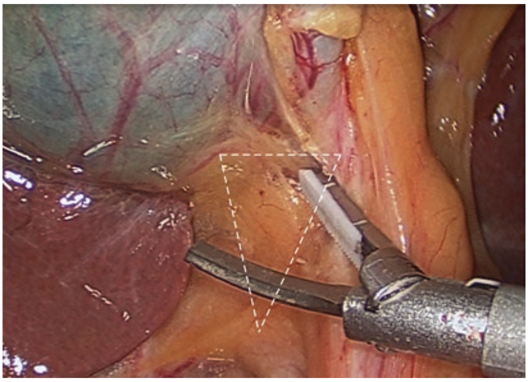
Our dissection begins with the exposure of the Budde-Rocko's triangle (hepatocystic triangle – ■ Fig. 23.4), a triangular space bordered by the common hepatic duct and right hepatic duct medially, cystic duct laterally and inferior margin of the liver superiorly, or of the "Moosman's area" (hepatocystic duct angle – ■ Fig. 23.5),



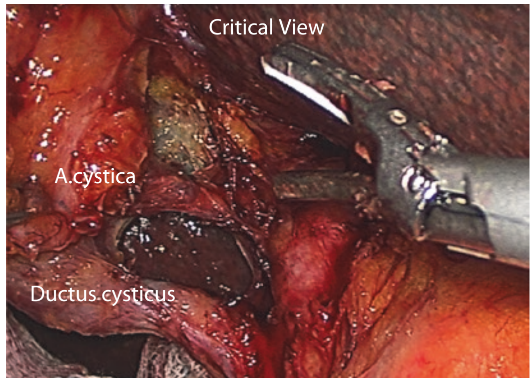
■ Fig. 23.4 Cystohepatic triangle (Budde-Rocko)



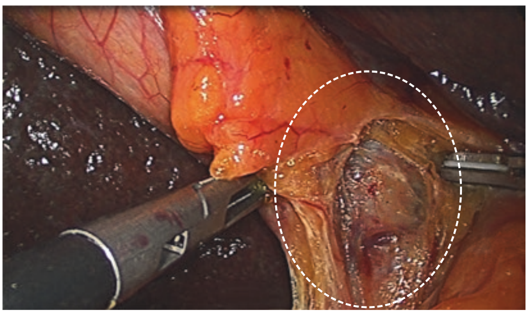
■ Fig. 23.5 Moosman-Areal



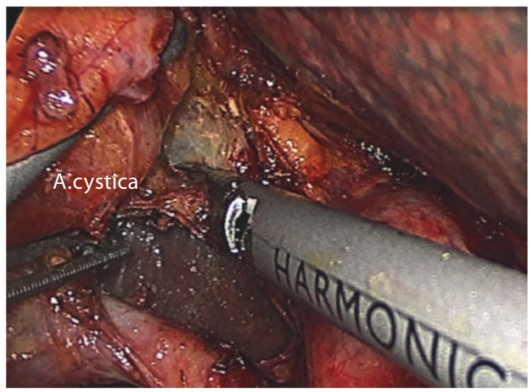
■ **Fig. 23.6** Opening of the posterior surface of Budde-Rocko triangle



■ **Fig. 23.8** Critical views before the transection of the cystic artery and cystic duct



■ **Fig. 23.7** Preparation of the anterior surface of Budde-Rocko triangle



■ **Fig. 23.9** Transection of the cystic artery with Ultracision

circularly extending for about 30 mm and containing the angle between the cystic duct and common hepatic duct: either of these spaces contain the Calot's triangle (common hepatic duct, cystic duct and cystic artery).

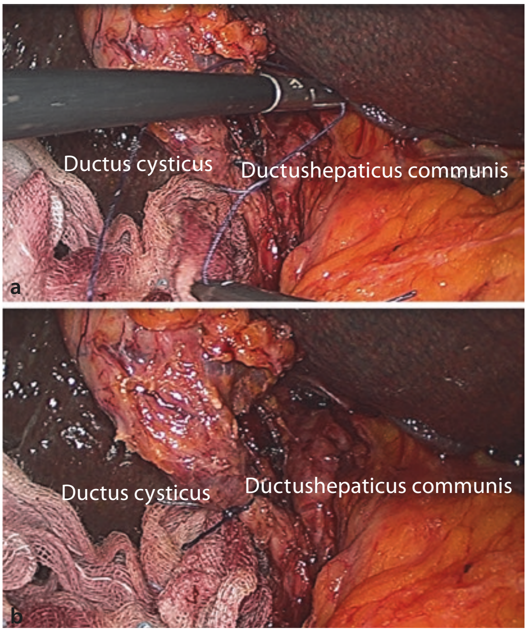
First, the infundibulum of the gallbladder is retracted to the left, and we open caudally the peritoneum of the posterior surface of Budde-Rocko's triangle (■ Fig. 23.6).

Then the infundibulum is retracted again to the right, opening the Budde-Rocko triangle, and we proceed to open the peritoneum of the anterior surface of this triangle, in close proximity of the visible border of the gallbladder facing the liver hilum (■ Fig. 23.7).

Using the opening in the peritoneum covering the triangle, the cystic artery and duct are bluntly dissected, producing two wide windows. It is important to keep the border of the gallbladder in sight, so that the window that we produce shows nothing else than cystic duct and artery by the border of the gallbladder (no more than two structures in the triangle, "critical view" dissection ■ Fig. 23.8). We have to consider that any vascular structure with a diameter superior to 3 mm may be the right hepatic artery. The hepatic artery crosses the hepatic duct posteriorly, but in about 12 % of cases, it may cross anteriorly. Caterpillar hump of the right hepatic artery occurs in 6–16 % of cases. After crossing the hepatic duct, the right hepatic artery often descends in the Calot triangle to an area dangerously close to the cystic duct. This tortuous artery gives rise to multiple small branches supplying the gallbladder, which, if severed inadvertently, may bleed profusely.

The cystic artery is generally isolated and prepared first (■ Fig. 23.9), followed by the cystic duct. Before proceeding, we prefer to visualise the junction between the cystic duct and the common hepatic duct (■ Fig. 23.10).

Once these structures have been identified, the artery is routinely coagulated with the HS and the cystic duct is ligated with a Vicryl stitch



◘ **Fig. 23.10** Displaying a connection between the cystic and hepatic duct and followed ligature of the cystic duct

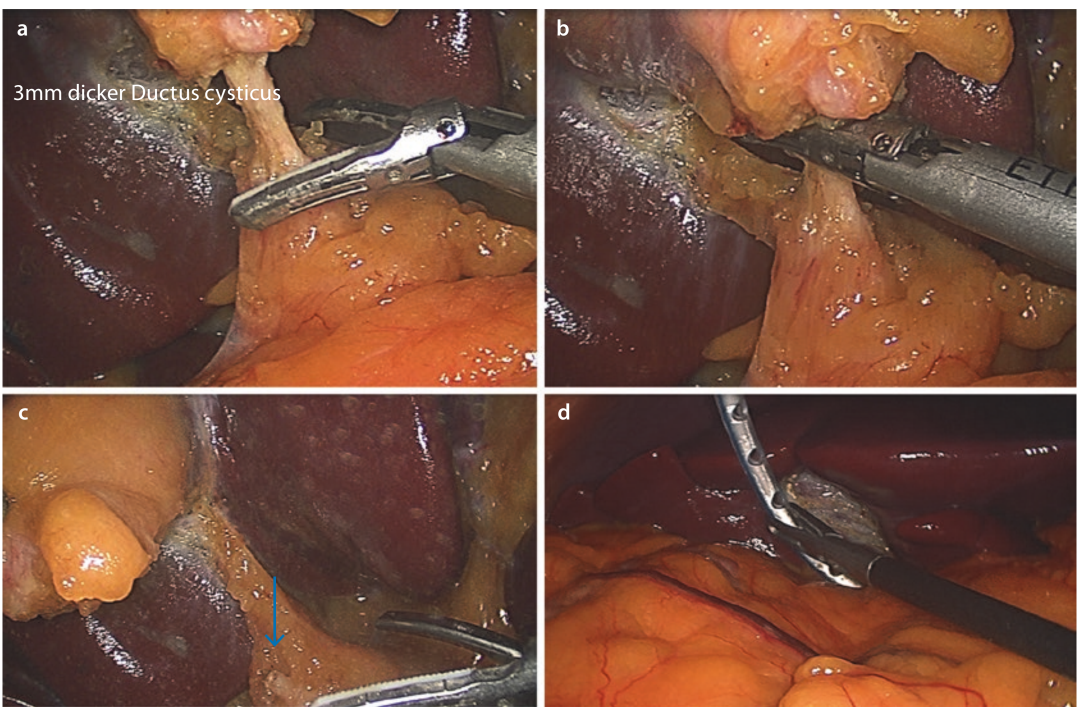
and divided with the HS. The cystic duct can be coagulated with HS alone when the diameter is inferior or equal to 3 mm and when no inflammation is present, no stones are inside and no transcystic approach is planned to remove CBD stones (◘ Fig. 23.11).

The dissection of the gallbladder from the liver bed is always carried out using the harmonic scalpel, dissecting as close to the gallbladder as possible. The control of bleeding originating in the hepatic bed is treated using the active blade of the harmonic scalpel, tangentially touching the surface of the liver.

Drain of the gallbladder bed after an uncomplicated elective cholecystectomy is used only in patients where the cystic duct was closed by using only the harmonic scalpel (◘ Fig. 23.10), in cases of acute cholecystitis and intraoperative bleeding or when the gallbladder was perforated. The drain is usually removed after a 24–48 h period of observation.

In the case of intense visceral adhesions, dissection is always performed using cold scissors, not diathermy.

The gallbladder is always placed in an Endobag before retrieval, trocar sites are always checked for bleeding and the fascial layer is closed in incisions larger than 5 mm.



◘ **Fig. 23.11** **a**–**b** transection of the thin cystic duct with Ultracision without ligation **c** inspection of the cystic duct stumpt **d** insertion of drain

23.2 Difficult Laparoscopic Cholecystectomy: When?

When performing a LC, we bear in mind that no case is routine. Situations where either access or identification or manipulation of the gallbladder and its related anatomical structures is limited configure the scenario of a difficult cholecystectomy.

These situations include cholecystitis (acute and chronic), gangrenous gallbladder, empyema of the gallbladder, pericholecystic abscess, contracted and fibrotic gallbladder, intrahepatic gallbladder, previous drainage of the gallbladder, previous pancreatitis and ERCP, abdominal surgery and in particular gastroduodenal surgery, with dense adhesions at the Calot's triangle, Mirizzi syndrome, cholecystoenteric fistula, liver cirrhosis with portal hypertension and pregnancy.

Different degrees of disease severity and status of biliary anatomy may influence the complexity of the procedure.

There may also be difficulties in the extraction of the gallbladder when it is friable, large, thick walled and frankly perforated or it contains a large stone.

23.3 Anticipating a Difficult Cholecystectomy

■ **Patient's History**

Previous abdominal surgery, especially gastric and duodenal surgery, anticipates difficulty if adhesions are present in the Calot's triangle; there is a higher risk of potential intestinal or biliary damage and chance of conversion to open surgery that should be discussed with the patient at the time of consent.

One of the most significant factors and independent predictors of conversion is the presence of a previous attack of acute cholecystitis (more than 72 h from onset).

Other local situations where inflammatory changes complicate LC include previous pancreatitis and ERCP.

■ **Clinical Picture**

Active cholecystitis may be suspected in case of right upper quadrant pain lasting more than 12 h, raised white cell count and temperature above 37.5 and needs confirmation by ultrasound. If raised inflammatory markers are associated with systemic signs of sepsis, this may be indicative of complicated cholecystitis such as empyema, perforation or gangrene. Elevated liver function tests may suggest cholangitis or common bile duct stones. Coagulopathy is a contraindication if not corrected prior to surgery.

■ **Imaging**

Imaging-detectable risk factors should always be considered before a LC. Abdominal ultrasound (US) may help predicting a complex LC: signs of wall thickening beyond 3 mm, calcification of the gallbladder wall, porcelain gallbladder or large stones may anticipate a gallbladder which is difficult or impossible to grasp at surgery. Liver fibrosis can be detected on US and has been associated with significantly longer operative time, difficult gallbladder bed dissection, higher rate of bleeding and higher rate of conversion. Specificity of US in predicting acute cholecystitis on the basis of wall thickening, gallbladder distention and pericholecystic fluid is generally limited and needs integration with the clinical picture. Signs of gangrene, perforation, pericholecystic abscess or other intra-abdominal diseases indicate further investigation with CT scan or MRI. MRCP may be helpful in the assessment of retained but not impacted CBD stones.

Plain abdominal X-ray can show evidence of gallbladder calcification or a porcelain gallbladder. Cholecystoenteric fistula may show with aerobilia on plain X-ray and be well demonstrated on CT scan or at ERCP.

23.3.1 Difficult Access (Difficulty II-III)

We create pneumoperitoneum by open technique routinely; this access may be of particular value in case of anticipated difficult access to the abdominal cavity, when adhesions are expected to sit in the vicinity of our incision. When possible, it is desirable to place the first incision away from an obvious scar or an abdominal wall hernia (umbilical hernia the most frequently encountered).

In portal hypertension, open technique helps controlling bleeding from collaterals when accessing the abdominal cavity. Divarication of recti, a

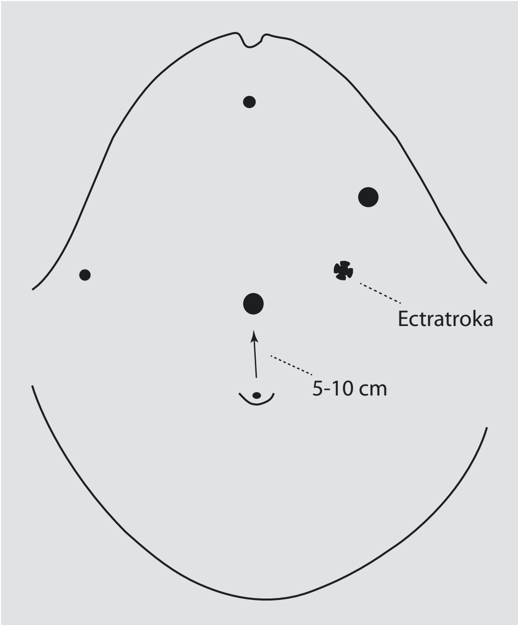


Fig. 23.12 Possible changing of trocar placement and additional trocar for obese patients

previous abdominoplasty or even distention of the stomach or colon may limit the access to the gallbladder. Obesity may pose difficulties in creating pneumoperitoneum.

23.3.2 Obesity (Difficulty II-III)

A thick abdominal wall, difficulties in obtaining a pneumoperitoneum, port displacement, prominent visceral fat and a heavy and friable fatty liver may contribute to added difficulty of LC in obese patients. There also may be a need for special equipment including longer ports, while correct site and angle of placement ports are important to achieve adequate exposure. Additional ports or change in the position of the existing ones may be necessary (Fig. 23.12).

23.3.3 Adhesions from Previous Procedures (Difficulty II-IV)

It is difficult to predict the degree of adhesions preoperatively: sometimes we anticipate adhesions that may not be found, while in other cases, adhesiolysis may prove exceptionally difficult, and other options, including conversion to open cholecystectomy, must be considered.

When pneumoperitoneum is established, it is generally preferable to first attempt division of adhesions to allow trocar positioning at usual sites.

We always take down visceral adhesion by meticulous sharp dissection without the use of energy ("cold blade"), aiming at the inferior margin of the liver as a landmark to then expose the fundus of the gallbladder.

Adhesions from gastric and duodenal surgery cause difficulty in accessing the gallbladder and in the dissection of the Calot's triangle.

Similarly previous pancreatitis and ERCP may either obscure the view of Calot's triangle or render its dissection difficult in view of the intervening fibrosis. Previous drainage of the gallbladder may limit access and manipulation of the gallbladder fundus. Adhesions prone to bleeding may be found in cirrhotic patients.

23.4 Technical Aspects in Difficult LC

In addition to the steps that we routinely follow in LC, specific considerations may apply to difficult cases:

- High-quality imaging equipment should be used.
- When looking for the gallbladder under adhesions, it is important to stay close to the liver margin.
- Once the fundus is seen, the gallbladder is retracted upwards, and adhesions are taken down to the neck of the gallbladder by strictly following the border of the gallbladder wall.
- If there is difficulty grasping a gallbladder that is tense and inflamed, it can be deflated with a long needle and the use of suction. A stitch to the fundus for retraction may be of help when a small contracted gallbladder or a trabeculated gallbladder due to heavy stone load is difficult to hold.
- Once the gallbladder neck is identified, the cystic lymph node (Morgagni lymph node) is a landmark to define cystic duct and cystic artery.
- After identifying the transition of the gallbladder into the cystic duct, the gallbladder is retracted in a slightly ventral position to expose the cystic duct, using mainly blunt dissection.
- Safe circumferential dissection around the cystic duct can be verified by lifting the

Hartmann pouch, often folded over the cystic duct and adherent to it in case of gallbladder inflammation.
- Dissection in Calot's triangle (Budde-Rocko's or Moosman's area) should be commenced only after identifying gallbladder/cystic duct junction. Surgical dissection of both cystic duct and cystic artery should begin adjacent to or near the point of origin of the cystic duct or near point of entry of the vessel, with the tip of the instruments aiming at the gallbladder wall, not medially at the liver hilum.
- The use of electrocautery should be minimal in Calot's and Budde-Rocko's triangle.
- The use of a 30-degree telescope provides better view of Calot's and Budde-Rocko's triangle.
- No structure presumed to be ductal or vascular should be divided until all the anatomical features have been identified. All the structure should be traced back to the gallbladder to avoid injury: at the end of dissection, only two tubular structures remain connected to the gallbladder, and vascular structures superior to 3 mm in diameter have to be considered as a right hepatic artery.
- Proper localisation of the common bile duct should be done from time to time during surgery by retracting the duodenum downwards, keeping in mind the plane of Rouviere's sulcus and retracting the right lobe of the liver with proper traction to the Hartmann pouch.
- In up to 25 % of cases, a right sectoral duct drains directly in the common hepatic duct and can have a prolonged extrahepatic course, being at risk during cholecystectomy.
- Dissection should be maintained in the cholecystic plate during detachment of the gallbladder from the liver. Leaving this plane may procure either injury to the liver and bleeding or may lead to perforation of the gallbladder with intraperitoneal spillage of bile and stones, increasing the risk of postoperative infection and abscess formation.
- Irrigation and suction should be frequently used during the procedure and the peritoneal cavity should be washed and sucked dry at the end.
- Once gallstones are spilled, every attempt should be made to retrieve as many as possible, although this situation alone is not enough to justify conversion, in view of the low incidence of postoperative complications from spilled gallstones.

■ Fundus-First Cholecystectomy

In case of anatomical variants or inflammatory events distorting the Calot's triangle, fundus-first cholecystectomy may be a valuable option. Dissection starts from the gallbladder fundus or body, avoiding Calot's triangle and helping the surgeon find the gallbladder neck or the cystic duct.

■ Subtotal Cholecystectomy

In anatomically difficult situations, or when the ductal or vascular structures are too inflamed for a safe dissection, laparoscopic subtotal cholecystectomy prevents bile duct injuries and decreases the rate of conversion: the gallbladder is incised adjacent to its anterior attachment to the liver, its contents are evacuated and the intraperitoneal gallbladder is removed leaving the posterior wall of the gallbladder attached to the liver, undisturbed. The cystic duct, if accessible, is controlled as usual. Drain is always positioned and observed for a few days.

■ Conversion

The open approach remains the gold standard when there is poor exposure and visualisation; confusing anatomy – especially when the Calot's triangle is obscured by severe inflammation; choledocholithiasis found untreatable by laparoscopic technique; and question of biliary damage, excessive bleeding and failure to progress in dissection (within 30 min in high-risk patients and 60 min in low-risk patients). The risk of perioperative complications has been found to be four times higher if laparoscopic cholecystectomy is lasting beyond 2 h than with a surgery which lasts between 30 and 60 min.

23.4.1 Cystic Duct Stone, Short Cystic Duct (Difficulty: II-III)

An impacted stone in Hartmann pouch induces inflammatory changes, thickening of the gallbladder neck and cystic duct with resultant fibrosis (but there is no CBD compression like in Mirizzi syndrome).

A short and wide cystic duct may not be amenable to safe clipping. careful suturing of a cystic duct, guarding the common bile duct from the needle is a safe and effective approach. Endolooping may be a difficult task that may result in either a bile leak or narrowing of the bile duct. Endo GIA stapler control is safe and quick provided the cystic duct is of adequate length to position the gun.

23.4.2 Acute Cholecystitis (Difficulty: II-IV)

Clinical studies have validated the safety and efficacy of early laparoscopic cholecystectomy in an acute setting.

Acute cholecystitis is for us an indication to LC if surgery is performed within 72 h from the onset of symptoms. In compromised patients that at anaesthetic assessment are considered unsuitable for emergency surgery, intensive care and percutaneous drainage of the gallbladder should be the first option. Percutaneous cholecystostomy may also be used as a bridge step to elective LC in a nonresolving cholecystitis. From a technical point of view, LC in acute cholecystitis benefits from emptying of the gallbladder. Blunt dissection may be conducted with the aid of the suction/irrigation device, cystic artery coagulated with HS, while cystic duct should be tied with a suture in all cases.

If LC appears technically very demanding, we consider subtotal cholecystectomy.

In acute cholecystitis, we always treat the liver bed with bipolar coagulation, argon beamer and thrombin-gelatin hemostatic matrix. Drain is always positioned.

The risk of conversion to open surgery is higher in acute cholecystitis, with the highest being expected when there is gallbladder gangrene or empyema.

The conversion rate ranges between 9 and 50 % and rises significantly after a delay of over 96 h from the onset of symptoms.

The highest risk of conversion is expected in gangrenous cholecystitis and empyema.

23.4.3 Gallbladder Empyema (Difficulty: III-IV)

Presentation of acute cholecystitis with gallbladder gangrene occurs in 2–30 % of cases. The gallbladder becomes thick walled, distended and friable. The conversion rate is higher than in acute cholecystitis, but when LC is successful, it is associated with a better outcome. Perforation of the gallbladder may occur in up to 20 % of cases. The threshold for conversion must be very low.

23.4.4 Laparoscopic Cholecystectomy During Pregnancy (II)

Biliary pathology is the second cause of abdominal acute pain and the second most frequently encountered inflammatory problem encountered during pregnancy. Gallstones are present in 5–12 % of all pregnancies. The surgical approach most often used for the treatment of acute cholecystitis during pregnancy is laparoscopy, and treatment does not differ from non-pregnant patients.

23.4.5 Cirrhosis of the Liver with Portal Hypertension (III-IV)

We do not consider Child A and B cirrhosis a contraindication to LC. Collateral portosystemic shunts and an elevated portal venous pressure may cause troublesome bleeding during dissection: adhesions may present increased vascularity, and both the liver hilum and the gallbladder bed present higher risks during dissection. Emphasis should be put on haemostasis with HS, while clotting factors, argon beamer coagulation and thrombin-gelatin hemostatic matrix should be available for use when handling these cases. An extra access epigastric cannula may be needed to aid retraction of a firm liver with chronic hepatitis, although exposure of hilum might still be inadequate.

23.5 Abnormal Anatomy

Knowledge of the standard anatomy along with biliary and arterial variants is of paramount importance if we consider that the majority of the biliary damages produced during cholecystectomy are due to anatomical misidentification or misinterpretation. Perioperative or intraoperative cholangiogram helps in identifying the anatomy in difficult cases and avoiding or reducing iatrogenic injuries. However, some situations pose a significantly higher risk to a cholecystectomy by significantly obstacling access to structures and manipulation of the gallbladder. Open cholecystectomy is a safe choice in cases of extreme difficulty.

23.6 Variants

23.6.1 Intrahepatic Gallbladder (II-IV)

Intrahepatic gallbladder is one of the ectopic locations of the gallbladder. This type of gallbladder results forms a developmental anomaly or a congenital arrest which prevents the gallbladder from migrating to its superficial location and may be partially or completely embedded in the liver parenchyma or even buried due to recurrent episodes of inflammation. The problem relating to this abnormality is an inability to grasp the fundus of the gallbladder and an absence of avascular plane of dissection between the gallbladder and liver bed. A completely intrahepatic gallbladder may require the same skills and experience as a segmental liver resection.

23.6.2 Hepatobiliary and Arterial Anatomical Variants (II-III)

Variations of ducts, cystic artery, hepatic artery, etc. are all common. The hepatic artery crosses the hepatic duct posteriorly, but in about 12 % of cases, it may cross anteriorly. A "caterpillar hump" of the right hepatic artery may be present in up to 16 % of cases. The cystic artery most commonly originates from the right hepatic within the Calot's triangle; it may though be doubled or originate from the proper or left hepatic, in which case crosses the common hepatic duct anteriorly. The cystic duct may follow a number of variations, some of which imply entry in the CBD posteriorly or from the left side.

True duplication of the gallbladder requires removal of both the lobes, which can be intrahepatic. Transverse, floating, intrahepatic and retrodisplaced gallbladders have been described that may require a port position of the ports. The left-sided gallbladder, with or without situs inversus, may be associated with ductal and vascular anomalies: the confluence of the cystic duct into the CBD might be unpredictable, and if there is doubt, an intraoperative cholangiogram should be performed.

23.6.3 Accessory Bile Ducts (II-III)

Accessory bile ducts originate from the liver parenchyma and may enter a large bile duct or gallbladder at any location or can directly enter the intestine. Lesions to accessory bile ducts are a frequent cause of postoperative complications, and good knowledge of the possible variants to the biliary anatomy is the key to reduce the incidence of postoperative biliary secretion.

When an accessory duct to the fundus of the gallbladder is found at surgery, even of very fine calibre, we prefer closing it with sutures (fine Prolene stitch), leaving a drain for observation over 24–48 h.

23.7 Pathological Anatomy

23.7.1 Massive Gallbladder Calcification, Porcelain Gallbladder (IV)

In addition to the technical difficulty in grasping a calcified gallbladder, there is a reported high incidence (12–60 %) of gallbladder cancer. In view of these risks, we consider porcelain gallbladder as a contraindication to LC.

23.7.2 Mirizzi Syndrome (III-IV)

Mirizzi syndrome occurs in approximately 0.1 % of patients with gallstones and is found in 0.7–2.5 % of cholecystectomies: a gallstone becomes impacted in the cystic duct or neck of the gallbladder causing compression of the common bile duct (CBD), resulting in CBD obstruction and jaundice or the creation of a fistula between the cystic duct and common bile duct. The obstructive jaundice can be caused by direct extrinsic compression by the stone or from fibrosis caused by chronic cholecystitis.

We utilise the Csendes classification and indicate LC in cases of types I (external compression of the common hepatic duct) and II (cholecysto-biliary fistula secondary to an eroded gallstone involving one third of the circumference of the common bile duct). In patients with Mirizzi I, the plan is cholecystectomy with intraoperative cholangiography (IOC) and in Mirizzi II laparoscopic partial cholecystectomy with suture of the remnant gallbladder and IOC or open choledocostomy with repair of the cholecystoenteric fistula when present. Dissection always has to be cautious, avoiding the use of electrified instruments when there are plans of biliary reconstruction; reabsorption sutures should be used along with T-tube positioning.

23.7.3 Cholecystoenteric Fistula (III-IV)

These cases may be difficult in view of the need to repair the fistula. Laparoscopic stapled cholecystofistulectomy may be performed avoiding contamination of peritoneal cavity, but open cholecystectomy is a valuable option considering that biliodigestive fistula is often associated with inflammation and adhesions and may occur at unexpected visceral sites. This procedure is sensitive to potential iatrogenic injuries especially in case of fistula with the transverse colon and duodenum, and sufficient experience is needed to perform the procedure safely.

23.8 Extrahepatic Bile Duct Injuries

An iatrogenic damage during cholecystectomy is the most common cause of acute injury to the extrahepatic bile ducts, while it is a less common event during upper GI or pancreatic surgery, after radiotherapy or the result of a trauma. Chronic pancreatitis may cause slow and progressive stenosis of the intrapancreatic distal portion of the CBD.

The classical mechanism of damage during cholecystectomy is misidentification of the cystic duct or artery. Excessive traction with avulsion of the cystic duct (mechanical trauma), clipping of CBD because of excessive pulling (CBD "tenting") or during urgent haemostasis and inappropriate use of electrocautery near biliary ducts are also factors inherent to the operative conduct. Anatomical variants, obesity, impacted stones and Mirizzi syndrome are all additional factors increasing the risks of bile duct damage.

If a biliary lesion occurs, there is first a need to classify the type of injury (we use the Strasberg classification) and plan for effective management. The best way to assess the state of biliary anatomy at surgery is to perform a cholangiogram.

■ **Intraoperative Diagnosis**

If the injury is detected intraoperatively and necessary expertise and facilities are available, the repair should be done in the same operation, as this option allows the best chance of repair. If not, a T-tube should be placed to the biliary injury and the peritoneal cavity should be drained and the patient referred to a specialist centre: because the best chance for patient's recovery in the long term relies in the first repair, attempts should not be made if expertise is not available.

■ **Postoperative Diagnosis**

An injury detected postoperatively may manifest with biliary fistula, symptoms of biliary peritonitis, jaundice or symptoms of diaphragmatic irritation and deranged liver function tests 24–48 h after surgery. The primary aim of treatment is to control biliary injury and the associated sepsis, which may require endoscopic or percutaneous biliary decompression and sepsis drainage. ERCP should be organised to localise the leak and if possible stent the system for decompression. If the system is completely blocked, we should wait for the intrahepatic and hilar ducts to dilate and perform an interval repair.

A vascular lesion may be associated to the biliary injury. CT scan, usually required to demonstrate resolution of intra-abdominal collections, may show liver atrophy which is generally associated with a vascular injury, making liver resection occasionally necessary at the time of repair.

■ **Biliary Reconstruction**

Biliary reconstruction is best performed under optimal conditions at the time of injury or soon thereafter (approximately 2 weeks). At laparotomy careful adhesiolysis is performed to free the small bowel for reconstruction. The common bile duct can be difficult to identify in case of extensive fibrosis and may benefit from the use of intraoperative ultrasound. Since there often is damage to the biliary blood supply at the time of injury, the common hepatic duct should be opened as proximally as possible; lowering the hilar plate may facilitate recognition of the left and right hepatic duct. Taking care to preserve a small superficial artery usually crossing the left hepatic duct, it is possible to extend the incision to the left hepatic duct to allow a wide anastomosis; alternatively the right and left ducts can be joined together before hepaticojejunostomy. Hepaticojejunostomy should be formed with a 70 cm Roux limb of jejunum (to minimise risk of enteric reflux), end to side with interrupted 4/0 or 5/0 reabsorbable monofilament suture (PDS). If a T-tube is positioned to protect a primary duct repair, it should exit through a separate choledochotomy.

23.8.1 Intraoperative Cholangiogram (IOC)

Although laparoscopic cholecystectomy can be performed safely without routine IOC, the use of intraoperative cholangiography may decrease the risk of injury and improve injury recognition.

Two to 12 % of patients will have choledocholithiasis on routine intraoperative cholangiogram, so our orientation is to use selective IOC, when liver function tests are altered preoperatively even without other evidence of CBD stones. A catheter is introduced from the right hypochondrium port or through a new incision – always in the right hypochondrium – that allows aligning of the catheter to the opened cystic duct. If a choledochoscope is being used, we introduce it from the epigastric port.

Example of difficult cholecystectomy:

Situation	A 42-year-old male, Child B cirrhosis with portal hypertension, ASA-III. Laparoscopic cholecystectomy for symptomatic gallstones, no evidence of common bile duct stones, no evidence of cholecystitis. At laparoscopy, collateral circulation is prominent, liver is firm and friable and bleeding occurs easily
Dilemma	Conversion to open surgery?
Solutions	Laparoscopic subtotal cholecystectomy, leaving the posterior wall of the gallbladder in place. The gallbladder is drained, the fundus and body of the gallbladder are resected down to the neck and the cystic duct is controlled by stitching its lumen close. The mucosa left on the posterior wall of the gallbladder is destroyed with argon beamer (this can also be done with diathermy). Drain is positioned
Outcome	No complications
Analysis	The use of subtotal cholecystectomy avoids risks connected with dissection of the Calot's triangle in a cirrhotic patient and can be carried out by laparoscopy; successful laparoscopy results in improved postoperative outcome

23.9 Common Bile Duct Stones

Over 90 % of benign biliary disease present with common bile duct (CBD) stones, and biliary stones are the most common indication to surgery of the biliary tract. Overall, the prevalence of common bile duct stones is 12 % (range 5–20 %).

- **Preoperative Diagnosis**

The majority of patients with persistent common bile duct stones is easily identified before surgery. ERCP, sphincterotomy and stone extraction are the treatment of choice. If the stones are cleared completely, then this is followed by laparoscopic cholecystectomy with or without intraoperative cholangiogram.

If the common bile duct stones are detected preoperatively but not cleared completely or if the stones are too large to be removed (beyond 2 cm), we perform laparoscopically guided exploration of CBD and stone clearance followed by laparoscopic cholecystectomy in first instance or open cholecystectomy with open CBD exploration if laparoscopy is not feasible.

Primary surgical approach to CBD stones is also indicated in case of previous gastrectomy with Roux-en-Y reconstruction or gastric bypass or Mirizzi syndrome.

- **Intraoperative Diagnosis**

Intraoperative diagnosis of CBD stones can be made by intraoperative laparoscopic cholangiogram or intraoperative laparoscopic ultrasonography.

Intraoperative cholangiogram is indicated on the basis of the risk for biliary tract stones: preoperative derangement of liver function tests in the absence of morphological evidence of stones or signs at the intraoperative exploration suggesting presence of stones spilled in the biliary tree.

Typically, these patients are either asymptomatic (but liver function tests are not normal) and undergoing elective cholecystectomy or had recent episodes of jaundice or gallstone pancreatitis and are showing mild dilatation of the common bile duct, with the lower end not seen well on ultrasonography.

Sometimes there is history of multiple gallstones and recurrent attacks of jaundice but preoperative US, MRCP and bilirubin are normal. A wide cystic duct seen during laparoscopic dissection may be the only evidence.

We prefer intraoperative laparoscopic cholangiogram to laparoscopic biliary ultrasound to assess the presence of stones in the extrahepatic biliary tree; it allows a better definition of the biliary anatomy, which may be limited on ultrasound; the pancreas also may obscure the views on ultrasound, although ultrasound is highly specific for stones.

When CBD stones are found intraoperatively, we proceed to clearance in one time, either by laparoscopically guided ERCP ("rendezvous" procedure) or through laparoscopic bile duct exploration, either transcystic or by choledochotomy. If a laparoscopically assisted approach fails, we convert to open surgical CBD clearance.

One-stage treatment combining laparoscopic cholecystectomy with laparoscopic common bile duct exploration is cost-effective, with no significant increase in morbidity or mortality from different approaches. Both single-stage laparoscopic and combined laparoscopic/intraoperative endoscopic approaches require time, equipment, skills and experience to be performed.

Choice of the treatment is influenced not only by patient's condition, CBD calibre, stone load, size and eventual impaction but also the availability of laparoscopic and endoscopic facilities, level of expertise of endoscopist performing ERCP and experience of surgeon performing laparoscopic biliary surgery.

23.9.1 Intraoperative Laparoscopically Guided ERCP (Difficulty II)

It is usually retrograde, with sphincterotomy performed through the duodenoscope, as opposed to antegrade (which we don't use); antegrade is usually performed during open surgery with the sphinctertome introduced through the choledochotomy.

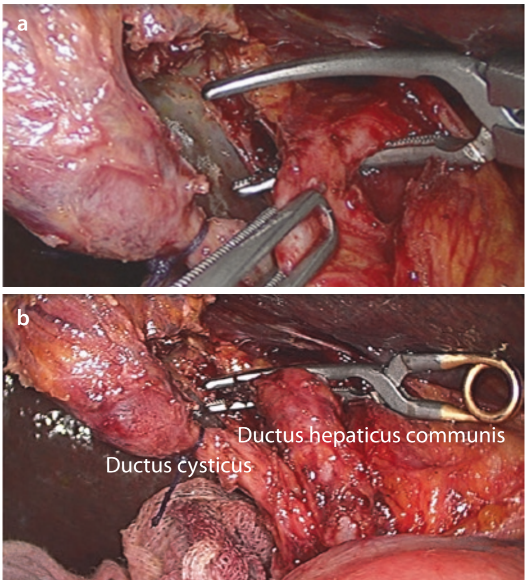
23.9.2 Laparoscopic Transcystic Approach (Difficulty II-III)

This is applicable when the calibre of the cystic duct is compatible to the size of the stones targeted (up to 6 mm), when there is not much discrepancy between the size of the cystic duct and the size of the CBD stones.

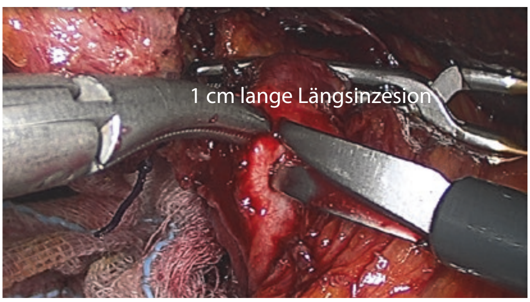
The cystic duct is incised up to 50 % of its diameter to preserve its wall strength. If stones are found in the cystic duct, they can be "milked" out of it before positioning the catheter for cholangiogram. Then a guide wire is passed from the cystic duct opening into the CBD, and sequential dilation of the cystic duct follows, with either balloon or bougie; dilation is functional to the use of instrumentation. Although surgeons may operate wire baskets under fluoroscopic control, an approach to CBD stones by means of wire basket entrapment under direct choledochoscope guidance is safer. Inserting the choledochoscope through the cystic duct requires sufficient dilation, and, if this is too vigorous or too close to the common bile duct while excessive tension is applied to the gallbladder, the cystic duct might be avulsed, making impossible the use of instruments. In general, this approach is accepted for stones within 6 mm and a cystic duct calibre larger than 4 mm, although the combination of stones and wire basket might result in entrapment of this complex in the CBD, with necessity to cut the guide wire free and open the CBD to retrieve the basket. This is an important limiting factor to the success of the procedure and bears a relatively high incidence of retained stones and complications. Otherwise, successful transcystic approach has the intrinsic benefit of eliminating risk of CBD stricture when closing a choledochotomy. Another limiting factor depends on anatomical variability of the cystic-to-CBD junction, being straight and lateral entry the ideal situation, while posterior insertion or CBD stone proximal to cystic insertion are contraindications to this approach.

23.9.3 Laparoscopic Choledochotomy for CBD Stones (Difficulty II-IV)

This approach is indicated when the CBD stones are large or impacted and may require lithotripsy, when transcystic approach is not feasible because of insufficient dilation of the cystic duct



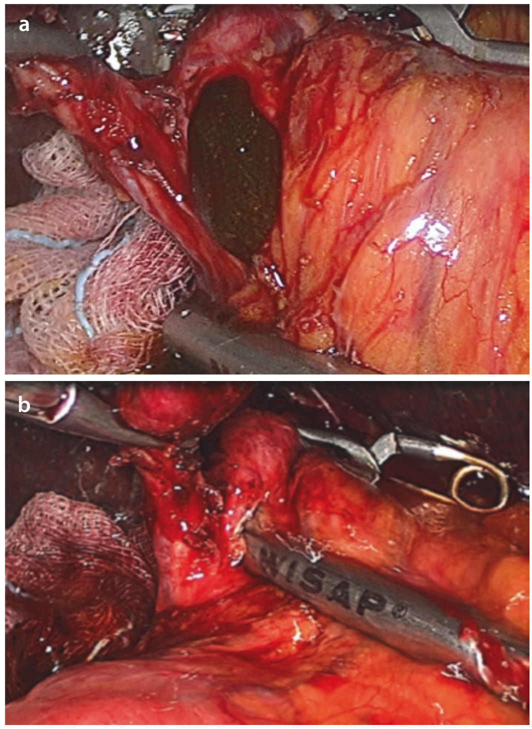
■ **Fig. 23.13** Preparation for choledochotomy through the cystic duct loop and the proximal clamping of hepatic duct



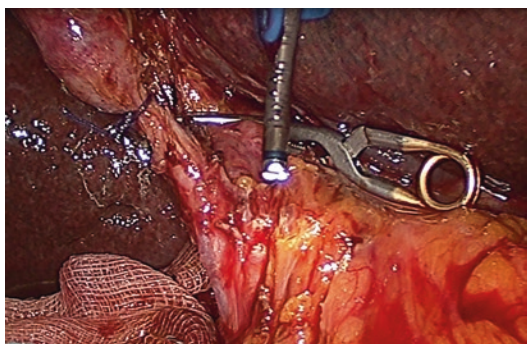
■ **Fig. 23.14** Choledochotomy

or transcystic approach fails. CBD must be dilated beyond 6 mm to allow for this procedure.

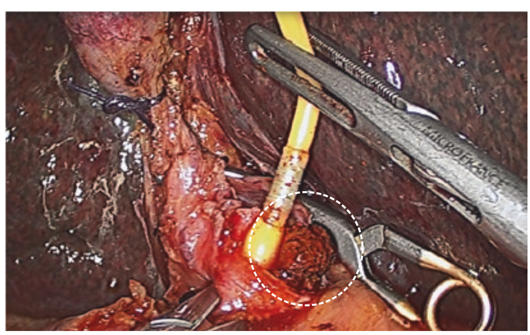
After applying a tie to the proximal cystic duct, the common hepatic duct upstream the junction with the cystic duct is closed with a soft clamp (■ Fig. 23.13). One cm longitudinal incision (preserves the CBD vascular supply) is taken on the anterior surface of supraduodenal portion of CBD (■ Fig. 23.14). After sucking sludge and stones eventually creeping through the incision, CBD is washed with warm saline (■ Fig. 23.15). A choledochoscope is inserted through the epigastric port and then carefully advanced into the ductal system (■ Fig. 23.16). Continuous infusion of warm saline maintains the choledochoscopic view clear. A balloon catheter can be used to drag stones (■ Fig. 23.17), or a wire basket may be care-



■ **Fig. 23.15** Suction (**a**) and irrigation of the common bile duct (**b**)



■ **Fig. 23.16** Intraoperative choledochoscopy



■ **Fig. 23.17** Insertion of the balloon catheter for the extraction of common bile duct stones

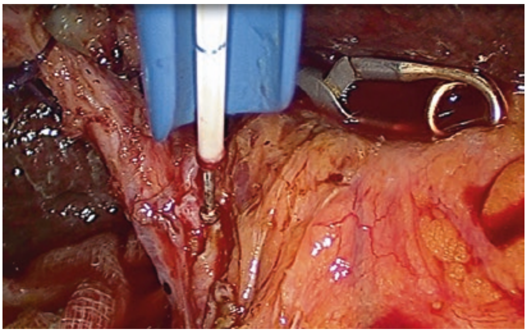


Fig. 23.18 Insertion of the Dormia basket for stone extraction

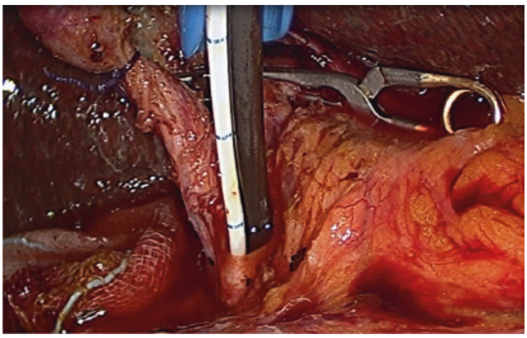


Fig. 23.19 Insertion of the Dormia under choledochoscopical control

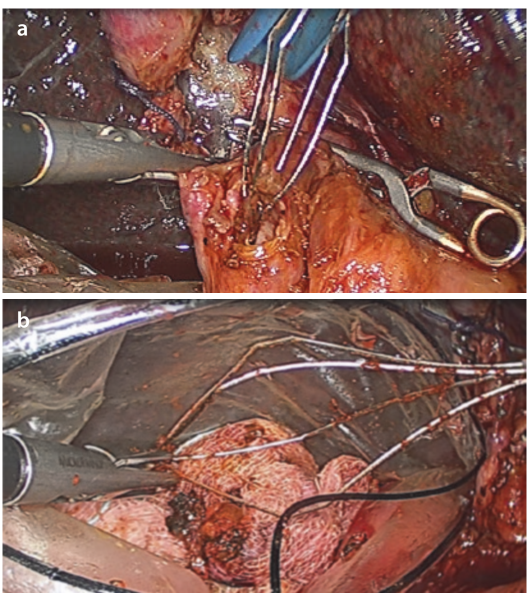


Fig. 23.20 (**a**) extraction of common bile duct stones (**b**) put it in extraction bag

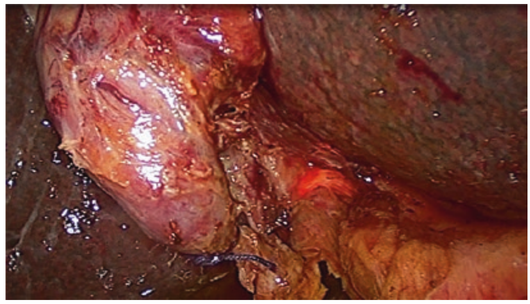


Fig. 23.21 Choledochoscopic control after the stone extraction

fully inserted under choledochoscopic guidance (Figs. 23.18 and 23.19) and advanced beyond the stones, opened and withdrawn with the captured stones that can thus be removed (Fig. 23.20).

If a calculus is impacted or too large (>2 cm) to be relieved, we prefer converting the procedure to open CBD exploration than using rigid choledochoscope. After confirming CBD clearance, we proceed to explore the proximal portion of the common hepatic duct and the biliary confluence (Fig. 23.21). Our preferred method for closure of a choledochotomy is direct continuous monofilament suture (4/0, 5/0) without internal stent ("ideal" choledochotomy) (Fig. 23.22), but it mandates verifying that no single residual fragment of stone is present in the CBD as well as there is no distal biliary stricture. We leave a transcystic biliary drain after closing the choledochotomy (Fig. 23.23) through which it is still possible to perform a cholangiogram.

Postoperative Diagnosis

If diagnosis of CBD stones is postoperative, ERCP is the preferred choice of treatment today. If this is not available, then laparoscopic CBD exploration may become an option provided that CBD is adequately dilated. Another option is classical open CBD exploration with T-tube drainage.

Example of difficult laparoscopic choledochotomy for CBD stones clearance:

Situation	A 70-year-old female, ASA-III. Intraoperative laparoscopic guided choledochoscopy and attempted (failed) clearance of a 1.5 cm stone, found impacted in the distal third of the CBD, cannot be overcome by a basket and is not moved by irrigation

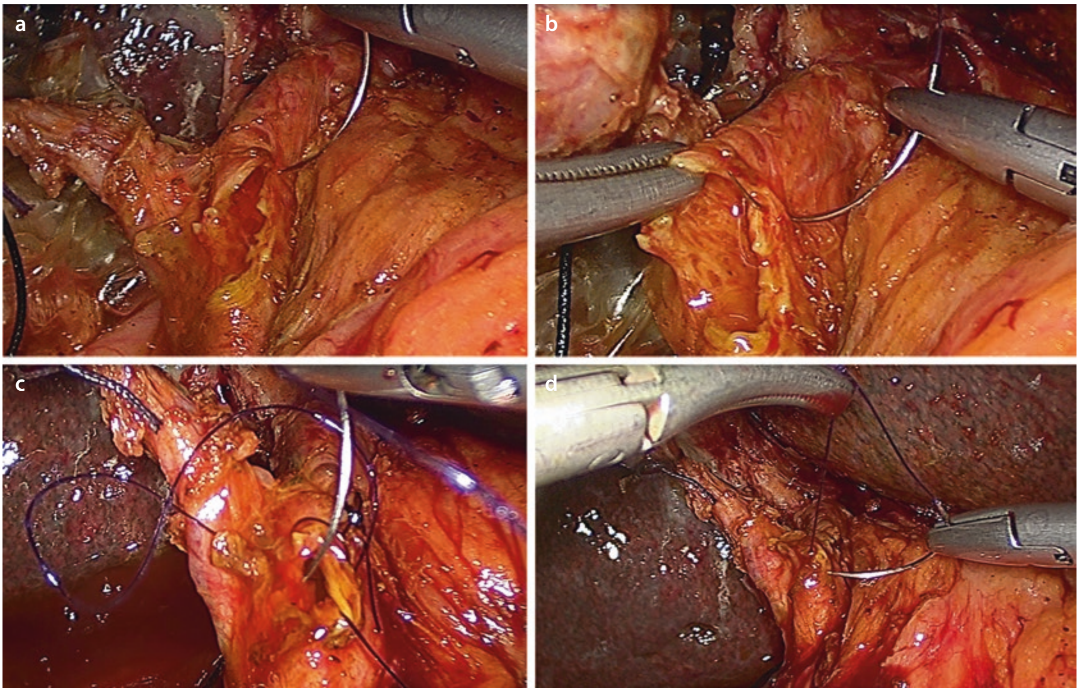


Fig. 23.22 Closure of choledochotomy with a running suture

Dilemma	Conversion to open surgery – open CBD exploration and stone retrieval?
Solutions	Laparoscopic Kocher manoeuvre, with freeing of the head of the pancreas and the relative intrapancreatic tract of the distal CBD. CBD is gently "milked" from behind the pancreas, and the stone is freed and retrieved
Outcome	No complications
Analysis	Expertise in advanced laparoscopic and pancreatobiliary surgery is necessary to manipulate the pancreas safely by laparoscopy; experience in biliary tract surgery is necessary to anticipate which scenario is likely to be positively affected by a modification to a standard technique. It is possible to safely retrieve large stones initially looking impacted and not amenable to laparoscopic CBD clearance

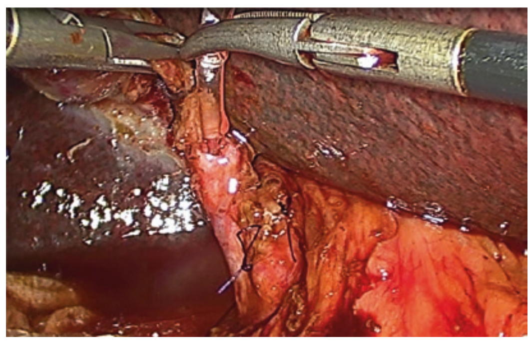


Fig. 23.23 Insertion of transcystic common bile duct drain

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Surgical Technique and Difficult Situations from Benoit Navez

Benoit Navez

M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations*,
DOI 10.1007/978-3-662-49878-1_24

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24.1 Laparoscopic Management of Common Bile Duct Stones (CBDS)

Laparoscopic management of CBDS is less and less a commonly used technique because the learning curve is long and advanced technology like flexible choledocoscopy is required. Most of the surgeons prefer an endoscopic sphincterotomy performed by themselves or by the gastroenterologists. However, there are some clinical conditions where the latter approach fails and where surgical CBD desobstruction is necessary.

During laparoscopic exploration of the common bile duct (CBD), several technical difficulties can be encountered.

- For stone extraction, a Dormia basket with a flexible tip must be used. It will avoid the "classical" perforation of CBD wall when using a Dormia with a rigid tip. Stones grasping and extraction need to be done under fluoroscopic and/or choledocoscopic control. If not, impaction of Dormia basket within the papilla can occur.
- Transcystic approach (TA) is indicated in case of a limited number (<5) of small-size CBDS located below the junction between the cystic duct and CBD. Ideally, the cystic duct should be short and dilated with a right implantation into the middle third of CBD. In all other cases or after failure of TA, choledocotomy is indicated. This approach is also preferable in case of multiple CBDS (>5) with at least one stone larger than the cystic duct and in case of a low implantation of the cystic duct. The CBD diameter should be 7 mm or more.
- It is necessary to ensure the complete clearance of the biliary tract before the end of the procedure, with an intraoperative cholangiography and a choledocoscopy.
- Impacted papillary stone remains the main cause of failure. Lithotripsy under choledoscopic control could help.
- Biliary drainage is indicated in case of doubtful complete clearance of CBD either with a T-tube in case of choledocotomy or with a transcystic drain. Anyway, external biliary drainage raises significantly the rate of complications (drain pulled out or ruptured, biliary fistula after removal …) and the length of hospital stay.

24.2 Subtotal Cholecystectomy and the "Inside Approach": A Safe Option in Severe Cholecystitis

24.2.1 Introduction

In severe cholecystitis with dense fibrosis of the Calot's triangle, the "inside approach" of the gallbladder combined with subtotal cholecystectomy (SC) is a safe alternative technique to classical dissection of the cystic duct and cystic artery which are frequently embedded in severe inflammation (Fig. 24.1). In a recent multicenter study, it has been shown that in case of cholecystitis, the rate of bile duct injury could reach 2.7 % in open surgery and 1.1 % in laparoscopic surgery [1]. Therefore, by avoiding to dissect close to the important biliary ducts, the risk to damage them is lower. The main advantage of this strategy is to decrease dramatically the CBD injury rate. It is also helpful when a difficult case is suspected to have an MRI in the preoperative workup. It allows to identify before the procedure biliary anomalies like a posterolateral biliary duct entering the common bile duct near the cystic duct

24.2.2 Surgical Technique

- The first step is laparoscopic exploration of the subhepatic area and mostly the porta hepatis. Technical difficulties of dissection will be suspected if the transition area between the gallbladder and the right side of the porta hepatis is rigid and

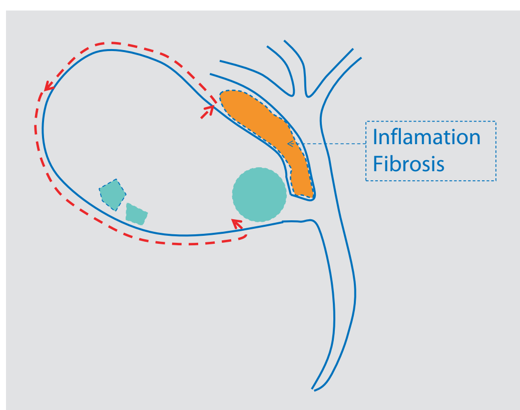


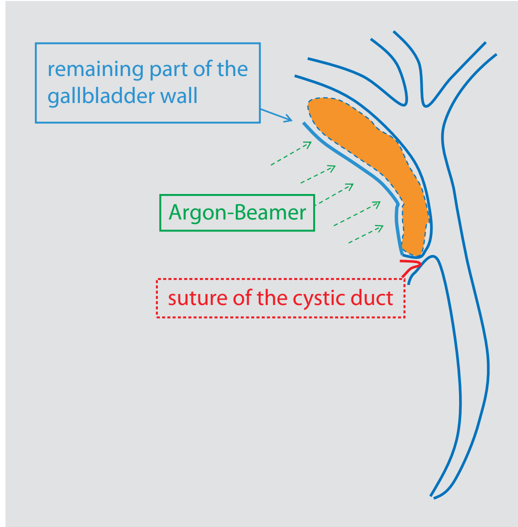
Fig. 24.1 Schematic representation of the subtotal cholecystectomy

inflammatory without any anatomical landmark visible. In that situation, to "force" the passage through the Calot's triangle could lead to severe damage to a biliary duct or the right branch of the hepatic artery.

- Before any dissection, the gallbladder is longitudinally opened on its peritoneal surface from the fundus to Hartmann's pouch (HP). Bile is aspirated and stones are placed in an endobag.
- Then the gallbladder wall is dissected from the liver bed. By checking the plane of dissection from the inside and outside of the gallbladder, it allows an easier determination of the precise limits of the gallbladder wall. However, sometimes it is difficult to separate the gallbladder from the liver bed, and in order to avoid a liver parenchyma injury that can lead to severe venous hemorrhage, a small part of the gallbladder wall can be left in place attached to the liver. Anyway, the dissection should be kept close to the gallbladder wall.
- At the level of the HP, the dissection is stopped and the gallbladder is incised circularly leaving in place a part or all of the HP. The resected gallbladder is placed in the bag. The cystic artery is usually encountered at the superior border of the HP and secured by clips or cautery.
- Finally, HP is left opened and the cystic duct is approached from the inside of the HP. It is catheterized with a special cholangiography catheter having a balloon on its tip. The latter is inflated inside the cystic duct in order to avoid any leakage of contrast material, and the intraoperative cholangiogram is performed.
- Cystic duct is closed by suturing intracorporeally the outlet of HP taking care not to widely anchorage and damage the CBD.
- The residual mucosa of HP is then superficially destroyed by using argon beam coagulator (◘ Fig. 24.2).

24.2.3 Indications

- Severely inflamed GB with severe inflammatory or fibrotic changes
  - Acute gangrenous cholecystitis, empyema
  - Severe fibrosis from scleroatrophic gallbladder
  - Impacted stone in an inflamed Hartmann's pouch
  - Difficult plane of dissection in the liver bed or between HP and right part of the hilum
- Cirrhosis and portal hypertension
- Mirizzi syndrome type I



◘ **Fig. 24.2** Coagulation of remaining mucosa with argon beamer

24.2.4 Results

In a consecutive series of 39 patients with local difficult conditions in the triangle of Calot which represents 7.1 % of all cholecystectomies, an endovascular approach was performed. Intraoperative cholangiography was feasible in 79.5 %, and only minor complications occurred in 15.4 %. There were no postoperative biliary or infectious complications [2].

24.3 Laparoscopic Management of Cholecysto-enteric Fistula

Various communications can occur between the gallbladder and the digestive tract. There are internal biliary fistulas like a cholecysto-choledochal fistulas (Mirizzi syndrome type II) and cholecysto-enteric fistulas. Classically, surgical management of such complicated cases should be done by open surgery, but for some

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surgeons skilled in laparoscopic techniques and with a huge experience in biliary surgery, the procedure can be attempted endoscopically.

The most frequent biliary fistulas are cholecysto-duodenal fistula and cholecysto-colic fistula. Usually, the gallbladder is severely and chronically inflamed (scleroatrophic cholecystitis). Intraoperatively, there are a lot of dense adhesions between the gallbladder and the neighboring fistulized organ. Do not hesitate to switch to an inside approach if dense fibrosis in the Calot's triangle makes the dissection dangerous. The fistula has to be clearly individualized, and the digestive side of the fistulous path has to be divided by using a linear endo-stapler. When closing and locking the stapler, it is important to verify that it does not cause a stenosis of the duodenum or the colon.

24.4 Classification of Intraoperative Difficulties

The operative difficulties for surgery of benign gallbladder and biliary tract diseases can be classified as summarized in ◘ Table 24.1.

◘ **Table 24.1** Grading of operative difficulties for benign gallbladder and biliary tract diseases

I.	Biliary colics, no cholecystitis, no stone migration
II.	Acute edematous cholecystitis. Sclero-atrophic gallbladder
III.	Acute purulent cholecystitis. Associated common bile duct stones
IV.	Gangrenous cholecystitis. Cholecysto-enteric fistula. Mirizzi syndrome

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Individual Surgery for Inflammatory Bowel Disease

Contents

Surgical Technique and Difficult Situations for Ulcerative Colitis from Adrian Greenstein

Alexander J. Greenstein and Adrian J. Greenstein

M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations*,
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25.1 Introduction

Surgery for ulcerative colitis and Crohn's disease has benefitted immeasurably from the transition from open to laparoscopic surgery. While traditional open surgery often provides easy visualization of the mesentery in relation to the intestine with short operative times, its well-known disadvantages include wound complications such as infection, disruption, and hernias, as well as a larger incision, worse cosmesis, more postoperative pain, more blood loss, later return of bowel function, later oral intake, and longer hospital stay [1].

Open surgery may also suffer from difficult visualization (specifically in the left upper quadrant and pelvis) – especially in the obese patient. On the other hand in laparoscopic surgery, special attention must be paid to correct orientation of the mesentery to avoid rotation of the bowel or of the mesentery. In particular, one must avoid rotation of bowel with stomas, rotation of the pouch, or herniation of bowel posterior to the mesentery in laparoscopic pouch procedures. Hand-assisted laparoscopic surgery (HALS) has some of the advantages and disadvantages of both and involves a relatively larger incision [2, 3].

Although there may be some difficulty in orientation, HALS does allow for hand dissection of the bowel hand dissection of the congenital adhesions, retraction, and exposure of mesentery, particularly when the bowel is fragile as in severe colitis. It also allows for palpation of masses and/or ureteric stents when the ureter cannot be visualized.

We will describe our technique in subtotal colectomy for ulcerative colitis using advanced laparoscopic methods with special emphasis on the transverse colon and flexures. We perform this technique for nearly all of our patients with ulcerative colitis, even for most of those patients with fulminant disease, and we rarely use hand assistance or a GelPort.

25.2 Preoperative Strategy and Planning

In general, surgery for UC is multistaged with three-, two-, or on occasion one-staged procedures. Fulminating disease, with fever, tachycardia, and elevated white cell count with a left shift, is in general done in three stages. Patients with intractable steroid-dependent disease and on biologic medications such as Remicade, Cimzia, and Humira, with hypoalbuminemia, and with anemia are preferentially done in three stages, but occasionally may be done in two stages in younger patients. Surgery for patients with dysplasia/DALM/ cancer, who are generally in better physical shape but usually older, may be done in two stages. One-stage procedures have been recommended by some surgeons, but should be limited to highly selected cases [1, 4, 5].

It is our preference to do a proximal defunctioning loop ileostomy in all J-pouch procedures. An Isovue enema evaluation of healing of the pouch prior to closure of the Turnbull-type loop ileostomy is routine.

All patients are fully evaluated with regard to ASA level, BMI, and comorbidities. The ileostomy site is always marked in the sitting position if an ileostomy is planned. This must be done by the surgeon or stoma nurse and future management and possible problems, such as hernias, dehydration, and skin irritation discussed in detail with the patient. Bowel prep is controversial, but it is our preference to use cathartics, antibiotics, and high colonic tap water enemas (except for fulminating disease with abdominal tenderness).

In terms of technical approach, there is some controversy regarding the medial to lateral approach vs. lateral approach which is the standard approach in open surgery. Either approach is appropriate provided careful visualization of retroperitoneal structures is carried out and the dissection is done with preservation of the continuity of the sympathetic nerves, the preaortic plexus, the ureters, and the gonadal vessels, all of which lie posterior to the embryonic retroperitoneal plane. Although the medial to lateral approach is technically more demanding, it is probably somewhat faster and more precise, allowing for high/proximal ligation of the colonic vessels when necessary. Obviously, if there is a dysplasia-associated lesion or mass (DALM) or cancer of the colon, vessels should be taken at their origin while mesenteric transection should be close to the colon for benign disease.

25.3 Laparoscopic Technique

25.3.1 Positioning

All patients requiring colonic resection should be placed in stirrups. An orogastric tube is placed and the stomach emptied; it is usually removed at the end of the operative procedure. Care is taken to position the patient using egg crates to protect all pressure points of the arms and legs. Straps are appropriately placed to prevent movement on the operating table during the operative procedure. A plastic warming blanket is placed over the upper chest to maintain a constant temperature. Placement of ureteric catheters is dependent on the discretion of the surgeon, but is advisable for severe cases of ulcerative colitis with fulminating disease and any patients with Crohn's colitis. With the patient in stirrups, we irrigate the rectum and rectosigmoid with an irrigating suction system (28 Foley catheter taped with Steri-Strips to a pool tip suction) using up to 3000 ccs of saline. Irrigation of the rectum is discretionary, but we use this on an almost routine basis during the course of rectosigmoid or rectal dissection prior to transection of the large bowel. This is particularly important when bowel prep has failed to adequately clean the colorectum. Preparation of the skin with ChloraPrep or Betadine is routine for the abdomen and perineum, and per standard technique, antibiotics are given within 30 min of incision.

25.3.2 Trocar Placement

To establish pneumoperitoneum, a 5 mm Fios Optiview scope is passed through a small incision in the umbilical region or left upper quadrant (if there is a previous umbilical incision). If there is distension, a 12 mm balloon Hasson trocar is placed through a periumbilical incision. 5 mm ports are then placed in the right upper quadrant, and on the left side (and sometimes in the suprapubic position) with a 12 mm port at the ileostomy site in the right lower quadrant. It is our preference to use 5 mm instruments whenever possible in order to minimize the chance of herniation and reduce the need for fascial closure. The future right lower quadrant ileostomy site can

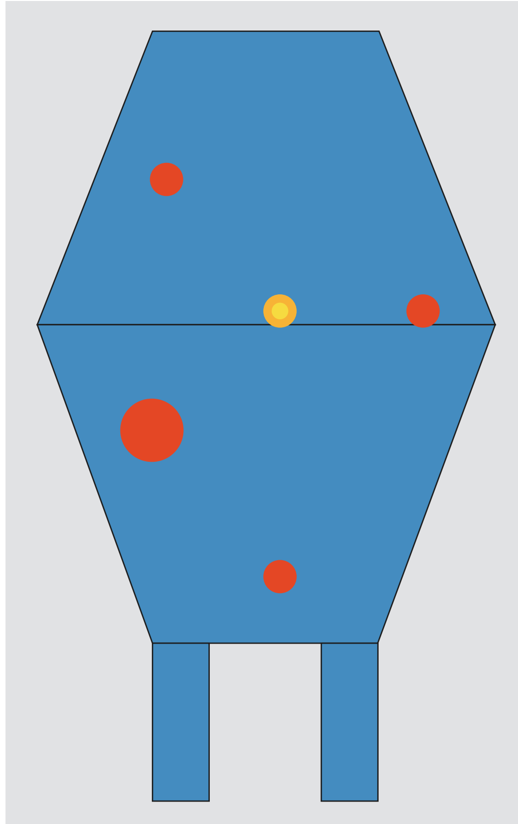


Fig. 25.1 Trocar Placement

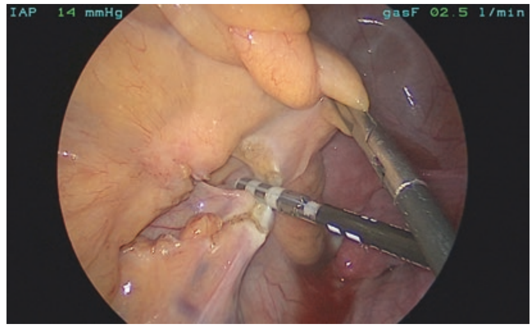
be used for extraction of the bowel through a wound protector and passage of the Endo GIA to transect the colon when the 12 mm port is in place. If it is deemed preferable to extract the colon through the midline, the umbilical port site can be extended up or down as a relatively short incision. We generally do not advocate the use of single incision laparoscopic surgery (SILS) for this procedure. Placement of trocars varies considerably, but we have noted our suggested trocar sites (Fig. 25.1).

25.3.3 Distal Left Colon and Transection at Rectosigmoid Junction

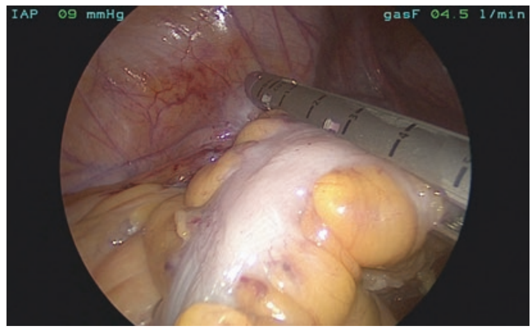
The dissection begins on the left side with the surgeon high on the right side and the assistant low on the left side. The table is inclined with the left side up in steep Trendelenburg. The small bowel is swept to the right and cephalad. The mesenteric dissection is carried out from medial to lateral using a 5 mm LigaSure or harmonic scalpel. We transect the peritoneum over the medial side of the mesocolon posterior to the marginal artery of Drummond and cephalad to the superior rectal artery in the relatively avascular plane. After defining the plane, care should be taken in this area to identify and visualize and preserve the preaortic hypogastric plexus and nerves. Subsequently, when the embryonic retroperitoneal plane is established by blunt dissection, the ureter and the testicular or ovarian vessels should be identified and preserved. In some patients, these structures cannot be easily identified so it is imperative that one stays anterior to the embryonic plane which is generally not difficult in IBD cases. A blunt instrument is then passed through to the lateral paracolic gutter anterior to the white line of Toldt. The tip is visualized by retracting the colon in an anteromedial direction after which the colon is retracted by the assistant once again in an anterolateral direction with two graspers. Transection of the sigmoid mesentery and vessels is then continued in a cephalad direction. Following this, the dissection is continued downward taking the mesentery to the rectosigmoid colon using the 5 mm LigaSure (◘ Fig. 25.2), and finally, the mesenteric fat is cleaned until the muscular layer of the bowel is visualized. A 60 mm Endo GIA staple load is then used to transect the rectosigmoid colon (◘ Fig. 25.3) and the staple line is air leak tested.

25.3.4 Proximal Left Colon and Splenic Flexure

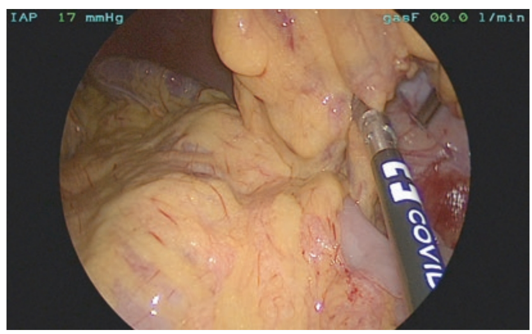
Following transection of the colon, the patient is placed in reverse Trendelenburg position, and the division of the mesentery is continued from the site of initiation of the dissection backup in a cephalad direction to the area of the splenic flexure, transecting the left colic vessels (◘ Fig. 25.4) and then the arc of Riolan at the splenic flexure. As the splenic flexure is approached, the surgeon moves to between the legs. Mesenteric transection is continued anteromedially to the ligament of Treitz, being careful to stay anterior to the fourth portion of the duodenum and the pancreas. During the course of this dissection, the lateral attachments of the left colon are taken immediately anterior to the line of the fascia of Toldt using either the 5 mm LigaSure or the harmonic scalpel. The colonic attachments to the diaphragm and spleen are taken down avoiding



◘ **Fig. 25.2** Distal Dissection



◘ **Fig. 25.3** Stapling Rectosigmoid Junction



◘ **Fig. 25.4** Dissection Splenic Flexure traction on the filamentous attachments to the spleen and thus any capsular tears. Capsular tears are not uncommon with open surgery but are rare with the better visibility of laparoscopic surgery. Any accessory spleens, which are not uncommon, should be preserved if the dissection does not compromise the vascular supply to the spleen.

25.3.5 Completion of Splenic Flexure and Lateral Dissection of Transverse Colon

Both surgeon and assistant may work from the right side for this part of the dissection. The assistant elevates the gastrocolic omentum either by lifting it upward from within the lesser sac just to the left of midline and the lesser sac is entered. Ideally, transection is continued below the greater gastroepiploic arcade toward the splenic flexure transecting the epiploic vessels in the avascular plane, meeting our prior dissection of the splenic flexure from the left side (◘ Fig. 25.5). At this point, the mesentery of the splenic flexure has been transected until its junction with the mesentery of the transverse colon. The surgeon and assistant now move to the left side and continue transection of the gastrocolic omentum from the midline toward the hepatic flexure as the patient is placed right side up. The plane of the mesentery superior to the hepatic flexure is defined and transected carefully down to the colon. The colon is lifted anteriorly and dissection continued separating the apex of the flexure from the posterior attachments below the gallbladder and proceeding through the peritoneal reflexion to separate the colon from the proximal duodenum.

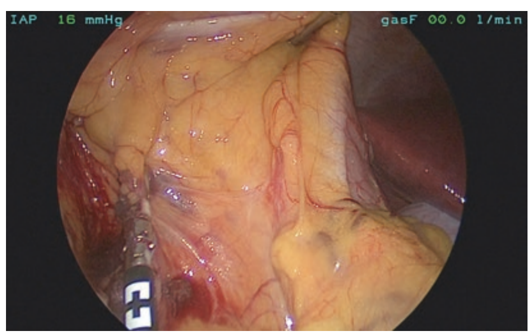
25.3.6 Right Hemicolectomy

At this point, we commence with a standard medial to lateral dissection of the right hemicolon with both the surgeon and assistant on the patient's left-hand side. The cecum and ascending colon are elevated by the assistant anteriorly and to the right, and the ileocolic vessels and the right colic vessels are transected with preservation of the branches to the terminal ileum, once again being careful to enter and remain in the embryonic plane and to display and preserve the ureter and gonadal vessels. The mesenteric transection is now continued (completed) past the lower part of the descending duodenum and the proximal part of the third transverse portion of the duodenum (◘ Fig. 25.6). After successful medial mesenteric dissection, the posterior peritoneal abdominopelvic attachments of the distal ileum and cecum (cecum and distal ileum) should be taken down. On occasion it may be preferable to take down the lateral attachments anterior to the fascia of Toldt prior to dissection of the ileocecal area, and this is clearly at the discretion of the surgeon.

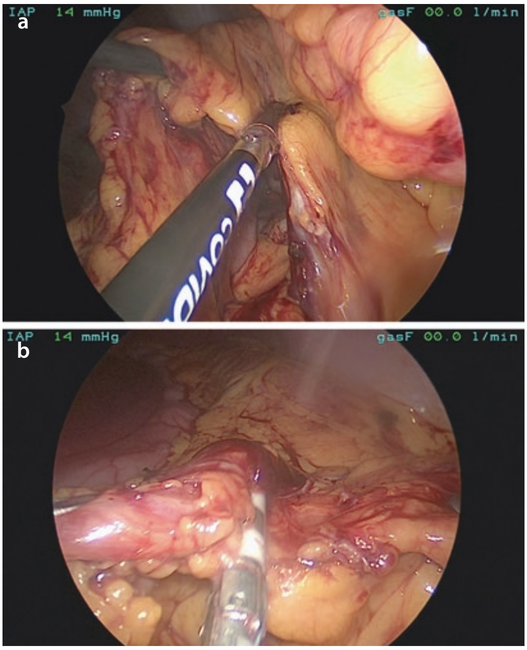
25.3.7 Completion of Transection of the Mesentery of the Transverse Colon

At this point, we are left with just the mesentery of the transverse colon. Ideally, it is possible to

◘ **Fig. 25.5** Opening Lesser Sac



◘ **Fig. 25.6** Dissection Right Colon



■ **Fig. 25.7** Dissection Transverse Colon

orient the bowel in such a way as to clearly visualize mesentery. In some cases, it is easier to lift it anteriorly and superiorly, while in other cases, it is better to let the transverse colon hang inferiorly from its mesentery (■ Fig. 25.7). In addition, placement of the 5 mm camera through a right-sided port may provide better visualization of the mesentery as the umbilical port is often directly anterior to the transverse colon. Once the mesentery is clearly and safely visualized, one simply advances from proximal to distal along the mesentery until the mesenteric dissection of the splenic flexure is encountered. A #7 JP is placed in the pelvis adjacent to the stapled off rectal stump.

25.3.8 Intestinal Extraction and Transection of the Terminal Ileum

Extraction of the colon may be carried out through a midline incision at the umbilicus, a Pfannenstiel incision, or an oblique right or left lower quadrant incision. We prefer to extract the colon or rectum through the ileostomy site after the 12 mm ports have been enlarged to accommodate two fingers and a small wound protector has been placed to stretch the site. The colon is extracted in a distal-to-proximal direction. In cases of very edematous, fragile, dilated colon, it is important to ensure that the size of the ileostomy canal is adequate even if it needs to be enlarged at both the skin and fascial levels. If the cecum enlarges and becomes filled with liquid stool, an opening may be made in the colon and a pool suction introduced into the cecum to aspirate the liquid. The mesentery to the terminal ileum is carefully examined. The cockscomb is excised, the ileum is transected 1 cm proximal to the ileocecal valve, and the specimen is removed (■ Fig. 25.8). The openings in the fascia of the ileostomy canal are sutured as needed to tighten the area, and an end Brooke ileostomy is created. It is critical to confirm that the mesentery is oriented correctly prior to creation of the ileostomy, and reinsufflation of the abdomen must be performed if there is any doubt.

■ **Fig. 25.8** Final Specimen

25.4 Conclusions

Laparoscopic surgery has improved our management of ulcerative colitis. Results are dependent upon surgical expertise, training, and experience. Nevertheless, most procedures in this country continue to be done via traditional open techniques. The training and number of experienced laparoscopic colorectal surgeons must be increased to meet the challenge of transition to laparoscopic colorectal surgery.

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Surgical Technique and Difficult Situations for Crohn Disease from Adrian Greenstein

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26

26.1 Introduction

Crohn's disease is a nonspecific transmural inflammatory bowel disease that may affect the intestinal tract from the mouth to the anus. The areas of maximum prevalence are Northern Europe and America. It is also characterized by multiple extraintestinal manifestations which may be colon related (mouth, eye, joint, skin, or liver) or small bowel related (urinary stones, fat-soluble vitamin deficiencies) [1]. There are two major forms of presentation of the intestinal form of the disease: "obstructing or stricturing" and "perforating or penetrating." "Inflammatory" is now considered to be a third group or a subtype of the non-perforating group [2, 3].

Stricturing disease generally affects the terminal ileum and is most commonly single. However, multiple strictures may present as jejunoileitis and occasionally also affect the duodenum and large bowel. Perforating or penetrating disease may be subdivided into three forms: acute free perforation with peritonitis, subacute perforation with abscess formation (pelvic, pararectal, paraintestinal, mesenteric, retroperitoneal or psoas, and lumbar), and the more chronic form of fistulizing disease (ileocolic, ileosigmoid, coloduodenal, cologastric, colojejunal, ileorectal, rectovaginal, ileocolovesical, enterocutaneous, and rectovesical in addition to other rare fistulae). This chapter will concentrate on the more complex forms such as ileocolic disease with abscess, various forms of fistulizing disease, and multiple stricturing disease.

26.2 Subacute Perforation: Abscess and Mass

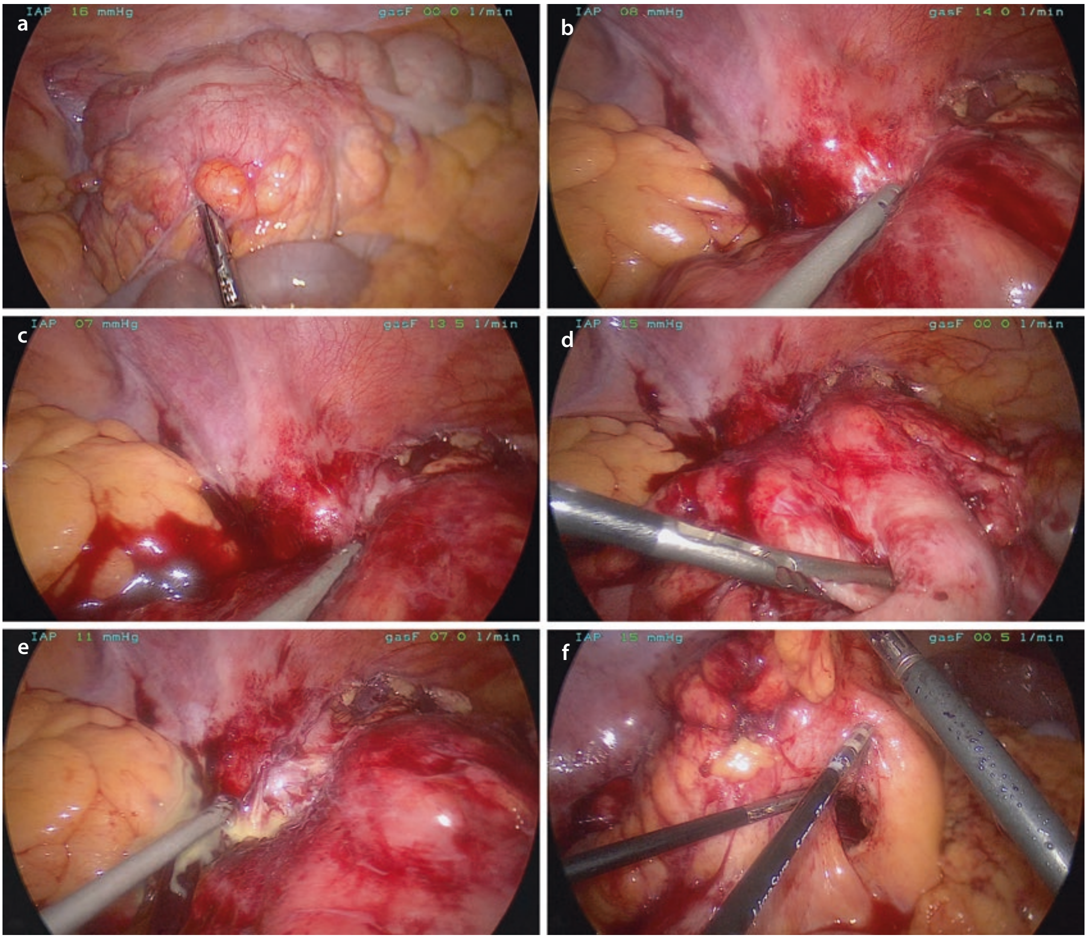
Intraperitoneal, pelvic, or retroperitoneal abscess formation remains a serious complication of perforating disease and may originate from any part of the bowel from the ligament of Treitz to the rectum. The patient presents with localized pain or change in the nature of the pain from central cramping pain to more severe sharp pain localized to the site of the perforation, usually right lower quadrant, but the left lower quadrant or pelvis is not uncommon. Remittent fever with elevated white cell count and "a shift" are the usual confirmatory features, and localization is by CT scan and/or sonography. Percutaneous drainage under radiological control is the standard of care,

■ **Fig. 26.1** 27-year-old male with retroperitoneal Crohn's abscess and preoperative drainage

provided there is a reasonable sized collection and the radiologist does not have to traverse loops of bowel. If percutaneous drainage is not possible, laparotomy or laparoscopy with aspiration of the infected purulent fluid and drainage may be necessary. Eventually the diseased segment from which the abscess originated must be resected. Occasional patients refusing reoperation have survived without recurrence of the abscess for many years, but ultimately the patient will present with obstruction, recurrent abscess, or fistula.

After successful drainage of intra-abdominal or retroperitoneal abscess (■ Fig. 26.1), resection of the perforating segment of bowel may be attempted laparoscopically. These cases usually involve difficult adhesiolysis requiring both blunt and sharp dissection. Conversion or hand-assisted laparoscopy with a smaller incision may be necessary, but we typically begin with a pure laparoscopic approach even in the setting of a large phlegmon. After Hasson entry to the abdomen adjacent to the umbilicus, two to three 5 mm ports are placed in a standard fashion for laparoscopic ileocolic resection. The ultimate goal in these cases is to mobilize the phlegmonous mass in order to exteriorize it through a small midline incision. We generally approach this in a lateral to medial dissection given the very thick mesentery that tends to accompany a Crohn's mass.

After mobilizing the hepatic flexure, we turn our attention to the ileocolic angle. Unfortunately, the area with greatest inflammation often tends to be adjacent to the confluence of the ureter and



■ **Fig. 26.2** **a–f** Blunt dissection technique for ileocolic Crohn's mass: we proceed in a lateral to medial manner, using primarily blunt dissection to mobilize the mass medially and access the underlying abscess. Once the mass is fully mobilized, we turn to mesenteric dissection prior to exteriorization, resection, and anastomosis

iliac vessels. Preoperative ureteral stent placement should be considered prior to any laparoscopic approach. Appropriate use of blunt dissection is paramount to a successful medial mobilization of the mass and avoidance of collateral damage. Our instrument of choice is the suction irrigating device which serves well as a laparoscopic replacement for finger fracture dissection. A LigaSure or ultrasonic scalpel should be available to lyse scar tissue. Eventually, the scar will be penetrated leaving the mesentery of the ileocolic region and allowing the entire mass to be mobilized medially (pls. see ■ Fig. 26.2a–f). Occasionally, a retroperitoneal plane is created, allowing for easier mobilization, but one must be careful to remain very superficial and anterior within this plane. At this point, a decision is made whether to transect the mesentery intracorporeally or extracorporeally. If the mesentery appears to be very bulky and at risk for bleeding after LigaSure transection, we place a wound protector and exteriorize the entire mass. Occasionally, the Crohn's mass is too large to fit through the small midline extraction site. In this case, it is necessary to exteriorize the colonic portion of the mass first and transect at the normal distal margin and then march proximally along the mesentery of the diseased terminal ileum, slowly extracting the mass through the midline wound as its bulk allows. Ultimately, we are left with clear margins on both sides.

In my experience, even in the setting of abscess, we do not find it necessary to create a diverting loop ileostomy for these cases. In order to minimize anastomotic leak rates, we believe in "oversewing" of the anastomotic staple lines. I first lay down a posterior continuous 3-0 silk back

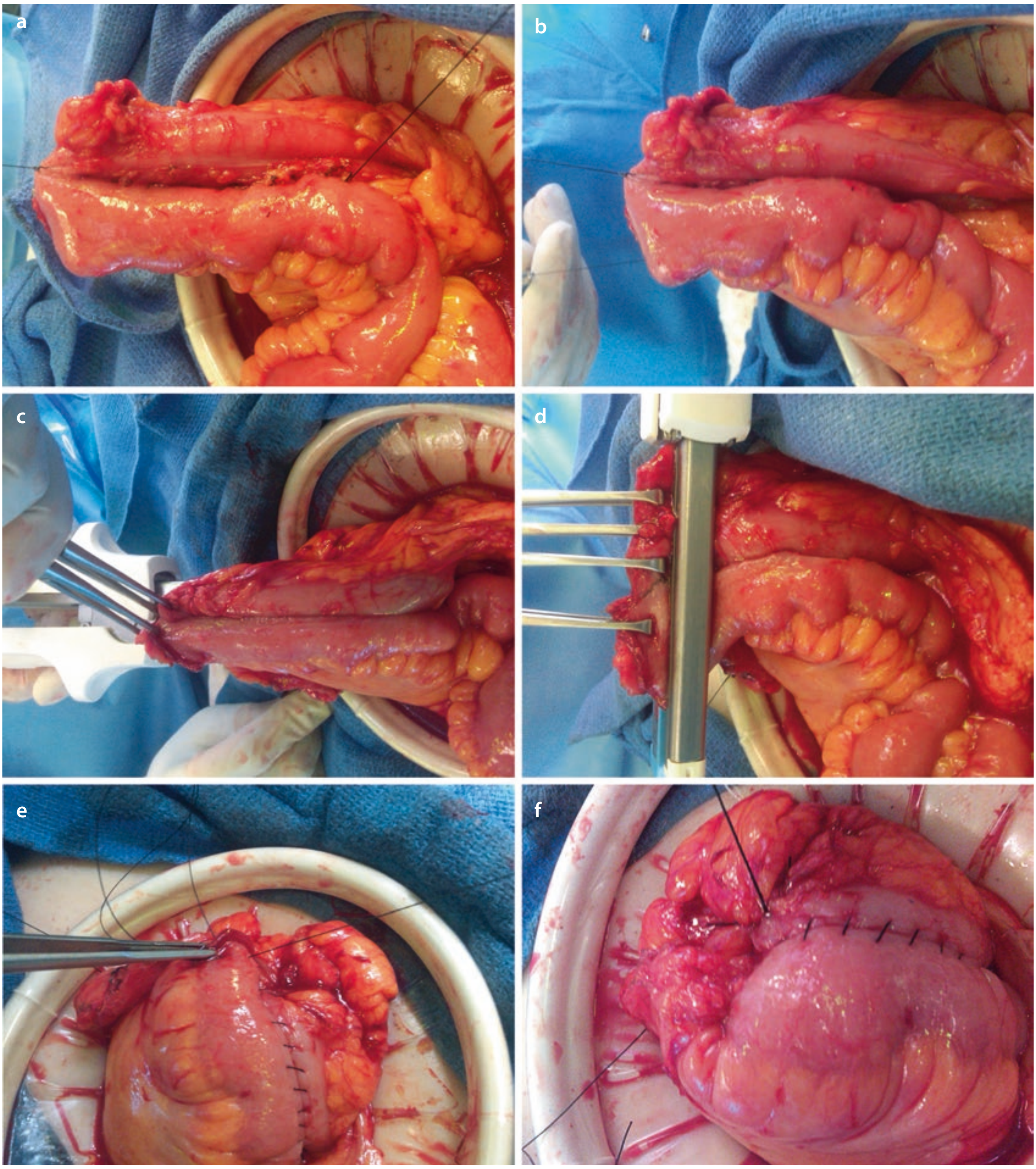


Fig. 26.3 **a**–**f** Oversewing technique for ileocolic anastomosis. After the two limbs are lined up, a back row of 3-0 silk is placed juxtamesenteric **a** and pulled posteriorly **b**. A stapled anastomosis is created **c**, **d**. All staple lines are oversewn with 3-0 silk and buried **e**, **f**

row adjacent to the mesentery. This row of silk sutures is then pulled posteriorly as the GIA stapler is placed to create the common enterotomy. A second GIA load is used to close the enterotomy and then all staple lines are oversewn and covered with running 3-0 silk suture. Although there is no objective evidence that oversewing the staple lines reduces anastomotic leak rates, we have found this technique to be very satisfying and has resulted in very low leak rates for our Crohn's patients (pls. see Fig. 26.3a–f for technique).

After the anastomosis is placed back in the abdomen, a drain may be placed in the right gutter if there is residual abscess or if a large amount of dissection has been performed in that area.

26.3 Duodenal Fistula

Most duodenal fistulae originate in other areas of diseased bowel, usually colon and occasionally small bowel or ileocolonic anastamoses, but there may be intrinsic duodenal Crohn's disease as the source of the fistula. The symptoms of duodenal fistulae include diarrhea and weight loss, but they may be asymptomatic and occasionally can only be recognized upon surgical exploration [4, 5]. Duodenal fistulae or strictures may be complicated by multiple jejunal or jejunoileal strictures or other fistulae. These must all be dealt with simultaneously. On occasion, a duodenal fistula may be complicated by a coloduodenocutaneous component if it follows previous laparotomy. It is important to appreciate that duodenal fistulae may originate in the small bowel or sigmoid colon in proximity to the transverse colonic mesentery, as the fistulae may pass through the mesentery into the duodenum. If the fistula is not recognized and repaired, postoperative intra-abdominal abscess and/or duodenocutaneous fistula may develop.

Surgery for duodenal fistulae may be relatively simple if there is only a pinpoint opening which may be closed in two layers. Generally, however, these fistulae require advanced surgical technique, and because of the proximity of the pancreaticoduodenal vessels, resection is not an option. Although a laparoscopic approach is possible, duodenal fistulae require advanced laparoscopic technique with intracorporeal sewing. Because of the depth of the duodenum and the difficulty of dissection, duodenal fistulae should generally be done as open procedures using lighted Britetrac retractors for adequate exposure. To limit the length of the incision, the flexures can be mobilized laparoscopically if one has a coloduodenal fistula. After appropriate separation from the duodenum and then resection of the diseased colon or small bowel, one can begin to address the duodenum itself. As with duodenal ulcer perforation, it is important when repairing a duodenal fistula that the edges be freshened back to well-vascularized pliable tissues. A limited wedge excision in a transverse direction is sometimes possible without compromising the lumen. Once this has been carried out, we always cover the repair with a jejunal patch, sutured circumferentially with interrupted #3-0 silk. If the lumen is narrowed, then a gastroenterostomy or Roux-en-Y duodenojejunostomy may be required.

26.4 Sigmoid and Rectal Fistulae

Ileosigmoid and Ileorectal fistulae are relatively common, representing 8.9 % of all internal fistulae. If large, they can result in an increase in the frequency and volume of liquid stool. The patient may have an appreciation of two forms of stool: one liquid and of large volume after having passed directly through the fistula; the second, relatively formed, having passed through the entire colon with concentration of the stool in the usual fashion with extraction of most of the liquid. It is not uncommon to find more than one ileosigmoid fistula. Management is dependent on the site of origin which is usually the more proximal terminal ileum, but occasionally the sigmoid. On occasion, there is disease of both the terminal ileum and sigmoid colon [6].

The extent of distal disease must be determined by preoperative colonoscopy. After fistula takedown, if both areas are diseased, the complex mass should be resected "en bloc." If the distal component of the fistula is nondiseased, it may be closed with interrupted #3-0 transmural sutures or in two layers – inner #3-0 Vicryl and outer #3-0 seromuscular silk. Although some surgeons staple between the two loops with a thick load stapler, the closure of the nondiseased side can be somewhat precarious due to friability of the tissues – therefore, oversewing is advisable in these cases.

While simple ileosigmoid fistulae can often be approached laparoscopically, fistulae low in the sigmoid colon or more distal in the region of the rectouterine or rectovesical pouch should generally be approached in an open fashion. The pelvic dissection is usually best done bluntly and needs hand and finger assistance until the small bowel and/or sigmoid has been elevated out of the deep pelvis. Continuing down the rectum to an area below the disease for anastomosis should be done under direct vision, avoiding damage to the bladder in the absence of fistula, autonomic nerves, and iliac vessels and ureters. It is imperative that the rectum be evaluated during the surgery with a rigid or flexible sigmoidoscope as well as through palpation and/or visualization. A potential point for transection of the rectum can be marked by passing a needle through the rectal wall.

After dissecting below the site of disease, one can consider anastomosing distally in the same way as a low anterior resection is routinely done, although this anastomosis in a friable pelvis is typically challenging. The rectum should be transected with a 45 or 60 mm TA stapler, and the anastomosis should be performed with a 28 mm EEA stapler. In Crohn's disease, it is sometime difficult to pass a 33 mm stapler through the rectum as it may be somewhat narrowed at a more distal level. If the anastomosis cannot be done to normal rectum, which has been "spared," a diverting proximal loop ileostomy should be carried out at the end of the case or an abdominoperineal resection and permanent ileostomy may have to be performed. Postoperatively the anastomosis should be reevaluated at 5–8 weeks with a barium enema prior to closure of the diverting ileostomy if one has been done.

Two difficult types of primary sigmoid or rectal fistulae that we have encountered include extraperitoneal and mesenteric fistulae. With an extraperitoneal fistula, it can extend through the pelvic peritoneal floor and enter the rectum below the peritoneal reflexion. It is sometimes difficult to appreciate this type of fistula, especially if there is extreme friability of the tissues and multiple fistulous openings. Mesenteric fistulae can also be virtually impossible to detect preoperatively and remain undetectable intraoperatively. Air passed through the rectum may fail to pass through a serpiginous fistula and cannot be relied upon to rule out a fistula. If one recognizes a diseased sigmoid or rectum with concomitant abscess, one must assume there to be a fistula even it cannot be detected and resect the diseased portion of bowel, with coloproctostomy to normal or relatively normal distal bowel.

26.5 Stricturing Disease

Strictures are a common problem that we encounter among our patients with Crohn's disease. For most short strictures, a Heineke-Mikulicz-type strictureplasty suffices. The stricture is incised longitudinally through the strictured area onto normal adjacent bowel when possible for at least 4–5 cms. The closure should be done in 2 layers: an inner continuous #3-0 Vicryl Connell suture and an outer #3-0 silk seromuscular suture placed either as a continuous or interrupted suture depending on the length of the diseased and adjacent normal bowel and the longitudinal incision. A Finney pyloroplasty should be reserved for long strictures when preservation of bowel is critical; otherwise, long strictures should be resected or

Fig. 26.4 Stricture plasty with invagination of mucose using continous connell suture

treated in selected cases by a Michelassi or Sasaki strictureplasty [7, 8]. Double adjacent strictures can be treated by a Fazio strictureplasty [9].

Of our patients with stricturing disease, the most problematic are those with extensive continuous disease with intermittent strictured areas and/or multiple fistulae (Fig. 26.4). We have seen up to 30 strictures in at least two patients and generally find at least twice as many strictures during the operative period as can be seen radiologically in the preoperative period. Clinical judgment is essential in these complex patients, and strictureplasty is often carried out with concomitant small bowel or ileocolic resection. The duration of surgery is usually very long but the outcome gratifying, despite the high probability of recurrence. The number of strictures and the number of strictureplasties are associated with Crohn's disease recurrence and may be used as prognostic indicators for Crohn's disease [10]. Eventually if satisfactory conservative surgery fails, an intestinal transplant is an option today. We have seen the development of Crohn's disease in the transplanted bowel although this is rare.

26.6 Conclusion

Complex Crohn's disease may occur with any of the three groups, perforating, non-perforating, and inflammatory, but fistulizing disease tends to create the most difficult surgical problems. Despite major advances in the medical therapy of this disease, most patients require surgical treatment at some time which has become more favorable given the advantages conferred by laparoscopic surgery. With careful monitoring and appropriate treatment, patients with Crohn's disease can expect to live a relatively normal life with good control of their symptoms.

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Surgical Technique and Difficult Situations from Karl-Heinz Vestweber

Karl-Heinz Vestweber

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27

27.1 Crohn's Disease

Surgical interventions especially for chronic inflammatory bowel disease were recognised at the end of the nineteenth century. The name Crohn's disease was created after B. B. Crohn has described the regional ileitis in 1932.

LESNIOWSKI from Poland describes already 1904 changes of the bowel wall corresponding to "Crohn's lesions". In 1913 the Scottish surgeon Dalziel operates on stenosis of the ileum which he describes as inflamed and stiff like "an eel in rigour mortis", obviously "ileitis terminalis Crohn".

Without doubt Crohn's disease is a domain of conservative treatment, and the indications for surgical interventions are either complications such as fistulas, abscesses, ileus or perforations or sometimes symptomatic resistable inflammations, which cannot be successfully treated by adequate medications.

It is remarkable that even after the introduction of highly effective drugs such as the anti-TNF-alpha drugs (infliximab), the number of surgical procedures has not changed substantially [1].

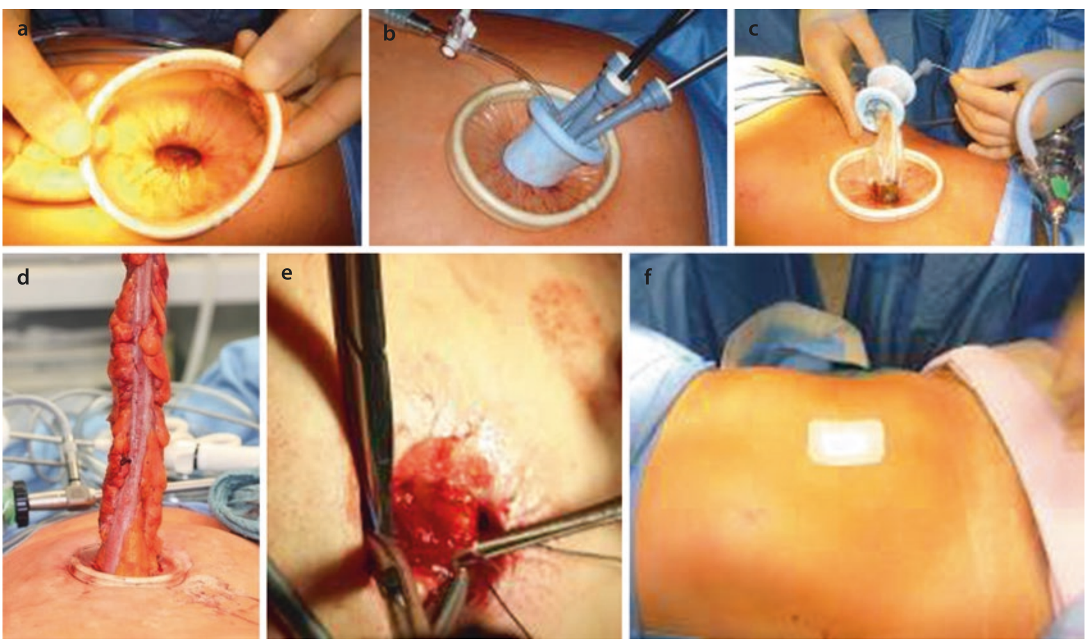
According to the surgical incisions, I do not think that paramedian or pararectal accesses are appropriate approaches for Crohn's disease patients. Especially young patients often need several operations during their lives – possibly in different abdominal quadrants, which results sometimes in a further different incision. Sometimes an ostomy is necessary and the previous scares interfere with the position of the intended ostomy site.

Since the mid-1990s, laparoscopic approaches became available routinely.

Additionally to the trocar incisions, usually a separate incision becomes necessary to take out the specimen from the abdomen. To find the best location for this is also crucial (f.i., Pfannenstiel incision).

Recently natural orifice transluminal endoscopic surgery (NOTES) and single-incision laparoscopic surgery (SILS) became available and proved to be very helpful especially for inflammatory bowel diseases.

Single-port incisions take place directly at the umbilicus or a later stoma location. It is possible to plug in all three working ports and at the end to take out the specimen after removing the SILS port ([2], ◘ Fig. 27.1a–f).

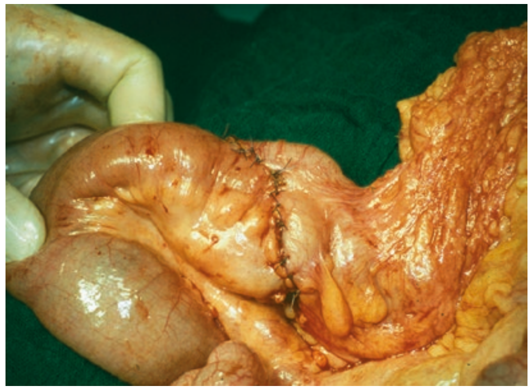


◘ **Fig. 27.1** Single-port operation through the umbilicus. **a** Umbilical incision with the wound protector (Alexis) in position. **b** Introduction of the flexible SILS port with trocars. **c** Extrusion of the SILS port together with the closed end of the bowel. **d** The large bowel exteriorized through the umbilical incision. **e** Closure of the umbilical wound. **f** Remaining a little incision with a small plaster

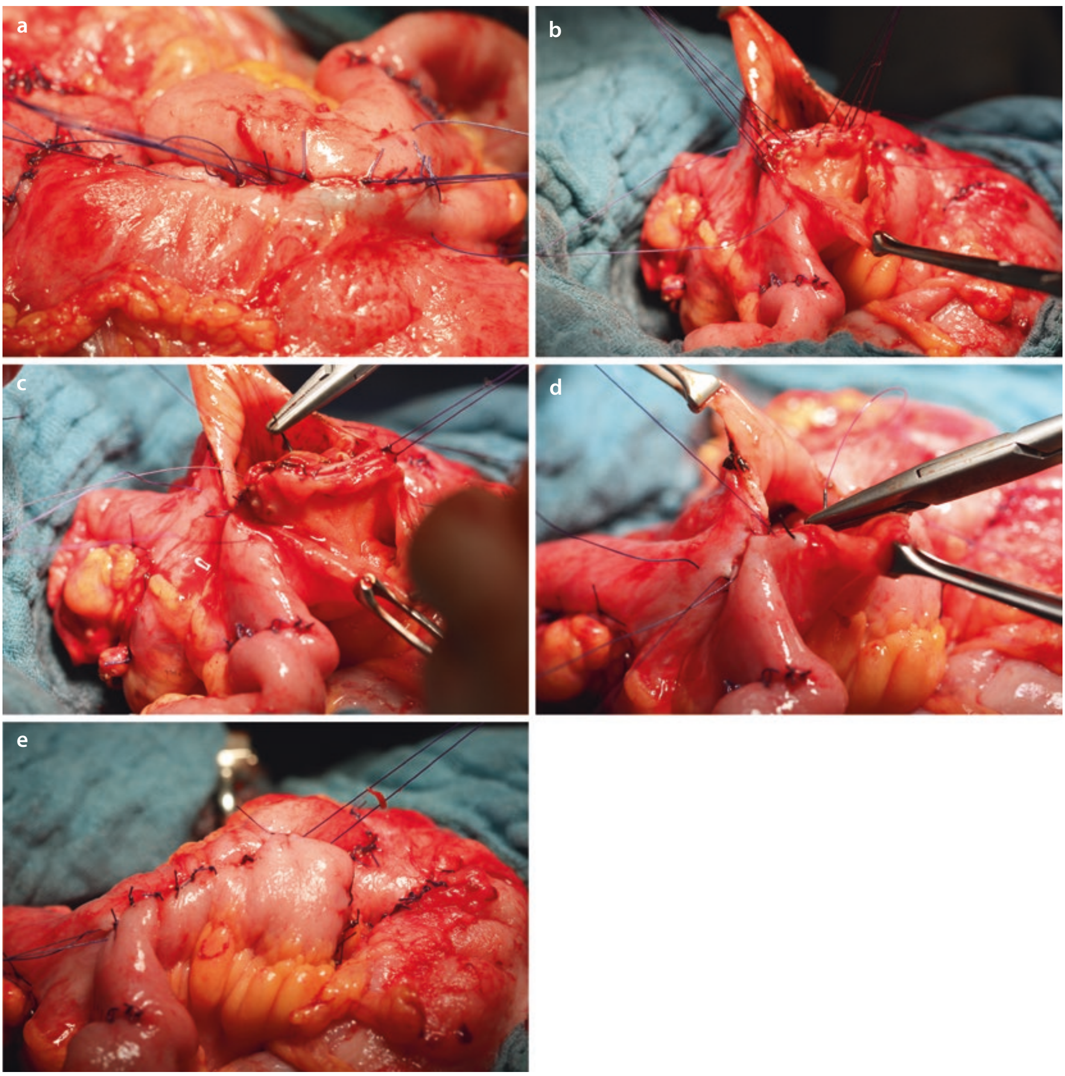
27.1.1 Technical Aspects of the Intestinal Anastomosis

For decades, we used an end-to-end anastomosis after ileocoecal resection. The lumen of the bowel endings was equalised by using an oblique to straight technique from the small bowel to the large bowel (◘ Fig. 27.2).

Some new data show that at least the old side-to-side anastomosis is suitable again. Nowadays we use the side-to-side construction in most cases ([3, 4], ◘ Figs. 27.3 and 27.4).



◘ **Fig. 27.2** End-to-end anastomosis after ileocoecal resection. The lumen is brought into line by oblique cut in the small bowel and a right angle cut in the large bowel



◘ **Fig. 27.3** **a** Side-to-side anastomosis. First row single sutures with closed bowel lumen. **b** Bowel lumen opened after finishing the back wall of the anastomosis. **c** Second back wall row – continuous monofilament suture. **d** Continuous Connell suture of the anterior wall. **e** Additional sutures (single stitch) finishing the anastomosis

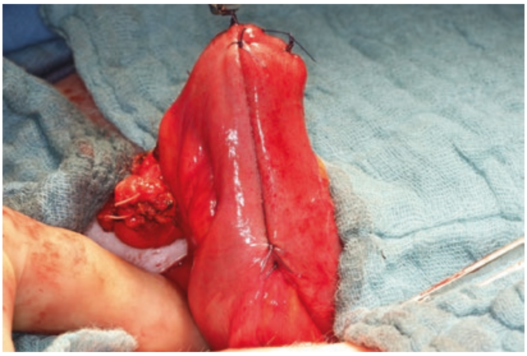


Fig. 27.4 Side-to-side anastomosis using a GIA stapler

27.1.2 Suturing Technique of the Anastomosis

In the 1970s, we constructed the intestinal anastomosis by using the classical seromuscular single stitch method with extramucosal sutures. Prof. Goligher suggested to use a double-row variation in the 1980s, which was accepted by my chief Prof. Troidl.

- Both ends of the bowel (usually closed by staples or clamps) are brought together.
- First row with single stitches of absorbable sutures.
- After opening of the bowel lumen on both sides, an absorbable running suture finishes the posterior wall.
- The anterior wall is closed by an inverting running "Connell suture".
- Outside-inside/inside-outside.
- Contralateral: outside-inside/inside-outside
- After slightly dragging the usually monofilament running suture, the bowel wall inverts. Care must be taken not to take too much tissue as there is the certain risk of stricture formation. The stitches are therefore best performed, close to the cutting line.
- A second row of interrupted sutures completes the continuous suture. It is important to make sure that only little additional tissue is inverted – again to be sure not to create stenosis. Technically best is to keep the anastomosis with the left hand on the thumb-index finger and then put in the individual stitches. Some of my colleagues put the second row of sutures also continuously using monofilament material – that makes obviously no difference.
- Of course the side-to-side anastomosis can be performed in stapling technology (GIA suturing device).

I personally oversew the staple line of the anastomosis with some fine single sutures, especially in the tip of the anastomosis (at the end of the stapling device). Leaks of the anastomosis were localised most often at this site and occasionally also at the closing site of the introduction holes for the stapler branches. My personal preference is the closure of this suture device insertion openings also by double-row technique (Connell suture and fine interrupted stitches additionally).

Small bowel anastomoses can also be performed using the side-to-side or end-to-end technique. For side-to-side anastomosis, we make sure that no big "CECA" arise.

27.1.3 Intestinal Stenosis: Strictureplasties

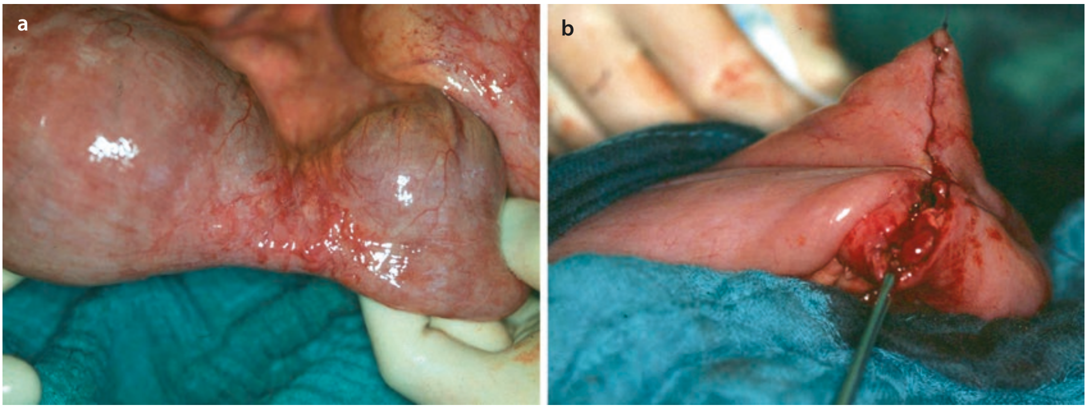
Whenever a resection can be avoided, it should be avoided. It is the aim to preserve as much bowel as achievable. One possibility is strictureplasties, which correct scarred stenosis by plastic methods without resecting bowel.

At the beginning of the 1980s, strictureplasties were introduced in the surgery of Crohn's disease by the surgical research group of Sir John Alexander Williams in Birmingham [5].

The original technique of the Heineke-Mikulicz pyloroplasty was used in stomach ulcer surgery to correct strictures in the pyloroduodenal area.

This technique is particular suitable for short segment stenosis. In this case, just like pyloroplasty, the bowel is opened between two stay sutures (one on each side of the stricture). The incision is longitudinal with an adequate length. Then the longitudinal incision is pulled apart into a transverse direction. The result is the desired widening of the stenosis. A double-row suture is then carried across accordingly (Fig. 27.5).

For long strictures, which should not be resected (f.i., already short bowel), another



◘ **Fig. 27.5** **a** A short stricture in the small bowel wall because of long-lasting Crohn's disease. **b** Strictureplasty suture (Heineke-Mikulicz technique), first row continuous Connell suture

◘ **Fig. 27.6** More than ten strictureplasties with various techniques to treat many stenoses in a patient with relatively short bowel (around 2 m)

◘ **Fig. 27.7** Heineke-Mikulicz strictureplasty more than 2 years after the primary construction. No restenosis happened. The "thumb-index finger test" is easily possible

technique originating from stomach surgery can be used. The Finney pyloroplasty allows a wide side-to-side anastomoses [6].

In very difficult cases with extraordinary long strictures, a very long side-to-side anastomosis can be used, especially in those cases which would result in short bowel syndromes after loosing bowel length further [7].

Recent data show new different constructions of strictureplasties. The aim is always to preserve bowel length as much as possible [8].

If the bowel is already critically short, we do not hesitate to use many strictureplasties in a single case instead of resection (◘ Fig. 27.6).

Our own data represent 57 patients with 130 strictureplasties. Main indications for the procedures were subileus because of enteric stenosis and fistulation and sometimes even conglomerate masses.

Relatively rare are restenoses at the former site of strictureplasty [9]. ◘ Figure 27.7 shows an old strictureplasty at a reoperation more than 2 years after primary surgery.

During surgery for Crohn's disease, it makes sense to explore the small intestine for stenosis and measure the length of small bowel to retain it in the operating report. Also during laparoscopic surgery, the intestine can be checked for lesions with atraumatic endoscopic instruments. Preoperatively, we ask for a hydro-MRI to check especially the small bowel; this of course can be done without radiation and gives helpful hints on pathologic findings.

27

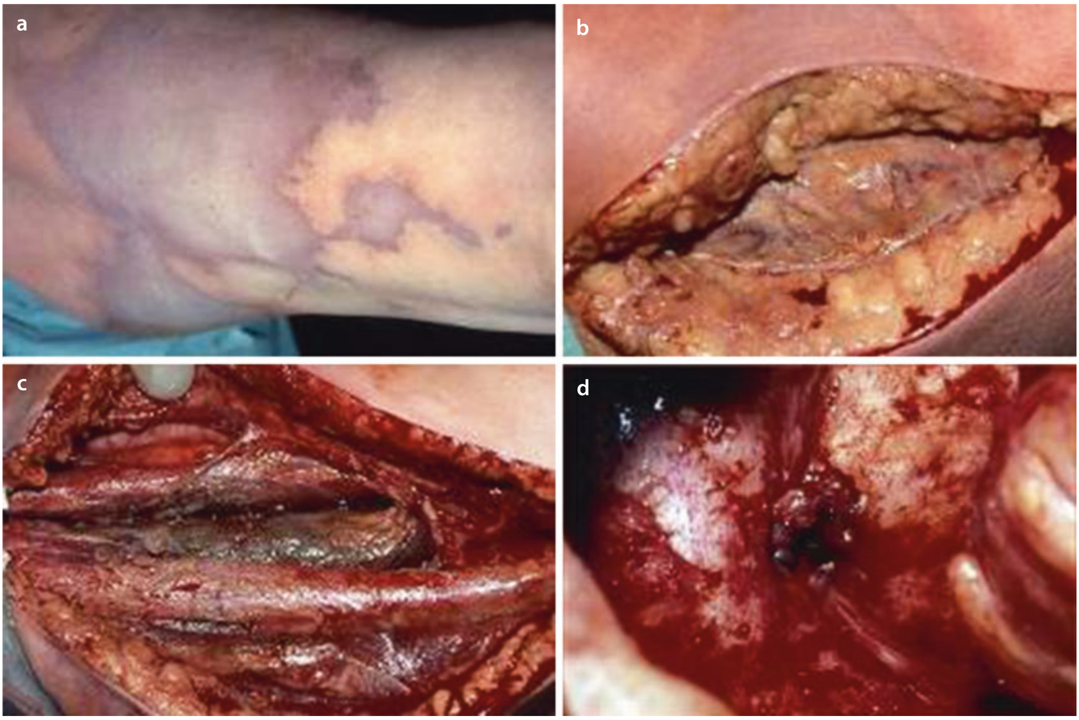


Fig. 27.8 **a** A young female patient with Crohn's disease coming into the emergency department with septic shock. The inner side of the thigh showing a sharply marked blue-violet demarcation at the skin level. **b** After incision ischemic tissue could be seen. **c** Exploration into deep spaces shows signs of necrotizing fasciitis and myositis. **d** The reason for this infection: a fistula from Crohn's involved large bowel to the retroperitoneum. The infection descended through the pelvic structures into the thigh. The inner fistula in the pelvic wall can be seen at the picture

27.1.4 Abdominal Fistulae

Fistulae are commonly associated with Crohn's disease. They can penetrate into different structures. In enterocutaneous tracts, bowel content reaches the skin, enteroenteric channels lead to short circuits, and enterovesical and retroperitoneal can cause severe infectious complications. In my opinion, all those types of fistulae have to be treated immediately or at least after a short period of conservative approaches – surgically.

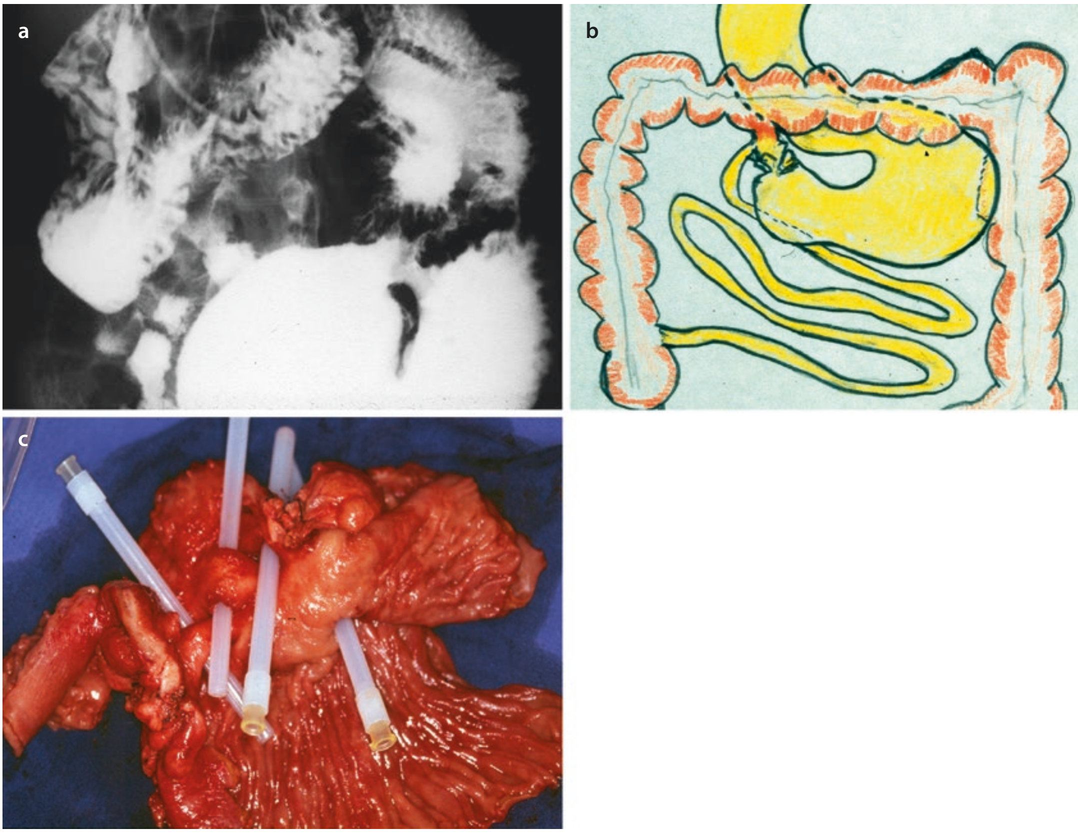
In particular, I have experienced dangerous entero-retroperitoneal fistulae which spread into the retroperitoneal space and cause very severe descending infections into the pelvis and the thigh with septic shock (Fig. 27.8a–d).

Enterocutaneous fistulae can interfere with the quality of life of the patients massively, so they should be treated to resolve the very distressing symptoms. Sometimes they can be corrected quite easily during operations, f.i., if one fistula from the small bowel loop to the skin exists. After

Fig. 27.9 Enterocutaneous fistulae in the suprapubic abdomen. The fistulation comes from a singular small bowel fistula

correcting the defect, the quite unpleasant symptoms resolve quickly (Fig. 27.9).

If enteroenteric fistulae, for example, from the upper jejunum to the large bowel exist, this can cause massive malnutrition. Long-lasting conservative attempts are useless; a careful preoperative nutritional therapy is necessary; most often parenteral nutrition is required [10].



■ **Fig. 27.10** **a** A barium contrast follow through shows an early passage from the upper jejunum into the transverse colon. The patient suffered from severe malnutrition. **b** Schematic sketch of the intraoperatively found situation. Behind the fistula from the jejunum to large bowel, quite long healthy small bowel is present. **c** The operative specimen shows the short resected parts of small and large bowel, fistulae are marked

An example of an enteroenteric fistula with short circuit from the upper jejunum to the transverse colon is shown in ■ Fig. 27.10a–c. The orally given contrast agent shows in the upper jejunum a direct access to the transverse colon.

The operation demonstrates a complex system of several fistulae before and within a jejunal stenosis draining directly into the colon. The small bowel below the stenosis was sufficiently long and was without further lesions. After resection of a short segment of the jejunum and colon including the fistula tracts, the patient recovered quickly with major improvement in nutritional status and quality of life.

Personal Conclusion for Surgical Treatment of Crohn's Patients

As long as possible, a conservative approach for Crohn's disease is justified. Early interdisciplinary consultations between gastroenterologists and visceral surgeons are important. Special office hours for those patients are required. Experienced consultants are necessary for best treatment of those patients with often difficult courses of the diseases.

If bowel stenosis occurs or conservative treatment is not successful or has too many side effects, surgery has to be considered. Resections are carried out with preserving as much as bowel as possible. In the moment, side-to-side anastomosis is preferred for restoration of continuity; we use a two-layer anastomotic technique.

Strictureplasties in many technical variations and correction of enteric fistulae should be used freely according to necessity.

Ulcerative Colitis

Ulcerative colitis is a disease with particularly bloody diarrhoea. This disease has been recognised very early in history. However, surgical approaches started around the 1930s. Nissen and Wagensteen tried to construct ileoanal anastomoses.

In the second half of the 1940s, it was mainly who tried to cure ulcerative colitis by colectomy and transanal mucosectomy [11].

Another essential step in the supply of colectomized patients was reached in the 1950s by the construction of a prominent ileostomy by Brooke [12]. This made a major step forward in stoma care. Aylett at the same time treated a series of patients successfully by ileorectostomy [13].

The continent ileostomy with a pouch system was introduced by Kock in the end of the 1960s [14]. The emptying of the pouch has to be done by catheterisation with an intestinal tube.

Parks and Nicholls have introduced the ileoanal pouch surgery into clinical practice since 1978 [15]. The relatively simple and well-functioning J-pouch was described by Utsunomiya in 1980 [16]. The J-pouch is currently the most widely used reconstruction worldwide.

Anal Canal-Sustaining Colectomy

The colectomy with preservation of the anal canal can be performed in one or more steps.

In patients with poor general condition or massive immunosuppression or as an emergency operation, a three-stage procedure might be preferred.

First the subtotal colectomy is performed. The rectal stump should be left relatively long in order not to be confronted with scars and problems resulting from previous pelvic dissection. We usually perform the resection at the sigma-rectum junction without going further into pelvic dissection. The staple line of the rectal stump is usually additionally oversewn by single absorbable sutures. In very few cases, we create a mucus fistula with the remaining stump in the left lower abdominal quadrant. The remaining rectal stump can be treated quite well by transanally applicated local preparations. After recovery of the patient, the ileoanal pouch reconstruction will be performed with a covering loop ileostomy; this can usually be closed after 6–12 weeks.

The two-stage operation corresponds with a classical approach. It is the routine procedure for elective operations. The colectomy is made, the pouch ileoanal reconstruction is performed, and a protective loop ileostomy is created in the right lower abdominal quadrant. After recovery and definite healing of the anal anastomosis, the reversal of the stoma follows.

Even a single-stage procedure is possible and supported by scientific evidence [17]. We use this approach with the "ideal patient". The colectomy should be performed without problems, the anal conditions are ideal and in particular the ideal pouch can be sewn without tension into the anal canal. Additionally, the patient should not be on immunosuppressive drugs. In such patients, we use a thick bladder catheter, which is introduced into the pouch and fixed to the buttocks for a few days. Pouch evacuations are easily possible and without stress for the patient.

The Pouch Design

Many design options for the ileum pouch have been described, and even now, new variants are still presented.

We prefer a variation of the J-pouch with 15 cm length of the edges. The GIA stapler is introduced from the oral aspect. The peak of the J will not be touched; a little tissue bridge remains usually. Maybe because of undisturbed blood supply at the region of the anastomosis, there have been few complications with the construction. Additionally there are no crossing staple lines at the level of the anastomosis. Usually this little bridge makes no problems, but if so it can be cut quite easily from transanally by using a stapling device.

The anastomosis of the pouch can be done in double stapling technique; some advantages have been described. Special attention is necessary not to leave a too long rectal stamp with diseased colitis mucosa. We prefer especially in patients with dysplasia in the rectum the transanal mucosectomy of 2 cm length. The pouch is fixed by stay sutures in the mucosectomized muscle cuff and the anastomosis created by single stitches using the exposure by a Lone Star retractor.

Colectomy and Definite Ileostomy

One option after total colectomy is the creation of definite ileostomy. The reason for this decision is often faecal incontinence preoperatively which usually worsens after pouch reconstruction. Other reasons are previous anal fistula and abscesses; sometimes it is a personal decision of the patient after having contacted other patients with ileostomy or pouch reconstruction. Usually

◘ **Fig. 27.11** A "classical" ileostomy position in the right lower abdominal quadrant. Because of problems with stoma care, a transposition into the very low left abdominal quadrant was necessary

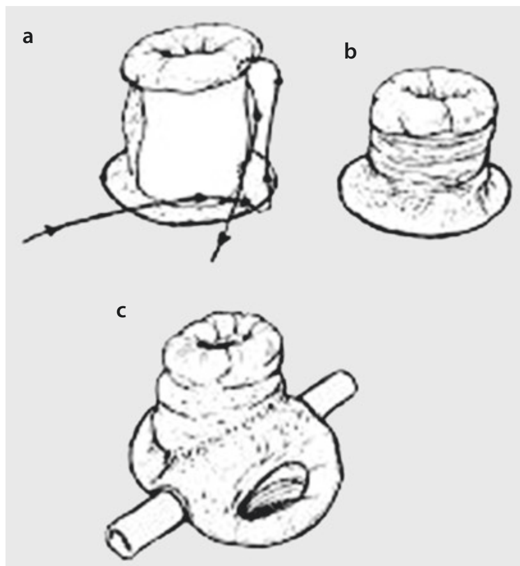
the ileostomy is positioned in the right lower abdominal quadrant. Meticulous planning of the ostomy position is essential. Sometime probatory wearing of the ostomy appliance is very helpful. Most often the position of the ileostomy is on a line between the spina iliaca anterior superior and umbilicus at the medial third of this connecting line, but sometimes this area is not suitable.

◘ Figure 27.11 shows the preparation phase before changing a stoma which was created in an unfavourable position. The ileostomy has to be repositioned in the left lower abdominal quadrant, because the recent stoma cannot be handled. The right-sided position is created just at the usual place in the right lower quadrant. If the patient is in a supine position, like the usual positioning during surgery, the ostomy site seems to be suitable. If the patient sits, a major wrinkle interferes with the appliances. The new position at the left side may be high up in the upper quadrant or low as marked with the cross (◘ Fig. 27.12).

The ileostomy should be everted. The top of the stoma is best 2–3 cm above skin level. The stitch technique is advisable in a 3-point manner. The stitch starts at the skin level from inside to outside and then catches the edge of the bowel, and the third point fixes the bowel wall at the best area to fix the intended eversion height. All nodules after tying are inside. The appliances can easily be positioned and there is no wick effect by the suturing materials.

◘ Figure 27.13a–c shows this technique of creating an end and loop ileostomy.

◘ **Fig. 27.12** Position of the ileostomy, when the patient is sitting. The ileostomy is covered by a deep wrinkle. The marked position in the very low left abdominal quadrant is possible; alternatively a high up position in the right upper quadrant is also acceptable



◘ **Fig. 27.13** Sketch of an end and loop ileostomy. **a** The fixating stitch has three points. It comes intracutaneously from the inner to outer side, next the edge of the bowel wall and then the seromuscular bowel wall to fix the eversion. **b** The terminal ileostomy finished, all knots are inside and cannot be seen. **c** Loop ileostoma with underlying plastic tube

Pouch Redo Surgery

"Redo" operations after ileum pouch reconstructions are complex and difficult procedure; the surgical morbidity is high.

The main long-term problems after pouch reconstructions are strictures at the pouch-anal anastomosis or in the anal canal. Usually this ste-

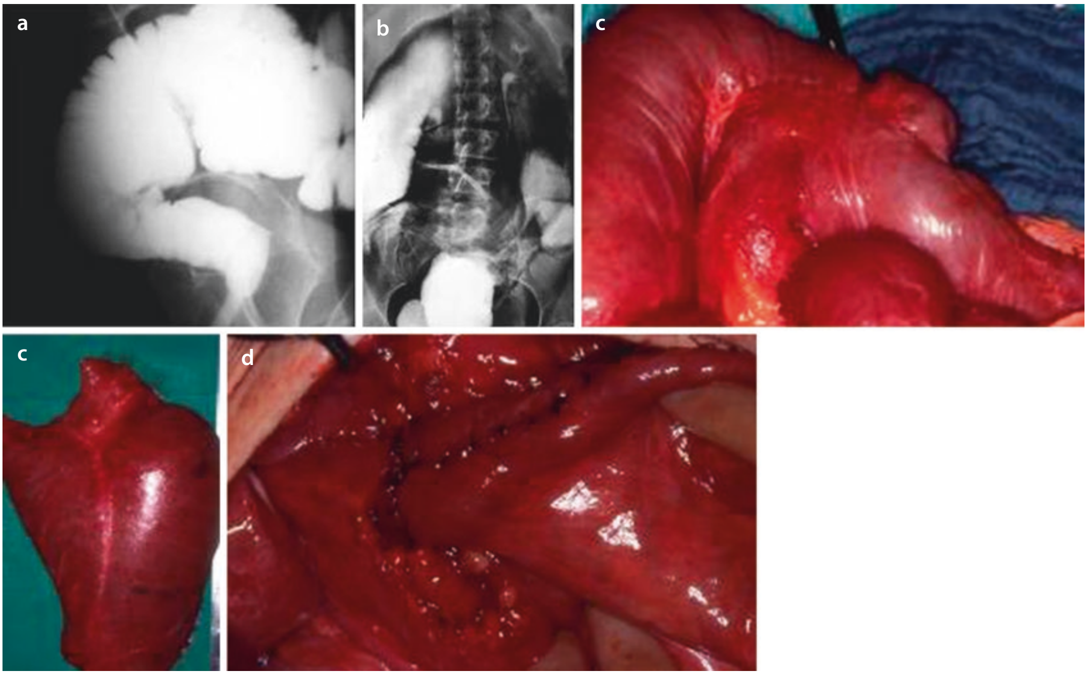


Fig. 27.14 **a** A contrast enema years after colectomy and J-pouch reconstruction. A dilated large pouch can be seen without pouch outlet obstruction. **b** Massive dilatation in the small bowel above the pouch. **c** Intraoperative findings: A huge "mega-pouch" and massively dilated small bowel. **d** Resected specimen of the J-pouch; major reduction in size. **e** Situation at the end of operation: Reduced pouch in the pelvis and operatively reduced small bowel slings

nosis can be dilated easily; often several dilatations are required before an acceptable diameter can be achieved. In some cases, it can make sense to instruct the patients for self-dilatations – best with one finger. Often this has an acceptable effect.

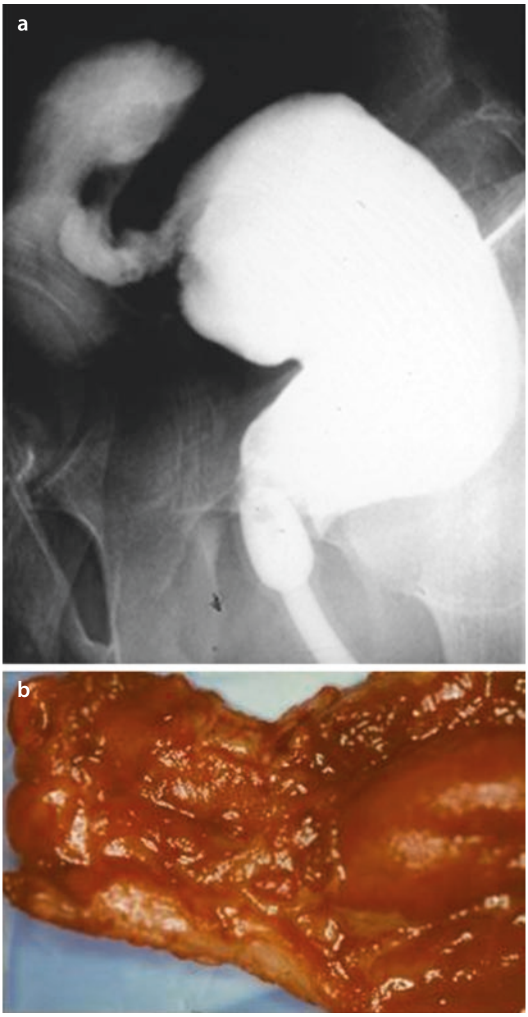
Perioperative abscesses often result in persisting fistulae or new fistulae without abscesses sometimes occur. Those fistulae can be treated following the rules of classic fistula surgery. Revision of the fistulae tract and closing with fistula plugs or advancement flap techniques are sometimes suitable. One major procedure for that is a partial or complete pouch advancement, sometimes a transanal procedure is possible, and in few cases, an abdominal operation is necessary. Complex pouch redo procedures are reported especially from Mayo and Cleveland Clinic [18– 20].

An example for one of the pouch reoperations is shown in Fig. 27.14a–d. Several years after restorative colectomy for ulcerative colitis, the young female patient complained of bowel motility disturbances and incomplete and fragmented pouch evacuations. With time the complaints increased with major abdominal distensions, but no complete obstruction happened. Further diagnostic (contrast medium enema) shows a mega-pouch and massive dilated small bowel above the J-pouch. There was no stenosis of the intestine especially not at the pouch outlet and no pouchitis was present. The impaired bowel function influenced the life of the patient significantly; therefore, an operative intervention to reduce pouch size was planned.

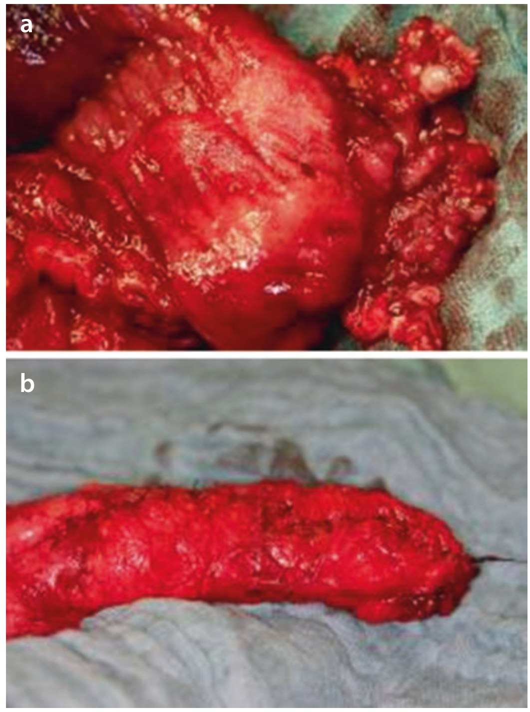
Figure 27.14c shows the intra-abdominal situation after laparotomy. A massive dilated J-pouch extends to the middle and upper abdomen full of gas, and further small bowel loops dilated above the pouch. No stenosis could be found, no pouchitis.

We decided to reduce the size of the pouch to an average volume and also to reduce the diameter of the small bowel loops.

Figure 27.14d shows the resected part of the pouch; of course the dissection of the mesentery has to be meticulous and near the bowel wall to avoid interference with the blood supply of the aboral part of the pouch left in the deep pelvis.



◘ **Fig. 27.15** **a** The contrast enema shows a stenosis at the upper end of the pouch. The patient initially was diagnosed with ulcerative colitis. After colectomy histologic examination of the removed colon revealed Crohn's disease. **b** The resected upper pouch shows involvement by Crohn's with the stenosis



◘ **Fig. 27.16** **a** Specimen of a long rectal stump after colectomy and J-pouch. A villous adenoma with dysplasia could be found. **b** The former pouch was renewed after resection of the diseased residual rectum and a new handsewn anastomosis with the anal canal was performed

◘ Figure 27.14e shows the situation at the end of the reconstruction with the new anastomosis to the residual part of the pouch in the pelvis and the diameter reduction of the small bowel. The patient recovered from the operation with a significantly improved functional situation lasting for years.

◘ Figure 27.15a shows the contrast enema study of a young man around 10 years after colectomy and J-pouch reconstruction because of ulcerative colitis. Meanwhile the diagnosis had to be changed to Crohn's disease. The pouch function was acceptable for years but then obstructive symptoms occurred. A major stenosis at the oral end of the pouch could be found.

The stenosis at the entrance of the pouch was resected. Again special attention had to be directed to the blood supply of the remaining pouch.

◘ Figure 27.15b shows the resected specimen with stenosis due to Crohn's disease.

One further patient presented with transanal bleeding after colectomy and J-pouch reconstruction using the double stapling technique. Dysplasia was present at the previous operation. The examination of the anal and pouch region showed villous growth in a remaining rectal stump of about 5 cm length. Biopsies revealed cellular dysplasia in villous adenomas. During reoperation, the pouch was dissected out of the pelvis; a transanal complete mucosectomy was performed. After resection of the long rectum stump, a new pouch-anal canal handsewn anastomosis was created.

◘ Figure 27.16a shows the specimen with the villous area.

Figure 27.16b shows the reconstructed pouch which was anastomosed to the anal canal. There were no complications after surgery.

Reoperations after major problems with ileo-anal pouches are worthwhile. The Mayo Clinic results show after around 10 years of follow-up that 80 % of the revised pouches are still in function. Even for Crohn's disease, the pouch function rate is 60 % [21].

27.2 Cancer and Ulcerative Colitis#

After long-lasting ulcerative colitis disease, the risk of developing colonic cancer increases. Epithelial cell dysplasia is very often the precursor of cancer. We recommend colectomy after diagnosis of dysplasia has been confirmed by too independent pathologists. It seems to be difficult to differentiate between low-, middle- and high-grade dysplasia. Small cancers often cannot be recognised during conventional colonoscopy. If staining and microscopic endoscopy helps should be evaluated in the future.

Our own patients show a high rate of malignancy during elective colectomy because of ulcerative colitis. 62 of 311 colectomy patients had to be diagnosed with already cancer. This rate of around 20 % is high compared to international data [22].

27.3 Conclusions

After total colectomy, we usually use a J-pouch ileoanal anastomosis for reconstruction. In the majority of cases, a loop ileostoma is created for temporary diversion. In special very favourite cases, we use a single-stage procedure; in emergency situation, a three-stage procedure is preferred. Recently the colectomies can be performed minimally invasive by laparoscopy, even in a single-port technique [2].

Considering dysplasia or colitis-associated adenomas with dysplasia (Dalm), we recommend prompt surgery.

Complications after pouch surgery like fistulae and stenosis can very often be treated successfully by reoperation. If unexpected Crohn's disease is diagnosed after colectomy and Crohn's disease-specific complications arise, revisions with the aim of preserving the pouch are worthwhile.

For anastomosing the J-pouch, we use double stapling techniques or the classical transanal mucosectomy especially in patients with multilocular dysplasia. The pouch is fixed first in the muscular cuff by sutures then the handsewn anastomosis with the anal mucosa can be performed.

27.4 Abdominal Drains After Operations Because of Crohn's Disease of Ulcerative Colitis

Usually abdominal drainage is avoided after finishing procedures for Crohn's or ulcerative colitis. It makes no difference if an anastomosis or only a stoma is created. After careful haemostasis a drain as indicator of bleeding can be avoided.

Drains are used when there is something to drain.

Especially in Crohn's patients, abscesses are common. Usually they are intended to drain preoperatively by percutaneous drains.

If intraoperatively an abscess cavity remains soft, drains are put in and those stay as long as necessary and as short as possible.

27.5 Difficult Situations

Case 1

Grade II: An Underestimated Local Situation

A 44-year-old patient after ileocoecal resection in 1994, because of classical stricturing terminal ileocolitis Crohn, had a reresection 13 years later.

In 2012 a new episode of symptomatic stenosis occurs. Abdominal pain especially after eating and a deterioration in general health conditions occurred. The diagnostic check showed a conglomeration of bowel in the lower and middle left abdominal quadrant; additionally there was a suspicion of intestinal fistulation which was proved by hydro-MRI (■ Fig. 27.17).

Several attempts of conservative treatment were not successful. Despite the two previous operations, a new surgical procedure has to be done. The median scar after the previous laparotomies was used as entry to the abdomen.

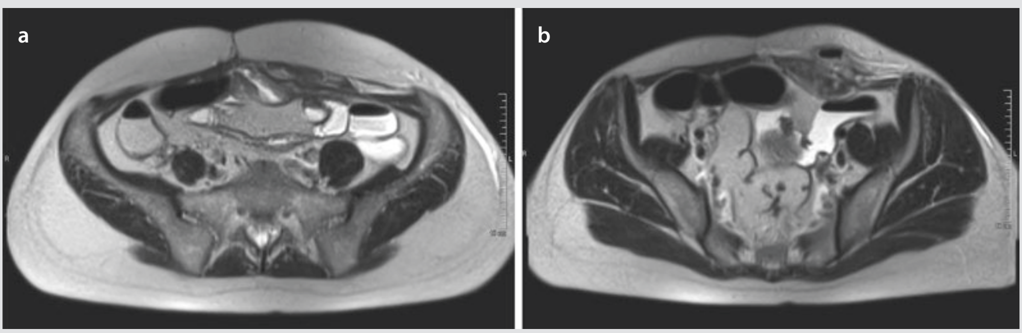
As expected there were massive dense adhesions and the conglomeration of small and large bowel with pus in between the bowel slings. After further exploration a large fistula became apparent this fistula originates from the prestenotic parts of the anastomosis.

The problem: While dissecting the bowel out, a penetration into the retroperitoneum with dense connective scarring tissue includes the left ureter. It was extraordinarily difficult and time consuming to free the ureter from the surrounding tissue.

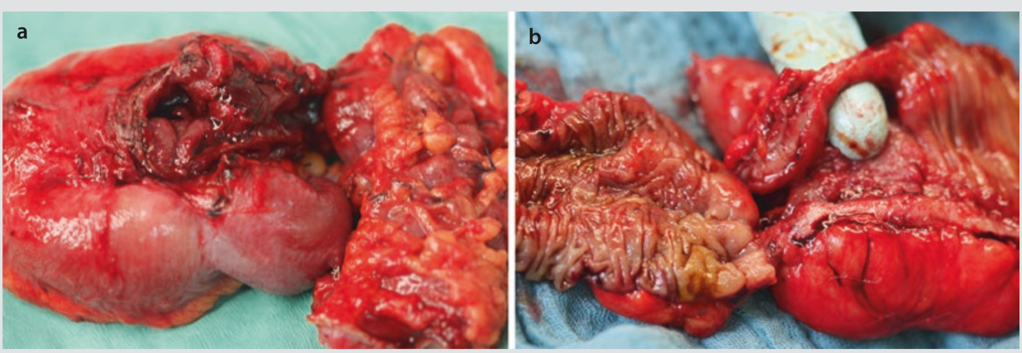
Solution: At the end the ureter had no lesion and the short parts of the bowel including the fistula and abscess could be resected (■ Fig. 27.18a, b). A prolonged antibiotic treatment was continued according to the microbiology report.

Analysis: The greatest difficulty during this operation was to dissect out the ureter. A preoperative ureter probe transvesically would have been of major advantage.

Result: The postoperative course was uneventful; immunosuppressive therapy with azathioprine was initiated.



■ **Fig. 27.17** **a, b** Hydro-MRI of a patient with several recurrences of Crohn's disease showing a conglomeration of bowel and enteric fistulae



■ **Fig. 27.18** **a** Specimen of large and small bowel with connective tissue infection in Crohn's disease. **b** After further preparation a narrow stenosis and a large fistula could be verified

Case 2

Grade III: Patient with Difficult Therapy

The patient had a long-lasting history of Crohn's disease. He had several previous operations followed by multiple complications, which includes an "open abdomen". There was a suspicion of short bowel syndrome. An anastomosis had been constructed between small bowel and left-sided colon. The "open abdomen" has been covered by skin only, resulting in a very fragile abdominal wall. Now a relevant disturbance of bowel passage happened and hydro-MRI showed two relevant stenoses in the left large bowel – one of those at the anastomosis of small and large bowel (■ Fig. 27.19). The patient additionally suffered from chronic renal failure.

Problem: Is the only reasonable approach a surgical procedure?

How massive and invasive would the operative procedure be?

Solution: Because of impossibility of endoscopic dilatation of the strictures and increasing symptoms, the decision for surgical intervention was made.

Intraoperatively there were complete adhesions of all bowel loops and bowel with the abdominal wall structures. A long-lasting complex adhesiolysis was necessary. After completely freeing the small bowel, the first stenosis could be realised at the anastomosis from small to large bowel; the other stenosis could not be found initially. A colonoscopy revealed a short but extremely narrow stricture in the sigmoid. Because of the already short large bowel, a bowel-sparing procedure was performed.

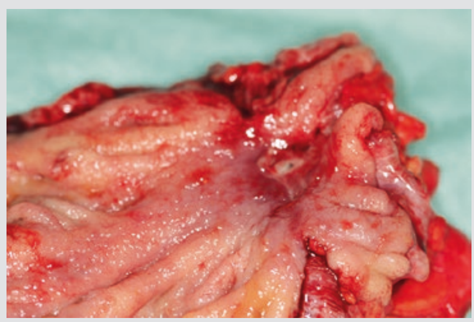
The anastomotic stricture was resected as short as possible (■ Fig. 27.20), and the second sigmoid stenosis was treated by a classical Heineke-Mikulicz strictureplasty. The stenosis was opened longitudinally and closed at right angles. The first suture row was an inverting continuing Connell suture and there after additional single stitches were made. After finishing a colonoscopy was performed ensuring tightness and competence of the reconstruction, also there was no intraluminal bleeding (■ Fig. 27.21).

Measuring the small bowel 2,70 cm could be documented – no short bowel was apparent.

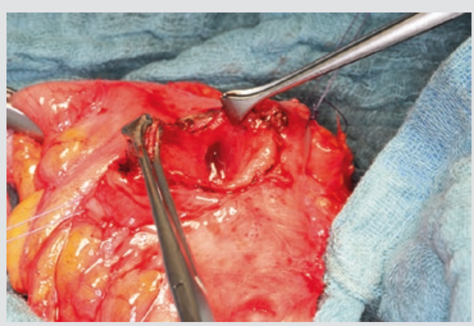
The abdominal wall was possible to close without a complex hernioplasty. Before closing a large Vicryl mesh covered the complete abdominal content.

Result: The postoperative course was completely uneventful. Evacuation of stool occurred 6–8 times per day.

■ **Fig. 27.19** This hydro-MRI shows a prestenotic dilated small bowel after recurrent Crohn's disease with prior anastomosis between the ileum and descending colon and at least one further colonic stenosis



■ **Fig. 27.20** The stricture with ulcer at the anastomosis between small bowel and descending colon was resected and a new anastomosis created



■ **Fig. 27.21** At the very narrow sigmoid stenosis, a Heineke-Mikulicz type of strictureplasty was done

Case 3

Grade IV: A Very Difficult Patient Situation:

A 16-year-old patient suffered from extended Crohn's disease. He presented with an oesophageal involvement causing a stricture with severe dysphasia. A conservative treatment with dilatation was initiated. At the end of one of the bougienages, he complained of massive thoracic pain and consecutively showed a severe deterioration of his physical condition with signs of shock. An x-ray examination showed free air in the mediastinum. The endoscopy revealed a deep long tear in the oesophageal wall; tracheal involvement was suspected. Stenting was not successful and the general condition of the young patient became worse. Finally the decision for emergency thoracotomy was made.

Problem: Intraoperatively a long rupture of the massive inflamed and scared oesophagus could be found with an additional rupture into the trachea.

Solution: A reconstruction of the oesophagus was, because of the severe destructive Crohn's, not possible. The only reasonable way to go forward seemed to be esophagectomy. An anastomosis was possible at the high thoracic or better of the cervical part of the oesophagus. The oesophagus was completely mobilised and the tracheal lesion was closed using an intercostal muscular flap. The oesophagus was cut high up in the thorax and mobilised down through the hiatus esophagi. Patient's position was changed to supine and an abdomino-cervical approach was used for reconstruction. A stomach tube was constructed and retrosternally transferred to the neck; the anastomosis was performed by single stitches.

After some days of intensive care, the patient has no further problems.

Some years later the same patients developed a severe toxic Crohn's colitis including perianal fistulation. An urgent operation was necessary, ending up in a Hartmann's procedure with ileostomy and a rectal stump. Several postoperative complications happened including severe abdominal wound infection. At the end the situation relaxed.

After that there was pus draining out of the rectal stump and anal incontinence was induced by severe fistulae. Patients' well-being was influenced significantly.

Very recently the remaining rectum could be removed by abdomino-perineal excision.

Result: The course of this severe Crohn's ended up in terminal ileostomy and oesophageal substitution by the stomach. The way of decision-making was very difficult and a great burden.

27

Case 4

Grade I: Ideal Effect of Therapy

In a young male patient with a history of ulcerative colitis for several years, a severe hemorrhagic colitis developed. Parallel a necrotizing dermatitis involved especially the upper part of the body (◘ Fig. 27.22).

Problem: Further conservative treatment expanding immunosuppression or surgery?

Solution: Surgery was chosen, which was the favourite of the patient too.

A subtotal colectomy with a long rectal stump was performed. An end ileostomy was created. The intraoperative situation shows the severe colitis with dilated large bowel (◘ Fig. 27.23). After colectomy the painful necrotizing dermatitis resolved stepwise (◘ Fig. 27.24). The next stage was rectal stump resection with J-pouch ileo-anal anastomosis and a covering loop ileostomy. Three months later, the ileostomy could be reversed.

Analysis: The prognosis of the very distressing necrotizing dermatitis could not be foreseen. At the end it healed quickly.

◘ **Fig. 27.22** Active painful necrotising dermatitis in a patient with ulcerative colitis

◘ **Fig. 27.24** Healing of necrotizing dermatitis around 3 months after colectomy

◘ **Fig. 27.23** Acute, toxic ulcerative colitis with dilated large bowel in the same patient

Case 5

Grade II: No Ideal Patient Situation

A young man suffered from ulcerative colitis since more than 10 years. A colitis-associated carcinoma of the large bowel developed. At the same time, a toxic megacolon made an emergency colectomy necessary. A subtotal colectomy was performed with a rectal stump. The colon was resected according to oncologic principles. The tumour was localised in the transverse colon (Fig. 27.25).

Problem: The preoperative sepsis persists postoperatively and the patient died as a consequence of sepsis.

Analysis: There was a coincidence of colitis-associated carcinoma and the acute situation of severe toxic colitis. Patient situation deteriorates despite emergency operation. In this case, an early operation before the carcinoma and the toxic colitis developed would have been the best approach.

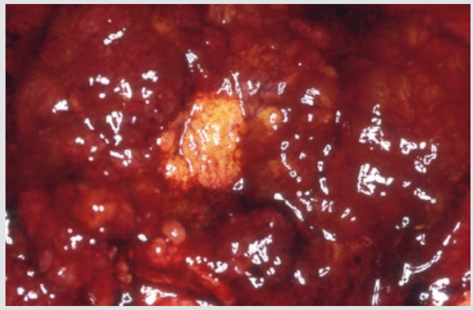


Fig. 27.25 Hemorrhagic, acute ulcerative colitis presenting with a colonic cancer (T3) additionally

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Further Reading

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Individual Surgery for Right Hemicolectomy

Contents

Introduction

Michael Korenkov, Christoph-Thomas Germer, and Hauke Lang

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The surgical treatment for right colon cancer consists from an ablative and reconstructive phase. The ablative phase is subdivided into following steps:

1. Approach
2. Exploration
3. Mobilisation of the right colon in CME technique (complete mesocolic excision)
4. Transection of vessels
5. Transection of the terminal ileum and transverse colon

In reconstructive phase, an ileotransverse anastomosis will be performed.

Currently both open and laparoscopic right hemicolectomy are established.

28.1 Open Right Hemicolectomy for Colon Cancer

28.1.1 Approach

Midline laparotomy, paramedian laparotomy and middle abdomen transverse laparotomy are most common approaches. All these incisions permit an adequate exploration. We believe that vertical incisions are more advantageous for patients with narrow inferior thoracic aperture. Contrary we prefer transverse laparotomy for obese patients with a broad distance between the right and left anterior axillary lines.

28.1.2 Exploration

For an adequate exploration, different wound retractor systems (Omni-Tract, Bookwalter, Rochard, Mercedes, etc.) will be used. In the abdominal exploration, a local tumour extent and availability of distant metastasis or peritoneal carcinomatosis will be evaluated. In dependence on the intraoperative findings, the perioperative defined strategy will be upgraded. Technical difficulties by this step can occur in patients with previous abdominal surgery and depend on the extent of abdominal adhesions. Accordingly a sufficient adhesiolysis is necessary for the adequate exploration. Strategical difficulties related to the extent of resection can occur in patients with locally advanced tumours (see below).

28.1.3 Right Colon Mobilisation

This step consists from mobilisation of the terminal ileum, caecum, ascending colon and the right part of transverse colon. The technical and tactical problems can occur for the most part in patients with locally advanced tumours with infiltration of neighbouring organs especially the superior mesenteric vessels, duodenum and pancreatic head. In this regard, the preoperative performance of abdominal CT scan is obligated. With the planning of operation, the following questions should be discussed already preoperatively:

1. How extent should be applied en bloc resection (wedge resection or complete resection of involved neighbouring organs or structures)? In case of the correlation between an intraoperative finding and preoperative CT scan, the operation will be performed as planned. In case of deviation between CT scan results and intraoperative finding (intraoperative tumour adhesions or infiltration is more extent than expected), en bloc resection should be aimed independent from inflammatory or malignant type of infiltration.
2. What kind of mobilisation (from lateral to medial or opposite) should be favoured for the locally advanced tumours? In such cases, we recommend using of “classic” mobilisation from lateral to medial.
3. When is a patient locally inoperable? From our point of view, an expanded tumour infiltration of mesenteric vessels is a limited factor for R0 resection. Also a widespread tumour infiltration of pancreatic lower edge is a risk factor for intraoperative tumour cell dissemination.

For the local, not advanced, tumour without serosal infiltration, the most difficult situations can occur during the mobilisation of the right part of the transverse colon. Not gentle tractions can lead to tear of gastrocolic trunk of Henle with severe bleeding. For the better control of this complication, we recommend to perform a mobilisation of the right part of the transverse colon from medial to lateral. An opening of the bursa omentalis in the middle of the transverse colon allows a good exploration and dissection from all vascular gastrocolic structures from the middle of the transverse colon to the right colon flexure.

28.1.4 Transection of Vessels

The transection of vessels (ileocolic vessels, right colic vessels as well as colica media vessels in case of extended right hemicolectomy) is technically the most unproblematic; difficult decision situations are not common. Because of oncological requested high arterial ligation increases a risk of accidental injury of the superior mesenteric vessels. In order to avoid this complication, arterial and vein mesenteric superior should be identified for the transection.

28.1.5 Creation of Ileotransverse Anastomosis

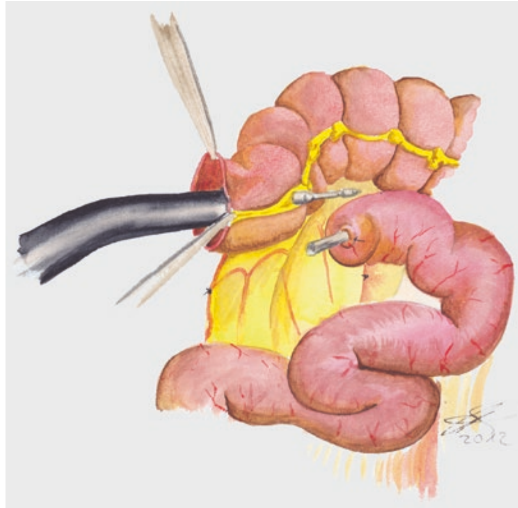
An ileotransverse anastomosis can be created using suture sewn by the hand or stapled end-to-end, end-to-side and side-to-side anastomosis. This part of the operation is usually not connected with technical or strategical difficulties.

Handsewn anastomosis will be created using one or two rows of sutures. Depending on the surgeon preference, differential suture materials (resorbable, non-resorbable, mono- or multifilament) will be used.

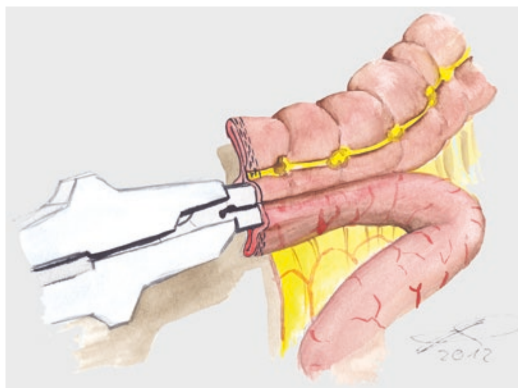
Stapled anastomosis will be created with a linear or circular stapler side to side or end to side. For the enterotomy closure, also a stapler but not a handsewn is recommended. With the creation of circular-stapled anastomosis, an anvil of circular stapler (25 mm mostly) will be introduced in a terminal ileum. A stapler stab will be introduced in the transverse colon whereon a stapler pin will be broken through a tenia libera and end-to-side anastomosis will be created (◘ Fig. 28.1).

By using linear stapler, an ileotransverse anastomosis will be side to side with antiperistaltic position of the ileum created (◘ Fig. 28.2). An enterotomy will be also closured with linear stapler (◘ Fig. 28.3).

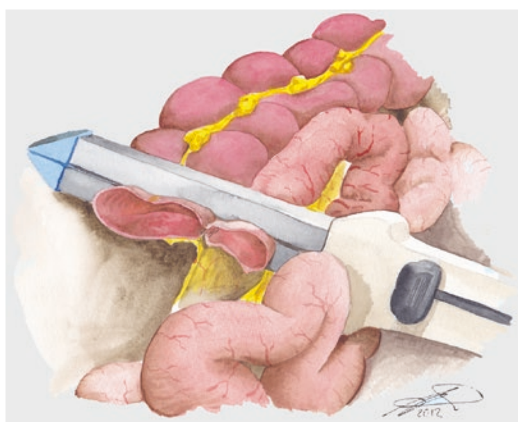
Difficult situations occur mostly in patients with a chronic small bowel ileus due to stenotic tumours. In such situation, it is sometimes problematic to create a safe anastomosis with severe dilatated terminal ileum with an oedematous and fragile wall. The question on “stapled anastomosis completely” or “handsewn anastomosis completely” or “mixed handsewn/stapled anastomosis” depends on intraoperative situation and surgeon preference and will be solved individually.



◘ **Fig. 28.1** Creation of ileotransverse end-to-side anastomosis with circular stapler



◘ **Fig. 28.2** Creation of antiperistaltic ileotransverse side-to-side anastomosis with linear stapler



◘ **Fig. 28.3** Enterotomy closure

28.2 Laparoscopic Right Hemicolectomy for Colon Cancer

Intraoperative steps are similar to the open approach procedure; however, their order can considerably deviate. Locally advanced tumours are a contraindication for laparoscopic approach for many surgeons. The technical performance of laparoscopic right hemicolectomy is much more difficult compared to an open approach. Accordingly, this operation is related to more intraoperative problems and difficult decision situations

28.2.1 Trocar Placement

The optic trocar will be placed most commonly infra- or supraumbilical. Two working trocars will be placed left from the midline. Number position and size of trocars are very variable and depend on the anatomical particularities and personal surgeon preferences.

28.2.2 Transection of Vessels

A lot of surgeons started the right hemicolectomy with transection of ileocolic vessels. It is almost always possible to identify an ileocolic pedicle if a patient will be placed in Trendelenburg position and turned on the left. Thereby the caecum should be pulled in ventrolateral direction. Transection of vessels can be performed between the clips, with energy devices or with vascular stapler. The preparation of ileocolic vessels can be performed as follows:

▪▪ **Preparation Along the Ileocolic Pedicle from Peripheral to Central** Thereby the peritoneum will be cut on both sides from the middle of the vascular pedicle. Further preparation should be performed in central direction to mesenteric vessels. After the identification of it, the central transection of ileocolic vessels should be performed. This step is especially useful in patients with a fatty mesocolon because it is easier to find an ileocolic pedicle than mesenteric vessels.

▪▪ **Preparation Along the Mesenteric Vessels** Thereby the mesenteric and colica media pedicles will be identified at first. Then the peritoneum will be cut along the mesenteric pedicle and the lateral side of them will be prepared. After that, the ileocolic and right colic (if available) vessels will be centrally transected.

Technical problems and difficult situation can occur because of bleeding due to vessel injury. Venous vessels can be injured frequently due to a blind preparation, not gentle traction or thermic damage. Particular difficult intraoperative situation can take place during the injury of mesenteric vessels. Predisposing factors for these complications are very fatty meso and a bad exposition of a preparation plain.

28.2.3 Right Colon Mobilisation

This step has a lot of technical varieties as follows:
1. From medial to lateral
2. From lateral to medial
3. From bottom to top
4. From top to bottom
5. Combination from one to four

The most common combinations are from medial to lateral and from bottom to top. The best conditions for such preparation are a good exploration of ileocolic, mesenteric and colica media pedicles as well as the lower part of the duodenum. After transection of the ileocolic vessels, the preparation along a mesenteric pedicle has been carried out between the meso of the right colon and parietal sheet of the retroperitoneum in the direction of colica media pedicle. Depends on volumes of resection (standard or extended right hemicolectomy) the mobilisation of the transverse mesocolon will be performed oral- or aboral sides from the colica media pedicle. After division of peritoneal sheet, a mesocolon "window" will be created near the bowel wall and bursa omentalis will be opened. The greater omentum will be divided at the resection level. A farther mobilisation takes place either from top to bottom (right transverse colon → right colic flexure → ascending colon → caecum → ileocecal area) or from bottom to top.

Technical problems and difficult decision situation can occur in the following cases:
1. Duodenal injury
2. Pancreatic injury
3. Vessel injury in the right part of the gastrocolic ligament
4. Opening of the posterior peritoneal sheet and retroperitoneal preparation

28.2.4 Creation of Ileotransverse Anastomosis

An ileotransverse anastomosis can be created either intra- or extracorporeal. For an extracorporeal anastomosis, a minilaparotomy (median supraumbilical or transverse in upper right abdomen) will be performed. This technique does not differ from the above described open technique. In obese patient, it is sometimes necessary to prolong a minilaparotomy incision that almost negates the advantages of laparoscopic technique. We recommend an extracorporeal approach for surgeons with not completed learning curve. With more experience, an intracorporeal anastomosis is preferable.

Technical problems and difficult decision situation can occur in the following cases:

1. Anastomotic tension
2. "Blue" anastomosis
3. Anastomotic torsion or kinking
4. Small diameter by end-to-end technique

In all these situations, a creation of a new anastomosis is necessary. In doubts about the quality of anastomosis, the indication to conversion should be given generously.

An intracorporeal ileotransverse anastomosis will be performed most commonly with a linear stapler side to side iso- or antiperistaltic. In isoperistaltic technique, an enterotomy closure will be performed with hand sewing. An enterotomy after antiperistaltic anastomosis will be closed with a linear stapler. We performed no preoperative colon cleansing for intracorporeal anastomosis.

An intraoperative testing of anastomotic leak with coloscopy is laborious and not routinely recommended. But meticulous visual inspection of all anastomotic segments is essential.

28.2.5 Removing of Specimen

The removing of specimen takes place via minilaparotomy by extracorporeal anastomosis technique or via a suprapubic approach by intracorporeal technique. Transumbilical, transvaginal or transrectal removing is not established as a standard access for oncological surgery. Technical problems and difficult situations may occur by discrepancy between the size of specimen and diameter of minilaparotomy. Because of a risk of tumour cell dissemination, every "powerful" traction of specimen should be avoided. If necessary, a minilaparotomy access can be adequately extended.

28.2.6 Classification of Intraoperative Difficulties

The operative difficulty for oncological right hemicolectomy can be classified as summarised in ◘ Table 28.1.

◘ **Table 28.1** Grading of operative difficulties for oncological right hemicolectomy

Grading	Case type
I (ideal cases) It is easy to operate; every operative technique is technically unproblematic	Slender or normal-weight patient No previous abdominal surgery
II (not quite ideal) Some minor technical difficulties may occur; some operative techniques can be more difficult as others	Moderate obese patient (BMI around 30 kg/m^2) Cholecystectomy as a previous surgery Otherwise similar to grade I
III (problematic) Difficult to operate, some operative techniques are considerably more difficult than others	Overweight patient (BMI > 35 kg/m^2) Locally advanced tumours with: Infiltration of the right flank peritoneum Infiltration of the duodenum Probable infiltration of mesenteric vessels or mesenteric root Probable pancreatic infiltration Previous oncological colorectal resection especially on combination with radiotherapy Previous extended upper abdomen surgery
IV (very problematic) Every operative step is very difficult	Extreme form of grade III factors

Surgical Technique and Difficult Situations from Roberto Bergamaschi (Laparoscopic)

Seth A. Stein and Roberto C.M. Bergamaschi

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29.1 Introduction

Although laparoscopic-assisted right colectomy was first reported in 1991 [5], descriptions of a standardized surgical technique became available in recent years. The first, termed *laparoscopic facilitated*, consisted of a five-step lateral-to-medial approach with extracorporeal vascular ligation and ileocolic anastomosis [7]. The second, termed *laparoscopic assisted*, included eight steps with a medial-to-lateral approach in which vascular ligation was performed intracorporeally while the anastomosis was fashioned extracorporeally [6]. Laparoscopic intracorporeal right colectomy entails ten steps with intracorporeal anastomosis followed by specimen removal in a bag [1].

29.2 Operating Room

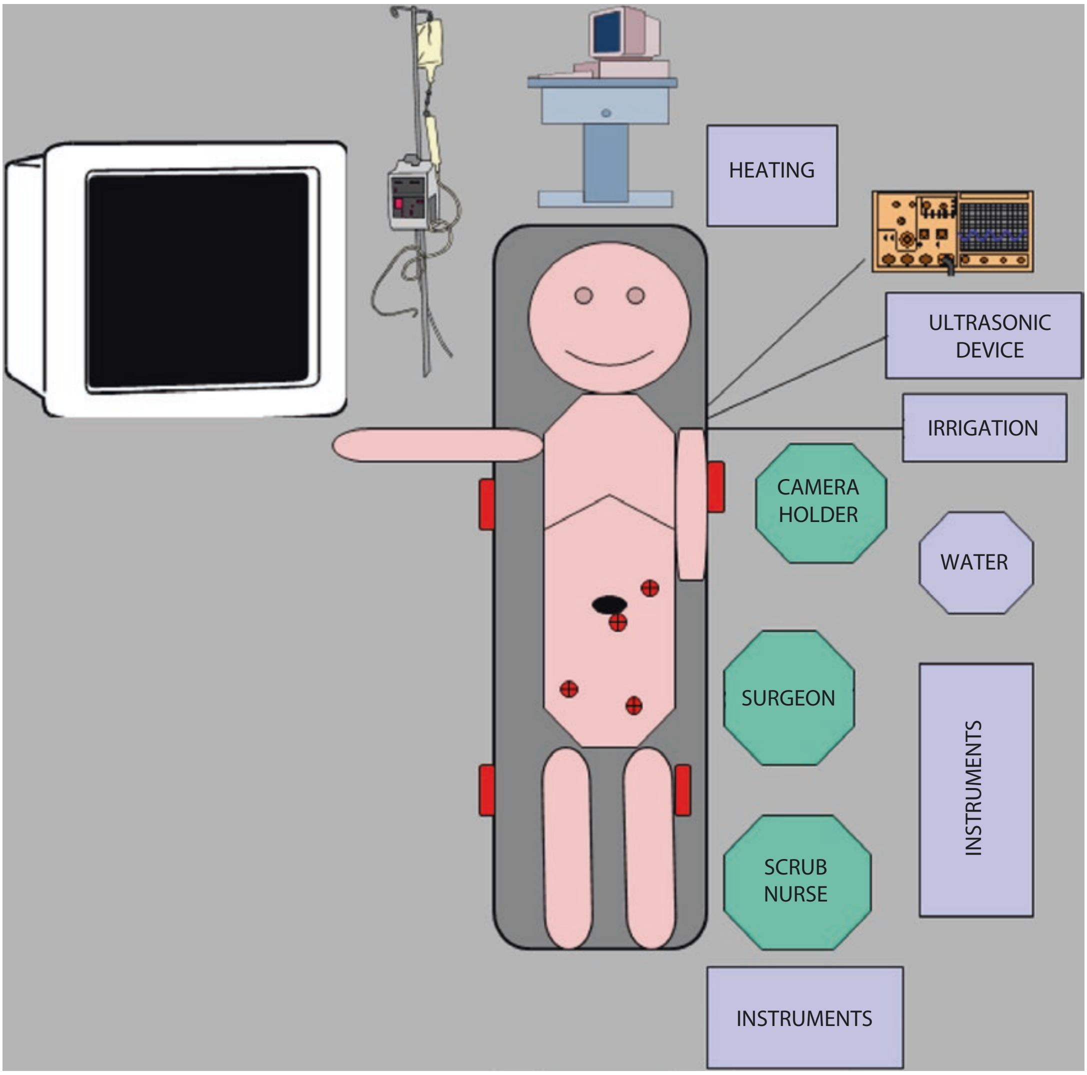
Before starting the surgery, the patient is identified with a time-out prior to the induction of general anesthesia with endotracheal intubation. Patients then undergo placement of a nasogastric tube and urinary catheter. If the patient cannot tolerate general anesthesia, the procedure can be performed with a spinal or epidural with the addition of a transverse block. A mechanical bowel preparation is achieved by using 2 l of polyethylene glycol ingested orally during the day before surgery. Adequate intravenous access should be ensured. Broad-spectrum intravenous antibiotics are given. Sequential compression devices are applied to the legs. Patients are supine in a bean bag with the right arm abducted and the left arm tucked. The patient should be securely strapped to the table at the chest since tilting the table will be necessary. The abdomen is prepped and draped sterile. The surgeon and the scrub nurse stand on the patient's left side, and the assistant stands on the patient's right side (◘ Fig. 29.1) with equipment, including monitors, being placed on the patient's right side in clear view of the surgeon. One assistant is needed to control the camera unless a robotic camera holder is available.

29.3 Surgical Technique

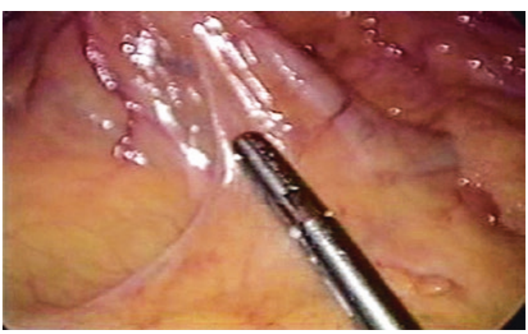
The abdomen and perineum are prepped and draped sterilely. The instruments used are all 5 mm in diameter and over 40 cm long including bowel graspers, scissors, right-angle forceps, and needle holders. An electrosurgical vessel-sealing device is used for division of vascular pedicles. The peritoneal cavity is accessed in an open fashion at the umbilicus. A reusable 10 mm port is placed at the umbilicus. A reusable 5 mm port is placed in the right lower quadrant lateral to the rectus muscle sheath and at least 3 cm medial to the right anterior superior iliac spine. A disposable threaded 12 mm port is placed in the left upper quadrant lateral to the rectus muscle sheath and rostral to the umbilicus. A reusable 5 mm port is placed 3 cm rostral to the pubic tubercle just left to the midline. A 30° scope (10 mm in diameter) is placed at the umbilicus.

All steps of the operation are performed laparoscopically, including an intracorporeal hand-sewn anastomosis. The ten standardized sequential steps include:

1. Identification and division of the ileocolic vessels (◘ Fig. 29.2).
2. Identification of the right ureter (◘ Fig. 29.3a, b).
3. Continued dissection along the SMV in a rostral direction to Henle's gastrocolic trunk (◘ Fig. 29.4).
4. Division of the omentum and opening of the lesser sac (◘ Fig. 29.5).
5. Identification and division of the right branch of the middle colic (◘ Fig. 29.6).
6. Transection of the proximal transverse colon with a laparoscopic stapler (◘ Fig. 29.7).
7. Hepatic flexure mobilization and mobilization of the mesentery of the ascending colon as well as division of the line of Toldt (◘ Fig. 29.8).
8. The terminal ileum is transected with a laparoscopic stapler and held by the assistant to prevent rotation of its mesentery (◘ Fig. 29.9).
9. The table is leveled from the left lateral tilt; the antimesenteric side of the stapled ends of the transverse colon and terminal ileum is approximated by a stay suture tied intracorporeally and then held by the assistant; an antimesenteric enterotomy and an antimesenteric colot-



■ **Fig. 29.1** Operating room setup



■ **Fig. 29.2** Ligation of ileocolic vessels

omy are made 10 cm proximal and distal to the stapled ends of the terminal ileum and transverse colon, respectively; a side-to-side anastomosis is fashioned with a laparoscopic stapler; after stapler extraction, the enterocolotomy is closed by two layers of sutures tied intracorporeally (■ Fig. 29.10a, b): the first of which is a continuous layer of 3-0 absorbable sutures and the second is a layer of interrupted 3-0 silk sutures; the mesenteric defect is left open.

10. The specimen is delivered in a bag through an enlarged umbilical port site.

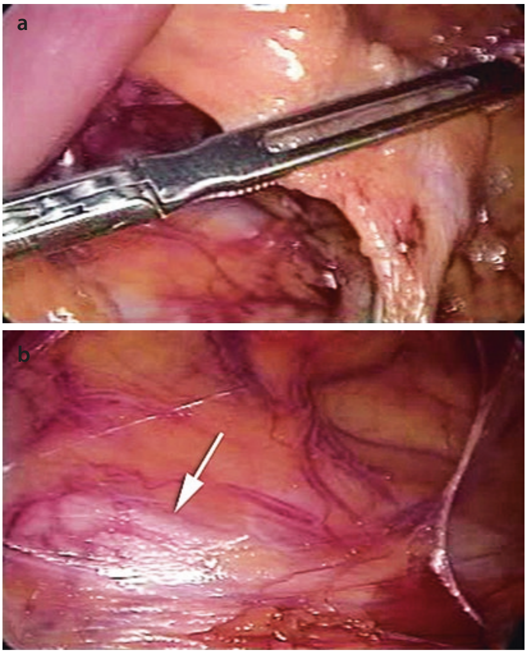


Fig. 29.3 Lifting the ileocolic vessel stump **a** to identify the right ureter (*arrow*) **b**

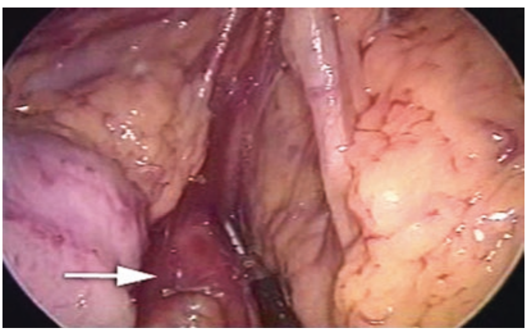


Fig. 29.4 Dissection along the superior mesenteric vein up to Henle's gastrocolic trunk. Duodenum (*arrow*)

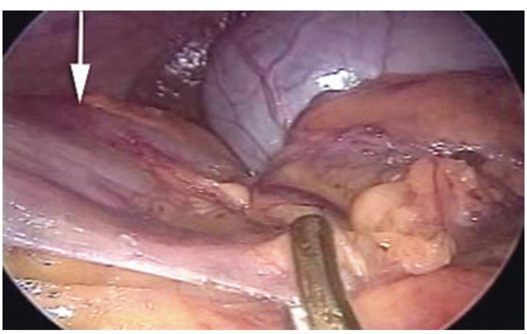


Fig. 29.5 Division of the omentum. Hepatic flexure (*arrow*)

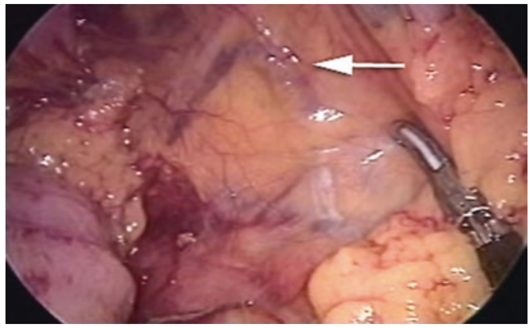


Fig. 29.6 Division of right branch of middle colic vessels (*arrow*)

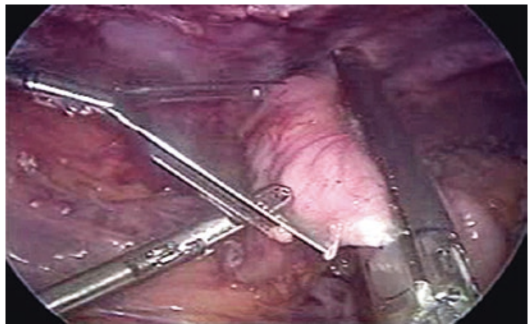


Fig. 29.7 Transection of the transverse colon

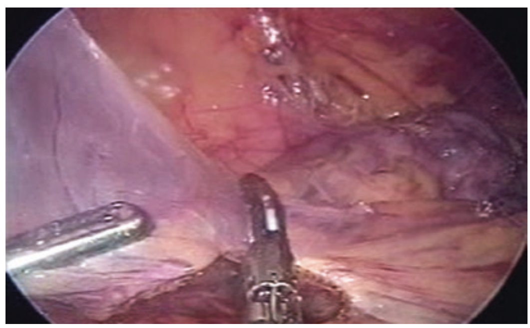


Fig. 29.8 Mobilization of the right colon

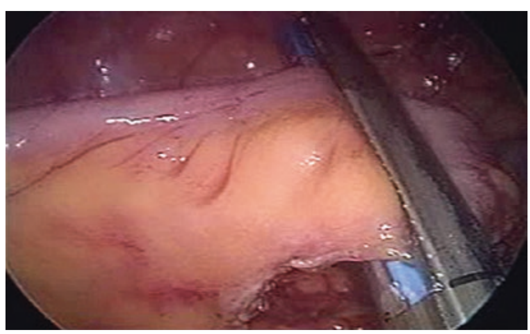


Fig. 29.9 Transection of the terminal ileum

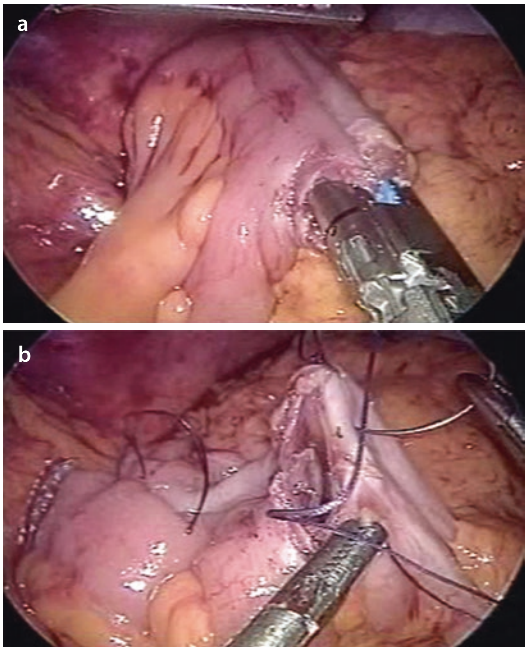


Fig. 29.10 Stapled ileocolic anastomosis **a** and hand sewing of enterotomy after stapler removal **b**

29.4 Pros and Cons of Intracorporeal Ileocolic Anastomoses

29.4.1 Pros of Intracorporeal Ileocolic Anastomosis

Intracorporeal ileocolic anastomoses have the following *potential* advantages:

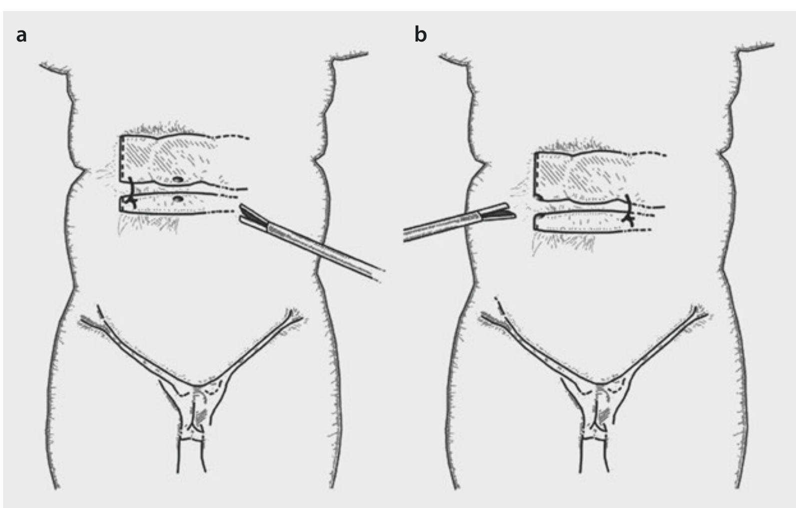
1. No need for mobilization of the transverse colon to reach the abdominal wall allowing anastomosing through a limited laparotomy as in the case of laparoscopic-assisted technique.
2. Anastomosing away from the abdominal (Fig. 29.11a) wall could reduce the rates of superficial and/or deep surgical site infection (SSI).
3. No manipulation of the abdominal cavity by the surgeon's hands could reduce formation of adhesions and hopefully rates of adhesive small bowel obstruction.
4. A 50 % reduction of the extraction site incision length could lead to clinical benefits such as decreased pain and superficial and/or deep SSI rates.
5. Laparoscopic visualization during the creation of the anastomosis could reduce unrecognized twisting of the terminal ileum mesentery.

29.4.2 Cons of Intracorporeal Ileocolic Anastomosis

Intracorporeal ileocolic anastomoses have the following *potential* disadvantages:

1. Performing an intra-abdominal colotomy on the transverse colon could increase the rates of organ space SSI rates.
2. Patients undergoing intracorporeal ileocolic anastomosis must drink and evacuate a bowel preparation before surgery in order to minimize fecal spillage through transverse colotomy and contamination of the abdominal cavity.
3. Surgeons must have undergone training and be proficient in laparoscopic suturing with intracorporeal knot tying.

Fig. 29.11 Stapled/handsewn anastomosis **a** and anastomosis totally stapled **b**



4. Longer operating time as compared to extracorporeal ileocolic anastomosing increases indirect cost and may potentially lead to higher complication rates.
5. Direct cost of intracorporeal anastomoses may be increased when compared to its extracorporeal counterpart, by the usage of laparoscopic staplers instead of conventional staplers and plastic bags for specimen extraction instead of wound protectors, respectively.

29.4.3 Totally Stapled Versus Stapled/Handsewn Intracorporeal Ileocolic Anastomosis

Potential disadvantages of totally stapled intracorporeal ileocolic anastomoses [4] include:

1. Everted anastomoses have *potentially* increased risk of complications as opposed to their handsewn inverted counterpart.
2. It requires usage of 60 mm long cartridge for side-to-side anastomosing as stapling enterocolotomy inevitably excises tissue and thereby reduces the final size of the anastomosis.
3. It most likely requires an additional port if performed on the transverse colon (◘ Fig. 29.11b).
4. It does not obviate the need for intracorporeal suturing as stay stitches are required to ensure safe stapler application on the enterocolotomy.
5. It may require multiple firings depending on the size of the enterocolotomy or whether the previous stapled line is being excised.
6. It may lead to higher direct cost due to the requirement of additional cartridges.

29.4.4 Iso- Versus Antiperistaltic Intracorporeal Ileocolic Anastomosis

The configuration of intracorporeal ileocolic anastomoses has been described as isoperistaltic [3] and antiperistaltic [1]. It is unknown what impact iso- and antiperistaltic configurations may have on the likelihood of potential complications such as anastomotic volvulus, leakage, internal hernia, or others.

29.4.5 Should the Mesenteric Defect Be Closed?

Cabot et al. [2] published a 7-year prospective review of 530 patients who underwent laparoscopic right colectomy in which the mesenteric defect was not closed. During the 20-month (median) follow-up period, 26 patients (4.9 %) developed small bowel obstructions (SBO). Of the 26, 12 were treated nonoperatively and 14 underwent surgery. At re-operation, 4/14 (0.8 % of all patients) were found to have an SBO due to the unclosed mesenteric defect; (1) internal herniation and (2) torsion of the anastomosis through the defect. Three of the four patients presented with an SBO within 10 days of their initial surgery and the fourth at 8 months after surgery. The authors concluded that their data do not support routine closure of the mesenteric defect after laparoscopic right colectomy for neoplasia.

29.5 Conclusions

Over time the surgical approach to right colon resection has drastically changed, from open to laparoscopic technique and from lateral to medial to medial to lateral. As surgeons refine their laparoscopic skills and become experts, the prior extracorporeal steps of the operation are being performed intracorporeally. Change in a surgical approach comes with close scrutiny and requires support with literature. This paper broadly summarizes the surgical literature in regard to the journey from facilitated laparoscopic to total laparoscopic right colectomy with intracorporeal anastomosis. The literature has shown that a total laparoscopic right colectomy is cost-effective and reproducible and has similar complication rates as laparoscopic right colectomy with extracorporeal anastomosis.

29.6 T4 Tumors and Alteration of the Standardized Surgical Approach

In the current literature, a controversy exists between laparoscopic and conventional open surgery for T4 tumors. In our experience, there exist five instances with T4 tumors that require a conversion of the standardized surgical approach. For the first three, we recommend conversion from laparoscopic to conventional open surgery:

1. T4 tumor invading the abdominal wall.
2. T4 tumor invading the kidney requiring en bloc right nephrectomy.
3. T4 tumor invading the pancreas requiring en bloc Whipple resection. The last two instances in our experience are potentially able to be performed in a laparoscopic manner.
4. T4 tumor invading the greater omentum requiring complete omentectomy.
5. T4 tumor invading Gerota's fascia requiring en bloc resection of the right colon and the fascia.

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Surgical Technique and Difficult Situations from Alain Gainant (Conventional)

Alain Gainant

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30.1 Introduction

The right hemicolectomy is defined as the excision of the colon vascularised by the superior mesenteric artery. The resection includes the last 10 cm of the terminal ileum, the cecum, the ascending colon, the hepatic flexure and the right third of the transverse colon. We carry out a mobilisation of the colon before the ligation and section of the vascular pedicles. In fact, the no-touch isolation technique has not demonstrated its efficacy [1]. One study suggests that it could enable a reduction in frequency of hepatic metastases, but would increase that of systemic and local relapses, and would have no effect on survival [2]. For these reasons, the initial ligation of the vessels is not routinely recommended in curative colectomies for cancer by the French Society of Digestive Surgery [3]. The ileocolic and right vessels are ligated at the origin from the superior mesenteric artery and vein, respectively. The central ligation of blood vessels which results in an increased retrieval of lymph nodes and the complete excision of the mesocolon (CME in analogy to the TME concept) is recommended. The CME is performed by carrying out a sharp separation of the perineum of the mesocolon (visceral fascia) from the retroperitoneal plane with preservation of this fascia. With this concept, lymph node harvesting is maximised [4], and the visceral fascia of the specimen of colonic resection is intact. This is of prognostic relevance [5]. This surgical technique has been shown to decrease local recurrence rates [6]. Intestinal continuity is then established by a side-to-side stapled anastomosis.

30.2 Preparation

No colon preparation is necessary for the right colectomy. Intravenous antibiotic prophylaxis with 2 g of cefoxitin is given routinely at the time of the abdominal wall incision. A nasogastric tube is only inserted in the event of occlusive syndrome.

30.3 Technique

The patient is placed in supine position. The surgeon stands on patient right side.

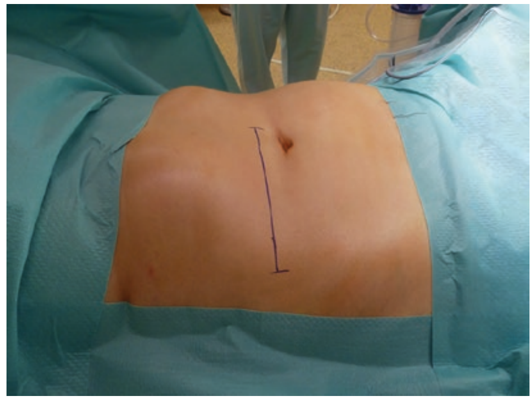

Fig. 30.1 Surgical approach. Patient in supine position, transverse horizontal laparotomy

The surgical approach

is a horizontal incision of the right flank located on a line passing two to three cm above the umbilicus (Fig. 30.1). It runs from the right anterior axillary line to 2 cm to the left of the umbilicus. This incision may be modified in its location and its dimensions according to the shape of the abdomen. The peritoneal cavity is exposed via two Rochard valves, one retracting the upper edge and the other the lower edge of the incision.

The exploration of the abdomen

is the first part of the procedure. It includes palpation of the liver looking for metastases not diagnosed preoperatively, examining the gallbladder for stones, the whole of the colon to locate the lesion and search other tumours and the peritoneum for carcinomatous nodules. The section of any parietal adherences allows the exposure of the whole right colon.

Mobilisation of the right colon

This starts with dissection of the terminal ileum, by incision of the peritoneum at the pelvic brim. Then the caecum and the ascending colon are mobilised by incision of the right parietal peritoneum by electrosurgical knife towards the hepatic flexure. The right mesocolon is then progressively detached medially and upwards. This dissection separates the visceral fascia and the extension of the Gerota's prerenal fascia (Fig. 30.2). Leaving intact the prerenal fascia and not visceral fascia containing the ureter and the genital vessels, thus preventing their injury. So it is possible to resect the whole of the mesocolon. This detachment is

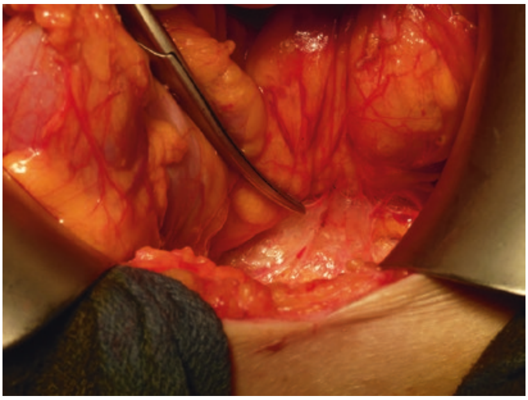

Fig. 30.2 Mobilisation of the right mesocolon: separation of the visceral fascia of the Gerota prerenal fascia (posterior)

continued up to the median line to the right of the superior mesenteric vessels. The second and third portions of the duodenum and the head of the pancreas are visualised and separated from the mesocolon and the mesentery.

The gastrocolic ligament is sectioned whilst preserving the right gastroepiploic artery and the accompanying vein and nerve branches. Haemostasis can be performed either by vascular ligation or by using sealing device, Ultracision® or LigaSure®. This section is continued as far as the future transverse colic section, at the junction of its right third and its middle third. This section meets the previous plane of dissection.

Vascular sections

The terminal ileum, the ascending and transverse colon, the right mesocolon and the transverse mesocolon are exposed. The mesentery is transected 10 cm from the ileocolic junction. The transection of the right mesocolon follows parallel to the right side of the superior mesenteric vessels. The incision extends vertically over the transverse mesocolon. The superior mesenteric vein is identified under the third portion of the duodenum. The ileocolic vein is controlled with suture ligation close to the superior mesenteric vein. The ileocolic artery is individualised distal to its origin and divided between sutures of slow resorbable thread n°0. An intermediate artery which is encountered in 10 % of cases is thus sectioned. These vessels present anatomical variations which involve the ligation of all vessels identified in the mesocolon to the right of the superior mesenteric artery. The mobilisation of the colon is completed by the ligation and section of the vessels of the transverse mesocolon and the right branches of the middle colic artery. The transection of the mesocolon is terminated at the point chosen for the colic section. The great omentum appended to the transverse colon is sectioned vertically opposite to this zone. Haemostasis is carried out by suture ligation or thermofusion.

The ileo-colic anastomosis

is then performed. The terminal ileum and the transverse colon are freed up from fatty attachments at the site of the future transection. Correct vascularisation of the transverse colon opposite the anastomosis zone is checked by viewing the arterial pulses. The lumen of the viscera is open on the antimesenteric border with a cold scalpel so as to view the satisfactory bleeding of the sections. The intestinal openings are cleaned with antiseptic solution, and any stool is removed from this zone. The branches of the linear cutting stapler are introduced into the intestine. Interposition of the mesentery is ruled out. The stapler is closed and its activation makes it possible to perform an ileotransverse side-to-side anastomosis. A slow resorbable monofilament 4/0 suture is placed at the left end of the staple line so as to secure it. Presentation threads are then passed into the proximal extremities of the anterior and posterior staple lines and at the lateral flexures of the colic and ileal openings. Staple lines are inspected intra-luminally. Bleeding is common at the posterior staple line. This is why the haemostasis is completed routinely by oversewing this staple line with a continuous suture of slow resorbable thread 5/0 (Fig. 30.3). If necessary, an identical continuous suture is passed over the anterior staple line. The threads previously placed enable the presentation of the staple zone of the linear stapler. The non-cutting stapler is placed horizontally, crossing the horizontal staple lines so as to carry out an anastomosis in a closed V (Fig. 30.4) During this procedure, it must be verified that the horizontal staple lines exceed the linear stapler by 1–2 mm and by palpation that the lateral anastomosis has a diameter of at least 40 mm. The colon and the ileum are sectioned with Mayo scissors against the anvil of the linear stapler. The section of the horizontal staple lines must be observed. The completely released resected specimen is removed. The section is cleaned with antiseptic solution. After having removed the stapler, the staple line is oversewn by a continuous suture

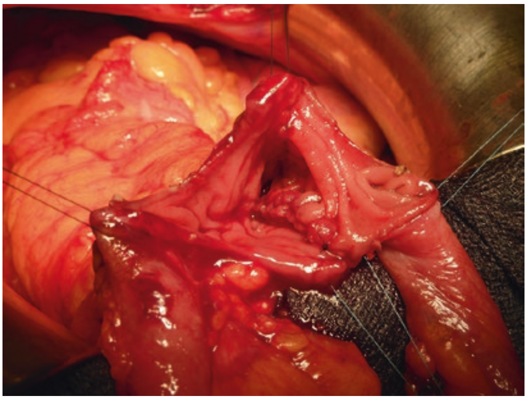

Fig. 30.3 Ileocolic side to side anastomosis: 4 presentation threads allowed the intra luminal haemostasis on the staple lines

Fig. 30.4 Ileocolic anastomosis: stapled closure of the colic and ileal openings, resulting in a functional end to end anastomosis

of slow resorbable thread 4/0 in order to complete the haemostasis of the sections.

The mesenterico mesocolic breach

is closed with separate sutures of slow resorbable thread. The intestinal loops are put back in order. The preserved great omentum is placed against the anastomosis. A non-aspirating drainage is optional. The abdominal wall is closed layer by layer with continuous sutures of slow resorbable threads 0 and 1. A Blair Donati continuous suture approximates the cutaneous edges.

30.4 Intraoperative Complications

The intraoperative complications that can occur during the right colectomy are injury to the duodenum, the right ureter or the superior mesenteric vein.

Duodenal injury

is due to excessive posterior dissection of the right mesocolon. This risk is limited by the initial mobilisation of the colon and the detachment of the mesocolon, which makes it possible to approach the second portion of the duodenum from right to left. When a wound occurs, it must be identified and sutured with separate stitches or a continuous suture of slow resorbable thread 4/0. Drainage via Delbet drain is left close to the suture. If the wound is longitudinal, the transverse suture avoids the risk of stenosis. If the suture is not perfect, it is preferable to place into the duodenal perforation a biliary T tube (Kehr drain) n° 18, secured with a purse string suture and exteriorised transcutaneously.

Injury to the right ureter

or the genital vessels is prevented by avoiding opening of the retroperitoneum during mobilisation of the right mesocolon. The integrity of the ureter must be checked routinely at the time of this mobilisation. In the event of injury, repair is carried out by suture with slow resorbable thread 5/0 over a ureteral drain. A bladder catheter will be left in place for 8–10 days.

Injury to the superior mesenteric vessels

can occur upon section of the right colic artery. The superior mesenteric artery must therefore be identified routinely and the section of its branches performed 2 cm to the right.

30.5 Difficult Situations

Tumours adherent to adjacent organs

Abdominal wall, stomach, bile duct, ileum, urinary tract, duodenum and pancreas. An en bloc resection entails a total resection of the viscera concerned, away from the tumour. These resections are contraindicated in the event that the superior mesenteric vessels are affected.

Invasion of the abdominal wall

requires peritoneal and sometimes muscular resection. The condition of the sections may be checked by an extemporaneous anatomopathological examination, involving if necessary an enlargement of the excision. In the event of fistulisation of the skin, all the parietal layers must be resected. The parietal reconstruction then requires implanting a bioprosthesis in order to avoid evisceration and prevent the risk of incisional hernia.

■■ Invasion of the greater gastric curve

is confined to cancers of the transverse colon. An atypical gastrectomy must then be carried out in the zone of invasion within a safety margin of 3–4 cm. In this circumstance, the section of the gastrocolic ligament entails the right gastric vessels. The stomach is closed by continuous sutures of slow resorbable thread or using a stapler. A nasogastric tube is left in place.

■■ Invasion of the small intestine

requires a segmental resection, either by enlargement of the ileal resection or by segmental resection followed by an end-to-end anastomosis.

■■ Invasion of the gallbladder

is resolved by a cholecystectomy.

■■ Adherence to the liver

in the V segment indicates an atypical resection. This is carried out after colic mobilisation. The liver parenchymatous section is performed in accordance with the techniques of liver surgery, usually without vascular clamping.

■■ Invasion limited to the second or third duodenum

can be treated by atypical duodenal resection. Digestive continuity is re-established by simple suturing if the defect is less than 5 cm. If it exceeds this, it is necessary to carry out a duodenojejunal Roux-en-Y anastomosis.

■■ Invasion of the urinary tract

can affect the right kidney or the ureter. If the renal parenchyma is invaded, a nephrectomy must be carried out once the presence and functionality of the left kidney are ascertained. When the tumour of the ascending colon is of posterior development, the ureter must be identified above and below the zone of adherence and dissected at this level. If the invasion is suspected, a resection is necessary. If its length is less than 5 cm, ureteral reconstruction on a ureteral catheter is possible after mobilisation of the ureter. If this cannot be done, a cutaneous ureterostomy can be carried out, with urinary continuity being re-established later.

■■ Invasion of the duodenum or the pancreas

requires a cephalic duodenopancreatectomy. Considering the extent of this excision, it must only be considered if the patient's condition allows so and if the curative nature of the excision is certain. Otherwise surgery becomes palliative.

One particular situation is represented by the *history of left colic resection* for cancer that has involved the sacrifice of the inferior mesenteric vessels. As the left colon is vascularised by the superior mesenteric artery, it is imperative to preserve this and therefore to ligate the right colic vessels close to the colon, verifying correct vascularisation of the remaining colon. The left colic ischaemia would involve a total colectomy and an ileorectal anastomosis.

30.6 Conclusion

The right hemicolectomy is a standardised procedure, carried out in the majority of cases for a malignant lesion. The main difficulties encountered are extension of the tumour to the neighbouring viscera, which involves an en bloc resection in order to prevent perforation of the colon and tumour cell spillage. Digestive continuity is re-established routinely. Open approach is still indicated. Whilst the laparoscopic route has demonstrated its feasibility and its safety, its superiority over the transverse incision of the right flank has not been established [7].

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Surgical Technique and Difficult Situations from Werner Hohenberger (Conventional)

Werner Hohenberger

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31.1 Introduction

With any operation, specifically in oncologic surgery, one will frequently find a differing individual situation, depending upon the site of a tumor, its regional extension, anatomical variations, or sequelae of previous operations. However, even relevant comorbidity like right heart failure or portal hypertension due to liver cirrhosis may increase the complexity with dilated veins of the intestine or in the retroperitoneum.

Nevertheless, despite all of that, any operation needs to be accomplished in a standardized manner with a clear objective, strictly following the demands of oncologic surgery. Unfortunately, this is not yet achieved by far for right and transverse colon cancer [1, 3–5].

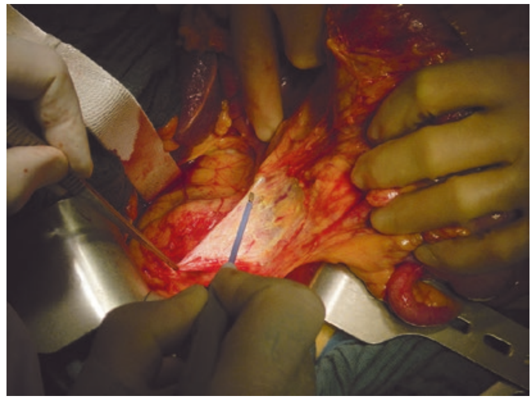


Fig. 31.1 Mobilization of the right colon for a right hemicolectomy. The tip of the forceps grasps the parietal plane (Gerota's fascia). The assistant provides countertraction and opens against the traction of the surgeon the areolar tissue resulting from air sucked. This is the line to be continuously incised by sharp dissection

31.2 Preparation

There is increasing evidence that preoperative bowel cleansing reduces postoperative complications, will avoid intra-abdominal stool contamination, and may even have an impact on oncologic outcome.

The patient is positioned on a normal table. The procedure starts with an adequately long median incision, to get unrestricted access to all quarters of the abdominal cavity, especially if individual circumstances need extended exposure.

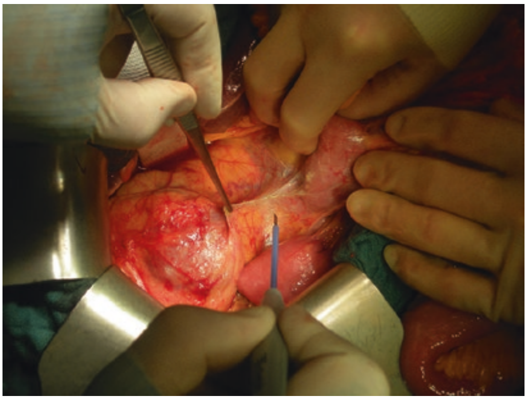
31.3 Surgical Technique

There is clear evidence that first of all tears by blunt dissection or incisions down to the muscularis propria plane of the colon involved by a tumor or even more of the tumor itself during developing the specimen reduce the prognosis of these patients, tremendously.

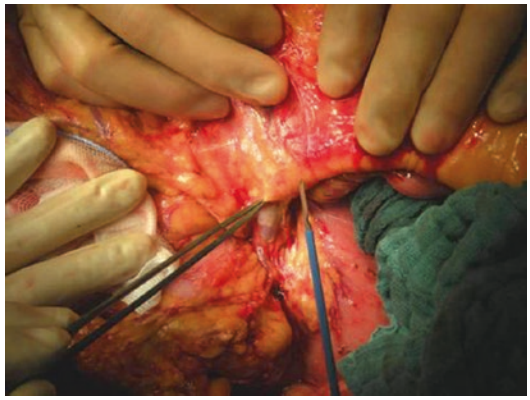
Therefore, any blunt preparation at any step during the surgical procedure is strictly forbidden. Only sharp dissection using diathermy, scissors, or any other suitable instruments allowing calculated separation of the anatomical layers can be accepted.

If there is a tumor fixed to what neighboring organ or structure ever, whether it is a small bowel loop or the pancreatic head, from the beginning a multivisceral en bloc resection has to be started, without trying to resolve these fixations or "adhesions." If the abdominal wall is involved, a circumferential margin of 1 cm is sufficient. It is important that even during the exploration careful maneuvers have to be applied, including the assistant's manipulations to avoid any shaving or tearing of tumor invasions in the sense mentioned above.

- This needs well-dosed traction and countertraction, to expose the incision line properly (Fig. 31.1). In this context, it increases safe plane preservation, if the assistant uses a compress, for example, to cover the tumor under his fingers to avoid tears.
- Personally, a later/caudal to medial/cranial approach is performed, starting the incision from the peritoneum lateral and parallel to the cecum and the ascending colon and later on along the descending part of the duodenum. Right from the beginning, the surgeon has to have in his mind that with the first incision, the parietal plane and the ascending mesocolon will be exposed and damage to both may occur immediately by blunt or crude dissection.
- The correct plane for dissection presents as areolar tissue ("angel's hair") due to air sucked by the distraction. This is the line to follow with additional incision of the mesentery medially including the so-called Treitz ligament, which is nothing else but a duplication of the mesentery. This procedure includes the duodenum and the pancreatic head, which are taken from the parietal plane, too



◘ **Fig. 31.2** The entire right colon including the mesenteric root and the duodenum with the pancreatic head are mobilized. The last bands of the Treitz ligament (= transition of the mesentery to the mesoduodenum) are going to be divided. The forceps grasps the intact parietal plane covering the retroperitoneal organs (kidney with the fat around, gonadal vessels, ureter). Next, the aorta and the vena cava will be visible. They all remain protected by this plane, why the ureter does not need to be taped



◘ **Fig. 31.3** The duodenum and pancreatic head including the uncinate process are fully mobile; the superior mesenteric vein lies right in front of the surgeon's eyes, without any twisting. The tip of the forceps keeps the mesocolon, which needs to be split, actively, as it covers in a semicircular manner the sup. mesenteric vein, to get access to the root of the ileocolic vein, next

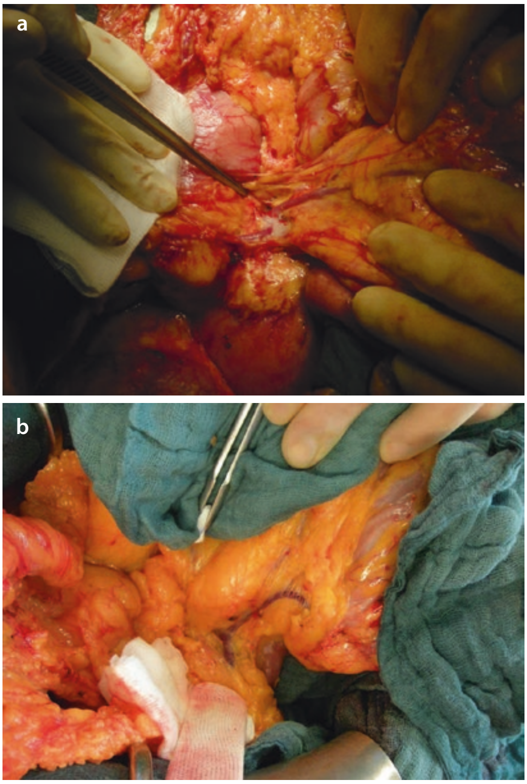
("Kocher maneuver"), also covered by the mesoduodenum and mesopancreas as the "meso" is a continuously running plane. Finally, the entire right colon with the tumor and the mesenteric root with the small bowel loops are completely mobile and can be brought in front of the abdominal wall achieving absolutely free access even in very obese patients (◘ Fig. 31.2).

- *This dissection includes two important issues*:
- *Strict preservation of the mesocolon for oncologic reasons.*
- *Also saving the parietal plane to avoid bleeding, for example, by lesions of the gonadal vessels. As this plane covers a part from the aorta and the vena cava also the ureter, it can never be injured, if the plane of dissection was correctly followed, and therefore it must never be taped in normal cases.*
- The next step is to take down the uncinate process of the pancreas from the ascending mesocolon until the sup. mesenteric vein is exposed, just covered by the mesocolon. Frequently the exposure is better and orientation easier if simultaneously the greater omentum is dissected off the right flexure and the transverse colon (see the following steps).

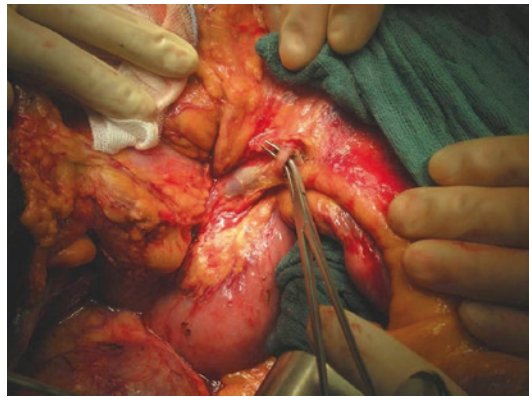
To get now access to the roots of the colic veins and the corresponding arteries, thereafter, the mesocolon covering the sup. mesenteric vein has to be split, actively right over and not lateral to the vessel (◘ Fig. 31.3), until the right and usually afterward the middle colic vein, too, are exposed right at their origin.

- The greater omentum is taken down, now from the hepatic flexure and the right half of the transverse colon. It must not be resected, if it is not attached to the part of the ascending colon involved by the tumor. The preparation itself is again performed by sharp dissection between the lower sheet of the mesomentum attached to the mesocolon until the lesser sac is completely open.

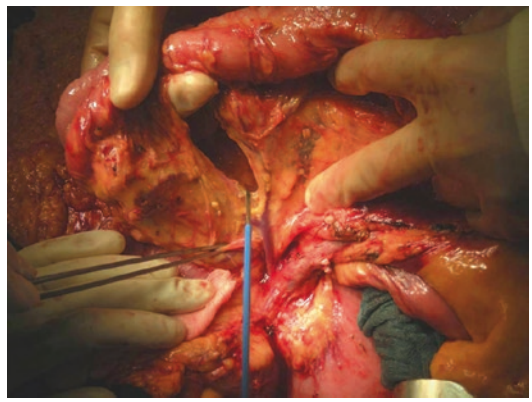
During this dissection on the right site close to the hepatic flexure, the surgeon must be alert and aware of the detailed anatomy of the veins and their conjunctions (Henle's loop): in about 90 %, the right colic vein is crossing the plane of dissection joining the right gastroepiploic (= gastroomental) vein, frequently together with the middle and an accessory right one [2]. If the mobilization was not performed as recommended above and the duodenum not taken down from the ascending mesocolon and the assistant did not relieve traction on the mesocolon, severe bleeding by tearing off these vessels may occur and may be difficult to stop. If, however, all structures are fully exposed, even a broad tear can be stopped by a vascular suture.



■ **Fig. 31.4** **a** The variation shown in this case with direct junction of the right colic vein with the superior mesenteric vein, will be found in just about 10 %. In the vast majority, these vessels join the right gastroepiploic vein creating the gastrocolic trunk (Henle's loop) **b**. Frequently, even the middle colic vein or additional veins form the right side may even join. This junction has to be precisely dissected with central tie of all colic veins to get free access to the sup. mesenteric vein. Otherwise, tears may happen with severe bleeding



■ **Fig. 31.5** Central division of the ileocolic artery, which frequently crosses the sup. mesenteric vein from below. The ileocolic vein is behind and will be tied afterward



■ **Fig. 31.6** The middle colic vessels are exposed. The branches running to the right will be divided next, flush with the main trunks. The mesocolon toward the bowel is already split, the sup. mesenteric vein freed; the stumps of the ileocolic vessels are close to the finger of the assistant with the central partly dissected already

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Sudden bleeding during these steps from the depth of the right upper abdomen always results from more or less extended tears of these vessels due to inadequate traction on the right colon. Therefore, these veins must be dissected completely and well exposed with central tie mainly of the right colic vein at its conjunction with the right gastroepiploic vein (■ Fig. 31.4).

- Usually, the ileocolic vein is centrally divided next. Quite frequently, the corresponding artery crosses the sup. mesenteric vein from below and presents, therefore, first (■ Fig. 31.5). Then, the middle colic vein is completely exposed; however, for a right hemicolectomy (cecal and ascending colon cancer), just the branches running to right will be divided later on. Now, the anterior and left lateral wall of the sup. mesenteric vein is freed and the sup. mesenteric artery exposed with the central tie of the ileocolic artery. The autonomous nerves covering the main artery must be strictly preserved. Otherwise, intractable diarrhea will follow.
- After the ileocolic vessels are divided and the middle colic once exposed, the transverse colon is transected, usually right over the root of the middle colic vessels. Then the branches coming off to the right are centrally tied (■ Fig. 31.6). Sometimes it is helpful to tape the root of the middle colic artery, mainly for better manipulation.
- Next, the terminal ileum is divided about eight cm proximal to the Bauhin valve, with

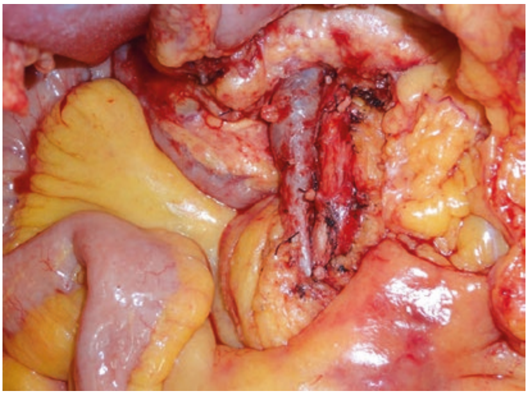

Fig. 31.7 Central lymph node dissection for a transverse colon cancer is completed. Therefore, the middle colic vessels are divided, too, with removal of the lymph nodes over the pancreatic head and the inferior aspect of the pancreas

Fig. 31.8 A right hemicolectomy specimen for an ascending colon cancer with invasion of the abdominal wall. The planes are fully preserved (mesocolic plane preservation) without any tear, complete "package" of the tumor and long vascular pedicles

radial incision of the mesentery down to the root of the sup. mesenteric artery with preservation of the autonomous plexus, which may sometimes even serve as a plane-like structure when dissecting centralward to the root of the middle colic artery. The right colic artery exists also infrequently with about 15 %. During this step, the central mesenteric lymph node dissection is completed (Fig. 31.7).

- The following anastomosis is fashioned as an end-to-end extramucosal running suture with closure of the mesenteric slit.

Only if relevant intra-abdominal secretion is assumed postoperatively, for example, if a patient had liver cirrhosis with ascites or after multivisceral resections including the pancreas, an intra-abdominal drain is applied. With a routine case, however, this is not necessary.

31.4 Extended Right Hemicolectomy

Cancer of the hepatic flexure and the transverse colon needs a more extended resection including the lymph nodes over the pancreatic head and/or those along the inferior aspect of the pancreatic corpus and tail and the greater omentum as well including the arcade of the right gastroepiploic artery (Fig. 31.8). The middle colic artery is always divided, centrally. The extent of colonic resection to the left side with central tie of the supplying arteries is based on the 10 cm rule: there are never pericolic lymph node metastases beyond this distance to both sides of the tumor. The open question, however, is whether the following vascular arcade needs to be included or not. As demonstrated by this specimen, the more radical approach is personally always performed.

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Surgical Technique and Difficult Situations from Stefano Saad (Laparoscopic)

Stefano Saad

M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations*,
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32.1 Introduction

In case of colon cancer, the technique of right laparoscopic hemicolectomy can be used with curative and palliative intention. The indication for laparoscopic colon resection for malignancy is similar to the open approach. However, the surgeon has to be aware of the general contraindication for laparoscopic surgery like multiple previous operations in the abdominal cavity. The laparoscopic oncological colon resection may not be considered in cases of T4 tumors with large masses or infiltration in neighboring organs.

◘ **Fig. 32.1** Trocar placement for right hemicolectomy

32.2 Patient Preparation

The preoperative patient workup for laparoscopic right hemicolectomy is similar to patients who are planned for open right hemicolectomy. Usually total colonoscopy with pathologic biopsy of the tumor is performed preoperatively. Additionally abdominal ultrasound and CT scan of the abdomen are done. After radiologic imaging, the surgeon can decide whether or not a laparoscopic approach for oncological right hemicolectomy can be performed.

When we plan to do an intracorporeal anastomosis of the bowel, we think that preoperative bowel preparation of the patient is essential. In selected cases, when tumor size is small, we ask the gastroenterologist for an ink mark of the tumor in order to easily identify the tumor during the laparoscopic procedure.

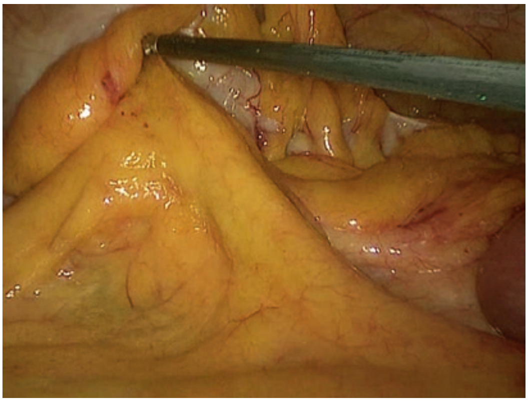
In the operating room, the patient is placed in a supine position on the operating table with the right arm tucked to the side. In the modified lithotomy position with low stirrups, the patient position can be changed during the operation. The operating table needs to be rotated to the left to move the small intestine out of the pelvis. Most of the time during the operation, the patient is in Trendelenburg position. The surgeon stands on the right side of the patient and the first assistant between the legs or vice versa. The monitor is positioned above the head of the patient or on his right side.

32.3 Operation Technique

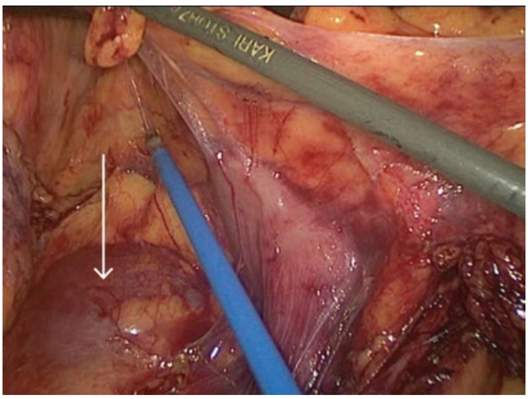
Pneumoperitoneum is induced with the help of a Veres needle which is placed below the left rib bow. The pressure induced by the pneumoperitoneum (around 12–14 mmHg) creates the operative space for a good exposure.

The number of trocars varies from 3 to 5 depending on the surgeon and the operative anatomy. The first port is placed 15 cm left to the umbilicus. After skin incision, we dissect the abdominal wall with scissors and open the abdominal cavity. Then the first port is inserted. Two additional ports are placed as seen in picture (◘ Fig. 32.1). We prefer single-use ports for 5–12 mm instruments. This allows the flexible use of the 30–40° angled laparoscope, sealing devices, and staplers. In some cases, three ports are not enough to allow an adequate dissection of the right colon. In these cases, another one or even two 5 mm ports are placed in the right lower or right upper abdomen. After a complete exploration of the abdominal cavity, the patient is placed in the Trendelenburg position, and the operating table is tilt to the left, where by gravity the right colon is exposed and the small intestine is placed in the left lower part of the abdomen. The greater omentum is retracted cranially toward the liver so that the cecum, the ascending colon, and the transverse colon are easily visible. As in open approach, we perform oncological right hemicolectomy with complete mesenteric resection. The resection starts medial to lateral with primary exposure of the main blood supply of the right-sided colon.

The first step is to identify the ileocolic vessels as the first landmark (◘ Fig. 32.2). With a laparoscopic grasper, the cecum is elevated and pulled in direction to the right abdominal wall. With this maneuver, the ileocolic vessels are easily identified. After opening the peritoneal layer, the ileocolic artery and vein are dissected in the direction toward the superior mesenteric vein and artery.



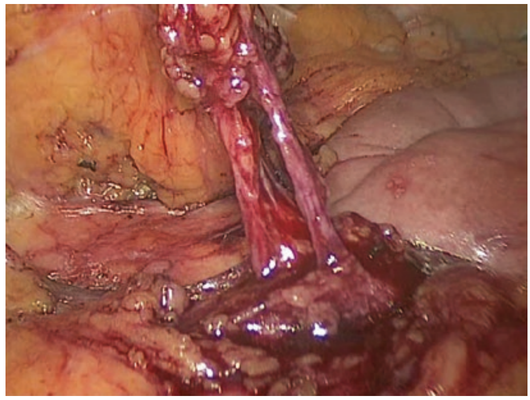
■ **Fig. 32.2** Cecal traction to identify ileocolic vascular pedicle



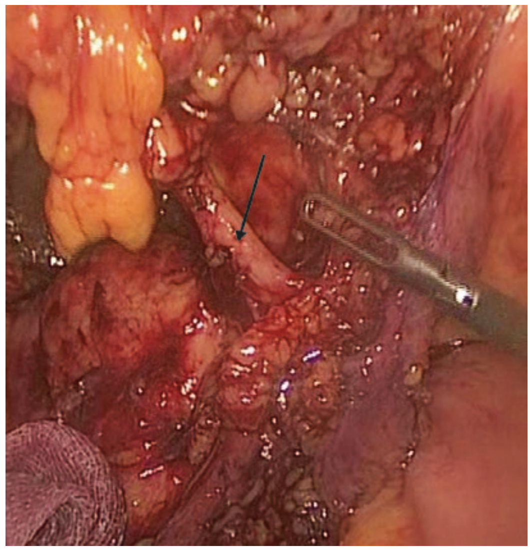
■ **Fig. 32.3** Preparation from medial to lateral with identification of duodenum

After isolation of the ileocolic vessels, a blunt dissection of the right colon mesentery can be performed to identify the duodenum which is the second important landmark (■ Fig. 32.3). This is the first key step for preparation and for avoidance of duodenal injuries. After isolation of the arteria and vena iliocolica (■ Fig. 32.4), these vessels can be divided. We usually use the LigaSure sealing device in the double-burn technique.

However, also clips or an Endo GIA, white cartridge, can be used for vessel division. After division of the ileocolic vessels, we continue the blunt dissection below the right colon mesentery in direction of the right liver and toward the lateral attachment of the ascending colon. Hereby we identify the right ureter and the gonadal vessels which can be identified in the retroperitoneal space below the dissection area. In the next step, we follow the superior mesenteric vein toward the pancreas head, which is the next important landmark. The



■ **Fig. 32.4** Central dissection of ileocolic artery and vein



■ **Fig. 32.5** Identification of right colic artery

gastrocolic trunk and its branches are identified, and the right colic vein is divided after isolation by the LigaSure device or clips. At this point, the surgeon has to be aware of the different variations of the venous branches of the gastrocolic trunk. In all cases, pancreatic branches must be preserved.

In the next step, the right colic artery is isolated and divided (■ Fig. 32.5). If an extended right hemicolectomy is planned, the middle colic artery and vein are then identified, isolated, and divided.

After the blood supply of the right colon is secured, the right colon mesentery can be dissected and divided until the resection line of the transverse colon is reached. Then the greater omentum is also divided with the LigaSure device in the same

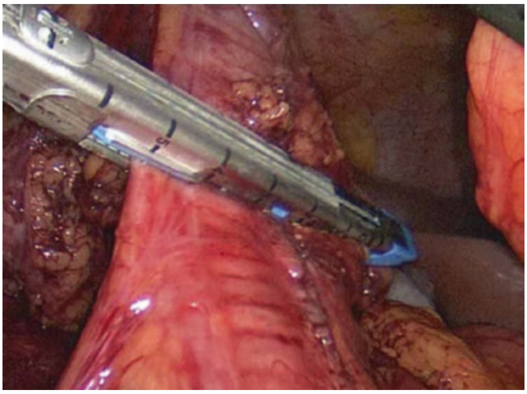


Fig. 32.6 Transection of transverse colon with Endo-GIA

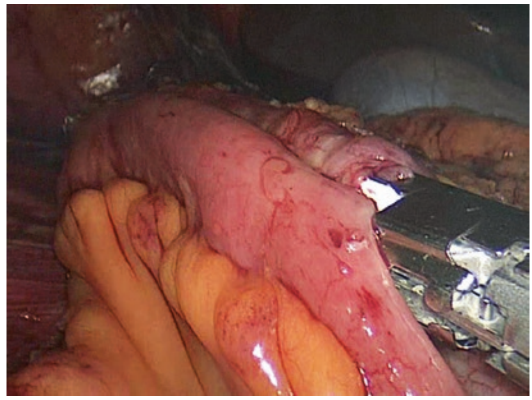


Fig. 32.8 Creation of ileotransverse seid-to-side anastomosis with Endo-GIA

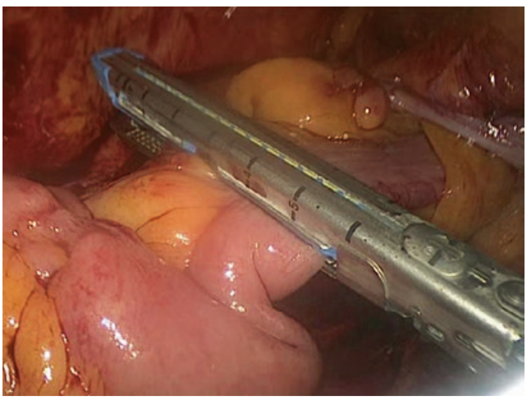


Fig. 32.7 Transection of terminal ileum with Endo-GIA

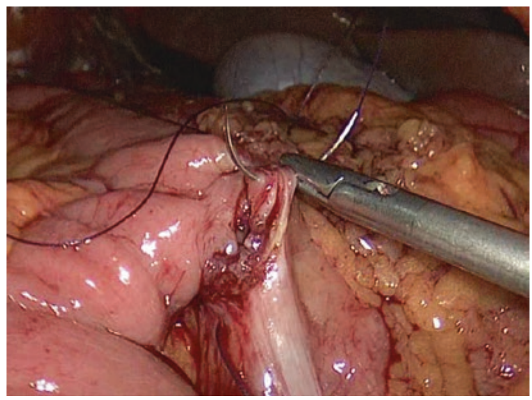


Fig. 32.9 Closure of GIA-opening with a running suture

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dissection direction. After this step, we dissect the lateral attachment of the ascending colon and the ileum. The small bowel mesentery can usually be divided with the sealing device. For complete resection and for gaining the specimen, the small bowel is cut with an Endo GIA (white cartridge), and the transverse colon is cut by an Endo GIA A with blue cartridge (Figs. 32.6 and 32.7). After the transection of the small and large bowel, the specimen is freed and can be placed behind the right liver lobe.

32.4 Reconstruction Phase

32.4.1 Intracorporeal Anastomosis (Ileotransversostomy)

We prefer to perform an intracorporeal anastomosis between the ileum and the transverse colon. In order to perform a side-to-side anastomosis, two stay sutures are placed to bring the small bowel along the transverse colon. Then the lumina of the small and large bowel are opened, and a side-to-side anastomosis is performed with the help of an Endo GIA (blue cartridge) (Fig. 32.8). After the inspection of the anastomotic side, the openings are closed with 3-0 Vicryl running suture in double layer fashion (Fig. 32.9). Some surgeons always close the mesenteric defect. This is usually done by a non-absorbable running suture. However, there seems no clear scientific evidence for this step. After inspection of the operating field and exclusion of any bleeding points, the specimen can be extracted.

32.4.2 Extraction of the Colon Specimen

As indicated, we prefer intracorporeal anastomosis which enables us to extract the specimen

Fig. 32.10 Removed right hemicolectomy specimen

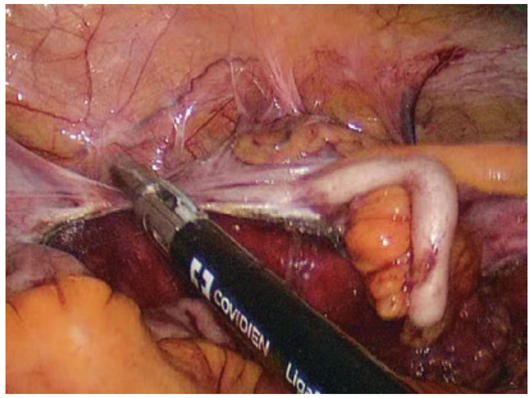


Fig. 32.11 Coecal mobilisation from lateral to medial (like open surgery)

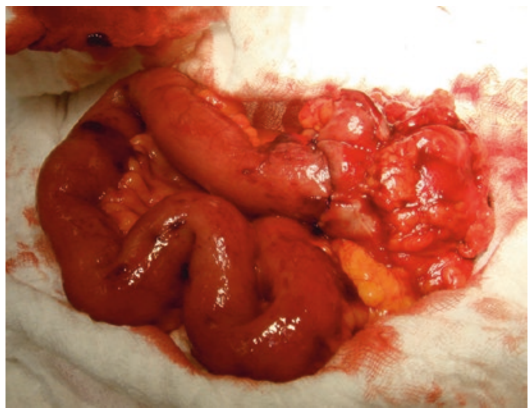


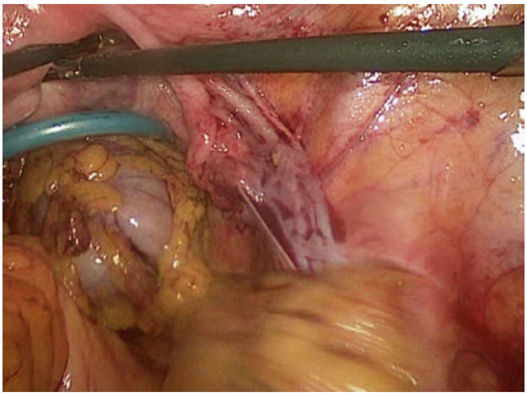
Fig. 32.12 Extracorporal ileotransverse anastomosis through minilaparotomy in right upper abdomen

through a Pfannenstiel incision. The advantage of Pfannenstiel incision seems to be more favorable since it creates lower postoperative pain and a lower rate of hernia formation. Another argument for Pfannenstiel incision is the better aesthetic result of the minilaparotomy. Usually we perform a 4 cm Pfannenstiel incision and insert a wound protector. With a grasper, we easily can extract the specimen (Fig. 32.10). After closure of the minilaparotomy usually with a 1-0 PDS running suture, we reestablish the pneumoperitoneum and check again the operative field. Usually we do not insert any drains.

Alternative dissection technique of laparoscopic right colectomy: lateral to medial.

Although we basically prefer the medial approach with primary central vessel ligation, there are some situations where this approach cannot be done. If the patient is extreme, obese identification of the ileocolic vessels can be obscured by a very fatty mesentery. Sometimes also the small bowel cannot be placed away from the central mesenteric axis, and in that situation, it is maybe preferable to dissect the right colon from lateral to medial. The lateral to medial approach is comparable to the traditional approach of open colectomy. The dissection starts at the terminal ileum and the cecum, and the attachment of the colon of the left lateral bowel is dissected (Fig. 32.11). After the release of the right colon ascendens, the patients will be placed in an anti-Trendelenburg position. Then the right hepatic flexure can be grasped with the laparoscopic grasper into the medial-caudal position. Then the hepatic flexure can be prepared with the LigaSure device. With this approach, the duodenum must also be clearly identified to avoid an injury. After mobilization of the ileum, ascending colon, and transverse colon, a minilaparotomy can be placed as a transverse incision in the right upper abdomen. After insertion of a wound protector, the small and large bowel can be delivered through the wound.

Vessel ligation and bowel dissection can be performed through the open incision similar to the technique of open colectomy. After resection of the colon segment including the lymphadenectomy, anastomosis can be performed extracorporeally (Fig. 32.12). Whether the gastrointestinal tract is reconstructed by end-to-end anastomosis, side-to-side anastomosis, hand suture, or stapler depends on the preference of the surgeon. After removal of the wound protector, the minilaparotomy is closed and the operative field is checked again by laparoscopic view. The technique of lateral to medial dissection with extracorporeal anastomosis is probably the adequate approach for surgeons with small experience in laparoscopic surgery, since this



■ **Fig. 32.13** Transvaginal extraction. The wound protector is introduced through posterior colpotomy

■ **Fig. 32.14** Wounds after laparoscopic right hemicolectomy

approach is very similar to the open right hemicolectomy. Another advantage of this approach with extracorporeal anastomosis is lower costs, if hand suture is done, and it will also allow teaching of hand-sutured anastomosis to surgical residents.

As an alternative to Pfannenstiel incision (■ Fig. 32.13), the extraction of the colon specimens can be done with minilaparotomy in the right upper quadrant of the abdomen or a small median incision near the umbilicus. These two locations of the extraction side allow extracorporeal anastomosis.

In selected female patients with small tumors below 4 cm diameter, a transvaginal extraction of the colon specimen can be done (■ Fig. 32.14). After intracorporeal ileotransversostomy, a small incision is done as a posterior colpotomy. We use the Alexis wound protector to deliver the specimen through the vagina. The colpotomy can be closed by single stitches with 1-0 Vicryl. This suture line can also be checked by laparoscopic view. The advantage of transvaginal specimen extraction is the avoidance of a minilaparotomy. The wound morbidity of a minilaparotomy like postoperative pain, wound infection, and hernia formation is avoided.

Here we classify the intraoperative difficulties in patients undergoing laparoscopic right hemicolectomy.

Classification of intraoperative difficulties in right hemicolectomy		
I	Ideal patient Technical easy to operate. Every operating technique is unproblematic	Laparoscopic technique with or without minilaparotomy Intracorporeal anastomosis
II	Not ideal patient Moderate technical difficulties Some operating techniques are more difficult than others	Laparoscopic with or without minilaparotomy Intra- or extracorporeal anastomosis
III	Problematic patients. Difficult to operate. Some operating methods are much more difficult than others	Laparoscopic-assisted hemicolectomy with minilaparotomy Intra- or extracorporeal anastomosis or laparoscopic hand-assisted or open surgery
IV	Very problematic patient. Every operative technique is very difficult	Laparoscopic, hand assisted with minilaparotomy Extracorporeal anastomosis or open colectomy

Individual Surgery for Left Hemicolectomy

Contents

Introduction

Michael Korenkov, Christoph-Thomas Germer, and Hauke Lang

M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations,*
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A left hemicolectomy is not a common surgical procedure. Many of the technical steps are similar to those of a sigmoid or rectal resection, but there are surgery-related features. The surgery can be performed via an open technique or laparoscopically; however, most surgeons prefer an open technique.

33.1 Open Left Hemicolectomy for Colon Cancer

Midline laparotomy, left paramedian laparotomy, and middle abdomen transverse laparotomy are the most common approaches. All of these incisions permit an adequate exploration of the area. For an adequate approach, both colon flexures and the rectosigmoid junction should be reachable without any difficulty. Some surgeons distinguish between a vertical and a horizontal type of incision depending on the location of the tumor. A middle abdomen transverse laparotomy has been favored by surgeons for tumors of the left colonic flexure. A vertical incision has been used for tumors of the descending colon.

The extent of resection depends on the location of the tumor. The "classic" left hemicolectomy with high ligation of the inferior mesenteric artery and vein and transection of the transverse colon aboral from the middle colic pedicle along with the distal bowel transection at the upper rectal level should be performed on tumors of the descending colon.

For colonic tumors located at the splenic flexure, the extent of resection consists of transection of left colic artery, proximal transverse colonic transection oral or aboral from middle colic pedicle, as well as distal bowel transection at the colosigmoid junction. In the case of transverse colon transection on the oral side from the middle colic pedicle, a middle colic artery should be centrally transected. The technical difficulties of left colon mobilization are similar to those of the left colon mobilization during rectal cancer surgery.

Most often, difficult decision situations occur during anastomosis creation. In case of distal bowel transection in proximal rectum, most surgeons favor a transversorectal end-to-end anastomosis created with a circular stapler. By preserving the sigmoid colon, both a handsewn (end-to-end) and stapled anastomosis are possible. A stapled anastomosis can be created with a linear (side-to-side) or circular stapler (end-to-end or end-to-side), whereas an anvil should be placed in the sigmoid colon, and the stapler stab should be introduced via colostomy in the transverse colon.

For the creation of a tension-free transversosigmoid or transversorectal anastomosis, it is sometimes necessary to perform a complete division of the gastrocolic ligament and mobilization of the right colic flexure. In some cases, it can lead to circus vicious. An extend bowel mobilization can cause a peripheral blood flow disorder and requires a new bowel resection that can lead to anastomosis tension, which requires a new mobilization. To avoid such situations, it is sometimes necessary to perform a partial colectomy with creation of an ileosigmoid anastomosis or transversorectal anastomosis with protective loop ileostomy.

33.2 Laparoscopic Left Hemicolectomy for Colon Cancer

A laparoscopic left hemicolectomy is more sophisticated than an open hemicolectomy. Given that a tumor localization on the descending colon and splenic flexure occurs only seldomly, this is relatively difficult for many surgeons because this requires a large number of patients to complete the learning curve.

The laparoscopic mobilization of the left colon for the left hemicolectomy is not distinguishable from the mobilization for the low anterior rectal resection. The most technical difficulties can occur during the transection of the mesocolon.

Contrary to laparoscopic preparation in the pelvic area, sometimes an adequate exploration of preparation plain in the middle left abdomen is much more difficult. Periodically, despite the maximal right overturning of the operating table and 30° left site elevating is not possible to see an operating plain. Additionally, the steps of the surgery have different grades of difficulty. The lateral mobilization of the left colon and transection of the inferior mesenteric artery are mostly technical rather than problematic. The transection of the descending and transverse mesocolon is more difficult, particularly in severely obese patients. In difficult situations, it is helpful to perform proximal and distal colon transection to improve the traction options. The distal colon transection is typically uneventful. The identification of the proximal transection plain related to the middle colic pedicle is often difficult in obese patients. An always gut identified landmark is a ligament of Treitz. The middle colic vessels located oral side from the projection of the ligament of Treitz on the mesocolon. After completion of the proximal and the distal colon transection, the identification of the medial preparation plain easier.

Removal of the sigmoid bowel is not absolutely necessary for tumors of the splenic flexure. In the event of using an intracorporeal stapler, it is more favorable to use a side-to-side linear stapler for an anastomotic technique. Preoperative bowel cleansing is necessary prior to the technique. Alternatively, a “technical” sigmoid resection with creation of transversorectal anastomosis with a circular stapler can be performed.

33.3 Classification of Intraoperative Difficulties

The surgical difficulty for oncological left hemicolectomy can be classified as summarized in ◘ Table 33.1.

◘ **Table 33.1** Grading of operative difficulties for oncological left hemicolectomy

Grading	Case type
I (ideal cases) It is a simple surgery; every surgical technique is technically unproblematic	Slender or normal-weight patient No previous abdominal surgery
II (not quite ideal) Some minor technical difficulties may occur; some surgical techniques can be more difficult than others	Moderate obese patient (BMI approximately 30 kg/m^2) Otherwise, similar to grade I
III (problematic) Difficult to operate, some surgical techniques are considerably more difficult than others	Overweight patient (BMI > 35 kg/m^2) Previous extended upper abdomen surgery (gastric resection, pancreatic surgery, splenectomy, transabdominal left nephrectomy) Patients with large bowel ileus from tumor obstruction Patients with difficult small bowel shifting on the right side
IV (very problematic) Every surgical step is difficult	Extreme form of grade III factors

Surgical Technique and Difficult Situations by Joerg C. Kalff (Conventional)

Joerg C. Kalff, Dimitrios Pantelis, and Burkhard Stoffels

M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations*,
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34.1 Introduction

The left hemicolectomy involves the resection of the left aboral transverse colon, the middle colic vessels, and the entire left hemicolon down to the upper rectum.

The most common indication for this surgical procedure is a malignant tumor in the splenic flexure or descending colon. Even with sigmoid carcinomas, an extension of the resection and thus performing a left hemicolectomy can become necessary (e.g., tumor location in the proximal sigmoid, poorly perfused oral resection margins, or due to descending colon unsuitable for anastomosis with extensive diverticulitis).

We prefer the minimally invasive approach for resections on the left hemicolon. However, the conventional open surgical technique in the radical left hemicolectomy remains the standard procedure and must be mastered by every colorectal surgeon.

34.2 Preparation

- All patients with histologically confirmed colon cancer and suspected presence of an infiltrative growth found during preoperative diagnosis are discussed in our oncology tumor board.
- Preoperative vaccination of patients occurs only in carcinoma of the splenic flexure with infiltration of the spleen and thus possibly required splenectomy.
- Based on the results of numerous randomized clinical trials before colonic resections, an orthograde colonic lavage can be omitted. In our clinic, we usually carry out a double enema to clean the rectum and distal sigmoid colon as the only action prior to operations on the left hemicolon on the day before surgery.
- In our clinic, a perioperative antibiotic prophylaxis is given 30 min before skin incision with ampicillin 2 g/1 g sulbactam (Unacid 3 g) iv or in the presence of penicillin allergy alternatively with clindamycin 600 mg/metronidazole 500 mg (Sobelin 600 mg/Clont 500 mg) iv. This is repeated after 4 h intraoperative, if necessary.
- Patient positioning is done on a rotated table with legs spread and using pneumatic alternating pressure cuffs on both lower legs. This positioning allows the intraoperative access to the perineum, thereby making a stapler anastomosis possible.
- The surgeon wears a head lamp. Surgery is carried out usually with two assistants and using a special abdominal retractor system.

34.3 Surgical Technique

The standards of oncological tumor surgery must be respected (exploration of the abdominal cavity, sufficient safety margins oral and aboral, central lymph node dissection, R0 resection of the tumor while avoiding tumor initiation, multivisceral resection in a situation with T4 infiltrative growth). During an emergency surgery, a primary resection of the tumor and the avoidance of a two-stage procedure with a proximal protective stoma should also be sought [1].

The exact extent of resection is definitely decided in the context of the exploration of the abdomen and possibly also after complete mobilization of the left hemicolon.

- Access is via a median laparotomy left side to the umbilicus. The abdomen is explored, and the local resectability and the presence of metastases (especially lymphatic, peritoneal, or hepatic) are evaluated.
- In open surgery, we usually prefer (in contrast to the minimally invasive approach) during left hemicolectomy the approach from lateral. The peritoneal adhesions are dissected with gentle retraction of the colon medially by the first assistant in the avascular layer. Bleeding indicates preparation in the wrong layer.
- The left ureter is identified just proximal to its crossing with the left common iliac artery, dissected and looped.
- The splenic flexure is completely mobilized.
- The omentum is cut to about the middle of the transverse colon. From here, the omental bursa is entered and the splenic flexure completely freed from the pancreatic lower margin. Especially at high left flexures, access is facilitated by maximum mobilization of the mesocolon of the Gerota's fascia.
- The middle colic artery is identified. The oral surgical margin at the transverse colon is marked preserving the artery and the intestine is looped.

Due to the central lymph node dissection and transection of the main trunk of the inferior mesenteric artery with consecutive inevitable hypoperfusion in the area of the entire sigmoid colon, transsection is carried out at the level of the upper third of the rectum (approximately 1–2 cm below the promontory).

- Approximately at the level of the promontory, the peritoneum is incised medially, and from here toward the duodenum, the origin of the inferior mesenteric artery from the aorta is depicted. To avoid injury to the inferior mesenteric plexus running directly next to the aorta, we transect the artery approximately 0.5–1 cm distal to its origin between two Overholt clamps.
- Centrally the artery is sutured and ligated. The ligature on the mesentery of the prepared specimen is left long for the pathologist to identify the boundary nodes.
- The lymph node dissection is completed by transection of the inferior mesenteric vein on the pancreatic lower margin at the specified oral surgical margins and under the protection of the middle colic artery.

In our clinic, we prefer performing rectal anastomoses with a so-called double-stapling technique (transection of the rectum with a curved cutter stapler and anastomosis using a circular stapIer). Alternatively, the anastomosis can be sewn manually in the upper rectum after left hemicolectomy. In most cases, a continuous, single-row suture with monofilament thread is used.

- Sufficient blood circulation at the level of transsection in colon (palpation of the pulse in the marginal artery, bleeding from the resection margins) and rectum must be checked before finishing the anastomosis. The anastomosis itself must be tension free.
- Anastomotic tightness is tested by perianal air insufflation.
- Regularly capillary drains (draining anastomotic area) can be omitted.

34.4 Postoperative Management

Seventeen years after the first publication of a fast-track rehabilitation program in elective colon resections by Kehlet et al. and 11 years after such a program was first established in a German clinic, it is proved that the fast-track rehabilitation for elective colonic resections compared to “traditional” treatment lowers the complication rate and reduces length of hospital stay [2]. Key points of the fast-track concept, such as the thoracic epidural anesthesia, early enteral nutrition, and early mobilization of the patient, are among the standards of perioperative care to our patients in oncological open left hemicolectomy.

34.5 Difficult Situations

34.5.1 Splenic Injury

It is a rare complication associated with a high morbidity. An injury to the spleen can occur during mobilization of the splenic flexure and especially in the transsection of the splenocolic ligament. In such a situation, one should take special care that tearing the colon or the major omentum while setting of situs can indirectly lead to a laceration of the splenic capsule. The incidence of splenic injuries is indicated with 0.42 % in a major review (13897 colectomies, Mayo Clinic, Rochester, USA) [3]. The risk is significantly increased in previously operated patients with adhesions in this area and in very obese patients. Splenectomy should be performed only as an *ultima ratio* if other surgical actions fail to control bleeding.

Smaller capsule injuries can be stopped by electrocoagulation and compression. Trying to reach hemostasis by hemostyptics, especially through the use of collagen matrix-bound coagulation factors, is always justified. For heavy bleedings and patients in unstable condition, the indication for splenectomy should not be delayed too long.

34.5.2 Ureteral Injury

The incidence of this rare complication is indicated with 0.3–1.5 % in the literature [4]. The key to avoiding an injury during a left hemicolectomy is the early identification of the left ureter [5]. Under difficult local circumstances (e.g., multiple previous surgeries, radiation, retroperitoneal fibrosis), a preoperative ureteral stenting is advisable.

Intraoperatively identified ureteral injuries need to be repaired directly. Postoperatively diagnosed ureteral injuries require surgical revision. The repair and supply of the ureter with a stent should be performed by a urologist if no appropriate expertise of the surgeon exists.

If the ureter is accidentally ligated, the ligature is removed and the ureter observed. If substantial injury results, resection of the affected section with end-to-end anastomosis is advisable. For long-segment defects, reconstruction should be performed by a "psoas-hitch procedure."

34.5.3 Poor Circulation of the Resection Margins

The blood perfusion of the resection margins must be controlled to reduce the risk of anastomotic leakage before suturing the anastomosis. Unfortunately, a reliable quantitative method does not exist, and therefore the judgment is highly dependent on the experience of the surgeon. On suspicion of hypoperfusion, a further resection should be performed. An extended left hemicolectomy with transection of the middle colic artery and an ascendo-rectostomy to achieve a tension-free situation may be required.

34.5.4 Left Hemicolectomy Under Emergency Conditions

Sometimes the first symptoms of a tumor require emergency laparotomy. In general, this is the case if the tumor perforates due to tumor-related intestinal obstruction. A mechanical ileus with impending decompensation may also require emergency surgery.

Standards of septic abdominal surgery apply in perforation with peritonitis. We always strive for a primary oncological resection with anastomosis in the same session, if necessary, under the protection of the anastomosis by a protective loop ileostomy. Only in bloodstream-compromised, high-septic patients or in highly complicated local findings resection according to Hartmann is indicated. A three-stage procedure with primary stoma leaving the tumor-bearing segment remains rare to individual cases.

34.5.5 Intraoperative Challenges in Unexpected Advanced Oncological Findings

Other Colon Tumors

In the case of intraoperative diagnosis of a second cancer in the ascending colon or transverse colon, we regularly carry out a subtotal colectomy with an ileorectostomy.

Infiltrative Tumor Growth (T4 Situation)

In case of intraoperative diagnosis of tumor growth into adjacent organs (stomach, pancreatic tail, spleen, left kidney), an en bloc resection is performed removing the entire tumor-bearing region. Hereby, extensive upper abdominal surgery (gastrectomy, distal pancreatectomy, splenectomy) might become necessary. In any case, left hemicolectomy is performed with oncological central lymph node dissection.

Peritoneal Carcinomatosis

In case of intraoperative diagnosis of peritoneal carcinomatosis and in the absence of distant metastases, an oncological left hemicolectomy is done. In the further course, cytoreductive surgery with hyperthermic intraoperative peritoneal chemotherapy (HIPEC) is evaluated.

Liver Metastases

In the case of intraoperative diagnosis of liver metastases, a primary histological confirmation is mandatory. If an option of an R0 resection by atypical liver resection or segmentectomy is given, this is done in the same session followed by an oncological left hemicolectomy. Advanced liver resections (e.g., hemihepatectomy) are usually carried out by a two-stage approach.

Liver Cirrhosis, Portal Hypertension

The presence of liver cirrhosis CHILD B and C is a challenge with respect to the occurrence of intraoperative and specifically postoperative complications. Preoperatively, the possibility of improving a patient should be investigated by a specialized hepatologist (e.g., by TIPS).

Table 34.1 Degree of intraoperative difficulties in conventional left hemicolectomy

Grade I: Ideal patient	Technically easy to operate, any surgical method is unproblematic feasible	Patients with normal BMI No previous abdominal surgery Small tumor
Grade II: Not quite ideal patient	Moderate technical difficulties, some surgical methods can be more difficult than others	Obesity Previous abdominal surgery Slight adhesions Large tumor
Grade III: More problematic patient	Difficult to operate, some surgical methods are more difficult than others	Scarred abdomen Previous colon resection Advanced infiltrative tumor growth Emergency surgery (ileus, perforation)
Grade IV: Very problematic patient	Any surgical action is very difficult	Former laparostoma Advanced liver cirrhosis (portal hypertension, ascites) Dense adhesions

A pronounced portal hypertension in the upper abdomen and retroperitoneum may make it impossible to carry out an oncological left hemicolectomy. Here a limited resection with a Hartmann procedure makes sense in some cases.

34.5.6 Classification of Intraoperative Difficulties

We classify intraoperative difficulties in patients who have to undergo a left hemicolectomy, as shown in Table 34.1.

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Surgical Technique and Difficult Situations from Amjad Parvaiz: Splenic Flexure Tumors (Laparoscopic)

Amjad Parvaiz and Manfred Odermatt

M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations*,
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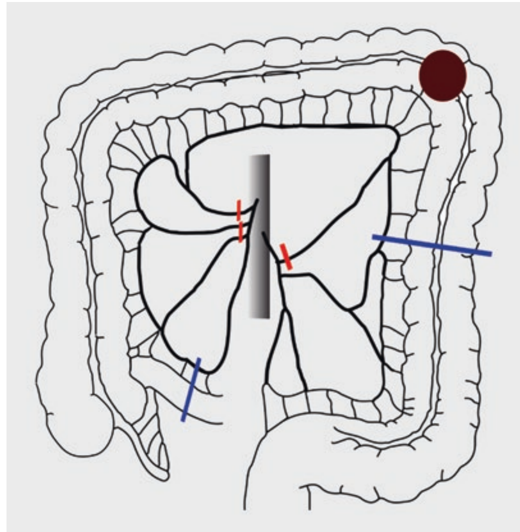
35.1 Introduction

Splenic flexure tumours are unique as they lay between two main arterial supply and venous and lymphatic drainage areas. There is no evidence-based consensus on how to best resect splenic flexure tumours. Mainly, there are two surgical approaches: the first is by an extended right colectomy and the second is by a left extended colectomy.

Data from our unit suggest that neither approach is superior with similar short- and long-term outcomes for these patients. However, the extended right colectomy seems to be preferable in obstructive splenic flexure cancers presenting as emergencies, especially when there are no endoscopic bridge-to-surgery options available or feasible. We will describe both approaches according to our personal method.



■ Fig. 35.1 Extended right colectomy for splenic flexure tumours. Division points of supplying vessels and resection lines

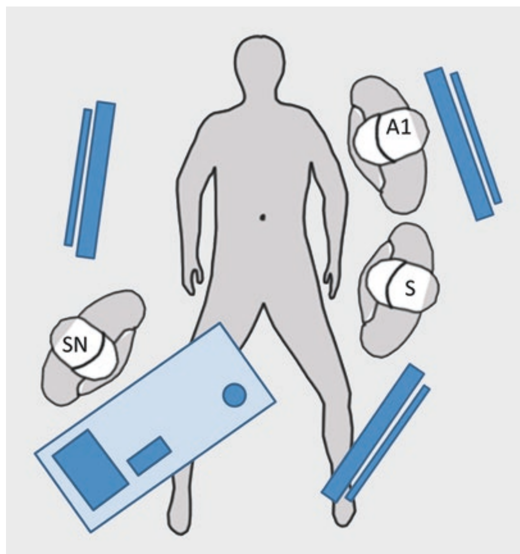
35.2 Treatment of Splenic Flexure Tumours by Extended Right Colectomy

35

Resection of splenic flexure tumours by extended right colectomy	
Step 1	Mobilisation of the right colon with ligation of ileocolic artery and vein and freeing of hepatic flexure
Step 2	Left colon mobilisation, central division of left colic artery
Step 3	Division of transverse mesocolon with high ligation of middle colic artery
Step 4	Exteriorisation of mobilised bowel segment and specimen resection
Step 5	Ileosigmoid anastomosis

35.2.1 Concept

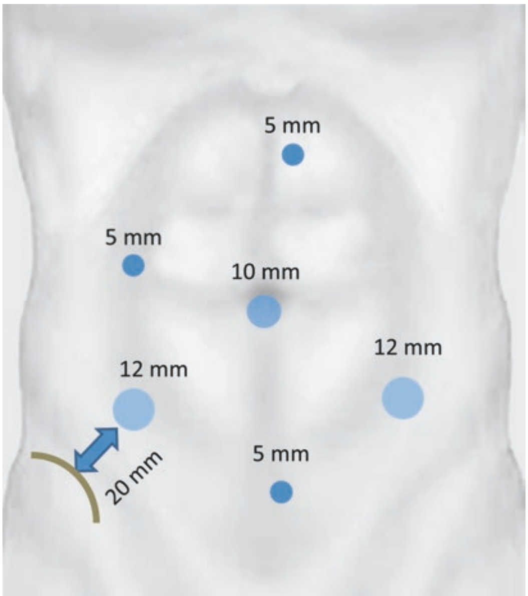
The extent of resection as regards blood supply is schematised in ■ Fig. 35.1.



■ Fig. 35.2 Operating theatre set-up for right colonic mobilisation

35.2.2 Mobilisation of the Right Colon

The patient is positioned in a modified Lloyd-Davies position. The operation begins on the right side. The initial set-up of the operating team is schematised in ■ Fig. 35.2. The site of the

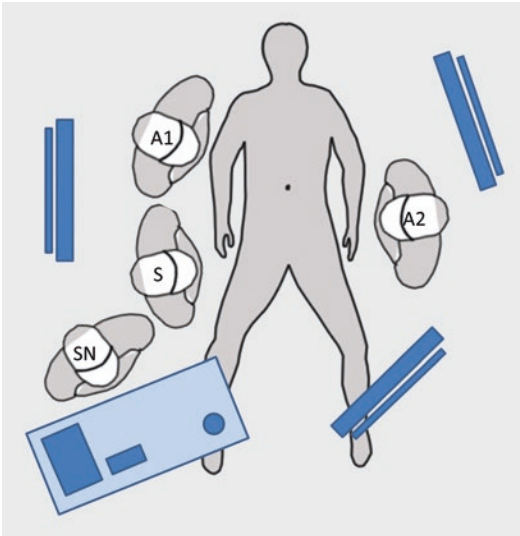


◘ **Fig. 35.3** Port sites for extended right colectomy

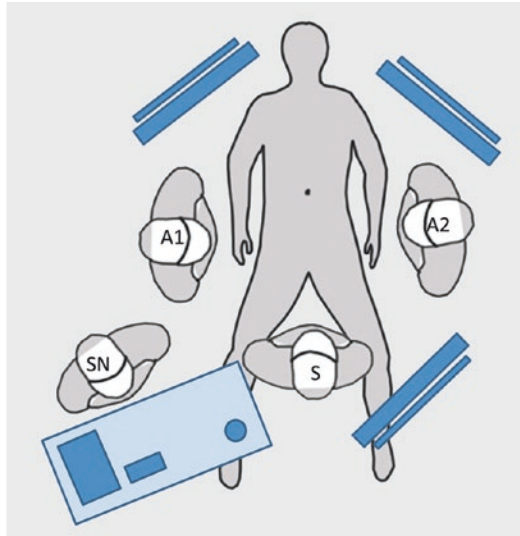
ports is shown in ◘ Fig. 35.3. The camera port is at the umbilical site. After the usual assessment, the patient is tilted towards the left side and slightly head down. The greater omentum is pushed cranially so that the transverse colon can be identified. The small bowel is swept towards the left side. The caecum is visualised. The mesentery in the ileo-caecal angle is grabbed by a Johann and pulled up ventrally, laterally and caudally. By this manoeuvre, the ileocolic artery is brought under tension and its course visualised. Centrally, an incision of the peritoneum of the mesentery is made below the ileocolic artery. After opening the peritoneal layer, air enters and automatically follows the embryological planes. Dissection is continued following the air until the mesentery can be separated from an underlying smooth shiny layer. The package containing the ileocolic artery is mobilised as centrally as possible. There, the ileocolic artery is circumferentially dissected and divided between two clips. By lifting up the ascending and right-sided transverse mesocolon and supporting it by an instrument, the separation of the planes is continued on top of the duodenum and pancreas and from medial to lateral on top of the Gerota's fascia. A swab is placed on the duodenum to facilitate the transection of the transverse mesocolon from above at a later stage. The dissection between the embryologic planes is mainly blunt and there should be no relevant bleeding. After this step, the caecum and ascending colon are mobilised from lateral which actually is nothing more than dividing the attachments of the right colon to the lateral abdominal wall as all the rest has been mobilised from medial to lateral in the previous steps. The lateral mobilisation is carried out in caudo-apical direction towards the hepatic flexure. Then, the hepatic flexure is retracted caudally and attachments to the gallbladder and liver are divided. The greater omentum itself can either be resected together with the specimen or be detached from the transverse colon. Then, the root of the right-sided transverse colon is divided. The swab which has been placed from below on top of the duodenum in a previous step is identified, while the transverse colon is retracted caudally. The transverse mesocolon is divided over the swab using, for example, a harmonic scalpel. The swab plays a crucial role as it prevents damage to the duodenum. After an opening of the root of the transverse mesocolon has been created, an instrument is inserted to support the mesocolon and protect underlying structures. After this step, the entire right colon should be completely mobilised till the right lateral aspect of the middle colic artery. At that point, we do not advocate continuing resection of the transverse mesocolon towards the left side as this becomes easier when performed as the very last step of the colonic mobilisation.

35.2.3 Mobilisation of the Left Colon

The set-up, port sites and positioning of the operating team are the same as described for the left colon mobilisation in the TME chapter (◘ Fig. 35.4). The surgical steps and applied principles also are the same. However, when performing an extended right colectomy for a splenic flexure tumour, the inferior mesenteric artery and the superior haemorrhoidal artery can be preserved depending on where the ileocolic anastomosis is intended to be performed. To achieve this, the vascular pedicle containing



◘ **Fig. 35.4** Operating theatre set-up for left colonic mobilisation



◘ **Fig. 35.5** Set-up for transverse colonic mobilisation

the inferior mesenteric artery is mobilised as described in the TME chapter. However, only the left branch (left colic artery) which normally goes off fairly centrally is divided. The inferior mesenteric vein is not divided centrally. Its branches will be divided when the exteriorised specimen is resected. Medial to lateral mobilisation, dividing the transverse mesocolon on top of the pancreas, lateral detachment, entering the lesser sac, completing the division of the transverse mesocolon and mobilising the splenic flexure are the next steps in analogy to its previous description. After this, the transverse mesocolon is still attached around the middle colic artery.

35.2.4 Mobilisation of the Transverse Colon

The position of the surgeons is shown in ◘ Fig. 35.5. First, the division of the gastrocolic and hepatocolic ligament is completed or, as an alternative, the greater omentum is detached from the transverse colon. As the laparoscopic central division of the median colic artery can be challenging, we approach this vessel by dividing the transverse mesocolon from both sides. In this way, we always have maximal vascular control. Even in case of inadvertent bleeding, the vascular pedicle of the middle colic artery can easily be controlled as accessible from both sides without risking damage of structures like the duodenum or pancreas. Once the middle colic artery has been isolated centrally, it is divided between clips.

35.2.5 Anastomosis

The specimen is exteriorised by extending the umbilical port site incision. Alternatively, an auxiliary incision of the left abdominal wall can be made. The right, transverse and upper part of the left colon is resected, and a handsewn or stapler anastomosis is performed. It is important to choose a large enough distal margin to the tumour.

35.2.6 Advantages and Disadvantages

Due to the mobility of the ileum, the anastomosis can be performed on each level. The right-sided approach for splenic flexure tumours offers flexibility and is technically easier than the left-sided approach. This approach is especially useful in obstructing splenic flexure tumours presenting as emergencies.

35.3 Treatment of Splenic Flexure Tumours by Left Colectomy

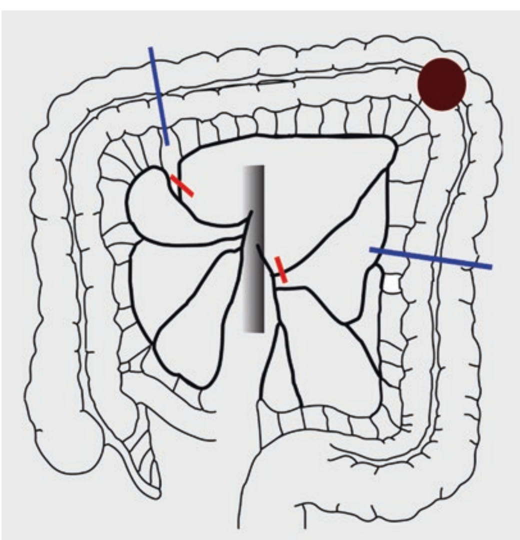
Resection of splenic tumours by (extended) left colectomy	
Step 1	Identification of IMA pedicle. Dividing left colic artery centrally
Step 2	Left colon/splenic flexure mobilisation
Step 3	Identification of middle colic artery and dividing the left branch(es)
Step 4	Exteriorisation of specimen through auxiliary incision
Step 5	Resection of the specimen
Step 6	Transverso-sigmoid anastomosis

35.3.1 Concept

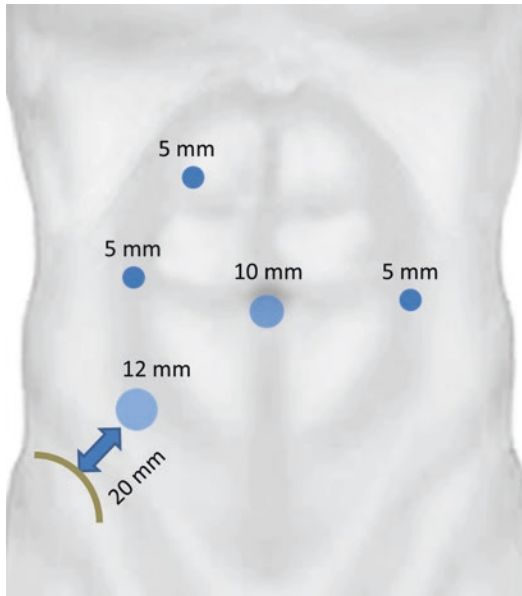
The extent of resection and the transection of blood supply are schematised in ◻ Fig. 35.6.

35.3.2 Set-Up

The set-up and port sites are the same as for the left colon mobilisation as part of a TME (◻ Figs. 35.4 and 35.7).



◻ **Fig. 35.6** Resection of splenic flexure tumours by (extended) left colectomy



◻ **Fig. 35.7** Port sites for left colectomy

35.3.3 Mobilisation of Left Colon

The vascular pedicle containing the IMA (inferior mesenteric artery) is mobilised as described previously. Instead of dividing the IMA at a central point, only its left branch, the left colic artery, is divided at its origin. This step is performed by circumferential clearing of the IMA close to the aorta. Following the IMA, the left colic artery can normally be identified. There may be anatomic variations. Important is to stay close to the IMA. Since the IMA remains intact, the mesentery containing the IMA cannot be lifted up as high as after division of the IMA, and space for blunt dissection on top of the Gerota's fascia is limited. Sometimes, incomplete medial to lateral mobilisation has to be completed from lateral at a later stage. The transverse mesocolon is incised from below on top of the pancreas and a swap is placed on the pancreas to facilitate completion of this step from the lesser sac. After lateral mobilisation, the lesser sac is entered by dividing the gastrocolic ligament or by detaching the greater omentum from the transverse colon. Attachments of the splenic flexure to the spleen are divided without applying traction on the spleen. The transverse mesocolon is divided over the swap which has been placed there to protect the pancreas from below. At this stage, the left colon has been fully mobilised, the left colic artery is divided at its origin, and the inferior mesenteric artery leading to the superior haemorrhoidal artery and sigmoidal branches has been preserved.

35.3.4 Mobilisation of the Middle Part of the Transverse Colon

To be oncologically on the safe side, it is mandatory to divide the left branch(es) of the middle colic artery at its origin. This step is challenging to perform laparoscopically, especially if the mesentery is short and fatty. The difficulty is to clearly identify the left branch(es) as there may be anatomical variation. The bifurcation of the middle colic artery may be centrally or more peripherally. Sometimes, there is no left branch but only a net of arcades. So, the best way to proceed is to clearly identify the middle colic artery at its origin and following its course while dividing all branches going to the left. However, the laparoscopic view can be misleading and frequent reassessment of the anatomy is necessary.

35.3.5 Mobilisation of the Hepatic Flexure

To gain length, the hepatocolic ligament and the hepatic flexure have to be fully mobilised. The length limiting structure, however, is the middle colic artery which can be very short. The mobilisation of the hepatic flexure includes the same steps as when performing an extended right colectomy with exception that there is no medial to lateral mobilisation.

35.3.6 Anastomosis

The mobilised transverse and descending colon are exteriorised by extension of the umbilical port site incision. The transection of mesentery and bowel is completed. Pulsatile bleeding of the marginal artery is confirmed and a handsewn or stapler anastomosis is performed. If there is a length issue, the following suggestions may be of help. Firstly, test whether the sigmoid colon can be mobilised further. Secondly, consider a right colonic transposition by complete lateral mobilisation and counterclockwise rotation of the right colon so that the right colon is positioned below the small bowel package. Thirdly, every left-sided resection can be transformed to an extended right colectomy.

35.3.7 Advantages and Disadvantages

Advantage of this approach is the sparing of the right-sided colon and possibly a better functional outcome. However, the left-sided laparoscopic approach to resect splenic flexure tumours is technically on an advanced level. Also, there may be length problems making a tensionless anastomosis impossible.

35.4 Risk Classification as Regards Difficulty Level of Laparoscopic TME

Portsmouth classification of laparoscopic TME surgery (level of intraoperative difficulty)	
I	Female no previous abdominal surgery upper rectal cancer BMI <26 T1 to T3 tumours tumour size <5 cm
II	Male upper rectal cancer BMI <28 no previous abdominal surgery tumour size ≤5
III	Any patient with upper to mid-rectal cancer T1–T3 tumour BMI <30 previous pelvic surgery
IV	Any patient with T4 rectal cancer mid- and low rectal cancer post-radiotherapy previous pelvic and abdominal surgery

35.5 Intraoperative Problem and Solution TME (Clinical Vignettes)

Case 1

Problem

In a post-radiation rectal cancer patient, the tissue had a high fluid content making the monopolar diathermy less effective during a laparoscopic TME. Also, the dissection produced a lot of smoke which made the area difficult to visualise. This is a common radiation-related problem.

Solution

The solution to this problem was to constantly use a suction device (by the assistant) and to apply dry gauzes during the dissection.

Outcome

Although more difficult, the rectal resection could be completed.

Case 2

Problem

During laparoscopic rectal resection, the anterior plane could not be visualised adequately in an obese male patient.

Solution

The base of the urinary bladder was hitched up to the anterior abdominal wall by a transabdominal Prolene stitch on a straight needle. We generally advocate to hitch the uterus or base of the urinary bladder in male patients to allow for better exposure. Often a second suture is needed for the obese male pelvis with a floppy bladder. During further dissection, counter-traction by the assistant's hand with a pledget held in a forceps allows better visualisation of the plane and therefore more precise dissection and avoidance of bleeding.

Outcome

The dissection could be completed.

Case 3

Problem

In a laparoscopic TME, there was a difficulty to apply the stapler below the tumour. This is a common problem with the laparoscopic approach particularly in obese male patients.

Solution

One of the contributory factors for this is due to failure to completely mobilise the distal rectal tube. In particular, the posterior median raphe has to be released to complete the division of the rectal tube by stapler. If in doubt, an inter-sphincteric dissection by a perineal approach in order to perform a handsewn colo-anal anastomosis is mandatory.

Outcome

Once the posterior median raphe had been completely released, the stapler could be applied below the tumour.

Case 4

Problem

During a laparoscopic TME, considerable bleeding from sacral veins occurred indicating that the operator had lost the correct plane.

Solution

This is a difficult position to be in. The Waldeyer's fascia normally provides the landmark for the dissection of about two third of the length of the posterior rectum and following the correct plane avoids injury to sacral veins. However, once the mistake of losing the correct dorsal plane is made, there is nothing worse than to keep on using the energy source in an attempt to stop the bleeding. The best thing to do is to use either a tonsil swab or an opened up gauze piece and apply direct pressure on the area for five minutes. Also think of an extra port in the left lower iliac fossa so that the assistant can continue to maintain the pressure while the operator is completing the rectal resection.

Outcome

With sustained pressure by the assistant, the rectal resection could be completed laparoscopically. After removal of the specimen, it was a lot easier to deal with the bleeding which stopped spontaneously after a short packing. Sometimes, bleeding from dorsal veins may require the insertion of drawing pins.

Case 5

Problem

During anterior dissection in a laparoscopic TME, the back wall of the vagina was opened. This can happen especially in patients with previous hysterectomy as the back wall of the vagina is often very adherent to the anterior rectal plane. The other problem is the loss of the pneumoperitoneum due to gas leakage.

Solution

A wet gauze piece was inserted into the vagina to stop the gas leak. The gauze was held by a sponge holding forceps (sponge stick) which additionally allowed counter-traction in order to improve visualisation of the planes. Once the dissection was completed, the defect of the vagina was sutured laparoscopically using absorbable sutures.

Outcome

Normal postoperative course without complications.

Surgical Technique and Difficult Situations from Thomas Schiedeck (Laparoscopic)

Thomas H.K. Schiedeck and Marten Schmerer

M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations*,
DOI 10.1007/978-3-662-49878-1_36

36.1 Preparation

- The patient is placed on a shaped vacuum mattress in lithotomy position.
- Preoperatively, the operational area is routinely cleaned with an antiseptic lotion.
- Two centimetres above the umbilicus, a longitudinal skin incision about 1.5 cm is performed, and the abdomen is opened under visual control. Therefore, the rectus sheet is exposed by means of two Langenbeck hooks and incised longitudinally.
- Below the rectus sheet, the peritoneum is incised and lanced about a short distance.

> **Many times the peritoneum is directly attached to the omentum majus. Especially in obese patients, it is often difficult to decide, whether the abdomen is completely opened or not. Therefore, it is advisable to lift up the Langenbeck hooks briefly under tension. The intruding air is then facilitating the separation of the omentum and the abdominal wall.**

- A 10 mm trocar sleeve is placed through the small incision by means of a palpation probe. Then CO_2 is insufflated.
- First an explorative laparoscopy is performed. This starts directly vertical under the first access to exclude injuries of the intestinal loops and the major omentum. This is followed by an intra-abdominal 360° view. Sometimes it is useful to insert a suprapubic urine catheter to empty the bladder and providing a better overview in the small pelvis.
- Following this, three trocars are placed:
  - A 12 mm trocar in the right lower abdomen (about two fingers medial of the superior anterior iliac spine and lateral of the epigastric vessels)
  - A 5 mm trocar in the right middle abdomen
  - A 12 mm trocar in the left lower abdomen (about two fingers medial of the superior anterior iliac spine and lateral of the epigastric vessels)

36.2 Operation Technique

- The operation starts with the mobilisation of the sigmoid colon. The patient is placed in head-down position with a slight tilt to the right side. The small bowel is moved to the upper abdomen to permit the view into the small pelvis.
- The lateral adhesions on the left side are cut sharply with scissors using the peritoneal reflection as guideline: the incision should be almost medially to this area. Gerota's fascia, which covers the retroperitoneum, should not be injured. Retroperitoneally located structures are identified but not routinely exposed. They should be left in placed covered by Gerota's fascia. The left ureter is most times located medial of the ovarian- respectively the testicular vessels. It is crossing the iliac artery/vein almost at the level of the promontory.
- The further preparation takes place along the descending colon heading up to the left colonic flexure. By separating the mesentery out of its secondary embryological adhesions, the preparation still continues from lateral to medial.
- Mobilisation of splenic flexure itself is facilitated with the patient in head-up position rotated to the right side. Sometimes it may be necessary to dissolve an adherent major omentum from the descending colon to allow direct view on the splenic flexure.
- Coming from lateral, the peritoneal reversal is incised nearby the colonic mesentery which opens the lesser sac. This step can be difficult and confusing especially in obese patients. In this case, it might be advisable to continue the dissection in the middle of the transverse colon. In case of a benign indication, the major omentum will be placed in the upper abdomen, grasped and lifted up to bring slight tension to the tissue. Then it is mobilised from the transverse colon and the lesser sac is opened through this approach. To achieve this, the grasper is inserted through the 5 mm trocar in the right upper abdomen. The dissecting tool is inserted into the 12 mm trocar in the left lower abdomen.

> **Especially in very huge or obese patients, it might be helpful to use an additional trocar (5 mm) in the left upper abdomen.**

> **Not respecting the Gerota's fascia is dangerous by getting too deep into the retroperitoneal space. This might lead to an injury of the pancreas, inferior mesenteric**

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vein or splenic vein. Regarding this, it should be ensured always to stay in the correct anatomical plane.

- **Specifically with the omentum directly attached to the spleen, it is important to avoid any traction to the spleen to prevent injury and bleeding.**

Following the mobilisation of the omentum from the spleen, the colonic mesentery has to be dissected from the lower margin of the pancreas. The left colonic flexure is brought down stepwise from lateral to medial. The better this is performed, the better the mobilisation of the colonic flexure will be. Complete mobilisation of the splenic flexure allows much easier identification and ligation of the inferior mesenteric vein.

- **The next step is the identification of the inferior mesenteric artery by opening the peritoneum from the medial aspect in the height of the promontory. The incision of the peritoneum should be performed carefully because the right main branch and the side branches of the hypogastric nerve are localised nearby. The hypogastric nerve should be identified immediately and pushed away dorsally.**

After this, the mesentery of the descending colon will be completely mobilised out of the retroperitoneum heading up to the inferior mesenteric vein at the inferior margin of the pancreas. The vein should be completely and precisely prepared and dissected between clips.

- **During this step, it is important not to dissect too deep into the mesentery of the descending colon; otherwise, the main branch of the inferior mesenteric vein can be easily missed and confounded with a mesenteric vein of the descending colon. Furthermore, it is important not to injure vessels of the medial arcade of the transverse colon. The correct identification of the vessels in the area of the medial colic artery may be very difficult in some cases. If in doubt, this step should be completed using the incision at the extraction site (see below).**

- **If it is acceptable with regard to the tumour, the rectovesical space should not be opened. Otherwise the risk of injuring the nerves is rising notably, especially in male patients.**

- **Transecting the rectum, any kind of conisation of the mesorectum has to be avoided. The mesorectum should be transected in a right angular shape. For placement of the stapler especially in cases with a bulky and thick-walled rectum, it is advisable to place an occlusion clamp in the area of the planned resection line. Afterwards the stapling device can be easily placed parallel to the clamp.**

- **Sometimes it is necessary to use two or three cartridges to transect the rectum completely. In these situations, it is absolutely necessary to follow the original right angular transection line. Otherwise stenosis of the rectal stump or reduced blood supply of the anastomotic segment may lead to difficulties and complications.**

- The proximal end of the transected bowel should be secured by a grasper.
- Many times bleedings are occurring between the staple lines. In almost all cases, these bleedings are stopping spontaneously. Otherwise a 5 mm clamp may be placed at the bleeding area to apply pressure for some seconds. It is not advisable to give coagulation directly to the stapled area because the energy flow along the staples is uncalculable. It may result in necrotic areas or leakages.
- For the extraction of the specimen, the trocar incision in the lower left abdomen is enlarged.

- **As an alternative, the extraction via the periumbilical incision may be of advantage, especially when an additional central mobilisation of medial colic vessels is necessary. Similarly the extraction through a Pfannenstiel incision is favourable if mobilisation of the rectum has to be completed.**

- In all resections for malignant indication, the incision at the extraction site must be covered using a kind of wound protection. Surgical transection through the muscles is seldom necessary. Usually it is sufficient to distract the muscle fibres.

- In the transverse colon (oral resection line), a purse-string clamp is placed and the resection completed. Before sending the specimen to the pathologist, it should be opened at a side table to prove the tumour localisation and resection margins.
- After this, a purse-string suture is performed. The size of the circular stapler is normally defined using bougies. The anvil is fixed by closing the purse string.
- Afterwards the bowel is replaced into the abdomen. The incision should be closed separately in all different layers.
- Then CO_2 is insufflated again to continue by laparoscopy. First the operation area is controlled to detect major or minor bleeding spots.
- Then a mild anal dilatation is performed and the circular stapler is inserted transanally. The spike is extended under sight. It should perforate the rectum in the area of the staple line either perfectly in the middle or exactly at a corner. The spike is then engaged into the anvil. The ends of the bowel are joined. It must be ensured carefully to prevent any torsion of the proximal bowel or an interposition of collateral tissues (small bowel, vaginal wall, appendices epiploicae, fatty tissue).
- The device is fired, opened and then extracted carefully.
- The donats should be checked for their completeness and will be sent to the pathologist. It is useful to prove the tightness of the anastomosis by transanal insufflation of air after setting the anastomosis under rinsing fluid intra-abdominally. As an alternative, the anastomosis can be checked by a careful rectoscopy.
- Especially if there are inflammatory alterations or patients with an immunosuppression, the anastomosis can be secured by using resorbable single stitches additionally.
- Multifilament suture material makes intracorporeal knotting easier. In addition it is recommendable to place a bougie intrarectally in the area of the anastomosis while performing the sutures.
- Finishing the operation the abdomen is rinsed and a drainage placed retrorectally. All trocars are removed under sight to exclude bleedings. Then the pneumoperitoneum is released. Closure of the fascia is performed in all incisions larger than 10 mm using Vicryl sutures. The operation is finished by wound disinfection and applying a wound dressing. In ◘ Table 36.1, some hints and proposals to overcome technical difficulties intraoperatively are given.

◘ **Table 36.1** Pitfalls and proposals for solution

Operation step	Tips and tricks
Adhesions	Complete laparoscopic adhesiolysis is recommended in case of previous surgery
Hypogastric plexus	1. Use the left main branch as guideline to identify the correct layer for preparation of the retroperitoneal space
	2. Preparation and identification of the nerve can be difficult if fibrosis and adhesions are existing
	3. If adhesions between the hypogastric nerve and sigmoid mesentery are existing, it is wise to free the nerve over a longer distance to prevent inadvertent injury
	4. In fatty tissue, preparation should start at the right branch of the hypogastric nerve, tracing proximally to the nerve plexus at the origin of the inferior mesenteric artery. Then the identification of the left main bough might be easier to perform
	5. Preservation of fibres of the superior hypogastric plexus while dissection and ligation of the inferior mesenteric artery

Table 36.1 (continued)

Operation step	Tips and tricks
Endoretractor	Using an endoretractor through the trocar in the left lower abdomen, the sigmoid colon can be elevated to the ventral abdominal wall
Suprapubic urine catheter	1. Better overview in the small pelvis
	2. Prevention of a postoperative urinary retention
	3. Prevention of a bladder injury
Safety for the anastomosis	By the presence of inflammation or in immunosuppression, the anastomosis is secured with additional interrupted stitches (e.g. Vicryl® 2.0)
Rings of the anastomosis	Have to be circular, complete and intact
	Have to be sent in for histopathological investigation in case of cancer
Anastomosis	The anastomosis has to be tension free, closed and with good blood supply
Firing the stapler	Interponated tissue between the anastomoses must be avoided
Checking tightness of the anastomosis	Bringing in rising fluid intra-abdominally
	(a) Transanal air insufflation
	(b) Rectoscopic control
Perforation of the rectum with the circular stapler	Ideally perforation of the rectum in the area of the clamp suture
	→ In the middle
	→ Exactly at a corner
Extraction of the bowel in front of the abdomen	(a) Expanding the trocar incision in the left lower abdomen
	(b) In need of additional central mobilisation
	→ Using of the periumbilical incision
	(c) In need of additional mobilisation of the rectum
	→ Using Pfannenstiel incision
Spleen	Careful: lesion of the capsule during mobilisation of the left flexure by tension and direct grasper injury
Pancreas	Careful: lesion of the pancreas during dissection of the mesentery of the transverse colon
Defining and marking of resection line	Placement of clips to an appendix epiploicum or marking by ultracision or bipolar coagulation
Position of the colon	Careful: correct position of the proximal bowel before closing of the anastomosis, torsion has to be avoided
Protective ileostomy	Depending on intraoperative findings and general state of the patient

Individual Surgery for Sigmoid Diverticulitis

Contents

Difficult Situations During the Surgery for Sigmoid Diverticulitis

Susan Galandiuk

M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations*,
DOI 10.1007/978-3-662-49878-1_37

Whether performed via an open or minimally invasive approach, surgery for diverticulitis can pose many technical challenges for the surgeon. These challenges can occur either during primary surgery for initial disease or during surgery for restoration of intestinal continuity following a sigmoid resection, colostomy, and Hartmann procedure.

37.1 Technical Difficulties During Primary Surgery for Initial Disease

The philosophy in treating patients with diverticular disease is changing. With a growing tendency toward nonoperative treatment, the advent of computed tomography (CT)-guided drainage has permitted drainage of pelvic and paracolic abscesses. In many cases, this drainage avoids the need for surgery or defers the operation until a time when the acute inflammation has subsided. In the latter instance, this drainage greatly facilitates the surgical procedure.

37.2 Basic Rules for Initial Operation

1. *Surgical approach*: If significant inflammatory disease is encountered, one should always start dissecting in a normal plane and work toward the abnormal plane. Approach the pelvis from posterior to anterior, where planes are always more "normal." The presacral area is almost never involved with inflammation, unlike the anterior area, which can be involved in inflammation associated with diverticular disease (◘ Fig. 37.1a–d). This is particularly true in patients with complicated diverticular disease associated with colovesical or colovaginal fistulas. In a patient with a significant inflammatory process, it is always easier to start mobilization, either (a) laparoscopically with a medial-to-lateral approach above the level of the disease with a high ligation (◘ Fig. 37.2) and where one is starting away from the disease or (b) in an open approach by a lateral-to-medial mobilization, beginning at the level of the splenic flexure and proceeding downward.
2. *Adequate colon mobilization*: Do not hesitate to mobilize the splenic flexure mobilization and/or divide the inferior mesenteric vein to permit adequate mobilization.
3. *Distal line resection*: The distal line of resection must be within the proximal rectum. Wolf et al. [1] showed that there was an approximately 25 % recurrence if not all of the sigmoid colon was removed. The proximal extent of the rectum varies greatly and can easily be identified by the point at which the sigmoid tenia coalesces. Failure to anastomose to the proximal rectum will result in a high recurrence rate [1]. Conversely, proceeding down, much lower than this point, which is commonly done, leads to an unnecessarily more difficult operation and especially reoperation. Diverticular disease does not extend into the rectum, and there is no need to resect it below this point, unless there has been an abscess that has perforated into the rectum.
4. *Palpably normal proximal colon*. Perform the proximal line of resection in an area of palpably normal colon. Symptomatic diverticular disease is characterized by muscular hypertrophy of the bowel wall (i.e., it feels thicker than the normal colon). Many patients have pancolonic diverticular disease, and one should not resect the entire colon as treatment for pancolonic disease. One needs only to feel for the area of palpably normal colon in order to determine a suitable area for the line of proximal resection. If the operation is done through a minimally invasive approach, it is important to exteriorize the proximal bowel through a specimen extraction incision to enable the operator to feel the proximal colon in order to determine the area of appropriate bowel transection.
5. *Always test the anastomosis*. Whether the procedure is minimally invasive or open, testing the anastomosis can easily be done by performing a proctoscopy and insufflating air into the rectum under direct visualization of the anastomosis in a pelvis filled with water. Check to ensure the anastomosis is airtight, while the colon just proximal to the anastomosis is occluded either with the surgeon's hand or with a surgical instrument. In constructing the anastomosis, it is

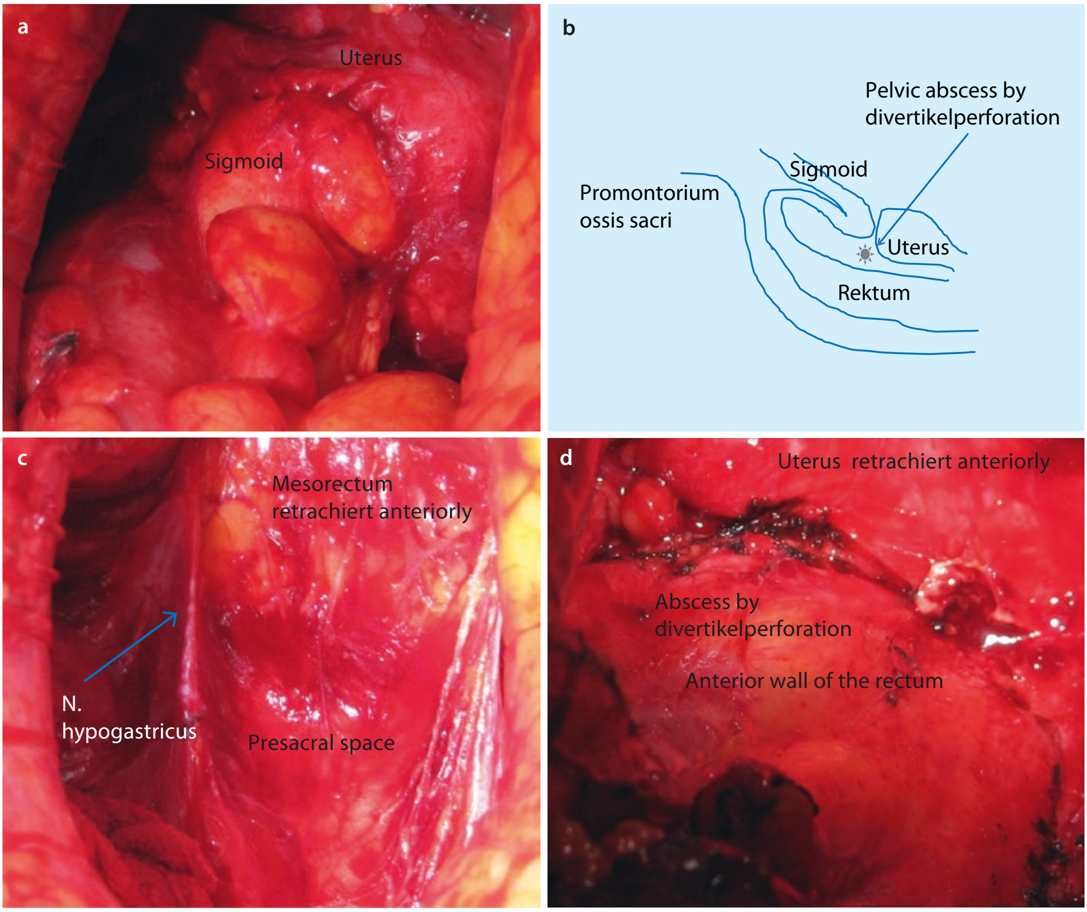


Fig. 37.1 **a** Woman with symptomatic diverticular disease following robotic oophorectomy. The uterus and tubes have become densely adherent to the proximal sigmoid colon without a clear plane, particularly on the patient's right side. **b** Schematic representation of anatomy. **c** Same patient as approached from the presacral space, showing clear planes without inflammation in this area. **d** Further dissection revealed an abscess between the anterior rectum, uterus, and sigmoid colon

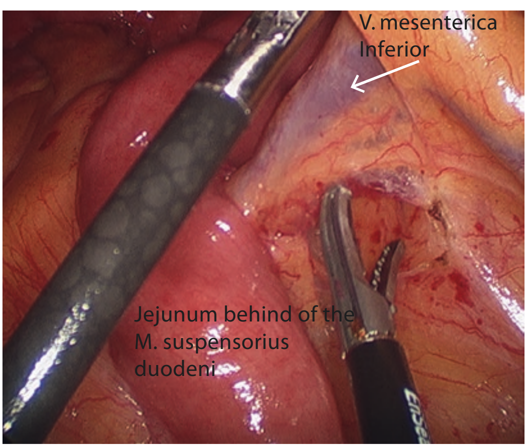
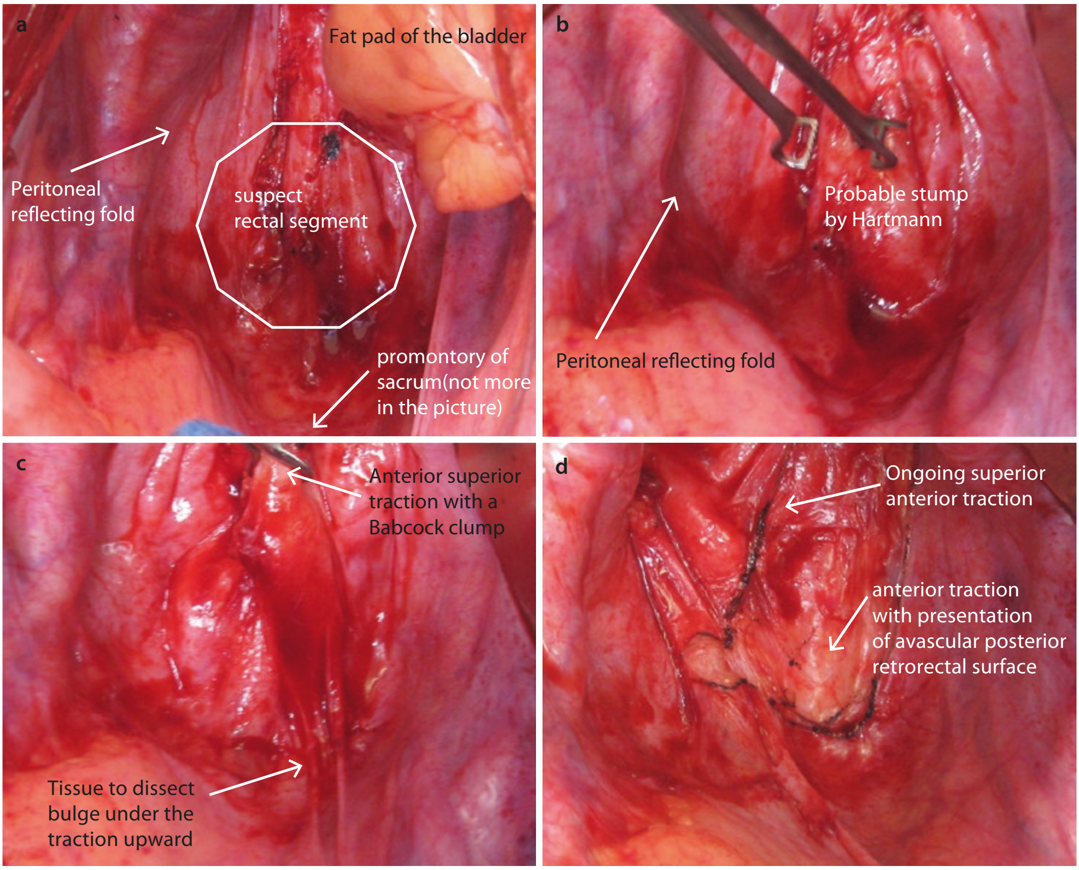


Fig. 37.2 Medial-to-lateral mobilization in cases of severe pelvic inflammation. Here, the inferior mesenteric vein is shown adjacent to the ligament of Treitz prior to beginning retroperitoneal mobilization of the colon

important to assure that there are no diverticula at the proximal staple line, since this will also result in a weakness of the anastomosis at this point and a greater tendency for leak.

37.3 Technical Difficulties During Reestablishment of Intestinal Continuity

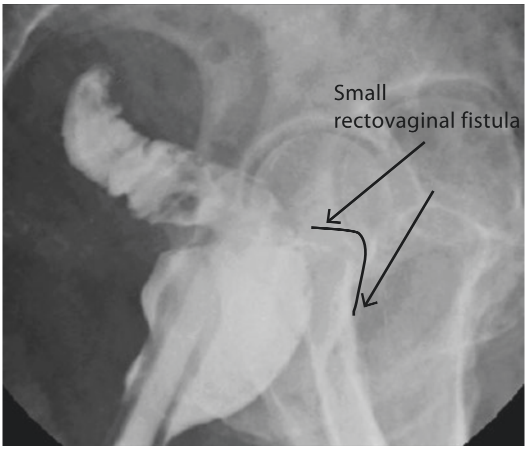
Reestablishment of intestinal continuity in patients with complicated diverticular disease can be particularly challenging, especially in those who have had pelvic sepsis and prolonged hospital stays. This is especially true in patients with an extremely short Hartmann stump and significant pelvic adhesions. In these cases, the



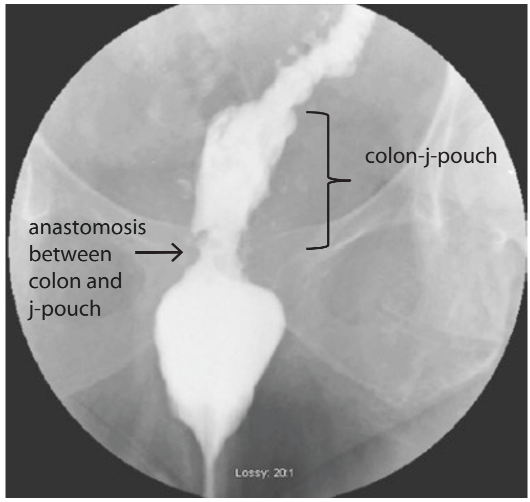
◘ **Fig. 37.3** **a** View of the presacral area following prior surgery for diverticulitis by another surgeon. Note the very short Hartmann stump. **b** In order to aid in identification of the rectum, a long Babcock clamp is placed on the tissue where it is suspected that the rectal stump may be located and superior-anterior traction is applied. **c** This traction causes the tissues that need to be divided to tent upwards. These tissues are divided using the electrocautery and traction used to help identify the correct plane posteriorly. **d** The posterior plane has been identified, and superior-anterior traction is continued as the dissection continues laterally and anteriorly

bladder and vagina tend to descend posteriorly and cover the Hartmann stump like a cap. The rectum can be particularly difficult to identify and the other organs very easy to injure. The common practice of placing polypropylene sutures for identification of the rectal stump is of little use. An easy aid in identifying the Hartmann stump is to place a Babcock clamp on the tissue in the presacral space and lift upward with vertical traction. Electrocautery is then used to score the posterior tissue and enter the presacral space. In this manner, the mobilization begins posteriorly before starting the more difficult anterior mobilization (◘ Fig. 37.3).

In female patients whose initial surgery has been performed by another surgeon, it is very important to include an endoscopic examination of the vagina in order to exclude the presence of a vaginal fistula. A pelvic abscess may sometimes spontaneously drain through the vagina, and this is sometimes overlooked. Conversely, in patients with an existing colovaginal fistula, this is sometimes unintentionally left in situ by the surgeon (◘ Fig. 37.4). These can still be persistent and need to be corrected at the time of the colostomy reversal. If more than one-half of the rectum has been resected, in consideration of improving postoperative functional results, it is important to create a colonic reservoir, such as a J-pouch when reestablishing intestinal continuity (◘ Fig. 37.5). This is particularly true in elderly patients or those with decreased mobility. Such a colonic J-pouch is constructed with standard 5-cm limbs. At the time of primary surgery and also secondary



■ **Fig. 37.4** Woman who had undergone numerous procedures for diverticular disease, now presenting for colostomy takedown. Endoscopic examination as an outpatient had suggested the presence of a rectovaginal fistula, which was confirmed on a radiologic contrast study



■ **Fig. 37.5** Elderly, frail patient with significant rectal resection at prior surgery for diverticulitis, reconstructed with a colonic J-pouch rectal anastomosis. Shows contrast study prior to closure of temporary loop ileostomy

surgery, I do not hesitate to use temporary loop ileostomy diversion. This is easy to close, particularly if hyaluronate film is applied around the loops of the ileum used for the stoma at the time of its creation.

Reference

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Surgical Technique and Difficult Situations from Jakob R. Izbicki

Jakob R. Izbicki and Kai Bachmann

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38.1 Timing an Indication of the Operation

The selection of the procedure and the timing of the intervention in diverticulitis are varying extremely between different centers which is rarely found in any other disease. Concerning the operation, it has to be distinguished between elective and emergency procedures. The presence of perforated diverticulitis is an absolute indication for surgical intervention, while the indication for surgery in chronic recurrence of diverticulitis is discussed controversial as the operation is not focusing on the treatment of an acute inflammation but on the prevention of recurrence with potential complications. The risk of recurrence is 5–43 %.

A complicated course of the disease with abscess, fistulas, or perforations, requiring surgical intervention, was found in 15–20 % of the patients. The treatment of those patients is associated with a considerable morbidity and mortality, in perforated patients up to 30 %. This has to be in balance to the perioperative risk of elective resection with a morbidity of 15–20 and mortality of 0–17 %. The assessment of these facts leads to controversial point of view regarding the optimal timing of the resection; the majority of experts recommend the resection after the first to fourth attack. Another problem is that no definition of an acute attack exists, resulting in the question if the history of pain in the left lower quadrant or proof of diverticulitis by CT scan or colonoscopy is necessary for the statement that an attack is present.

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The "American Society of Colon and Rectal Surgeons" recommends a decision case by case for the indication of surgical resection in diverticulitis. In patients with complicated, non-perforated diverticulitis, the indication for resection is seen after the first episode of diverticulitis, as a correlation of the severity of the attack and the risk of recurrence and complicated courses including perforations were described.

The elective sigmoid resection was traditionally performed 6–8 weeks after an acute attack and initial antibiotic treatment. During the last years, the early elective resection was established as an alternative. After 2–5 days of antibiotic treatment, the resection is performed minimally invasive.

The outcome of both approaches is comparable, while the early elective resection is associated with an increased rate of complications. But in patients with complicated non-perforated diverticulitis, it has to be considered that the risk of need of urgent surgery due to perforation within the waiting period of 6–8 weeks is relevant.

38.2 Tactics of the Operation

In patients with non-perforated diverticulitis, the laparoscopic resection is the gold standard. Single-incision laparoscopic surgery (SILS) or NOTES procedure are described but at present not the therapy of choice. In patients with perforated diverticulitis with peritonitis, open access is indicated.

Independently from the access to the abdominal cavity, a decision has to be made for primary anastomosis, anastomosis with loop ileostomy, or Hartmann's procedure.

38.3 Loop Ileostomy

The loop ileostomy can reduce the clinical impact of anastomotic leakage leading to a lower operative re-intervention rate, as the patients remain clinical stable, but the loop ileostomy cannot reduce the number of anastomotic leakages after descendorectostomy.

It has to be considered that a second operation is necessary for the reversal of the loop ileostomy, which is associated with complications especially anastomotic leakage as well. Additionally the impairment of the quality of life during the presence of the ileostomy must be taken in consideration, and the increased risk of dehydration with acute renal failure is relevant. Due to higher rates of complications of a reversal procedure, a loop colostomy is not recommended.

38.4 Hartmann's Procedure

The Hartmann's procedure without reconstruction of the continuity is associated with shorter operating time and lower risks. It prevents from the development of an anastomotic leakage, as no anastomosis is performed. But the risk of an insufficiency of the rectal stump and higher rate of complications of reversal operation compared to loop ileostomy have to be pointed out.

In summary the indication for the Hartmann's procedure are the presence of perforated diverticulitis with fecal peritonitis with planned abdominal lavage or septic shock or patient's associated factors such as incontinence, or very old, immobile and in need of care patients, where not reversal of a stoma will be performed.

38.5 Laparoscopic Sigmoid Resection

The laparoscopic sigmoid resection is normally performed in general anesthesia, and an epidural catheter is placed to ensure fast recovery and mobilization according to a fast track concept. Patients were operated in lithotomy position with pads at the shoulders, allowing a Trendelenburg position during the operation. Previous to incision of the skin, cefuroxime (1.5 g) and metronidazole (500 mg) were administered as antibiotic prophylaxis.

The surgeon and assistant stand on the right side of the patients. The optic trocar (10/12 mm) is placed 2 cm above the umbilicus. After installation of the pneumoperitoneum, a camera is inserted and an explorative laparoscopy is performed. The local situation of the sigma is evaluated as well as signs of abdominal malignancies, especially at the liver and peritoneum. After exploration and decision for laparoscopic preparation, additional trocars (5 mm right upper quadrant and 10 mm right lower quadrant and 5 mm left lower quadrant) were placed.

The sigmoid colon is moved with atraumatic grasper to medial. The lateral adhesion to the abdominal wall of the colon was mobilized in the vessel-free layer with the harmonic scalpel. The preparation is continued to the left flexure, which is mobilized as well. The extent of the mobilization is depending on the length of the colon and extent of the diverticulosis.

After that, the mobilization is continued caudal to the upper third of the rectum. The left ureter is identified and secured with a yellow vessel loop. Adhesions to the bladder, abdominal wall, and adnexa are mobilized; after that, the mesosigma is dissected close to the colon. The sigmoid artery and vein are identified and selectively transected with a scissor between titan clips (two central, one distal).

The preparation is supported by the assistant by pulling the sigma to the abdominal wall by placing a grasper below the mobilized part of the colon. The preparation is continued to the upper rectum. After incision of the peritoneum, the mesorectum is dissected. The superior rectal vessels are indented and closed with titan clips and cut through. The fatty mass dorsal of the rectum is dissected to the gut wall, and the wall of the upper rectum is identified circular, below the lower end of the diverticulosis. It is important to resect the high pressure zone of the rectosigmoid junction. The extent of the resection should be the same in open and minimally invasive surgery.

After complete dissection, a transverse transection of the rectum is performed with a curved Endo GIA stapler (blue), which is introduced in the 10 mm trocar in the right lower quadrant. After that, the planned proximal transection line of the colon is transposed to the transection line of the rectum to test that this is possible without tension. Otherwise the left flexure/transverse colon was mobilized additionally. After ensuring a tension-free transposition, a grasper is placed at the planned transection line and secured. The pneumoperitoneum is blown off, and the incision of the 10 mm trocar in the lower right part is enlarged to medial to 4 cm including a transection of the rectal muscle. A circle enforced wound protection sheet is placed and the colon with the grasper is moved to the incision and the sigmoid is pulled out of the abdominal cavity.

The colon is closed with a soft clamp and transected with the diathermia. A tobacco pouch is laid around with Prolene 2/0 (ensuring enough serosa is used), and die head of a circular stapler (CEEA) is introduced. The tobacco pouch is closed and sutured. The clamp is removed and the colon is repositioned into the abdominal cavity. The incision is closed with Vicryl. After restoration of the pneumoperitoneum, the colon is placed to the rectum to test the tension-free position.

Transanally the circular stapler CEEA is introduced (generally 31 mm), to ensure sufficient lumen and avoid stenosis. Under direct view to the end of the rectal stump, the spike is moved out close to the brackets of the transection line, while the gut wall is stabilized with the laparoscopic grasper. The spike is removed and directly recovered out of the abdominal cavity. The spike is connected with the head and under direct view. The colon and rectum are approximate making sure that the gut is not twisted. The circular stapler is closed while the surrounding fat tissue is kept away. After closing the stapler, it is fired and held for a few seconds. It is important to maintain the stapler in a constant position to avoid traction on the anastomosis. After that, the stapler is opened two complete turns and the stapler is removed carefully in circulation movements. The rings of the anastomosis were checked for completeness. The anastomosis is inspected; if indicated, additional sutures are placed laparoscopically. No standard testing for insufficiency is performed.

Finally a lavage of the abdominal cavity and control of hemostasis are carried out. A drain is placed close to the anastomosis. Trocars were removed under direct vision and the pneumoperitoneum is blown off. The fascia and skin are closed followed by sterile adhesive bandage.

38.6 Loop Ileostomy

After completion of the colorectal anastomosis, the distal ileum is identified. 30 cm proximal of the valve of Bauhin, the ileum is crossed below with a grasper and a loop is used to rein the ileum. Both ends are placed in a grasper. After lavage and placement of the drains, the pneumoperitoneum is blown off. At the preoperatively marked position in the right part of the abdominal wall (marked in sitting and lying position), a circular excision of the skin and subcutaneous fat tissue is performed, followed by a crosswise incision of the fascia. The rectal muscle is divided bluntly to medial and lateral, followed by an incision of the dorsal fascia. The orifice should be easily traversable with two fingers. In case of visualization of the epigastric vessel, they should be ligated to avoid bleeding. The selected part of the ileum is extracted in front of the abdominal wall using the placed loop. It is important to avoid twisting of the ileum or tension on the future ileostomy. The discharging channel of the loop ileostomy is placed cranial and the delivering channel caudal. If indicated, a rider is used to prevent a retraction of the ileum.

After normal completion of the operation and sterile draping, the gut lumen is opened with a diathermia. And the loop ileostomy is sutured to the skin in single-stitch technique. A stoma bag is trimmed to cover the skin completely.

38.7 Hartmann’s Procedure

In patients that underwent laparoscopic resection of the sigmoid colon with an existing indication for Hartmann’s procedure, the planned resection margin of the proximal colon is marked with clips or a stitch after transection of the upper rectum with the Endo GIA. The distal end of the sigmoid colon is grabbed with a grasper. After lavage and placement of the drains, the pneumoperitoneum is blown off. At the preoperatively marked position in the right part of the abdominal wall (marked in sitting and lying position), a circular excision of the skin and subcutaneous fat tissue is performed, followed by a crosswise incision of the fascia. The rectal muscle is divided bluntly to medial and lateral, followed by an incision of the dorsal fascia. The orifice should be easily traversable with two fingers. The grabbed end of the sigmoid colon is extracted in front of the abdominal wall.

It is important to avoid twisting or tension on the future colostomy. The colon is transected in the marked area, the specimen is resected, and a terminal colostomy is fixed in single-stitch technique.

A stoma bag is trimmed to cover the skin completely.

38.8 Open Resection of the Sigmoid Colon

An open sigmoid resection is performed in general anesthesia, and an epidural catheter is placed to ensure fast recovery and mobilization according to a fast track concept. Patients were operated in lithotomy position with pads at the shoulders allowing a Trendelenburg position during the operation. Previous to incision of the skin, cefuroxime (1.5 g) and metronidazole (500 mg) were administered as antibiotic prophylaxis.

The surgeon stands on the right side of the patients, the first assistant on the left side, and the second assistant between the legs. A median laparotomy is performed and the local situation of the sigma is evaluated as well as signs of abdominal malignancies, especially in the liver and peritoneum. After exploration and decision for resection, a Bookwalter retractor is placed for optimal exploration. The small intestine is placed in the upper right part of the abdomen.

The colon sigmoid is moved to medial, and the lateral adhesion to abdominal wall of the colon was mobilized in the vessel-free layer with the harmonic scalpel. The preparation is continued the left flexure, which is mobilized as well. The extent of the mobilization is depending on the length of the colon and extent of the diverticulosis.

After that the mobilization is continued caudal to the upper third of the rectum. The left ureter is identified and secured with a yellow vessel loop. Adhesions to bladder, abdominal wall and adnexa are mobilized; after that the mesosigma is dissected close to the colon. The sigmoidal artery and vein are identified and selective sutured. Proximal and distal resection margin were defined. The gut wall is crossed below with an overholt and the colon is transected with a GIA 80 (blue).

The preparation is continued to the upper rectum. After incision of the peritoneum, the mesorectum is dissected. The superior rectal vessels are identified and sutured. The mesosigma is transected close to the wall of the gut. The fatty mass dorsal of the rectum is dissected to the gut wall and the wall of the upper rectum is identified circular, below the lower end of the diverticulosis. It is important to include the high pressure zone of the rectosigmoid junction in the resection. After complete dissection a transverse transection of the rectum is performed with a linear stapler (TEA 45 blue). After that the proximal transection line of the colon is transposition to the transection line of the rectum to test that this is possible without tension. Otherwise the left flexure/transverse colon were mobilized additionally.

After ensuring a tension-free transposition, a clamp is placed to avoid contamination with gut bacteria; the end of the colon is opened with the diathermia and a tobacco pouch is laid around with Prolene 2/0 (ensuring enough serosa is used) and die head of a circular stapler (CEEA) is introduced. In a narrow pelvis, the use of a curved contour stapler is recommended. The tobacco pouch is closed and sutured. The clamp is removed and the colon is placed to the rectum to test the tension-free position. Transanally the circular stapler is introduced (generally 31 mm) CEEA, to ensure sufficient lumen and avoid stenosis. Under direct view to the end of the rectal stump, the spike is moved out close to the brackets of the transection line, while the gut wall is stabilized with manually. The spike is removed and directly recovered out of the abdominal cavity. The spike is connected with the head and under direct view. Colon and rectum are approximated making sure that the gut is not twisted. The circular stapler is closed while the surrounding fat tissue is kept away. After closing, the stapler it is fired and hold for a few seconds. It important to maintained the stapler in a constant position to avoid traction on the anastomosis. After that the stapler is opened two complete turns and the stapler is removed carefully in circulation movements. The rings of the anastomosis were checked for completeness. The anastomosis is inspected, if indicated additional sutures are placed. No standard testing for insufficiency is performed. Finally a lavage of the abdominal cavity and control of hemostasis is carried out. Two easy flow drains are place close to the anastomosis. Closure of fascia and skin followed by sterile adhesive bandage.

38.9 Open Loop Ileostomy

After completion of the colorectal anastomosis the distal ileum is identified. 30 cm proximal of the valve of Bauhin the ileum is crossed below and a loop is used to rein the ileum. Both ends are placed in a clamp. After lavage and placement of the drains a circular excision of the skin and subcutaneous fat tissue is performed at the preoperatively marked position in the right part of the abdominal wall (marked in sitting and lying position), followed by a crosswise incision of the fascia. The rectal muscle is divided bluntly to medial and lateral, followed by an incision of the dorsal fascia. The orifice should be easily traversable with two fingers. In case of visualization of the epigastric vessel, they should be ligated to avoid bleeding. The selected part of the ileum is extracted in front of the abdominal wall using the placed loop. It is important to avoid twisting of the ileum or tension on the future ileostomy. The discharging channel of the loop ileostomy is placed cranial and the delivering channel caudal. If indicated a rider is used to prevent a retraction of the ileum.

After normal completion of the operation and sterile draping, the gut lumen is open with a diathermia. And the loop ileostomy is suture to the skin in single-stitch technique. A stoma bag is trimmed to a cover the skin completely.

38.10 Open Hartmann's Procedure

The resection is previously described. In patients that underwent open resection of the sigmoid colon with an existing indication for Hartman procedure, the planed resection margin of the proximal colon is marked with clips or a stitch. After lavage and placement of the drains, a circular excision of the skin and subcutaneous fat tissue is performed at the preoperatively marked position in the right part of the abdominal wall (marked in sitting and lying position) followed by a crosswise incision of the fascia. The rectal muscle is divided bluntly to medial and lateral, followed by an incision of the dorsal fascia. The orifice should be easily traversable with two fingers. The complete colon sigmoid is extracted in front of the abdominal wall up to the planned upper resection margin.

It is important to avoid twisting or tension on the future colostomy; optimal perfusion of the colon is mandatory. After completion of the closure of the laparotomy and skin, the colon is transected in the marked area, the specimen is resected and a terminal colostomy is fixed in single-stitch technique. A stoma bag is trimmed to a cover the skin completely.

- **Difficulty Level I "Ideal Patient"**

Slim patients, no previous major abdominal surgery, no anticoagulation

- **Difficulty Level II " Nearly Ideal Patient"**

Obese patient, relevant active inflammation

- **Difficulty Level III "Difficult Patient"**

Immunosuppression; previous surgery especially laparotomy, presence of sigmovesical fistula

- **Difficulty Level IV " Very Difficult Patient"**

Adherence of surrounding organs (small intestine, adnexa) in the inflammatory mass

Septic patient with perforated diverticulitis and shock

Patients with severe pulmonary or cardiac disease are not able to be in a Trendelenburg position. Patients with anticoagulation or Plavix

- **Difficult Situation**

Situation: A laparoscopic resection is performed in a 61-year-old patient with recurrent diverticulitis (up to the upper part of the rectum).

Dilemma: After transanal placement and firing of circular stapler, a complete dysfunction of the stapler is detected. The anastomosis is completely insufficient. Fecal contamination of the abdominal cavity.

Management: Immediate conversion to open surgery. Resection of the insufficient anastomosis to proximal and distal with linear stapler. Reanastomosis with new CEEA stapler. Intensive lavage.

Due to deep anastomosis decision for additional loop ileostomy.

Result: Fast recovery of the patients. No postoperative complications. The reversal of ileostomy was carried out contemporarily.

Analysis: The occurrence of severe problems or confusing situations in laparoscopic surgery can be managed by conversion to open surgery. Conversion is no complication; it is a responsible surgery.

Individual Surgery for Rectal Cancer

Contents

Introduction

Michael Korenkov, Christoph-Thomas Germer, and Hauke Lang

M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations*,
DOI 10.1007/978-3-662-49878-1_39

Anterior or low anterior rectal resection with a partial (PME) or a total mesorectal resection (TME) is currently the standard surgical procedures for rectal cancer. These operations will be performed in open or laparoscopic techniques. The basic operation steps are the following:

1. Mobilisation from sigmoid and descending colon
2. Transection of inferior mesenteric artery and vein
3. Transection of descending colon
4. Rectal dissection in PME or TME technique
5. Rectal transection
6. Anastomosis
7. Creation of a protective stoma (optional)

Technical problems and difficult decision situations occur mostly during a ventral rectal dissection, rectal transection as well as by anastomosis creation.

39.1 Low Anterior Resection (LAR) in Open Technique

39.1.1 Approach

A midline laparotomy is a most common approach. Some surgeons prefer a left paramedian laparotomy or a right paramedian laparotomy in case of planned rectal extirpation for reaching a sufficient distance between the laparotomy wound and stoma. In order to reach a maximal access, the aponeurosis should be open till to the symphysis.

Step 1: Sigmoid and Descending Colon Mobilisation

This step is mostly technical unproblematic. Technical problem and difficult decision situation can occur in case of spleen injury as a result of uncareful bowel traction. In order to avoid such situations, laparotomy should be long enough to cranial direction. Combination of rectal cancer and sigmoid diverticulitis can be also a cause for technical difficulties.

Step 2: Transection of Mesenteric Inferior Vessels

This step is also mostly technical unproblematic. Inflammatory or fibrotic retroperitoneal infiltration can make an appropriate dissection between Gerota's fascia and meso significant, more difficult or even impossible. The predisposing factors for such difficulties are previous gynaecological cancer surgery with a para-aortic lymph node dissection and postoperative radiation as well as previous abdominal aorta surgery.

Seldom there is a worst-case combination of rectal cancer and primary retroperitoneal fibrosis. In such situation a preparation technique should be used according to individual requirements. If a pelvic infiltration is less pronounced, we recommend at first to create a retrorectal window below of promontorium and after that perform a colonic mobilisation from the presacral space to cranial direction.

Step 3: Transection of Descending Colon

This step is not related with technical problems and difficult decision situations.

Step 4: Rectal Mobilisation in PME or TME Technique

This part of operation consists of several substeps:

- Exposure of the presacral nerves
- Presacral dissection
- Lateral dissection
- Ventral dissection

The exposure of the presacral nerves requires own technical tips and tricks (see the chapter from W. Kneist).

A presacral dissection is mostly unproblematic. Technical difficulties may occur in case of locally advanced tumours with dorsal penetration. In such situation a "classic" presacral dissection till to the pelvic floor is not possible. If an infiltration of the presacral fascia is suspected, an indication to sacral resection should be evaluated.

Lateral dissection can be difficult because of missing the bordering lamellas and avascular layer. Locally advanced tumours, narrow pelvis as well as a post-radiated infiltration after neoadjuvant radiotherapy are predisposing factors for the technical difficulties.

A difficult decision situation can also occur if the infiltration of the lateral wall of the lesser pelvis is suspected. In such situation a surgeon is facing the dilemma of either R0 resection will be not achieved or an expanded dissection of the lateral wall of the lesser pelvis with possible resection of iliac vein or rather artery should be considered. The last option is related with significantly higher intra- and postoperative morbidity and unexplained survival benefit. Therefore in case of local advanced tumour is the exactly preoperative work-up examination essential for the planning of surgery.

A ventral dissection can be also connected with technical problems and difficult decision situations. Technical steps of this procedure are different for female and male (see a chapter from Ulrich and Buechler). Denonvilliers' fascia, which is applicable as a guide for the ventral dissection, has a lot of anatomic varieties from the well-presented multilayered lamella till to the complete absence of this structure. In the last case, there is increased risk of an accidental opening of rectal or vaginal lumen or rather for accidental removing of the seminal vesicle or autonomic nerves. In order to avoid these complications, the use of rectal and vaginal splinting by female and rectal splinting by male patient can be helpful.

Step 5: Rectal Transection

The rectal transection during low and ultra-low anterior rectal resection is related not seldom with technical problems and difficult decision situations. The following problems can lead to difficult situations:

- Problematic stapler placement
- Not sufficient safe distal resection margin

For the distal rectal transection, different staplers (TA45, Contour Stapler, different Endo GIA) will be used. In case of very narrow and deep lesser pelvis, the use of TA and Contour Stapler can be most problematic. Also the external compression of the pelvic floor can't be always helpful. In such situation, the use of Endo GIA stapler with roticulated branches can be helpful. In order to avoid tangential or z-form rectal transection, the stapler branches should be always placed in 90° position to rectal axis. Sometimes it is also difficult to place a 60-mm stapler in a narrow lesser pelvis. In this situation it is helpful to use a 45-mm Endo GIA for the first cutting and 60-mm stapler for recut. Certainly relates such procedure to higher cost.

A not sufficient safe distal resection margin has a direct relation to problematic stapler placement. In such situation we recommend endoscopic control (flexible or rigid rectoscopy) of stapler position before the transection.

Step 6: Anastomosis

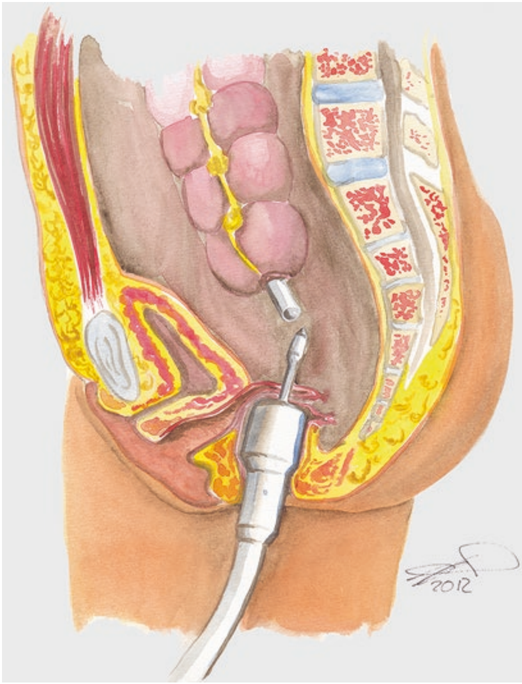
A reconstruction after low anterior resection can be performed as end-to-end, side-to-end, colon j-pouch as well as transverse coloplasty anastomosis. Creation of colon j-pouch anastomosis can be problematic for patients with a fatty mesocolon or very narrow deep lesser pelvis. Technical problems and difficult decision situation can occur in the following cases:

- Problematic tension-free placement of the colon in lesser pelvis
- Poor blood flow in anastomotic colon
- Rupture of rectal stump staple line during transanal introduction of stapler
- Accidental involvement of the vagina into the stapler line

Despite of an adequate mobilisation of the splenic flexure, a tension-free placement of the colon in lesser pelvis by some patients is not possible. Such problem can take place in obese patients. In this situation, a transverse colon should be further mobilised towards the right flexure. Sometimes it is necessary to transect the middle colic vessels. Such a situation can lead to a vicious circle: further transverse colon mobilisation can lead to a new insufficient blood flow in the distal colonic segment. This required recut of the distal colon that can lead to a new problematic tension-free placement of it. Such a situation requires special surgical skill and great experience. Sometimes a temporal cross-clamping of the middle colic vessels can be useful to estimate a surgical situation.

A rupture of the rectal stump staple line during transanal introduction of the stapler is unpleasant but a solvable problem. To avoid this situation, we recommend the following measures:

- Transanal introduction of a circular stapler before the rectal transection. Thereby a jerky stapler introduction in a very short rectal stump will be avoided.
- In case of ultra-low transection, the use of Contour Stapler should be avoided. There is no tissue overage above a staple line after cutting with this stapler that can reduce a holding force of a stapler line (the personal opinion of one of the authors).
- Severe adhesion process in lesser pelvis after amputation of the uterus. In this case there is a risk of vaginal wall interposition between stapler head and anvil with creation of "colovaginorectal" anastomosis (◘ Fig. 39.1). In order to avoid this serious complication, it is an obligation to make sure that there is no tissue interposition between the stapler components



◘ **Fig. 39.1** Accidental involvement of the vagina into the stapler line during the creation of descendorectal anastomosis

before the stapler firing. In an uncertain situation, it is sometimes helpful to introduce intravaginally a Hegar's dilatator or perform a vaginoscopy before the stapler firing.

Step 7: Creation of a Protective Stoma

Loop ileostomy or loop transversostomy will be created as a protective stoma. We consciously avoid a discussion about advantages and disadvantages of both types of protective stoma. Creation of a tension-free and well-vascularized stoma can be difficult in obese patients with a short fatty meso. In order to reduce a distance between the peritoneum and skin level, it is helpful to sew the fascia or even skin with the peritoneum. If these steps remain successless, we recommend to waive a creation of a loop stoma in favour of double-barrel stomas.

39.2 Low Anterior Resection (LAR) in Laparoscopic Technique

The technical performance of LAR in laparoscopic technique is more difficult than in open approach. Nevertheless the laparoscopic technique is suitable for patients with local advanced tumours.

Technical steps of laparoscopic approach are similar to an open technique; however, there are some technical peculiarities and pitfalls. Technical problems and difficult decision situations can occur in the following situations:

- Overlay of lesser pelvis with intestinal loops
- Problematic finding of correct preparation plain for the dissection of inferior mesenteric artery
- The loss of orientation in mobilisation of the splenic flexure
- Inadequate placement of linear stapler during the rectal transection

In spite of extreme Trendelenburg position and right lateral tilt up to 30°, it is not always possible to reach a clear view in the lesser pelvis. As a measure for improvement, we recommend to check a situs of the terminal ileum. Sometimes the terminal ileum is fixed through embryonal or acquired adhesions in the lesser pelvis. As a result the cranial shift of small bowel loops is impaired. In some cases, an additional assistant should be called, and additional trocars for the grasping and use of bowel retractor should be introduced.

Appropriate anatomical dissection between the posterior wall of inferior mesenteric artery and Toldt's fascia can be difficult in obese patients or in case of inflammatory or fibrotic infiltration. Diffuse bleeding and poor visibility in this plain can be cause for the conversion to an open approach.

The mobilisation of splenic flexure in very thin or severely obese patients can be related with problem of orientation and dissection in a wrong plain. An accidental creation of a mesocolon window can significantly reduce the blood supply to the corresponding bowel segment. In order to avoid such situation, it is sometimes helpful to open the omental bursa and mobilise the splenic flexure from transverse to descending colon. This step requires sometimes a placement of additional trocar in the upper abdomen or use of extra long laparoscopic instruments.

A rectal transection in low-seated tumours is difficult. Roticulating linear stapler will be used in laparoscopic approach. In case of a low rectal cancer, it is most commonly not possible to place stapler jaws along the entire length at right angle to the rectum. The rectum will be transected in more steps. Thereby it is important to avoid a stepped or

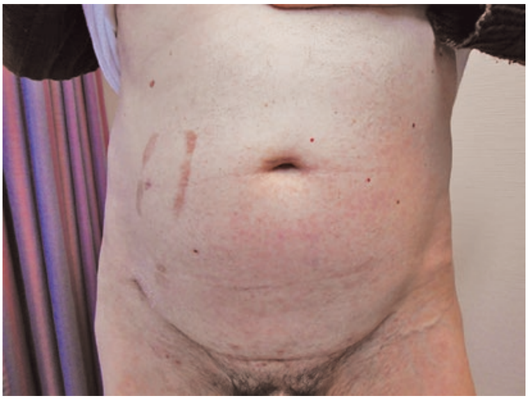


Fig. 39.2 Postoperative scars after an ultra-low anterior rectal resection in a "hybrid technique"

zigzag running staple line. It is also important to control a safe distal resection margin after every staple firing. Putting the stitch markers on the transection line or placement of stapler jaws under rectoscopic or digital control can be useful. For the performance of the low rectal transection, a suprapubic placement of 12-mm trocar is obligatory. In some situations especially in patients with very narrow and deep lesser pelvis, it is not possible to perform a safe rectal transection. In such situations, we recommend to perform a suprapubic laparotomy (so-called hybrid approach) and use TA45 or 45-mm linear stapler (Fig. 39.2).

39.3 Rectum Extirpation

The intra-abdominal steps are similar to laparoscopic or open LAR technique. Additional a based on the left gastroepiploic vessels pedicled flap of omentum to fill a lesser pelvic defect will be created. Diffuse bleeding or thermic injury of transverse colon can occur during the laparoscopic detachment of the greater omentum from the transverse colon.

The extra-abdominal part of operation will be performed through perineal or sacral approach. Standard and extra-levatoric techniques will be used in the perineal approach. The special technical features of the abdominoperineal rectum extirpation are presented in the following chapters. We believe that the sacral approach should be used only in cases of locally advanced or locally recurrent rectal cancer with a growth trend towards dorsally because of much more extended wound cavity and much more difficult wound closure.

39.4 Classification of Intraoperative Difficulties

The operative difficulty in the surgery for rectal cancer can be classified as summarised in Table 39.1.

Table 39.1 Grading of operative difficulties in the surgery for rectal cancer

Grading	Case type
I (ideal cases) It is easy to operate; every operative technique is technically unproblematic	Slender or normal weight patient No previous major abdominal surgery
II (not quite ideal) Some minor technical difficulties may occur; some operative techniques can be more difficult as other	Moderate obese patient (BMI around 30 kg/m^2) Otherwise similar to grade I
III (problematic) Difficult to operate, some operative techniques are considerably more difficult than others	Overweight patient (BMI >35 kg/m^2) Patients with local advanced tumours of low rectum Previous gynaecologic oncology surgery especially in combination with radiotherapy Previous radical prostatectomy
IV (very problematic) Every operative step is very difficult	Extreme form of grade III factors

Surgical Technique and Difficult Situations from Matthias Anthuber

Matthias Anthuber

M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations*,
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40.1 Introduction

According to today's literature, primary rectal cancers that have not yet infiltrated into adjacent organs can successfully be resected laparoscopically. The lead surgeon has to be well trained and experienced in minimally invasive procedures and techniques. Although minimally invasive, the laparoscopic approach has to equally follow all principles of cancer surgery that are well established for the open approach. The surgical steps for every procedure are defined preoperatively and can vary according to the training the lead surgeon went through. However, these variations in surgical steps should neither influence the early postoperative results nor the oncological long-term results.

40.2 Preparations

For the laparoscopic approach, the safe positioning (modified lithotomy position) of the patient is of utmost importance. Since the procedure involves extreme positioning maneuvers of the operating table, the patient has to be fixated very well. The positioning maneuvers of the operating table must be tested before draping the patient to make sure that he does not shift or slide. To avoid positioning injuries (e.g., neck plexus injuries or compartment syndrome of the lower extremities), vulnerable body parts should be especially patted to be immobilized. The use of a vacuum mattress and a silicone cushion is helpful with securing particularly exposed body parts. The safe positioning of the patient is of such significance because the extreme table maneuvers and the consecutive movement of the organs following gravity are crucial to the success of the procedure. Next to the colleague handling the camera, gravity is the surgeon's most important assistant (◘ Fig. 40.1).

- The surgeon and his camera assistant are positioned at the right side of the patient. A second assistant is only needed later during the procedure for the transanal anastomosis. The laparoscopic tower and ideally two monitors are placed opposite of the surgical team. The scrub nurse is standing at the patient's legs at the right side of the operating team.

◘ **Fig. 40.1** Safe positioning of the patient on a vacuum mattress and testing of extreme positioning maneuvers before draping the patient

- After a standardized team time-out, the procedure begins with the placement of the first 12 mm trocar. It is placed through the left rectus abdominis muscle, two fingers cranial and one finger left of the umbilicus. The pneumoperitoneum should not exceed a maximum pressure of 12 mmHg.
- Using a 30° laparoscope, all other trocars can now be placed under vision: one 10 mm trocar in the right upper quadrant, another 12 mm trocar in the right lower quadrant, and one 5 mm trocar in the left lower quadrant.
- All four abdominal quadrants should be carefully inspected to exclude pathological findings which may have been missed by former diagnostics.
- The patient is now put into the Trendelenburg position and turned to his right side.

40.3 Surgical Technique

- The small bowel has to be shifted into the right upper abdominal quadrant. The greater omentum is turned over and also put into the upper abdominal quadrants.
- The first important anatomical landmark is the promontory. It can best be exposed by pulling the sigmoid mesocolon with an atraumatic grasping forceps up toward the abdominal wall and toward the patient's feet (◘ Fig. 40.2).
- With a 5 mm ultrasonic dissecting device (e.g., Ultracision Ace, Johnson & Johnson,

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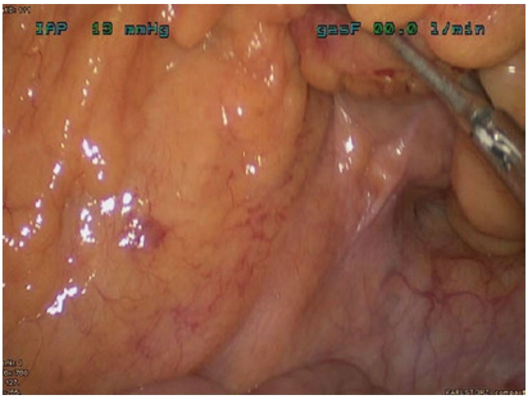
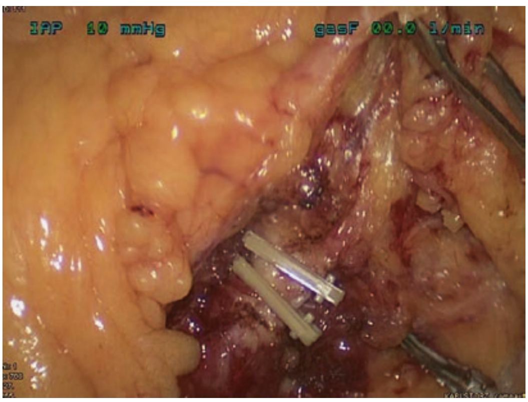


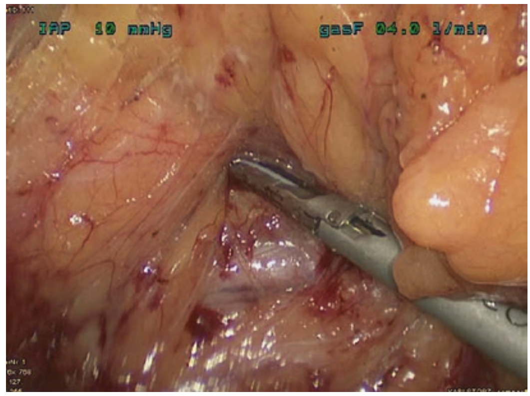
◘ **Fig. 40.2** View from the patient's right side onto the sigmoid mesocolon stretched over the promontory



◘ **Fig. 40.3** Transection of the inferior mesenteric artery after ligating the vessel with absorbable clips

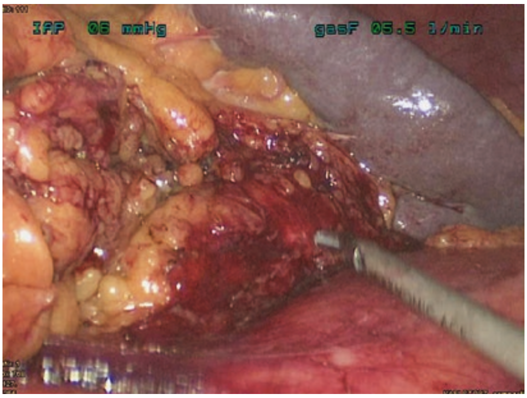
Norderstedt), the peritoneum of the sigmoid mesocolon is being incised just above the promontory. The dissection is performed with a ventral distance of 1 cm to the infrarenal aorta up to the takeoff of the inferior mesenteric artery.
- The inferior mesenteric artery has to be clipped with a distance to the aorta of at least 1 cm using resorbable clips and can then be transected (◘ Fig. 40.3).

The mentioned distance of 1 cm to the aorta is important to avoid injuries to the superior hypogastric plexus of the autonomous nerve system.
- Lateral and cranial of the artery the inferior mesenteric vein can be found. This vessel is normally running lateral of the ligament of Treitz toward and behind the corpus of the pancreas. It should be clipped and transected at the lower border of the pancreas.

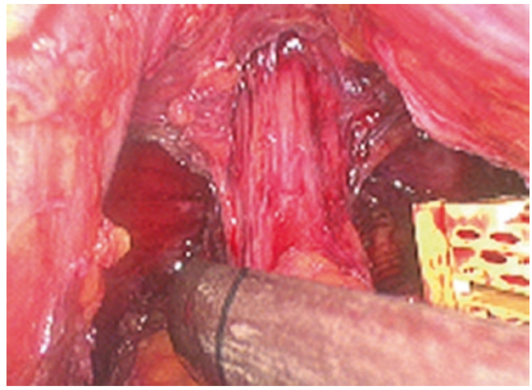


◘ **Fig. 40.4** Identification of the left ureter from medially

In patients that are very skinny, the spermatic or ovarian vein, which are running retroperitoneally, can easily be mistaken for the inferior mesenteric vein.
- Dissecting from medial to lateral, the left ureter and the left Gerota's fascia should now be identified (◘ Fig. 40.4).
- Starting at and staying close to the posterior wall of the distal part of the transected inferior mesenteric artery, the dissection is continued caudally to mobilize the sigmoid mesocolon all the way to the mesorectum. The preaortal autonomous nerve system has to be preserved.
- Only after this step, the left hemicolon is being mobilized from laterally up to the splenic flexure. Thus the surgeon prevents the left hemicolon from falling from lateral to medial obstructing the view to the central vessels as described above. The left ureter, earlier identified from medially, should also be seen from laterally.
- Respecting the anatomical layers, the descending mesocolon has to be completely removed from the left Gerota's capsule.
- The splenic flexure has to be mobilized completely. To make this step easier, the patient is turned into a reverse Trendelenburg position.
- After exposing the inferior splenic pole, the pancreatic tail has to be laid open. Ventral of the pancreatic tail and medial of the spleen the gastrocolic ligament has to be transected all the way to the gastric corpus and fundus. Additionally, the gastrocolic ligament has to



■ **Fig. 40.5** Opened lesser sac after complete mobilization of the splenic flexure



■ **Fig. 40.6** Positioning of the laparoscopic linear stapling device below the mesorectum for the transection of the distal rectum

be taken down from the distal transverse and the descending colon. The lower sac is being laid wide open exposing the pancreas, the spleen, and the back wall of the stomach (■ Fig. 40.5).
- The mesocolon at the lower border of the pancreatic body is being dissected from left to right up to the middle colic vessels.
- The transverse and descending colon can now be brought far down to the pelvis without any tension.
- The dissection is now continued in the pelvis. The mostly well-sized hypogastric nerves can be visualized below Waldeyer's fascia by consistently dissecting alongside the posterior wall of the transected inferior mesenteric artery.

The ultrasonic dissecting device must not be used to closely to the nerves to avoid thermal injuries.

- The rectum is transsected using a laparoscopic linear cutting stapler with a minimal distal margin to the tumor of 0.5–1 cm (■ Fig. 40.6).

Transanal hand-sewn anastomosis can be necessary in ultra-low intersphincteric resections. In such a case, special retracting systems with elastic stays (e.g., Lone Star® retractor) are very helpful for optimal exposure.

40.4 Difficult Situations

Case 1

Situation

62-year-old male patient, primary rectal cancer 6 cm from anal verge (uT3, uN1, cM0), no significant comorbidities, and status post radiochemotherapy. During the procedure (laparoscopic anterior rectum resection) an injury to the spleen occurred while mobilizing the splenic flexure.

Problem

Severe bleeding from the injured spleen. The mobilization of the splenic flexure could not be continued due to bleeding an impaired view.

Solution

Via the 12 mm trocar, two swabs were inserted. The swabs were placed directly at the splenic laceration, and pressure was applied with two 10 mm grasping forceps over a period of 5 min. After having achieved hemostasis, the swabs were left in situ and removed at the end of the procedure.

Result

The bleeding stopped spontaneously. To additionally secure the result, a fibrin covered sealant patch was applied onto the laceration.

Analysis

Not every severe bleeding requires prompt conversion. Local hemostatic measures combined with the surgeon's patience are often successful.

Case 2

Situation

68-year-old male patient, normal body weight, rectal cancer 7–9 cm from anal verge between 2 and 6 o'clock (uT3, uN1), no significant comorbidities, and status post preoperative chemoradiotherapy. It is discovered intraoperatively that the tumor was attached to the left seminal vesicle.

Problem

It is impossible to differentiate intraoperatively between a peritumoral inflammation and a tumor infiltration.

Solution

En bloc resection of the left seminal vesicle and proximal part of the left vas deferens together with the rectum

Result

Pathohistologically no infiltration of the tumor into the seminal vesicle could be seen. However, there was a peritumoral inflammation with desmoplastic reaction after radiochemotherapy.

Analysis

In the laparoscopic approach, just as with the open approach, potentially infiltrated adjacent organs have to be resected en bloc. That does not necessarily involve a conversion, as long as the surgeon has the expertise to perform such advanced laparoscopic resections oncologically adequate.

Case 3

Situation

62-year-old female patient, rectal cancer 8 cm from anal verge (uT2, cN0, cM0), no significant comorbidities, and except for a large uterus.

Problem No. 1

The large uterus impaired the view into the pelvis.

Solution

Using a strong nonabsorbable 2–0 surgical suture, the uterus is fixated to the ventral abdominal wall. The suture runs through the wall of the uterus, perforates the abdominal wall suprapubically, and is tied there over a swab (to avoid pressure injuries of the skin).

Result

With the fixation of the uterus to the ventral abdominal wall, the view into the pelvis is.

Problem No. 2

Subtotal opening of the rectal stump stapling line by forced transanal insertion of the circular stapler into the rectal stump for the anastomosis at 5 cm from the anal verge.

Solution

Further mobilization of the rectal stump and resection of an additional 1.5 cm of the distal rectum with two laparoscopic linear cutting staplers. The mini-laparotomy was reopened to retrieve the additionally resected part of the rectal stump. Irrigation of the pelvis. In a second attempt, the transanal circular anastomosis could successfully be fashioned. At the end the suture of the uterus was cut.

Analysis

An impaired view into the pelvis because of the uterus can be improved by fixating the uterus to the ventral abdominal wall. A subtotal opening of the rectal stump while inserting the circular stapler has to be treated by further mobilization of the rectal stump and resection deeper down. If a deeper mobilization is impossible and there is no more space for the stapling device in the rest of the rectal stump, a hand-sewn coloanal anastomosis has to be fashioned.

40.5 Classification of the Intraoperative Difficulties

We classify the intraoperative difficulties in laparoscopic rectal surgery.

Surgical Technique and Difficult Situations from Markus W. Buechler (Conventional)

Alexis Ulrich, P. Antony, and Markus W. Buechler

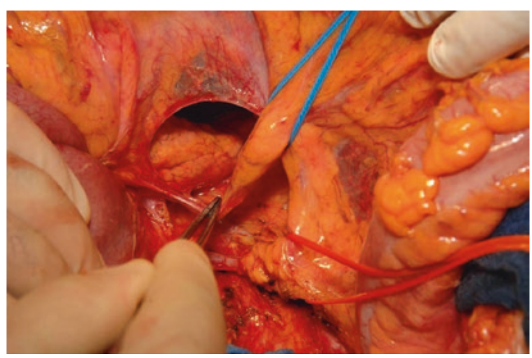
M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations,*
DOI 10.1007/978-3-662-49878-1_41

The current gold standard for oncological resection of tumors derived from the middle and lower rectum remains the total mesorectal excision (TME). In contrast, tumors derived from the upper third are often treated with a partial mesorectal excision (PME). In cases where a PME is planned, care must be taken to ensure a minimum distance of 5 cm between tumor border and excision margin. In addition, the bordering lamella of the entire resected tissue must be excised without damage, and a coning of the perirectal tissue should be avoided. This is of particular importance because lymph node metastases extending up to 5 cm distal to the lower border of the tumor have been described (Heald). In cases where a deep anterior rectum resection with complete removal of the mesorectal tissue is performed, a tumor-free border at the excision margins is adequate and allows sphincter function to be preserved.

In the following chapter, we present our standard operating protocols for high, middle, and deep tumors that allow for the preservation of sphincter function. The abdominoperineal rectum extirpation, used in cases of tumor infiltration of the external sphincter or levator muscles, is described elsewhere.

The patient is positioned in the extended lithotomy position and prepped for surgery. Thirty minutes after the administration of antibiotics, a long midline incision from the xiphisternum to the symphysis pubis is made to the left of the navel. The borders of the fascia are covered with abdominal cloths, and a self-retaining retractor is employed. Thereafter, a thorough laparotomy is performed, looking, in particular, for liver metastases, lymphadenopathy, as well as intra-abdominal spread. The initial steps of the operation are generally independent of tumor localization. Using a damp abdominal cloth, the small bowel is packed away into the right upper quadrant, and mobilization of the left hemicolon can begin. The surgeon divides the adhesions between the colon on the left lateral wall to expose the peritoneal reflection. This process continues to the base of the mesocolon until the superior rectal artery, located in the "pedicle package," is encountered. Here, particular care must be taken to avoid injury to the hypogastric nerve. If done correctly, the Gerota fascia remains intact, and the ureter is swept laterally and need not be manually retracted. At this stage, the ureter is easily identifiable through the fascia. The plane of dissection is extended further, mobilizing the entire left colon upto the midline until the splenic flexure is reached, destroying the so-called double-barrel phenomenon in the process. At this point, particular care must be taken in order to avoid excessive traction on adhesions between the omentum and the splenic capsule, as this can easily lead to tearing and severe bleeding. Such traction can be easily avoided if the principal force is applied by the assistant away from the colon and in the direction of the spleen. In this case, the colon itself is merely held in position rather than mobilized. Similarly, care should be taken when dividing mesocolonic adhesions from the lower margin of the pancreas in order to prevent injury.

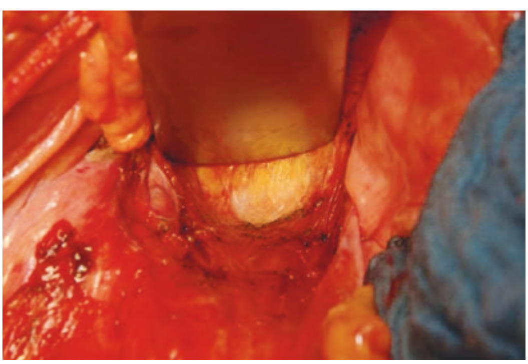
Our focus then shifts to the central vascular structures. Further dissection leads to the inferior mesenteric vein, which is secured, ligated, and divided at the inferior border of the pancreas, close to its point of origin (◘ Fig. 41.1). Thereafter, the inferior mesenteric artery is exposed, ligated, and divided approximately 1 cm distal to its point of origin. In this manner, injury to the hypogastric plexus is avoided (◘ Fig. 41.1). The arterial stump is ligated with a 2-0 non-resorbable monofilament suture. Because the "pedicle package," along with the superior rectal artery, has already been exposed during lateral mobilization of the colon, dissection into the plane between rectum and sacrum is easy. At its lower border, the superior rectal artery is embedded in the border lamella which, more distally, serves as the border to the mesorectal tissue. This pelvic fascia has been affectionately called the "holy fascia" by Bill Heald. Before, however, the mesenterial excision



◘ **Fig. 41.1** Ligation of the inferior mesenteric vein (*blue*) at the lower border of the pancreas and ligation of the inferior mesenteric artery (*red*) 1 cm from its origin can be carried out, the resection borders must be established. This must be done in a manner that later allows for a tension-free anastomosis. To aid in this endeavor, the mobilization of the left hemicolon is completed up to the branching point of the middle colic arteries, thereby ensuring maximum mobility.

The mesentery is divided up to the colonic wall, making sure that the ligated trunks of the inferior mesenteric artery and the superior rectal artery remain attached to the resection specimen, as the relevant lymph nodes are found along the course of these vessels. In addition, it is important to ensure that the vascular arc adjacent to the intestinal wall is not compromised, to guarantee optimal blood circulation to the remaining intestine. In order to do so, it is often useful to first sever the vessels of the vascular arc at the resection site with scissors in order to ensure adequate arterial circulation. Thereafter, the bleeding vessels can be sutured.

Now, we are able to devote our attention to the operation in the pelvis. The colon and the small intestine loops are removed from the pelvic entrance. In order to facilitate further preparation, the surgical assistant becomes indispensable. The tissue is pulled firmly forward clearly demarcating the plane between the pelvic fascia and presacral tissue. The preparation then ensues directly along the border to the pelvic fascia in order to prevent damage to the hypogastric nerve, which often runs along the lateral pelvic wall near the border lamella (◘ Fig. 41.2). At this stage, we prefer the use of unipolar electrocoagulation. First posterior dissection progresses to the apex of the sacrum, and then dissection moves to the right and left of the rectum. Here, it is often difficult to adequately expose the border lamella, and dissecting laterally from a dorsal position while firmly pulling the rectum in the opposite direction facilitates identification of the correct plane. Here again, dissection must occur directly adjacent to the pelvic fascia, as deviations may injure the pelvic plexus (S2–S4). Individual fibers leading to the rectum must be severed. Anterior dissection differs according to sex. Dissection continues until the Denonvilliers aponeurosis, located just atop the pelvic fascia, is reached. This fascia consists of obliterated peritoneal tissue, which, in men, leads to the prostate, and in women often cannot be precisely identified. In order to reach the aponeurosis in males, the plane is developed between the anterior mesorectum and the seminal vesicles. An incision is made into the peritoneum 2 cm above the bottom of the excavatio rectovesicalis exposing the seminal vesicles. Thankfully, no nerve fibers are found anterior to this position, and the aponeurosis can be easily dissected until the tumor is reached. In this manner, an additional tissue section remains between the tumor and excision margin, which is of particular importance for anteriorly located tumors. As soon as the tumor plane is breached, the aponeurosis is incised and the pelvic fascia is dissected to the pelvic floor. Finally, the anterolateral pelvic fascia is dissected. Here again, resection must occur directly adjacent to the fascia, as otherwise nerve fibers of the pelvic plexus may be injured.

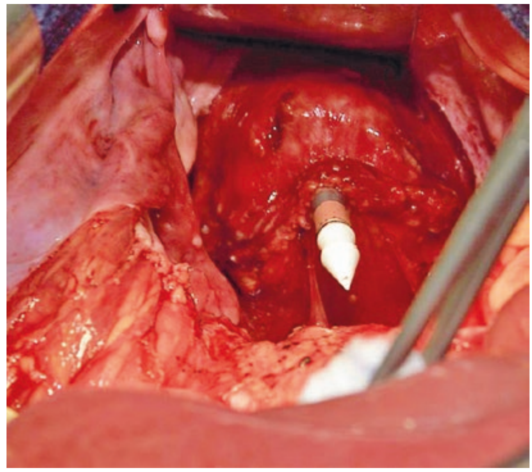


◘ **Fig. 41.2** Dissection of the lamellar border (an avascular plane of connective tissue between the visceral and parietal pelvic fascia) or between the mesorectum and presacral tissue plane in order to spare the hypogastric nerves (observed retractor pulls the rectum and mesorectum out of the field of vision)

In women, the anterior incision of the peritoneum is made at the deepest point of the excavatio rectovaginalis. At this juncture, the layer between the pelvic fascia and vagina are most easily recognizable. Great care must be exercised to prevent excessive bleeding from the posterior wall of the vagina. In order to improve visibility, it may be useful to hitch up the uterus.

The final portion of the rectal dissection to the pelvic floor may require division of some coarser strands of connective tissue leading from the sacrum to the rectum. These should be dissected in the direction of the levator muscles rather than adjacent to the rectum itself, which is easily perforated. Such perforation has been linked to poor oncological prognosis. The TME is thus complete. The rectum is clamped at a point that is low enough to be clear of the distal limit of the tumor. The intestinal lumen is washed with a 10 % Braunol solution and sealed below the level of the mesorectum using a TA-45 linear stapler. The to-be-excised mass is then freed from the stapler using a scalpel, and the product is analyzed on a macroscopic level. If necessary, an intraoperative frozen section analysis is performed. Should further excision prove necessary, a second TA-45 stapler, placed below the initial stapler, is employed, and the excision margins are adjusted accordingly. The excised tumor mass is additionally analyzed for TME quality and classified in accordance with the MERCURY criteria.

The reconstructive phase begins with control of the blood circulation to the descending colon as well as determination of the necessary colonic length. If necessary, further colonic tissue may be removed at this point. The guide plate of a 31 mm circular end-to-end stapler is then inserted and secured in place using a "purse string" suture of 0 Prolene. Our personal preference is the 31 mm circular stapler produced by Covidien. In order to ensure adequate and improved stool function in the first 12 months postoperatively, our clinic strives to avoid coloanal anastomoses. Instead, our clinic favors the use of a transverse coloplasty pouch (TCP). A 5 cm incision is made in the descending colon approximately 3 cm proximal to the guide plate and closed laterally by a stapler. Care must be exercised to make sure that the mesenteric tissue is not incorporated into the staple line. According to the surgeons' preference, the staple line can be sewn over with a 4-0 PDS suture. Alternately, a side-to-end anastomosis can be used. The short arm, of approximately 3 cm, serves to prevent anastomotic necrosis. The guide plate of the circular end-to-end stapler is inserted in the stapled colonic loop and diverted in an antimesenteric direction. The colon stump is sealed using a GIA stapler and sewn over using a 4-0 PDS suture. The circular stapler is then inserted through the anal canal so that it abuts on to the staple line on the rectal stump. This works best if the rectum has already been expanded preoperatively. Doing so after rectum resection risks destroying the staple line created. The center rod is advanced through the center of the staple line (◘ Fig. 41.3). The guide plate is attached to the center rod, and the staple gun is fired after ensuring that no fatty or vaginal



◘ **Fig. 41.3** Advancing center rod of a circular stapler through the center of the staple line (created by a linear stapler) of a rectum stump

tissue has been incorporated. In order to prevent excessive movement of the stapler, it is recommended that the stapler be further stabilized by the left hand of the surgeon. The integrity of the anastomosis must then be analyzed. This is easily done by the insufflation of air from the anal canal, while the pelvis is filled with a sodium chloride solution.

In cases of ultra-deep tumors, in which the external sphincter muscle and levator muscle are not infiltrated, an intrasphincteric resection may be warranted. Here, it is necessary to dissect the pelvic floor between the internal and external sphincter muscles, taking care that the rectal wall and internal sphincter muscle are not injured in the process. In tumors located up to 1 cm above the dentate line, the rectum can be removed intersphincterically with a stapler. More distally located tumors require resection through the anal canal due to the improved vantage point. In such cases, a "Lone Star retractor" is placed and the internal sphincter muscle is incised underneath the tumor level. The whitish internal sphincter muscle is easily distinguished from the darker reddish external sphincter muscle making resection at this level feasible for experienced surgeons (◘ Fig. 41.4). At this juncture, it is best to avoid the use of electrocoagulation, as this may obscure color distinctions between the two muscle layers. After the tumor mass is removed, a total of 16 4-0 PDS sutures are placed in a circular fashion under inclusion of the internal sphincter muscle. With

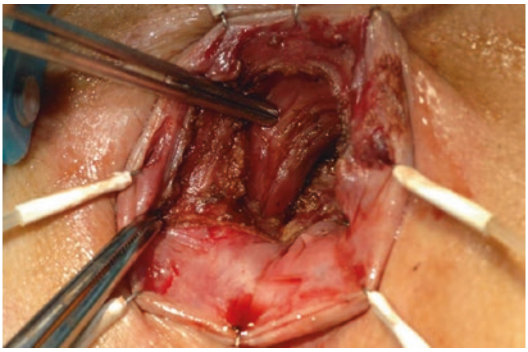


Fig. 41.4 Intersphincteric resection and severing of the internal sphincter muscle. The external sphincter muscle (forceps) is shown prior to anastomosis formation

the help of these sutures, the coloanal anastomosis is completed. The descending colon is pulled externally through the sphincter using Ellis clamps, which are inserted into the pelvis through the anal canal. The pouch is created directly at the point of exit. Here too, the descending colon is split longitudinally and sealed laterally with a stapler. Again, the staple line is sewn over. Now it is possible to return the colon to the pelvis, and, using the prepared sutures, affix it to the internal sphincter muscles.

All patients receiving a TME in our clinic are equipped with a stoma. In such cases, we tend to favor the double-barrel ileostomy, which is generally placed in the right lower abdominal wall.

In order to provide a more complete analysis, we endeavor at this point to describe the partial mesorectal excision (PME) used in tumors found in the upper third of the rectum (12 cm above the anus). Here, it is of tantamount importance that the dissection of the mesorectum be completed without injury to the pelvic fascia and extend 5 cm below the lower tumor border. Rectal tissue, as well as the associated perirectal fatty tissue, found below this point can be preserved, leading to improved functionality. In addition, in such cases, it is possible to forego the use of a protective stoma, as the risk of anastomotic insufficiency at such heights is significantly reduced. In order to prevent coning, or, in other words, the lateral resection of mesorectal tissue, we prepare the mesorectum laterally at the level of the resection margin up to the lateral rectal wall. Here, one is able to carefully remove the rectum using a TA-45 stapler. Thereafter, the mesorectum is cut and secured using clamps or a ligature device. The colorectal anastomosis takes the form of an end-to-end anastomosis without a pouch or protective stoma.

Regardless of the type of rectum resection, the abdominal cavity is carefully irrigated and checked for the cessation of bleeding. Two easy flow drains are placed leading from the small aperture of the pelvis to the left abdominal wall. This is followed by wound closure in layers with suturing of the fascia and stapling of the skin after instrument removal. Afterward, the wound is covered and the ileostomy completed using everting single-button sutures.

Troubleshooting

1. In cases where the staple line at the rectum tears, a purse string suture can be used. By pressing the pelvic floor in the direction of the pelvic aperture with a fist, adequate room is created to safely place the needed sutures.
2. If, after the left hemicolon has been mobilized to the middle colic artery, a poor perfusion of the intestines is observed, it becomes necessary to remove more tissue. If a tension-free anastomosis is no longer possible as a result, one can attempt to lead the left hemicolon through a mesenterial slit between the ileocolic artery and the terminal branch of the superior mesenteric artery. Should this fail, the only remaining option is to sever the middle colic artery and rotate the colon in a counterclockwise direction. This allows for an ascendo- or transversorectostomy.

41.1 Abdominoperineal Rectum Extirpation

In cases where the external sphincter or levator muscles are infiltrated, a more radical abdominoperineal resection must be performed. Large-scale observational studies, as well as randomized controlled studies, such as the Dutch radiation study, have shown poorer outcomes for patients with an APR compared with those treated with deep anterior rectum resection. This phenomenon can be partially explained by a higher perforation rate affecting the circumferential resection margin (CRM). For this reason, our clinic favors the extralevatory APR with intraoperative repositioning of the patient as described by von Holm et al. (*Br J Surg* 2007). It has been shown that the resultant larger tissue surface positively influences the CRM and rate of perforation.

The operation is performed as follows:

The patient is placed in the lithotomy position, and the transabdominal portion of the operation is performed as described in the previous chapter for TME. Dissection extends to the coccyx. From this position, the pelvic plexus, in which the nerve fibers of the hypogastric nerve and the pelvic splanchnic nerves (S2–S4) run, can be seen laterally. Dissection extends below this nerve bundle. In men, dissection continues beyond the seminal vesicles to the prostate. In women, the upper third of the vagina must be separated from the mesorectal plane.

Thereafter, an abdominal cloth is placed between the rectum and the small aperture of the pelvis. In order to complete the abdominal portion of the operation, the descending colon is led out the abdominal wall at a predetermined position, in preparation for its use as a colostomy. In general, a left-sided omentoplasty is favored, as this allows for the preservation of the gastroepiploic vessels and only the branches leading to the greater gastric curvature must be removed. From the right, the gastroepiploic vessels are severed after being clamped and ligated. Thereafter, the omentum can be moved along the lateral abdominal wall into the small aperture of the pelvis. Using a single suture, the apex of the omentum is fixed to the to-be-resected rectum so that it can be later placed in the pelvis without problem. The same procedure is repeated for an easy flow drain which is brought in from the right abdominal wall. Finally, the abdominal cavity is closed layer by layer.

After the abdominal portion of the operation is completed, the patient is repositioned in the jackknife position. This provides optimal access to the perineal region. The perineal, gluteal, as well as lower back regions are cleaned and covered. The buttocks is spread and fixed in this position with tape. The anal canal is then closed using a purse string suture. An incision is made from the middle of the lower back (approximately 3 cm above the tip of the coccyx) to the anus. Thereafter, the incision continues semicircularly along the sides of the anus coming together behind the anus. The next step involves dissection onto the levator muscles and mobilizing the associated cutis and subcutis layers. In order to ensure that

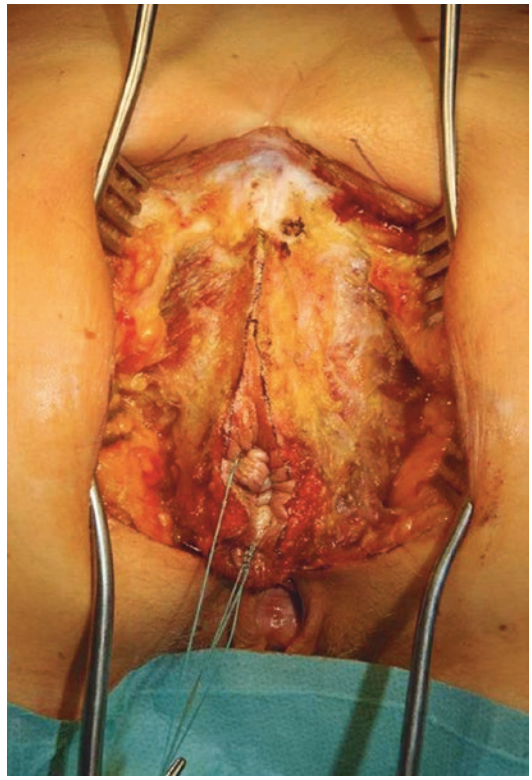
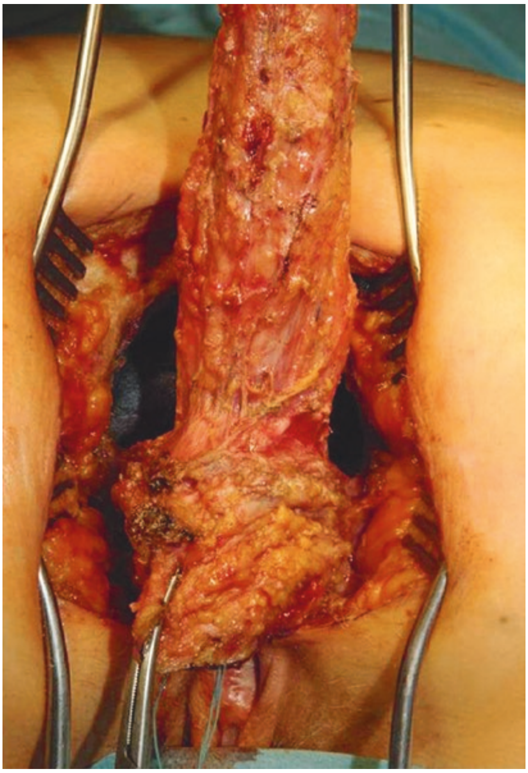
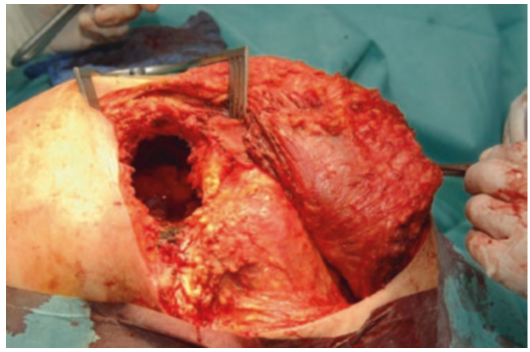


Fig. 41.5 Dissection of the subcutis from the levator muscles through positioning of the patient in the jackknife position during extralevatory APR. Sutures at the sealed anus are shown

enough soft tissue remains to adequately cover the defect, it is important to remove as little subcutaneous tissue as possible, assuming of course that this tissue is not infiltrated by tumor cells (Fig. 41.5). The coccyx is exposed and separated from the sacrum using a chisel or strong scissors. In this manner, one advances into the small aperture of the pelvis until the abdominal cloth previously placed between the sacrum and mesorectum is reached. At this point, the levator muscle can be palpated and cut through using a monopolar electrical cautery. The dorsal gap is thus continuously enlarged, until the rectum can be luxated out of the pelvis and the surrounding abdominal cloth can be removed. The sutures to the omentum and easy flow drain are severed, and dissection continuous in the anterior and caudal direction. The levator muscles are further removed, and the mesorectum is separated from the prostate or vagina (Fig. 41.6). If tumor infiltration of the prostate has already occurred, the lamellar resection of the prostate can be completed



■ **Fig. 41.6** Luxated rectum including mesorectum after transection of the levator muscles on both sides during the abdominoperineal rectum resection. Using the jackknife position, visualization of the vagina or prostate is optimal



■ **Fig. 41.7** Formation of a right-sided gluteoplasty in order to cover the defect left after extralevatory APR is performed

without problem. In this case, however, a transurethral urinary catheter is placed in order to serve as a positional control. In men, the preparation must strictly adhere to the mesorectal border lamella as deviations could risk injury to nerves running along the prostate to the bulbospongiosus and lead to impotency. The caudal margin of the resection border, defined by the superficial transverse perineal muscle running above the urethra, should be preserved. Now the excised mass can be disposed of and the abdominal cavity irrigated and inspected for surgical bleeding. Closure of the pelvic floor is dependent on the size of the defect. In some cases, it is possible to directly readapt the subcutaneous tissue. When this is not possible, a pelvic floor reinforcement consisting of a biological implant, such as pig collagen or a composite net can be used. The remaining subcutaneous tissue is closed layer by layer. A Redon drain is placed subcutaneously. Finally, the skin is closed using single-button sutures. Such primary closure is usually easy if the initial incision is done carefully.

In cases where the skin defect is more substantial, a plastic reconstruction may be necessary. In such cases, the vertical rectus abdominis muscle flap (VRAM) or a single- or double-sided gluteal flap (■ Fig. 41.7) can be used.

Surgical Technique and Difficult Situations from Alois Fuerst (Laparoscopic)

Alois Fuerst, Arthur Heiligensetzer, Gudrun Liebig-Hörl, and Peter Sauer

M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations*,
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42.1 Introduction

Standardisation of the laparoscopic surgical procedure in rectal cancer has favourable effects in terms of security aspects, economic workflow and teaching factors. Self-evident the oncological aspects of surgical quality must be taken into account. The autonomic nerve-sparing TME technique is the gold standard in rectal cancer resection even in conventional or laparoscopic procedure. In open surgery, most surgeons start the operation left laterally mobilising the sigmoid colon first. In the laparoscopic technique, we recommend the medial to lateral approach starting the preparation at the right side of the rectum and the sigmoid colon. Following this approach, the nerve-sparing TME technique can be performed easier and the identification of the left ureter may be simplified. Since more than 10 years, we perform a standardised "laparoscopic ten-step TME procedure" in rectal cancer:

1. Medial to lateral preparation of the A. rectalis superior preserving the autonomic nerves
2. Identification of the left ureter
3. Clip the A. mesenterica inferior
4. Clip the V. mesenterica inferior
5. Mobilisation of the left colon (medial and lateral)
6. Mobilisation of the left flexure (medial/lateral/omental)
7. Preparation along the mesorectal plane
8. Transection of the distal rectum (Endo Stapler)
9. Extra-abdominal resection of the descending colon
10. Anastomosis with a transanal stapler device

The sequence of the surgical steps can be varied if necessary. For example, the mobilisation of the left flexure can be done at the beginning of the operation.

42.1.1 Position of the Patient in the Operation Room

Lloyd Davis position is the standard position of the patient. A broad support device is mandatory at the right side of the patient. A support system at the shoulders is not recommended. An extreme Lloyd Davis position (more than 30°) must be prevented to avoid a compartment syndrome of the lower extremities. The operating table must have a multiplane flexibility.

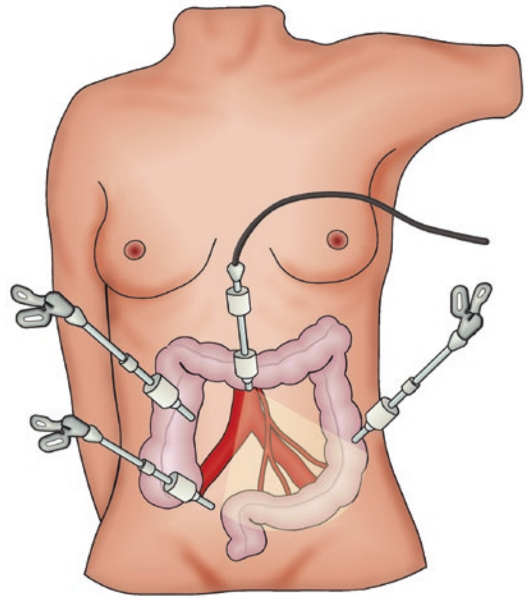


Fig. 42.1 Trocar placement

42.1.2 Insertion of the Trocars

- For safety reasons we recommend an open access of the first trocar. The position of the camera trocar is located 2 cm above the umbilicus. Two trocars are localised at the lower part of the abdomen and one trocar at the right middle part. Further trocars are optional (Fig. 42.1).

42.2 Operation Technique

- The preparation of the rectum starts at the right posterior peritoneum. After incision of the peritoneum, the proximal mesorectal plane can be identified clearly. The autonomic nerves must be preserved. The right ureter is located laterally in most cases.
- The preparation proceeds at the posterior side of the proximal mesorectum, the left ureter and the Aa., and Vv. ovaricae resp. testiculares can be identified.
- The superior rectal artery has to be elevated carefully and followed up to the inferior mesenteric artery. Now the retroperitoneal adhesions of the sigmoid colon are dissected, the left ureter in a save position and the risk of a damage of the ureter during preparation at the left side of the colon is very low. Anatomic variations of the ureter can be recognised easily.

- Clipping of the inferior mesenteric artery should be done about 1.5 cm distal of the aorta and then dissected.

> **On the origin of the A. mesenterica inferior, the autonomic nerves are localised more ventrally and should be preserved.**

The autonomic nerves along the aorta have to be preserved. The preparation is orientated behind the inferior mesenteric vein up to the pancreas. We clip and transect the inferior mesenteric vein centrally in order to get an optimal mobility of the left colon.

- Occasionally some adhesions of the duodenum have to be mobilised.
- We proceed the mobilisation of the left colon as far as possible from medial to lateral, elevating the mesenterium with an atraumatic Babcock clamp. In general a defined plane between the left kidney and the mesenterium of the colon can be found.
- Finally the colonic adhesions can be transected easily.
- An important step is the *mobilisation of the left colonic flexure* and is sometimes time consuming. One can find adhesions due to infections in the patient's history, adhesions of the omentum and enteroenteric adhesions. There are three different options for the mobilisation of the left flexure. One option is the continuous preparation of the flexure along the lateral track. The second option is the mobilisation of the omental fat and opening the bursa omentalis. An early transection of adhesions of the spleen is mandatory to prevent a damage of the capsule and bleeding. An attractive option is the mobilisation of the flexure continuing the medial to lateral approach and opening the bursa omentalis caudally.
- When the mobilisation of the left colon is completed, we proceed with the mesocolonic preparation along the mesorectal plane, preserving the distal autonomic nerves. The mesorectal dissection starts posterior then laterally and finally anterior until the pelvic floor is reached. The nerves along the pelvic floor must be preserved.
- The transection of the distal rectum has to be done with the endoscopic linear stapler. In the majority of cases, we need two cartridges for transection.
- Using a Pfannenstiel incision and a wound protecting device, we transpose the rectum and the sigmoid colon in front of the abdomen wall. We transect the colon between the descending and sigmoid colon. A short 5 cm long colonic pouch should be created or a side-to-end configuration can be prepared alternatively inserting the anvil of the circular stapler.
- After reposition of the colon, the Pfannenstiel incision will be closed. We use local anaesthetic infiltration to minimise postoperative pain.
- The colon pouch-anal or side-to-end anastomosis will be performed with a transanal inserted circular stapler.
- Finally a "bubble test" will be done to test the integrity of the anastomosis.

42.2.1 Colonic Pouch Following Rectal Resection

According to the results of the clinical research, a neorectal colonic pouch formation is mandatory even in laparoscopic technique. A significant better neorectal function can be expected. If the formation of a J-pouch is not possible, a side-to-end anastomosis is mandatory alternatively. Actually there is high-level scientific evidence to favour the J-pouch procedure.

42.2.2 Protective Ileostomy

After rectal resection including TME, a protective loop ileostomy is mandatory according to scientific evidence.

42.2.3 Intersphincteric Rectal Resection

In patients who need an intersphincteric rectal resection, we make the transabdominal preparation down to the intersphincteric level and continue the operation per anal using the Lone Star retractor.

An attractive variation is the reversed procedure: The operation starts with the per anal intersphincteric preparation using the Lone Star retractor or using a single-port system. This innovative procedure allows the distal TME continuing the abdominal operation in a second step. In slim patients with low-volume mesorectum, we extract the specimen through the anus and perform the anastomosis in a handsewn side-to-end technique.

42.3 Discussion and Conclusion

The value of the laparoscopic rectal resection including TME and ANP was a point of discussion over many years. The laparoscopic procedure is feasible and safe according to more than 20 randomised clinical trials and many case control studies.

If the laparoscopic technique is comparable to the open procedure, highlighting the oncological dimension is the most important issue. Up to date, all published retrospective and prospective studies demonstrated equivalent results comparing morbidity and mortality in laparoscopic and open surgery.

Up to date, there are only a few studies presenting long-term data of laparoscopic rectal cancer operations. No differences were found compared to open surgery. An actual review from Gopall et al. in 2012 (22 randomised and 25 non-randomised studies, 31 case control studies, 14 reviews and one Cochrane analysis) demonstrated the feasibility and "non-inferiority" of the laparoscopic technique.

All well-known advantages of the laparoscopic colonic resection were found in laparoscopic rectal cancer surgery. The problems of the different conversion rates and study-related data generated in the learning course of some surgeons were discussed extensively.

The early results of the largest randomised study including more than 1000 patients show the "non-inferiority" of the laparoscopic operation compared to the open procedure in rectal cancer (COLOR II study, published in Lancet Oncology 2013).

42.4 Demanding Situation in Laparoscopic Rectal Resection

42.4.1 Situation

An underweighted 62-year-old patient (BMI 16,5) presenting with a proximal rectal cancer, multimorbidity including chronic rheumatoid arthritis, long-term therapy with corticoids and generated atherosclerosis looks like a slim "perfect patient" for laparoscopic rectal resection (Level 1). A standardised laparoscopic rectal resection was started. After incision of the peritoneum at the right side of the rectum and preparation of the proximal mesorectum preserving the autonomic nerves, the preparation followed the superior rectal artery up to the inferior mesenterial artery. At 1.5 cm distal the origin of the inferior mesenteric artery, the clipping of the artery was intended. The atherosclerotic artery was elevated for clipping. Suddenly there was an unexpected splashing bleeding at the aortomesenteric angle.

42.4.2 Solution of the Problem

We performed a local compression of the aorta using a laparoscopic swap. With this manoeuvre the bleeding could be stopped sufficiently. While compressing the aorta, we converted the operation. After laparotomy we found a 3 mm wide arterial defect at the angle of the inferior mesenteric artery and the aorta. We close the aortic defect with vascular sutures sufficiently. The amount of blood loos was 150 ml.

42.4.3 Analysis

A small aortic defect of the atherosclerotic aorta and a sharp sclerotic plaque at the aortomesenteric angle was found. The plaque had perforated the aorta while elevating the interior mesenteric artery obviously.

42.4.4 Conclusion

A prepared laparoscopic swap is important in case of unexpected bleeding. The surgeon can compress the bleeding point immediately and have time to plan further steps to stop bleeding. An atherosclerotic inferior mesenterial artery has to be manipulated very carefully.

Surgical Technique and Difficult Situations from Werner Hohenberger (Conventional)

Werner Hohenberger

M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations*,
DOI 10.1007/978-3-662-49878-1_43

43.1 Introduction

Rectal resection for cancer including partial or even more total mesorectal excision has made most substantial progress in surgery over the last 20 years. Before, enormous deficits of standardization and surgical quality had resulted in local recurrence rates up to 50 %. Thanks to the efforts of Bill Heald (Heald 1982), worldwide improvement was achieved. However, from personal experience, there are still deficits to be closed.

Apart from that, there is obvious "upcoding" all around the world with rectal cancer surgery. Epidemiologic data support that about one third of all rectal cancers, mainly in the upper third are finally sigmoid cancers. The reasons are higher refunding, the need to achieve minimum quantities, and more prominent reputation ("colon cancer, easy; rectal cancer, more difficult").

Therefore, exact designation of the lower border of the tumor measured by a rigid rectoscope is inevitably needed. In most countries, per definition the length of the rectum is 16 cm, from the anocutaneous line. For cancer of the lower third, the distance to the dentate line should also be documented.

Similar confusion exists with the description of the extent of the resection. The term "ultralow" resection increasingly used is more suggestive and does not exist, officially. Finally, an "ultralow" resection is nothing else but a low anterior resection with the anastomosis laying either right within the dentate line or in distance of less than 2 cm. This can most frequently be achieved even by an abdominal approach, exclusively.

Finally, there are three different resections with preservation of the sphincter:

- Anterior resection
- Low anterior resection
- Abdominoperanal intersphincteric resection

The individual procedure to choose mainly depends upon the height of the tumor.

43.1.1 When Is a Sphincter-Preserving Resection Technically Still Feasible and Functionally Sensible?

Concerning oncological aspects, sphincter preservation is challenged only with cancer of the lower rectal third and a minimum distance to the dentate line of less than 2 cm.

Provided that there is no extended invasion of the levator muscle, neoadjuvant radiochemotherapy may enable a sphincter-preserving operation, later on, even though this option seems to be impossible, before. As a relevant remission may occur even beyond the sixth week after completion of radiochemotherapy, one should wait up to 12 weeks if necessary. Later on, usually no relevant further regression will be observed.

Broad tumor invasion of the M. levator ani, the sacrum, or the prostate does not allow sphincter preservation. Nevertheless, these patients, too, should receive neoadjuvant irradiation, as even in case of an R0 resection the risk of local recurrence will be increased due to the small circumferential margin to be less than 1 mm.

Very low resections with an anastomosis right at the dentate line, and even more if they were established by a peranal approach, are followed in at least 20 % of the patients by permanent functional disturbances (low anterior resection syndrome). Incontinence is not the most pronounced problem, but rather urgency, repetitive and fractionated stool, and disposition to diarrhea. These symptoms may be most severe right after taking down a diverting stoma. If some degree of incontinence was present already before rectal resection, it may be even worse. Therefore, these patients may do better if sphincter preservation is omitted just for functional reasons.

The same applies to pronounced fibrosis of the levator muscle following excessive remission after neoadjuvant radiochemotherapy.

43.2 Surgical Technique

43.2.1 Mobilization of the Left Colon

Any sphincter-preserving operation needs complete mobilization of the left colon, to achieve a tension-free anastomosis. This is even more essential, if a pouch will be created:

- This entails full mobilization of the left colon including the splenic flexure with the left transverse colon with taking down the greater omentum from it. The transverse mesocolon is divided right at the inferior border of the left pancreas (◘ Figs. 43.1 and 43.2).

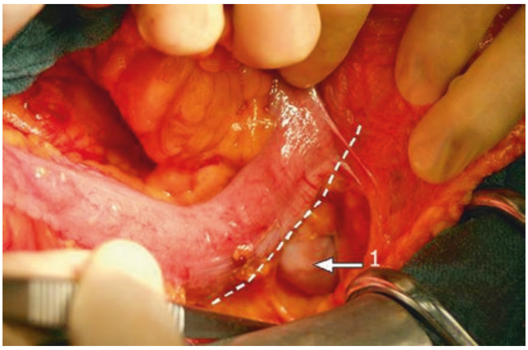


Fig. 43.1 For mobilization of the splenic, the dissection plane is running right along the bowel wall (---) to avoid tension on the serosa of the spleen and eventually following bleeding. The lesser sac is opened, with the stomach exposed (1)

Fig. 43.2 The lesser sac is fully opened. Frequently, a flat groove right below the left pancreas is visible, indicating the transection line of the anterior and afterward the posterior blade of the mesentery to be divided (---) (transition of mesocolon to mesopancreas). Between these two blades, 3–4 small arteries originating vertically from the left branch of the middle colic artery and running to the transverse pancreatic artery inside the pancreas have to be divided. Here are potentially regional lymph node metastases of a transverse colon cancer

- Further gain of length is achieved by dividing the inferior mesenteric vein, again below the pancreas. Thin sympathetic fibers running parallel vertically right to left to the aorta must be watched and preserved, when dissecting this vein (Fig. 43.3).
- This step is followed by the dissection and division of the inferior mesenteric artery. Attention has to be paid to the superior mesenteric plexus (sometimes also called mesenteric plexus), which extends like a tent from the aorta to the proximal 1–2 cm of the root of this artery (Fig. 43.4).

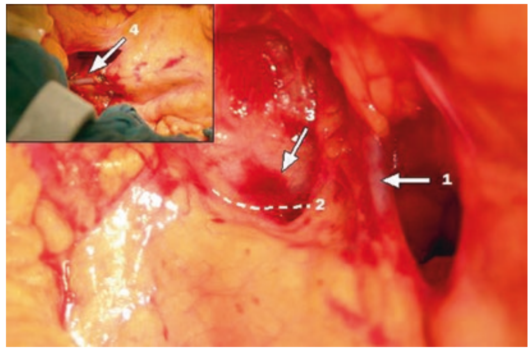


Fig. 43.3 Transection of the inferior mesenteric vein (1, 4). Immediately next to it and lateral to the aorta, thin sympathetic fibers are running parallel (3), which have to be preserved to avoid retrograde ejaculation, for example, with males (2 = incision line)

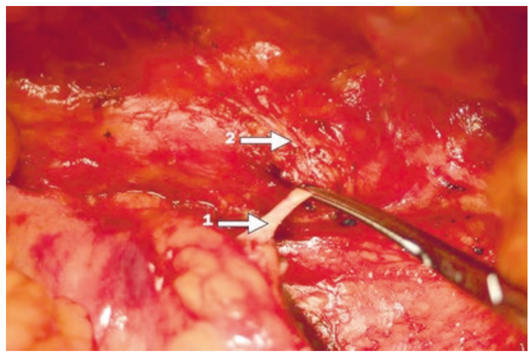


Fig. 43.4 The mesenteric plexus over the aorta includes like a tent the root of the inferior mesenteric artery, too ("adventitia"). These fibers are transected about 3 cm distally of the origin of the sup. mes. a. (2) with the vessel itself clearly exposed (1)

43.2.2 Anterior Rectal Resection

Now, the dissection in the small pelvis follows. An anterior resection is eligible for cancer of the upper rectal third, only and without obvious lymph node metastases:

- Alike with a low anterior resection, the mesorectum is exposed, first, carefully watching the hypogastric nerves on both sides. Frequently, the Y-like splitting main cables form a thin presacral network (Fig. 43.5).
- For carcinomas of the upper third, a distal margin of 5 cm of the rectum in situ is sufficient. Therewith, the distal level of the rectal transection lies closely below the seminal vesicles. This requires that even with an anterior resection, the inferior hypogastric plexus at

Fig. 43.5 The mesorectum and the mesosigmoid as well are fully dissected off the parietal plane. The gonadal vessels (1) are crossing the iliac vessels. The sympathetic fibers are visible as thin white fibers running parallel to the inf. mes. a

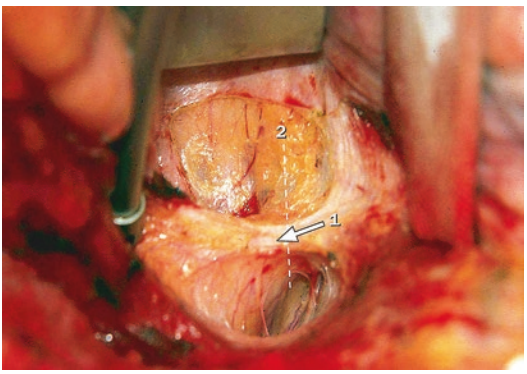


Fig. 43.6 Exposure of the right lateral pelvic wall. Sometimes, as in this demonstration, the "T junction" can be dissected (1), which results from vessels crossing the dissection plane, thus creating an extension of the mesorectum to the parietal plane. It contains the middle rectal artery or sometimes small vessels. The transection has to follow the dashed line (2). Putting a clamp just on the lateral pelvic wall would increase the risk of damage to inferior hypogastric plexus just behind

the sidewall of the pelvis and the Denonvilliers' fascia must be watched and preserved. This fascia includes the parietal fascia, small branches of the inferior hypogastric nerves running to the seminal vesicles, and the base of the bladder and muscle fibers as well (Figs. 43.6 and 43.7).

- When transecting the tube of the rectum, the corresponding mesorectum must be divided at the same level, to avoid coning. For restoring continuity, mainly with females, a hand-sewn anastomosis is usually performed. The

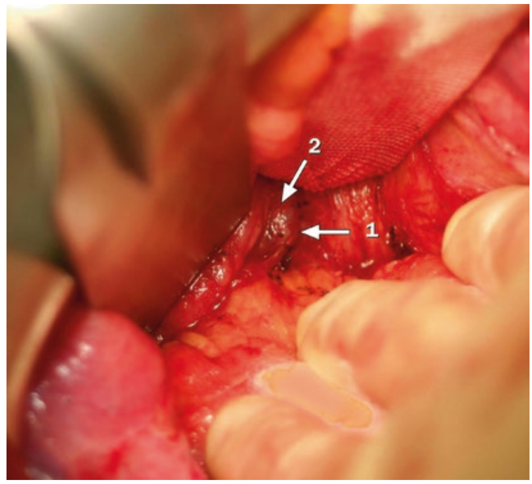


Fig. 43.7 View on the right anterolateral wall of the small pelvis. The parietal plane over the right seminal vesicle (2) is divided, and the Denonvilliers' fascia (1) incidentally incised, too

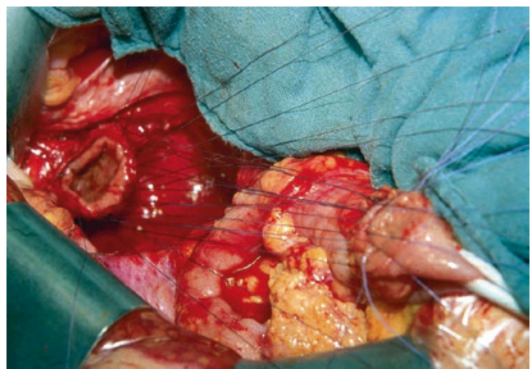


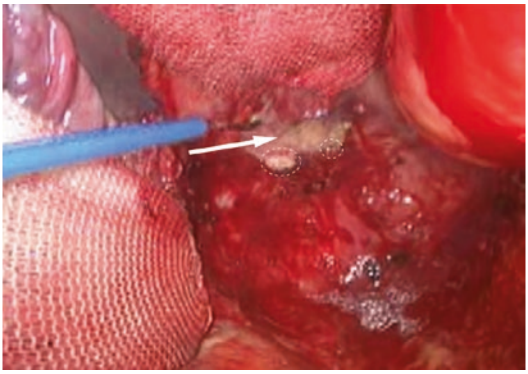
Fig. 43.8 Fashioning of a descendorectostomy; the sutures for the posterior half of the anastomosis are placed already

posterior sutures are laid on a distance (Fig. 43.8).

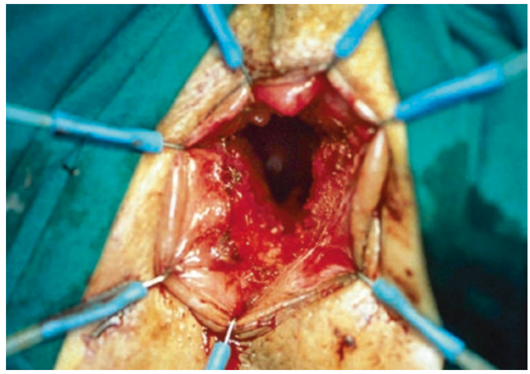
- Next, interrupted sutures of the anterior part of the anastomosis follow. If a stapler is applied, the transection of the bowel is also performed in an open manner, followed by a hand sewn purse string suture.

43.2.3 Low Anterior Resection

Any tumor of the middle or lower rectal third necessitates a low anterior resection, a procedure which is well standardized, in the meanwhile. Finally, it will result in an anastomosis within a



◘ **Fig. 43.9** The twin coccygeorectal muscles are divided, which is essential to get access to the intersphincteric space (*arrow*). They are pretty pronounced in this patient



◘ **Fig. 43.10** The peranal transection of the lowest rectal wall right at the dentate line is completed. The retractor shown facilitates the exposure of the low rectum and anal canal as well

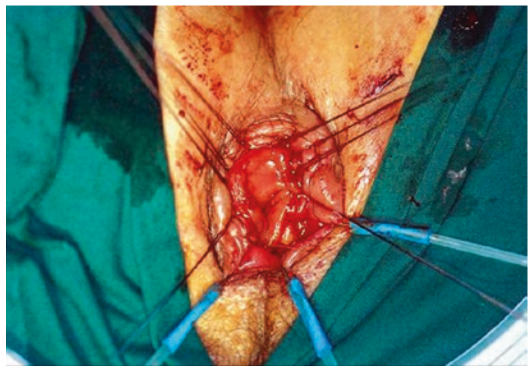
distance of no more than 2 cm above the dentate line. However, from technical and oncologic aspects (no undifferentiated carcinoma, at least without neoadjuvant radiochemotherapy), a minimum of 0.5 cm of a distal margin of clearance can be accepted. Such a low resection demands always an intersphincteric dissection down to the level of the dentate line. In the vast majority of cases, this can be achieved by an abdominal approach, exclusively.

> *The exclusive abdominal approach for an intersphincteric dissection necessitates the transection of the M. coccygeorectalis (Stelzner). This muscle is not known by most surgeons. It is a twin muscle originating lateral to the os coccygis reaching the rectal wall right below the mesorectal sac. There are individually enormous variations, including its symmetry. It may present as a thin stringlike band but also as a muscle up to 1 cm thick. The space between the rectal wall ("internal sphincter") and the levator muscle ("external sphincter") cannot be reached without splitting this muscle* (◘ Fig.43.9).

43.2.4 Abdominoperanal Intersphincteric Rectal Resection

With very obese males, for example, or if the tumor is very close to the dentate line, it may be uncertain, finally, whether an adequate distal margin of clearance can be achieved by an abdominal approach only. Only then, a combined procedure is needed. To make this clear and also because the term "intersphincteric" was stressed unreasonably in recent years, the term "abdominoperanal" was introduced by the author, several years ago, already:

- First, with a retractor placing the hooks into the dentate line (◘ Fig. 43.10), the distal rectum is exposed. The peranal intersphincteric starts with the incision dorsally in a semicircular fashion through the rectal wall or even the dentate line itself. The correct plane will be reached, when the rectal wall retracts, abruptly. Anteriorly, over about one third of the circumference, extensions of the external sphincter muscle are crossing the intersphincteric space. Therefore, here sharp transection is needed (◘ Fig. 43.10).
- The anastomosis is fashioned by hand sewn sutures including the dentate line and the descending colon, which is brought outside through the hole of the levator sling (◘ Fig. 43.11).



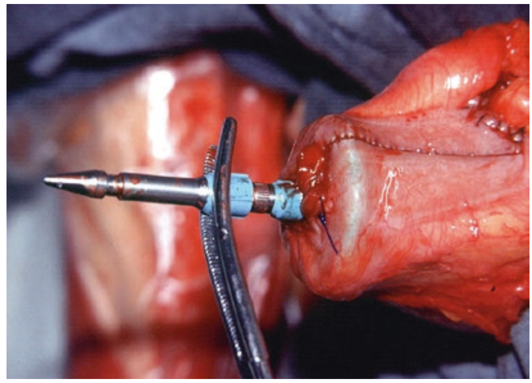
◘ **Fig. 43.11** The anastomosis is performed

- A pouch reconstruction is desirable; however it is not always realized, as a pouch may be too bulky to pass the levator.

43.2.5 Low Anterior Resection Syndrome

At least a quarter of all patients suffer from symptoms of a low anterior resection syndrome. The detailed obviously multifactorial etiology is not yet clear. Preoperative irradiation and probably preciseness of surgical dissection between the lowest mesorectum and the shiny parietal plane covering the levator muscle, too, have a significant impact on its severity.

The construction of a pouch may reduce its symptoms (◘ Fig. 43.12). An end-to-side anastomosis and a transverse coloplasty are probably less effective; however, this is a matter of ongoing trials.



◘ **Fig. 43.12** A colonic pouch created with a 75 mm stapler and the anvil of a circular stapler already introduced

Surgical Technique and Difficult Situations from Rolv-Ole Lindsetmo (Laparoscopic)

Kim Erlend Mortensen, Stig Norderval, and Rolv-Ole Lindsetmo

M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations*,
DOI 10.1007/978-3-662-49878-1_44

44.1 Contraindications to Laparoscopic Surgery

The obese patient offers a challenge in laparoscopic surgery in the pelvis, especially in men. However, it is these patients which have the biggest potential benefit from minimal invasive surgery because they suffer more often from wound infections and incision hernias after open surgery. It is therefore our opinion that obesity in itself should not be a contraindication to laparoscopy. In any case, most of the procedure may be done laparoscopically before eventual conversion (like taking down the splenic flexure and mobilisation of the descending colon). In fact, it is actually often easier to find the right plane of dissection under the mesocolon and behind the mesorectal plane in obese patients due to less tenuous texture of the tissues in the correct plane of dissection.

Previous abdominal surgery or radiation may result in challenging adhesions. However, most adhesions tend to be located in the midline and may be taken down by placing trochars on either side (outside the midclavicular line) advancing towards the centre. A usually safe area to place the first trochar is under the left costal margin.

The need for extreme Trendelenburg position creates increased intracranial pressure that must be recognised in patients with known intracerebral aneurysm or previous intracerebral bleeding/stroke. Similarly, the increased cardiac afterload will deteriorate a weakened cardiac muscle because of ischemic cardiomyopathy or severe aortic valve stenosis. Patients with group IV chronic obstructive lung disease will also have problems with ventilation of the CO_2 gas used for the needed pneumoperitoneum. An alternative inert gas source might be used.

Locally advanced T4 tumours are in any way a surgical challenge. The need for resection outside the mesorectal fascia must be carefully evaluated and the final decision made individually to fit the patient's need for an optimal oncological result. The chosen operative technique should reflect the best treatment option available and not the preferences of the surgeon or lack of laparoscopic experience.

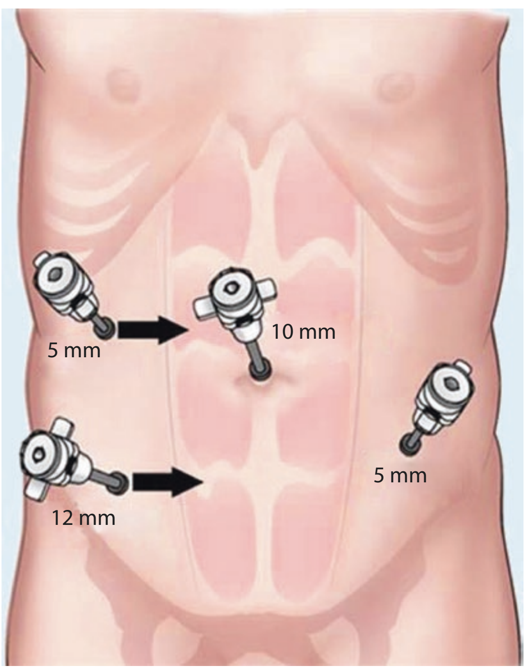


Fig. 44.1 Trocar placement

44.2 The Surgery

44.2.1 High Anterior Resection (HAR)

For tumours located in the upper third of the rectum, a partial mesorectal excision will suffice given a minimum luminal distal margin of 2 cm [1]. Depending on the redundancy of the sigmoid colon, the splenic flexure may have to be taken down, and this is usually the trickiest part of the procedure and accordingly should be done initially when the surgeon is most attentive. Port placement is illustrated in Fig. 44.1 or 10.29 in German version. With the patient tilted 30° to the right and in the anti-Trendelenburg position, the omentum majus and small bowel is lifted over the stomach and liver (in that order) until the transverse colon is clearly visible. Sometimes the transverse and the descending colon are fused together on the medial aspect of the splenic flexure in which case often necessitates division when taking down the splenic flexure. Once the medial aspect of the colon is clear, the jejunum at the ligament of Treitz is exposed, together with the upper part of the inferior mesenteric vein (IMV) just before it disappears under the pancreas. Exposing this area is sometimes difficult if the small bowel is not placed over the transverse colon as much as possible. An additional retractor placed from a port placed in the suprapubic area is sometimes useful to hold the small bowel over to the right at this

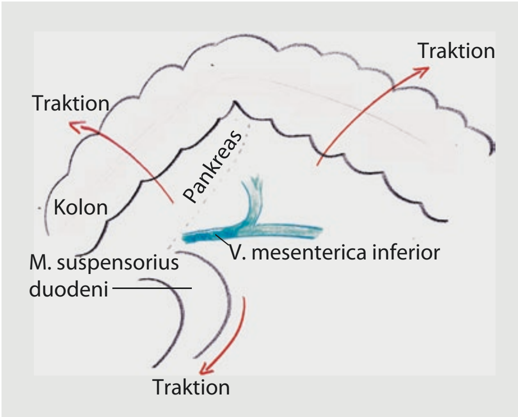


Fig. 44.2 Triangulation-traction of transverse and descending colon for identification of the inferior mesenteric vein

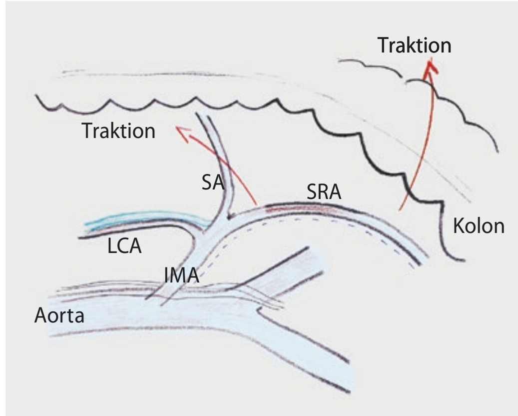


Fig. 44.3 Traction of mesosigmoid for identification of the inferior mesenteric artery *LCA* – left colic artery; *SA* – sigmoid artery; *SRA* – rectal superior artery

point. Sometimes, adhesions between the proximal small bowel and the medial aspect of the descending colon's mesentery may have to be taken down with scissors without diathermia. Traction with triangulation of the tissues away from the point of dissection is vital (Fig. 44.2 or 10.30 in German version). When the IMV is exposed, go under it. Do not divide it immediately because it is often useful to use it as an anchor to lift up the mesocolon when taking down the splenic flexure with the medial approach. At this point you should begin seeing the anterior aspect of Toldt's fascia. Go straight laterally and cranially but be careful here not to go too deep, as it is easy to go under the pancreas here. Once the lateral abdominal wall is reached, come back and divide the IMV with vascular clips or LigaSure (never use Ultrasonic for this). The next step will be to enter the omental bursa by going cranial over the pancreas through the transverse mesocolon. Be careful not to damage the vascular arcades of the transverse colon as your anastomosis depends on the arcade from the middle colic artery (Drummond's arcade) going down to the descending colon. Once in the bursa, proceed lateral. Here there usually is a tenuous adhesion between the lower border of the pancreas and the colonic mesentery which must be divided with LigaSure or UltraCision but be careful not to pull too hard ventrally as you might triangulate the anterior surface of the pancreas and damage the capsule eventually leading to pancreatitis or leakage of pancreatic fluid. Once everything is released from the medial aspect, go caudally, following the avascular plane over Toldt's fascia until you arrive at the inferior mesenteric artery (IMA) trunk. Again, upward traction of the mesocolon is vital to separate the tissue in the right plane. Be careful not to go too deep (dorsally) when dissecting laterally and caudally in which case you may end up underneath the ureter or testicular/ovarian vein (especially when using a 30° camera). If you decide to do a D3 resection (high tie), the IMA should be isolated 1 cm from the aorta. In this area, the inferior hypogastric plexus lies directly on the IMA and aorta and must be spared as much as possible (Fig. 44.3 or 10.31 in German version). Try to avoid using monopolar diathermia here. If you find locating the IMA trunk difficult, go further down along the medial aspect of the sigmoid. Have the assistant lift the distal mesosigmoid ventrally to create traction on the superior rectal artery, creating the mesenteric groove, and incise the peritoneum directly underneath the superior rectal artery. Follow the vascular trunk all the way down past the promontory until you find the beginning of the avascular plane behind the mesorectum (the "holy" TME plane). Now, you will see that the IMA trunk will be easier to identify when coming back. Before dividing the IMA, the retroperitoneum with all the nerves, ureter and testicular/ovarian vein must be pushed downwards dorsally. Finally, the IMA and the left colic artery (LCA) are secured with vascular clips and divided. The rest of the peritoneal fold lateral to the descending colon and sigmoid are divided until the TME plane in the pelvis is reached. Now the dissection proceeds down in the TME plane until you have reached a

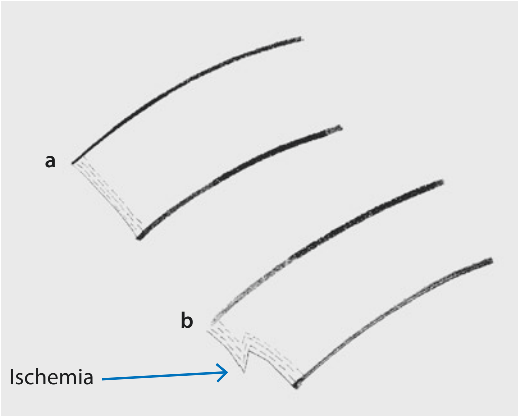
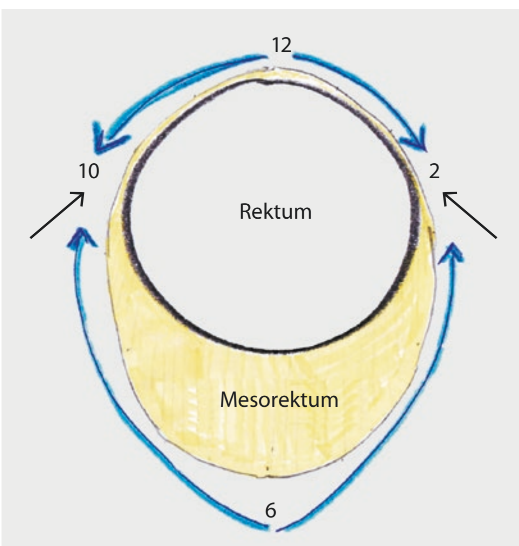


Fig. 44.4 **a** correct stapler line **b** bad transection with Z shaped stapler line (increased risk of ischemia)

margin of 4–5 cm distal to the tumour. Be aware that the nerve trunks of the inferior hypogastric plexus can be damaged if the plane of dissection is not kept close to the mesorectal fascia. At the same time, it is important, for oncological reasons, not to breach the mesorectal fascia. Transecting the bowel can be done either before or after dividing the mesorectum. In adipose patients, it is often easier dividing the bowel first. At this level (i.e. high anterior resection) there is usually no problem dividing the bowel with one 60 mm Endo GIA magazine. Start by carefully incising the peritoneum just under the bowel wall and advance slowly under the serosa along the fascia transversalis by using a long-armed forceps spreading the fatty tissue to both sides, meticulously taking care of any possible bleeders with a bipolar, LigaSure or UltraCision. What is most important here (as always) is to maintain a bloodless operation field so you can see what you are doing. Once under to the other side of the mesentery, place the Endo GIA perpendicular to the bowel wall, close, inspect on both sides and fire slowly after allowing 20 s for tissue moulding. Fire slowly. If a second magazine is required, be sure that the staple line crosses on the distal side (Fig. 44.4 or 10. 32 in German version). Now divide the mesorectum. When dividing the mesorectum before the bowel, make sure not to spiral downwards around the bowel wall. A good locking forceps (e.g. Endo Babcock) is placed on the distal end of the bowel to be externalised through a wound protector. We prefer making this incision at the 5 mm trochar on the left hypogastrium. The proximal level of resection should be at least 10 cm proximal to the tumour, but in any case a spurting arterial bleeding from the mesocolic arcades should be verified. Once the colon is transacted at least 10 cm proximal to the tumour and an anvil is secured with a purse string, the bowel is replaced in the abdomen, the fascia closed and pneumoperitoneum re-established. Do not remove too much fatty tissue around the anvil as this may compromise the vascular supply to your anastomosis. Before making the anastomosis, make sure that the bowel is not rotated by visualising a tenia all the way from the left flexure down to the anvil. The circular stapler is introduced into a well-cleaned rectum and the anastomosis completed. Do not push too hard on the stapler in the rectum, as this may damage the rectal stump. Check both rings and test for an air leak. If you see bubbles in the irrigation water in the pelvis, remove the water by suction, have the assistant inject more air and slowly pour water over the anastomosis to find the exact spot of leakage. Then place one or more cross sutures over the anastomosis line until the leak is stopped. Unless the field is very bloody, we do not routinely place a drain. Make sure the small bowel is not herniated underneath the descending colon's mesentery. Reposition the omentum and small bowel, deflate and remove trochars. Depending on the size and type of trochars (cutting), we close the fascial openings after 12 mm trochars with a suture.

44.2.2 Low Anterior Resection (LAR)

Before a LAR, the patient receives bowel prep because he or she will have a diverting loop ileostomi. The initial steps for a LAR are the same as for a HAR. The splenic flexure is always taken down to attain a tension-free anastomosis. For a LAR, it is absolutely essential that the small bowel is out of the pelvis. It is sometimes necessary to incise the peritoneum of the lower border of the ileal mesentery due to adhesions on the promontory. Start the TME excision by following the avascular plane in front of the promontory and straight downwards as far as you can go. Then develop this plane out laterally to both sides. The key to success in lateral pelvis dissection is traction and countertraction. Be careful not to damage the sympathetic nerve bundles of the inferior hypogastric plexus and the parasympathetic nerves from S3 and S4 as they are easily drawn inwards sticking to the mesorectal fascia. At the same time, it is important not to breach the mesorectal fascia. When pushing/pulling the mesorectum to the side, it is sometimes beneficial to use a 10 × 10 cm dressing (introduced through a 10 or 12 mm trochar) between the forceps and the mesorectum. This dressing may also be of use in the pelvis when using suction because placing the tip of the suction instrument into the dressing prevents fatty tissue blocking the tube. At approximately 2 and 10 o'clock, the TME plane becomes somewhat obscure around the so-called side ligaments. Stop here and go ventrally to incise the peritoneum at 12 o'clock and work your way outwards to both sides (◘ Fig. 44.5 or 10.33 in German version). In women the uterus usually needs to be hoisted up with a suture and in men the bladder and vesiculae seminalis and prostate can be lifted up with an angulated retractor introduced via the suprapubic port. In men, if the tumour is located ventrally, the Denonvillier's fascia in men should be dissected off the prostate to attain a proper oncological margin (the trade-off being probable impotence). Be careful not to go straight into the vesiculae initially, as this will mess things up due to bleeding. As this is an avascular plane, bloodless dissection can be accomplished if dissection is aided by traction and countertraction. Any use of monopolar or bipolar diathermia or



◘ **Fig. 44.5** Dissection plane in paraproctium surface to avoid nerve damage

UltraCision with heat dissipation in this area will damage fibres of the hypogastric nerve plexus and the nervi erigentes but is often difficult to avoid. Follow this plane as far as you can past the tumour. Have a second assistant indicate the lower border with a rigid rectoscope, or palpate by digital rectal examination yourself. For low anterior resections, we routinely go all the way past the mesorectum at the level where the puborectal muscle becomes visible. To transect the bowel on the pelvic floor, a 45 mm Endo GIA is needed and often more than one firing. Make sure to fire as perpendicular to the bowel as possible, introducing the stapler through the 12 mm port in the right iliac fossa or through the suprapubic fossa (now changed from a 5 to a 12 mm port). Angulate the head as much as possible. Pass the branches over and under the bowel wall carefully with your right hand, at the same time pulling the rectum into the stapler with your left. Close, wait 20 s and fire slowly. If placing a second magazine, make sure to make a straight line and not a Z-line (◘ Fig. 44.4 or 10.32 in German version). The limited space in a male pelvis can make this step of the operation technically challenging. A third assistant might push the perineum upwards giving an extra 1–2 cm closer view. If a fatty mesorectum and a narrow pelvis make the placement of the stapler under vision control impossible, then transect the rectal wall anterior to posterior. Still, it is mandatory to have a 90° angle of the transection. The rectum and colon with the tumour is externalised and transected in the same manner as when performing a HAR. When advancing the EEA stapler head into the rectal stump, do it gently so as not to stretch the top of the rectal stump because this will result in a smaller diameter of the distal ring. Make sure that no epiploica from the colon becomes interposed between the colon and the rectum when closing the stapler (to make the anastomosis). Make sure the proximal bowel is not rotated. Again, as after a HAR, do a leak test with air insufflation. Place a drain for 1 day if the field is bloody. Make sure no small bowel is herniated underneath the descending colon. Reposition the omentum and small bowel. We routinely perform a diverting loop ileostomi if the patient received preoperative radiochemotherapy or if the anastomosis is below 7 cm from the anal verge.

44.2.3 Abdominoperineal Resection (APR)

Laparoscopic APR is identical to LAR in that the dissection is performed all the way to the pelvic floor. Be sure to scrutinise the preoperative MRI closely if the tumour is locally advanced (i.e. affecting the levator ani or puborectal bundle) because this will determine how far down the pelvic dissection should go. If the tumour lies dorsally, one should stop in a safe distance to the tumour and excise the whole area with the coccyx once the patient is turned around in the jackknife position. We routinely divide the sigmoid so that all lymph nodes around the IMA and sigmoid arteries are removed en bloc. A 10 × 10 cm dressing is placed in the midline behind the rectum on the pelvic floor and then an 18 French drain in the pelvis. The proximal descending colon is pulled out to make a permanent stoma. The patient is turned around on his/her stomach to complete the amputation. The anus is closed with a purse ring suture after meticulous cleaning of the skin. The incision line is drawn with a waterproof pencil. The upper border of the incision is the os coccyx. Depending on the extent of the cancer, the levator or extralevator plane is dissected by monopolar diathermy. Enter the abdominal cavity beneath the os coccygus or under the distal sacrum if the coccygus is de-articulated and removed with the specimen. Identify the dressing and remove it. If needed to ensure safe resection margins, the pelvic floor muscles are resected with or without the posterior part of the prostate or posterior vaginal wall. Be aware of the risk for urethral dissection injury in men during the dissection because the traction of the specimen will lift up the soft tissue inferior to the genitourinary membrane.

44.3 Locally Advanced Tumours

Locally advanced tumours are not in themselves a contraindication to laparoscopic oncological surgery as long as a radical margin is attained.

Urinary Badder Some high rectal tumours do seem to grow into the dorsal bladder wall but with close scrutiny of the preoperative MRI, and possibly a preoperative cystoscopy will aid in deciding whether laparoscopy is an acceptable approach. If deciding upon laparoscopic resection, it is advisable (as with open surgery) to place ureter stents preoperatively to identify the ureter ostia. The transection of the bladder wall should be done with at least 1 cm margin to the tumour involvement. An UltraCision scissors is useful. Closure of the wall is done in two layers with running or interrupted sutures. Always do a patency test by filling the bladder with methylene blue via a Foley catheter. The patient should keep this catheter (opened) in place for 3 weeks.

Small Bowel When encountering a small bowel segment or mesentery with suspected local ingrowth from a colonic or rectal tumour, just do the same as when performing the operation open, that is, a wide en bloc resection of the bowel and its mesentery. If the mesentery dissection is deemed risky due to impending damage to the superior mesenteric artery, make a low midline incision, resect the small bowel, anastomose and proceed laparoscopically. The same incision can be used later to extract the rectal tumour.

Pelvic Lymph Nodes Sometimes, pathological lymph nodes will be found outside the mesorectal fascia. These should be removed, irrespective of whether they respond to neoadjuvant chemotherapy or not. It is feasible to do a laparoscopic lymph node dissection by following the bifurcation of the iliac artery and vein down to the pelvic floor. This will invariably result in ipsilateral nerve damage.

Synchronous Liver Metastasis The management of synchronous liver metastasis must follow national guidelines. However, superficial metastasis, if easily accessible, can easily be removed with free margins during the primary laparoscopic rectal cancer operation. LigaSure or UltraCision can be used for the liver resection.

44.4 When to Convert

Previous trials have shown a larger incidence of complications in patients where the surgeon converts to open surgery (cost, classic, colour). However, it is not the actual conversion in itself but the delay in conversion which results in complications. In other words, convert early when it becomes evident that complications may occur or when progression stops. One should however bear in mind the fact that laparoscopic surgery of the rectum is demanding and necessitates patience and tenacity. The time invested in the operation will pay off postoperatively in reduced pain and shorter hospital stay for the patient. However, patient safety and high-quality oncological surgery are the main issues.

44.5 Tips

44.5.1 Patient Positioning

For all laparoscopic surgery in the pelvis, it is absolutely mandatory to have the possibility to place the patient in an extreme Trendelenburg position. Therefore, the patient should be securely strapped to the operating table with two crossing belts over the thorax with gel cushions underneath preventing slippage and boots (paying attention not to exert pressure on the triceps surae musculature). We advocate not using shoulder braces as this may sometimes result in injury to the brachial plexus.

44.5.2 Port Placement

We prefer Visiport because they make minimal holes in the abdominal wall not necessitating extra fascial closure. They also facilitate visual entrance to the abdominal cavity. When placing the other ports on the sides, tilt the patient first to the preferred position and then place the working trochars. This will minimise the chance of damaging the small bowel when entering the abdomen.

44.5.3 Access in the Abdominal Cavity

Always use full muscle relaxant as this will ensure maximum abdominal wall distension at normal working pneumoperitoneum pressures (12 mmHg). Always place a gastric tube to deflate the stomach, as this will facilitate lifting the greater omentum and small bowel away from the left colon.

44.5.4 Technical Tips

At least three active laparoscopic instruments should be in the operating field and always under visual control. The first assistant must be an experienced colorectal and laparoscopic surgeon. If the second assistant is not comfortable with handling a 30° laparoscope, use a 0° to avoid frustration.

44.5.5 The Adipose Patient

A medial approach with high ligation of the IMA and low anterior resections in adipose patients are a major challenge because the small bowel is constantly in the way. In some cases, despite full muscle relaxant, Trendelenburg position and placement of the greater omentum and small bowel over the transverse colon, access to the base of the colonic mesentery is hampered by small bowel loops constantly sliding into your “working space”. In these cases it is much safer and quicker to do everything with the lateral approach. In this way the colon and its mesentery is pulled gradually over the entire small bowel eliminating any risk of damage. The ureter and gonadal vessels can easily be visualised from the lateral side and the dissection can actually be carried far down into the pelvis in the TME plane from the left lateral side. All that remains after this approach is incising the peritoneum on the medial side (without using diathermia). With this approach one must be careful not to go too far away from the bowel wall and its mesentery when taking down the splenic flexure as this could easily result in damage to vessels in the spleen hilum. Maintaining the complete mesorectum: A complete mesorectum is a quality indicator of rectal cancer surgery. Traction and countertraction should not be performed with sharp instruments. Any manipulation and traction of the mesorectum during a laparoscopic rectal resection entails a risk of tearing the mesorectum. Severe mesorectal tears impact on prognosis. A liver retractor can be used to avoid grasping and traction directly on the mesorectal fascia. Alternatively, a long dressing may be placed around the mesorectum and held tight with a grasper, pulling the rectum up and out from the small pelvis. The frequency and severity of mesorectal tears should be measured prospectively. Laparoscopic surgery should not be associated with decreased local control of the disease.

44.6 Quality Control

Every surgeon or institution starting with laparoscopic rectal cancer surgery must have ensured that the requirements for advanced laparoscopic skills are met for the whole operating team. The success lies in the standardisation of the procedure and in the correctly performed detailed surgery performed by certified high-volume rectal cancer surgeons. Prospective registration of the circumferential and distal resection margins, completeness of the mesorectal fascia, anastomotic leak rate, reoperations and other complications should be a part of the quality control in any surgical oncological department. It is achievable to have a local recurrence rate of less than 5 % in an unselected rectal cancer patient population as well as an anastomotic leak rate also less than 5 %.

44.7 Pitfalls

44.7.1 Injury to the Inferior Epigastric Vessels

Some trochars have cutting edges which sometimes cause haemorrhage when cutting the inferior epigastric artery when introduced in the lower quadrants. Firstly, this may be avoided by paying attention to the interior abdominal wall where the vessels can usually be visualised. Furthermore, by placing the ports at the lateral margin of the rectus sheath, you will avoid this problem altogether. A benefit of this placement is also less resistance to trochar movement during dissection because there is less muscular tissue surrounding the port in the abdominal wall.

44.7.2 Small Bowel Injury

Be aware of the heat generated in the metal branch of the Ultrasonic scissors. Never touch the small bowel with it or use it as a grasping device. When using a monopolar diathermia in close proximity to small bowel, be aware that an electrical injury to the bowel may occur if some current is conducted away from the tip of the scissors (close to the end of the insulation). If this occurs, necrosis may occur after a few days. The area of damage must be dealt with at once because the mark of serosal damage will after a few minutes change in appearance making it difficult to find again. Secure the bowel wall with a suture at once.

44.7.3 Injury to the Ureter

Firstly, always have a low threshold for placing a stent if in doubt whether a tumour may affect the retroperitoneum. Furthermore, when dissecting along Toldt's fascia, be careful not to go too deep, especially when using a 30° scope and tilting the patient to the right. If you can see the fascia of the iliopsoas muscle, you are too deep. Go back and then go upwards. In this way you will avoid ureter injuries. Using traction and countertraction and dissecting with a monopolar diathermia scissors or hook will also help you to remain in the right plane of dissection. Going through the tissue with LigaSure or UltraCision will, in our opinion, increase the risk of injury because these instruments melt the planes together. Finally, going close to the IMA trunk before ligation will also ensure not inadvertently dividing the ureter. Some surgeons will insist on a positive identification of the left ureter before dividing the IMA and, if not found, convert to open surgery after laparoscopic mobilisation of the left colon.

44.7.4 Nerve Injury

Avoiding injury of some of the nerves around the IMA trunk is difficult because some of them do adhere right onto the adventitia. However, further down in the TME plane, the trunks on either side are clearly visible given that the field is relatively bloodless. Therefore, always stop any bleeding, however small, at the start of the TME dissection. At the level of the peritoneal deflection anteriorly in the pelvis, the incision should always be posterior to the seminal vesicles. If the upper lateral borders of the vesicles are visualised, then injury to the inferior hypogastric nerve plexus have already occurred.

44.7.5 Colon/Rectum Injury

When transecting the rectum or colon, try to visualise the thinner branch of the Endo GIA stapler all the time because this can perforate the bowel wall. This is a serious complication not because of the iatrogenic bacterial contamination but more so due to the increased risk of local relapse because of bowel perforation close to the tumour. If perforation occurs, the patient should be offered adjuvant chemoradiotherapy within 4 weeks postoperatively.

44.7.6 Injury to the Vagina

Lifting up the uterus with a suture is useful in most patients; however, in some, the recto-uterine fossa is not deep. When dissecting in front of the rectum, behind the vagina, injury to the posterior fornix may occur. These can be closed with running sutures. A more serious complication may occur if the posterior vaginal wall is inadvertently incorporated into the anastomosis. This is avoided by pulling the vaginal wall anteriorly/upwards when stapling the anastomosis. Visual control when performing the anastomosis is mandatory.

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Surgical Technique and Difficult Situations from Neil Mortensen (Laparoscopic)

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M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations*,
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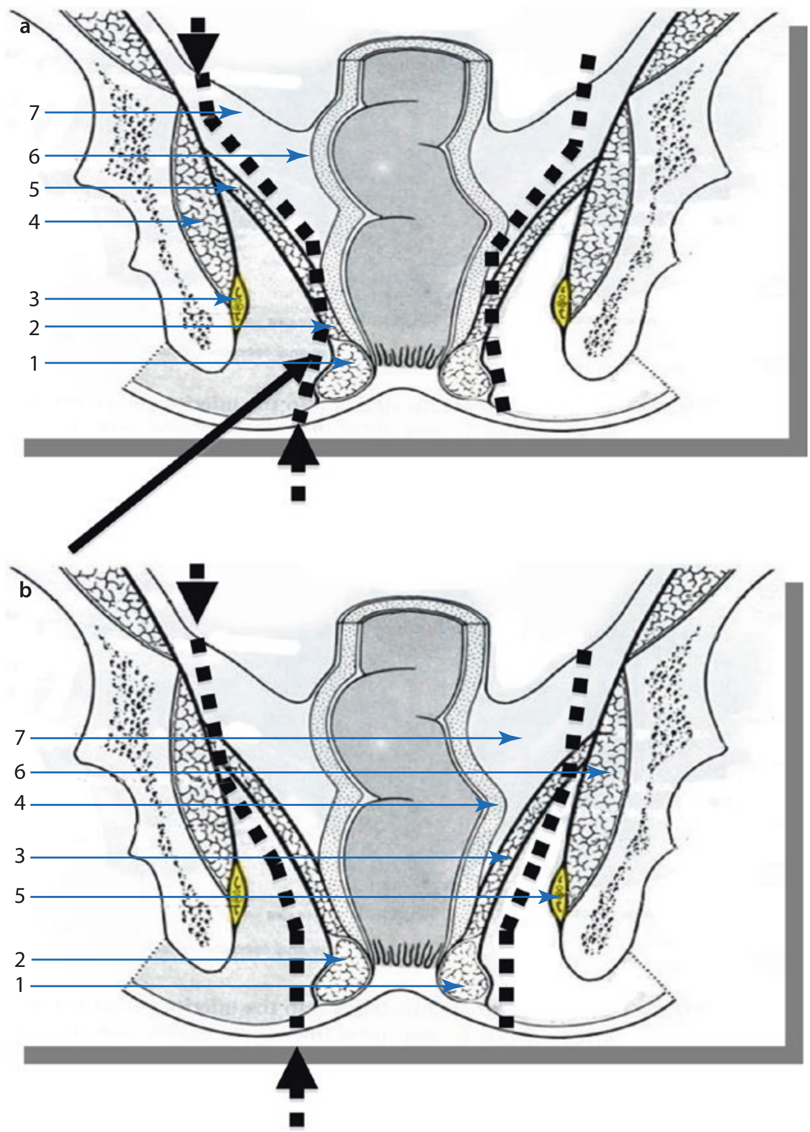
45.1 Introduction

The prognosis of rectal cancer has significantly improved over the last decades since the introduction of the total mesorectal excision (TME) surgery. However, the outcome of lower rectal cancer has not improved to the same degree despite the increased use of neoadjuvant treatment. Large multicentre studies have shown that abdominoperineal resection (APR) for low rectal cancer is associated with increased intraoperative perforation and circumferential resection margin (CRM) involvement and subsequent worse prognosis compared to similar stage of rectal cancer resected with a low anterior restorative procedure [1–3]. For this reason, the surgical technique of the standard APR is under debate. Because of anatomical coning of the mesorectum at the level of the pelvic floor, there is less margin for error resulting in increased rates of R1 or incomplete resections (◘ Fig. 45.1a). A more extensive resection by extralevator dissection with a cylindrical specimen is associated with decreased intraoperative perforation rates, CRM involvement and sub-



◘ **Fig. 45.1** **a** Dissection within the levator ani; the arrow points towards the anatomical coning of the mesorectum **b**; extralevator dissection plane anatomical landmarks: 1 internal sphincter, 2 external sphincter, 3 levator ani, 4 rectal wall, 5 pudendal nerve, 6 obturator muscle, 7 mesorectum sequently less recurrence and better survival in several studies [4]. Although forms of bias in these publications are present and other reports have shown good outcome after standard APR, the extralevator abdominoperineal resection (ELAPR) has clear advantages for treatment of more advanced lower rectal cancers [5].

During the last decade, there has been a significant reduction in APR rates since the introduction of (laparoscopic) TME in Europe. Some argue that the proportion of APRs is a marker of quality of a centre by demonstrating that specialists performed significantly fewer APRs than generalists [5]. However, this argument is questionable since the APR has still a significant place in treatment of lower rectal cancer. Especially for elderly patients and patients with marginal continence, an APR is probably a better option even if it is technically feasible to perform a sphincter-saving procedure. Moreover, the general opinion that the sphincter-saving procedure is superior is incorrect. It has been shown that an APR results in an equal quality of life compared to a low coloanal anastomosis [7].

45.2 How I Do Abdominoperineal Resection

The decision making for the best treatment schedule of a patient with lower rectal cancer starts with full diagnostic workup and a discussion within a multidisciplinary team. The final decision is made between the surgeon and patient. Furthermore, a preoperative consult with a dedicated stoma nurse specialist is essential for patient education and for finding and making the best colostomy location.

45.3 Preparation

- We use general anaesthesia combined with a transversus abdominis plane (TAP) block. The patient is in Lloyd-Davies position on bean-/sandbags with both arms alongside the patient. The rectum is re-examined for exact tumour location and is washed out preoperatively with Savlon. In patients with a documented history of pelvic inflammation by diverticulitis or previous surgery, we tend to ask the urologist to stent the ureters preoperatively due to a higher risk of injuring the ureter.

45.3.1 Procedure, Abdominal Part

- The trocar positioning includes a subumbilical 12 mm camera port, two 5 mm ports bilaterally and a 12 mm port in the right lower quadrant. A pneumoperitoneum of 12 mmhg is used for the entire procedure. The omentum is mobilised from the transverse colon during this first part of the procedure in order to use for later wound closure to minimise wound-related problems. For mobilisation, we start at the right side of the transverse colon. If needed, we resect the omentum from the right side from the stomach by dissection of the right gastroepiploic artery and its branches close to the stomach which enables a good vital omental flap to be brought down on the left side of the colostomy into the pelvis.
- With the patient in Trendelenburg and left side up, the rectosigmoid is exposed using traction from the instrument from the left port. A medial to lateral dissection of the mesocolon is achieved by opening the peritoneum halfway between the origin of the inferior mesenteric artery (IMA) and the proximal rectum close to the promontory. It is advisable to open the peritoneum all the way from the rectum and across the IMA facilitating inflow of the CO_2 and finding the right plane.
- Before central ligation of the IMA, the left ureter must always be identified. It is acceptable to perform a “low tie” by clipping the descending superior rectal artery, leaving the left colonic artery in place for a better blood supply. This low tie principle has been shown to result in equal lymph node retrieval and similar oncological results whilst leaving blood supply of the proximal colon [8]. A central ligation of the IMA however results in better mobilisation, which can be needed for a total tension-free colostomy.
- From medial to lateral, the sigmoid is detached from the lateral sidewall and the proximal descending colon from the posterior plane, Gerota’s fascia and retroperitoneum. The sigmoid is then freed completely, detaching it from the abdominal wall. The dissection is

extended distally on the left side of the rectum as far as the peritoneal fold whilst keeping visualisation of the ureter to avoid injury.

- The development of the TME is started by good traction on the sigmoid-rectum and dissection in the posterior plane opening the presacral space between the fascia propria of the rectum and the presacral fascia [9]. The traction of the distal sigmoid can be optimised using a sterile Nylon tape which is wrapped around the sigmoid and its mesocolon well away from the tumour. This provides a better grip with less bleeding and tissue damage. To perform a mesorectal dissection, a laparoscopic hook is probably the best-suited instrument, allowing precise coagulation and gently pushing. It is essential for a good TME not to damage the inferior hypogastric nerves lying on the lateral side of the presacral fascia. Another danger is to go through the presacral fascia especially in irradiated patients, damaging the presacral venous plexus. This results in bleeding that is difficult to manage laparoscopically. Once the posterior plane has been developed, the distal lateral attachments containing neurovascular bundles can be dissected for which a sealing device might be more appropriate.
- The development of the anterior plane can be more difficult because of the lack of an anatomical plane. In man the rectovesical pouch is incised and the dissection is performed ideally leaving Denonvilliers' fascia on the anterior side since the innervating branches of the prostate and erectile bodies are anterior of the fascia [10]. In male patients with tumours located anteriorly, we include Denonvilliers' fascia in the resection specimen exposing seminal vesicles and the prostate in order to obtain a free anterior margin. In women, the anterior plane is marked by the posterior surface of the vagina. In radiation-induced fibrosis, it is useful to perform intraoperative vaginal examination to avoid unintentional perforation.
- To perform an extralevator APR, it is essential to stop the dissection of the mesorectum before it angles towards the rectum at the level of the lateral attachment of the levator ani muscle. The anterior identification of the prostate vesicles in man or the mid posterior aspects of the vagina in women are good markers to stop the dissection. The posterior marker to stop dissection before the perineal procedure is the proximal side of the posterior rectococcygeal ligament at the sacrococcygeal junction although this can be difficult to recognise. Digital rectal examination whilst laparoscoping helps to identify this level. It is practical to leave a surgical gauze swab at this posterior dissection ending to identify the connection of this abdominal dissection plane from the posterior perineal approach. In selected cases, simultaneous abdominal dissection and perineal dissection in lithotomy position can be performed which enables to identify the exact point of breakthrough in the ELAPR.
- The level of division of the proximal margins of the resection is determined after assessment of the length of the sigmoid to the abdominal wall for proper colostomy. After dissection, the omentum being already mobilised is positioned in the right lateral paracolic space. It is advisable to suture the omentum to the proximal rectum so that it is easily pulled outwards in the perineal phase when the specimen is retracted.
- After closure of the trocar sites, formation of the colostomy and positioning of two drains in the pelvic cavity, the patient is repositioned for the perineal phase in prone position.

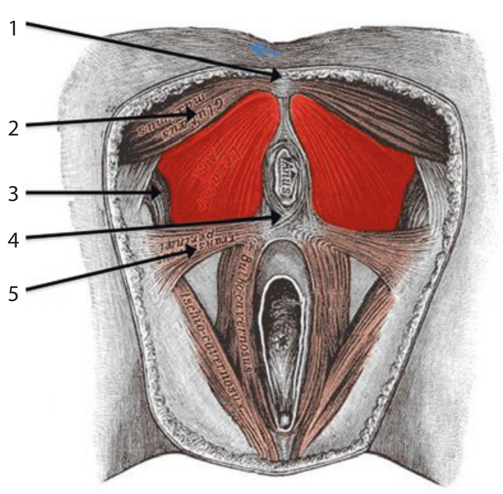
45.3.2 Procedure, Perineal Part

- The perineal phase can be safely performed in lithotomy if the tumour is located anterior invading the vagina in women. Small tumours can be easily managed in lithotomy. Furthermore, presacral bleeding during the perineal part can be better managed in lithotomy with easy abdominal access to control the bleeding. Other anteriorly located tumours are probably better approached in the prone position closely resembling the abdominoperineal procedure as described by Miles in 1908 reporting his first 12 rectal resections. However both prone and lithotomy can result in a good extralevator excision in trained hands. A recent non-randomised comparison between lithotomy and prone APR did not show a difference in oncological outcomes [11].

In *lithotomy* the anus is sutured with a purse-string suture. A skin incision is made elliptically, and the subcutaneous fat is dissected close to the external sphincter complex all the way up to the levator ani muscle. The levator is dissected laterally to ensure the mobilisation does not curve inwards towards the waist of the anorectal junction. The break-through into the pelvic cavity is performed away from the tumour side either laterally or posteriorly. The specimen is pulled outwards with care not to damage it. The omentum is secured, and the anterior dissection of the prostate or vaginal wall can be performed whilst taking extra care to feel the urethra marked by the catheter to avoid injury.

The *prone position* allows better visualisation for both the surgeon and assistant when the rectal tumour location is on the posterior side or on the anterior side in male. The patient is turned into the prone position, and the anatomical landmarks are marked on the skin: the coccyx (1), the lower borders of the gluteus maximus (2) being the posterior border, the ischial tuberosities (3) as lateral borders and anteriorly the transverse perineal muscles and perineal body (4 and 5) (◘ Fig. 45.2).

The anus is closed with a purse-string suture, and an incision is made around the anus up to the coccyx. There is no need to take more skin than in a standard APR. The coccyx can be excised by exarticulation enabling easier access to the posterior plane especially in posterior tumours. The subcutaneous fat, outside the external anal sphincter, is dissected up to the levator ani muscle on both sides. The levator is exposed all around to the borders of the gluteus muscle, the lateral pelvic wall and posterior to the transverse perineal muscles. It is important not to damage the distal pudendal nerve branches lying on the posterior transverse perineal muscle, which innervate the genital organs.



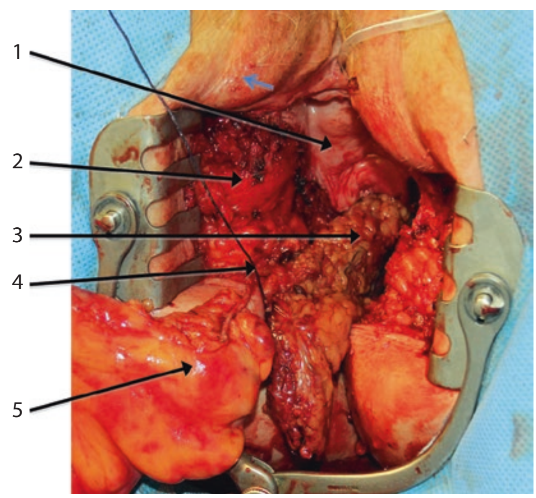
◘ **Fig. 45.2** Anatomical landmarks of the perineal rectal resection (*1* Coccyx, *2* glutaeus maximus, *3* ischial tuberosities, *4* transverse perineal muscles, *5* perineal body)

The connection with the abdominal pelvic cavity from the perineal approach is best made in the posterior plane proximal to the sacrococcygeal junction or proximal to the site of the resected coccyx by dissection in front of Waldeyer's fascia. Care has to be taken not to dissect the posterior plane of the presacral fascia causing extensive bleeding from the venous plexus, which is not easily managed in the prone position. Once entered, the levator ani muscle can be dissected bilaterally enabling extraction of the specimen out of the pelvis with the omentum still attached on it. The omentum is secured, and the anterior dissection of the prostate or vaginal wall can be performed whilst taking extra care to feel the urethra marked by the catheter to avoid injury. The prone position enables a good view of this difficult anterior dissection where most perforations of the rectal wall occur and is especially recommended in large anterior tumours. Moreover it provides a superior view where excision part of the prostate is needed for oncological clearance.

45.4 Common Problems and Solutions

- *Wound infection*, incidence about 15 %. *The wound closure* after ELAPR is under intense debate since the ELAPR procedure results in a bigger perineal defect with no levator ani to use for closure as compared to standard APR and therefore has higher wound-related complications. These include not just wound infection but also delayed wound healing and chronic perineal sinus. In most cases where there is less need to resect the whole levator muscle on both sites, we think that a primary, multilayer closure with vital omentum brought down and sutured subcutaneously (omentoplasty) is sufficient and is accompanied with low infection rates [12]. There are some reports showing that the use of local gentamicin in the presacral wound bed decreases the risk of infection, but at the cost of increased serous fluid production during the first week [13]. In more extensive resections taking all of the levator muscle on either sides or resections following long-term chemoradiation, more robust reconstruction is needed. Where the surrounding tissue is sound, a biological mesh can be used for closure of the pelvic floor, decreasing herniation rates. In female patients with a wide pelvis, the resulting big pelvic floor defect is more difficult to close. In this specific case with healthy surrounding tissue (no neoadjuvant treatment), we use a biological mesh for closure of the pelvic floor. The Permacol mesh is sutured to the cut edges of the levator ani muscle and the paracoccygeal ligaments, and then the subcutaneous layers and skin are closed. It is obligatory that there is enough skin and the tissue is vital to diminish wound infections. Alternatively, especially where surrounding tissues are less robust, a gluteus maximus flap reconstruction can be utilised to fill a large perineal defect resulting in low rates of wound complications [14]. Others have reconstructed the perineum with a vertical rectus abdominis myocutaneous flap with success using the expertise of reconstructive surgeons.

- *Presacral bleeding.* Especially in patients with long-course preoperative chemoradiation, patients with portal hypertension, patients on thrombocyte aggregation inhibitors or patients with a less visible anatomical plane because of previous proctitis or previous surgery, preoperative bleeding can be a major problem. Laparoscopic control of a presacral bleeding is challenging since haemostasis from the venous plexus is often not being achieved by coagulation. In the case of significant presacral bleeding, we pack the presacral space laparoscopically with swabs and optimise the patient's position and condition (anaesthetic optimisation). When haemostasis is not adequate, we apply a supportive product with procoagulative effects and repack. When these methods fail, we convert to an open procedure allowing better packing and other methods such as muscle fragment welding or application of thumbtacks. It is very important to avoid losing time, which will lead to deterioration of the patient's condition. A significant presacral bleeding in the prone position can be very difficult to control, and if so, the patient should be turned back in supine to allow abdominal access.
- *Ureteric injury. In* patients with known hydronephrosis due to obstruction, with a history of significant pelvic inflammation or with a tumour close to the ureter, we will ask a urologist to stent the ureters before starting the APR. Stenting itself will not prevent an injury. However the injury is more easily recognised and managed when the ureter is stented. The other option is to stent the ureter on demand during the operation, which does increase operation time, but does not increase morbidity compared to preventive stenting.
- *Urethral injury* can be avoided by careful dissection whilst sensing the catheter inside the urethra. If this is still not palpable, a urethral sound can be placed to avoid urethral injury. An anterior T4 tumour in man must be resected by taking a part of the prostate. The prone position enables a good view of this difficult resection ◘ Fig. 45.3.



◘ **Fig. 45.3** Resection specimen taken out in lithotomy with omentoplasty and vaginal back wall reconstruction with omentum (*1* anterior vaginal wall, *2* obturator muscle, *3* omentum, *4* omentum attached with suture to the *5* specimen)

	Lithotomy	Prone
Advantages	Enables vagina reconstruction after resection of anterior tumours	Excellent view of anterior tumours invading the prostate
	Simultaneous abdominal and perineal dissection provides controlled connection between abdominal plane and perineal plane	Good exposure and anatomical view for both the surgeon and assistant
	Allows abdominal control of bleeding	Good access to posterior planes and enables removal of the os coccyx or part of the os sacrum
Disadvantages	Poorer view of anatomical landmarks	Less control in case of presacral bleeding

To conclude, the surgical treatment of low rectal cancer is moving towards an individual patient-centred approach including neoadjuvant downstaging and TEM surgery for early cancers. The treatment of selected early lower rectal cancers (T1) is safely performed by a local excision since the introduction of transanal endoscopic microsurgery (TEM) has shown to have equivalent oncological results in T1 low-risk rectal cancer [6]. The laparoscopic ELAPR will be the procedure of choice for lower rectal cancers staged T2 and more. Compared to sphincter-saving procedures, the ELAPR is a good resection with a good outcome for both recurrence and survival and in quality of life especially for elderly and/or marginally continent people. The cylindrical ELAPR has clear advantages compared to the conventional abdominoperineal resection providing wider margins near the tumour at the level of the anatomical coning of the mesorectum at the level of the pelvic floor. The ELAP resection needs to be tailored to the patient and its tumour in several aspects. The perineal part of the ELAPR can be done either in the prone or in the lithotomy position. Both positions have their own specific advantages and disadvantages. We tend to perform the perineal part in the prone position when there is a large T3+ tumour, a posterior location, lateral locations or anterior tumour in man. We use the lithotomy position for an anterior tumour in women, for smaller tumours and for procedures with high bleeding risk. The wound closure can be optimised by omentoplasty, biological mesh in the case of a wide pelvic defect and a muscle flap reconstruction when the surrounding tissue is at risk.

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Surgical Technique and Difficult Situations from Amjad Parvaiz (Laparoscopic)

Amjad Parvaiz and Manfred Odermatt

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46.1 Introduction

Since the first laparoscopic colonic resection undertaken by Jacob [1] in 1991, laparoscopy has now become a gold standard for colorectal cancer surgery. Early doubts over oncological safety have been quashed in numerous randomised controlled trials which have shown that laparoscopic resection is associated with better short-term outcome and without oncological compromise [2–5]. However, many who might accept that laparoscopic resection may be appropriate and optimal for colonic carcinoma still have reservations regarding its use for rectal cancer and question whether an oncologically sound total mesorectal excision (TME) is feasible laparoscopically.

46.2 Laparoscopic TME Offers Better Short-Term Outcomes Without Oncological Compromise When Compared to Open TME

Advances in instrumentation and imaging technology coupled with increased surgical skill, training and experience have led to several reports of successful laparoscopic resection for rectal cancer with TME, and there is increasing evidence that this is safe and appropriate [6–13].

As regards short-term benefits of the laparoscopic approach, operative blood loss, duration of ileus and length of hospital stay were significantly reduced in most studies. Operating times are significantly longer. Complication rates are not increased. Long-term data suggest that there is no compromise on oncological outcome when laparoscopy is compared to open technique.

46.3 Initial Workup

Once the diagnosis of rectal carcinoma has been confirmed by biopsy, a systemic staging is performed with a CT scan of the abdomen, pelvis and chest. Routinely, an MRI scan of the pelvis is performed for loco-regional staging.

In cases of low rectal carcinoma, we often employ endo-anal ultrasound to better visualise the exact tumour location and in particular its relationship to the sphincter complex. Once the staging is complete, each individual case is discussed in the multidisciplinary tumour board meeting. Preoperative chemo-radiotherapy is given to patients with T3b and T4 rectal cancer with either threatened or involved circumferential resection margins.

46.4 Patient Preparation

- Preoperative assessment of operability takes place in the anaesthetic clinics
- For mechanical bowel preparation, the patient has to take two sachets of Picolax® (sodium picosulfate) the day before surgery.
- Modified enhanced recovery programme as popularised by Henrik Kehlet [14] is applied in all patients, however, with exception of a more selective use of an epidural catheter for postoperative pain control.
- Patient is marked preoperatively for loop ileostomy by the stoma nurse.
- Informed consent is signed by the patient.

46.5 Patient Positioning

- Patient is placed in a modified Lloyd-Davies position on an operating table that allows maximal head down and side tilting during surgery.
- To avoid the patient to slip during the head-down position, a vacuum bean bag is used.
- We avoid any additional supporting devices. Shoulder supports can result in brachial plexus injury particularly in patients with high BMI.
- Sequential compression devices are placed on the lower extremities.
- Prophylactic single-shot antibiotic is administered before the start of the operation.
- Digital rectal examination in the relaxed patient is essential to assess tumour height in relation to the sphincter.
- The operating surgeon and the assistant holding the camera stand to the right of the patient. A further assistant is required to stand on the left side of the patient in order to provide traction and counter-traction during the operation.
- Monitors are placed on both sides and on the lower left side of the patient so that all surgeons have appropriate view during the different steps of the operation (Fig. 46.1).

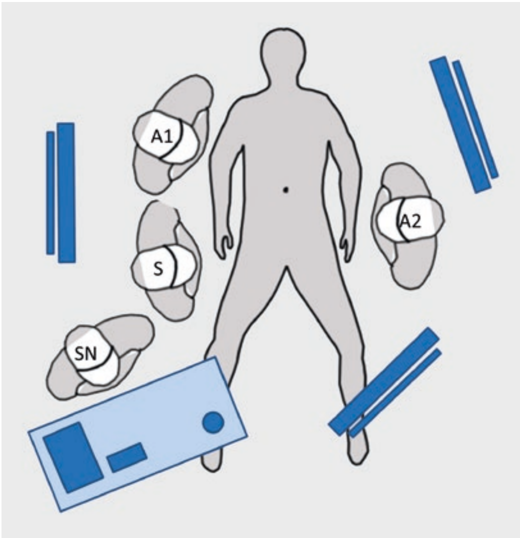


Fig. 46.1 Setting of surgeon (S), first assistant (A1), second assistant (A2) and scrub nurse (SN) in the theatre. For splenic flexure mobilisation from above (division of gastrocolic ligament, transverse mesentery and splenic attachments), the surgeon and first assistant change places

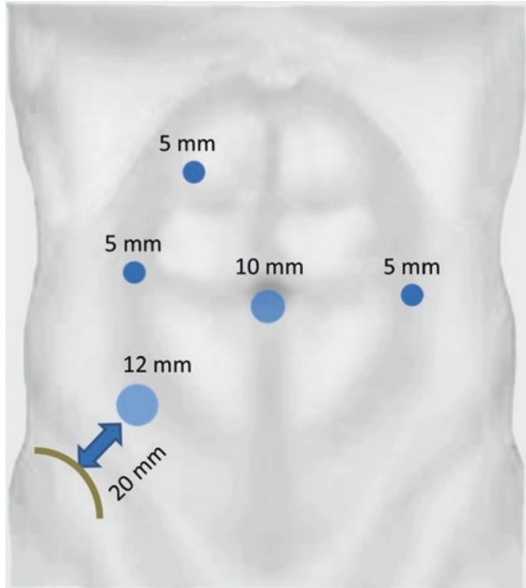


Fig. 46.2 Port placement: The camera port is inserted at the umbilicus. Two 5 mm ports are placed at the level of the umbilicus and lateral to the rectus muscle. A 12 mm port is inserted 20 mm above the right anterior superior iliac spine. An additional 5 mm port is placed subcostal and in the mid-clavicular line

46.6 Equipment

- High-definition camera and monitor system with two screens are preferred.
- 30° 10 mm laparoscope.
- Atraumatic bowel graspers.
- Monopolar hook electrocautery and additionally a harmonic scalpel (Harmonic®).
- Alexis® wound protector.
- Articulating endoscopic linear stapler for division of the rectum.

46.7 Operative Technique

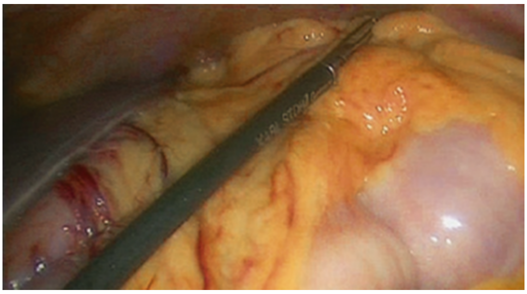
46.7.1 Port Placement

Pneumoperitoneum is set by using a modified Hasson technique at the umbilicus. The umbilical port is a 10 mm trocar and used for the 10 mm 30° camera. The following ports are placed under vision after subperitoneal injection of a local anaesthetic. A 5 mm port is inserted on the left side at the level of the umbilicus and at the outer border of the rectus muscle. A second 5 mm port is placed on the right side at just above the level of the umbilicus and at the lateral border of the rectus muscle. A third 5 mm port is placed in the mid-clavicular line below the costal margin. This port is helpful to elevate the rectum out of the pelvis during the total mesorectal excision. The patient is then brought in head-down position to allow the small bowel to leave the pelvis by gravity. This leads to a safe placement of a 12 mm port 2.5 cm medial to the right anterior superior iliac spine. All ports are inserted perpendicularly to the skin which allows for less fatigue during a lengthy operation (Fig. 46.2).

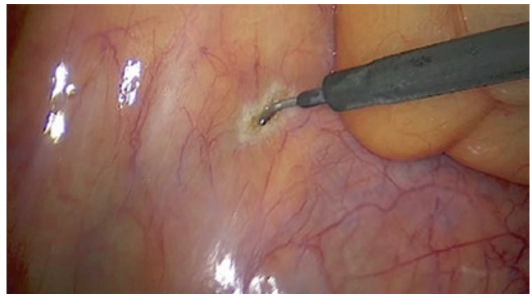
46.7.2 Colonic Mobilisation

Exposure

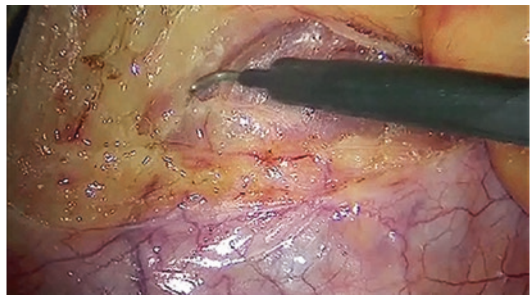
Optimal exposure at any stage of the procedure is essential for accurate and safe laparoscopic surgery. For the mobilisation of the left colon, good exposure is achieved by having the patient in steep head-down and right tilt position. This will place the small bowel away from the pelvis and to the right side. Then the greater omentum with the attached transverse colon is placed under the left lobe of liver (Fig. 46.3). If the stomach is distended, a nasogastric tube has to be inserted. The tube is removed at the end of the operation.



■ **Fig. 46.3** The greater omentum with the attached transverse colon is placed under the left liver lobe



■ **Fig. 46.4** The operation is started with scoring of the peritoneum below the inferior mesenteric artery which is brought under tension by lifting up the sigmoid mesentery at the level of the pelvic brim

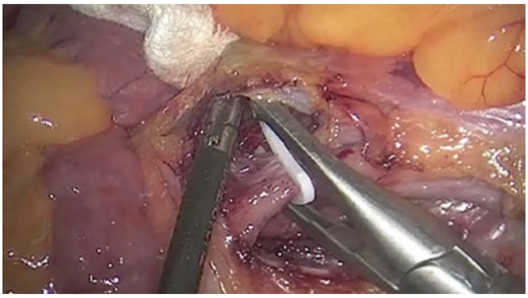


■ **Fig. 46.5** Fatty tissues dorsal to the inferior mesenteric artery is dissected until a shiny and smooth plane is identified

In case of a short mesentery of the small bowel or in patients with higher BMI, we routinely place a small swab at the edge of the small bowel package in order to prevent bowel loops from gliding into the operating field. To expose the course of the inferior mesenteric artery, the mesentery of the sigmoid colon at the level of the pelvic brim is now lifted by the assistant standing on the left side of the patient. Sustained traction is applied. The operating surgeon should have a clear view of the medial aspect of the sigmoid mesentery and the inferior mesenteric artery.

Isolation and Ligation of the Vascular Pedicle

The dissection is started by using a monopolar cautery hook inserted through the 12 mm port. With an additional grasper for counter-traction, the mesentery is brought under tension. The power setting of the electrocautery is on 25 W each, for coagulation and cutting. No spray function is used at any time. In our experience, this setting allows for minimal charring of the tissues leading to precise dissection of the embryologic planes. First, the peritoneum is scored at the level of the sacral promontory in a caudo-cranial fashion (parallel and below to the IMA) in the direction of the duodeno-jejunal junction (■ Fig. 46.4). When opening the peritoneum with the cautery hook, gas enters the retroperitoneal space (■ Fig. 46.5). This air is like a roadmap for further dissection. If there is no air spread, the entry point is either too low or too high. The dissection has to stay at the upper border of the air close to the dorsal side of the IMA, keeping a safe distance from both the left ureter and the gonadal vessels. Once the peritoneum is incised alongside and below the IMA, the vessel is supported by a grasper from below. The fatty tissue of the mesentery is divided until a shiny surface appears which indicates that the right embryologic plane for further dissection has been found. Dissection continues bluntly from medial to lateral. As long as the IMA has not been divided yet, the dissection stays below and close to the IMA until its origin at the aorta. By using gentle traction and counter-traction and by teasing off the adjacent fatty tissue of the vessel, the clean surface of the IMA can be exposed for subsequent ligation and division. Further dissection of the initially identified correct planes from medial to lateral is achieved by using blunt dissection staying on top of Gerota's fascia keeping this thin layer of fascia intact overlying both the left ureter and gonadal vessels. This dissection leads to a better access to the root of the inferior mesenteric artery. Once the left ureter has been safely identified and put out of harm, the IMA is ligated and divided at its origin. This is done by creating a window around the IMA proximal to the ascending left colic artery. We divide the IMA between Hem-o-Lock® clips

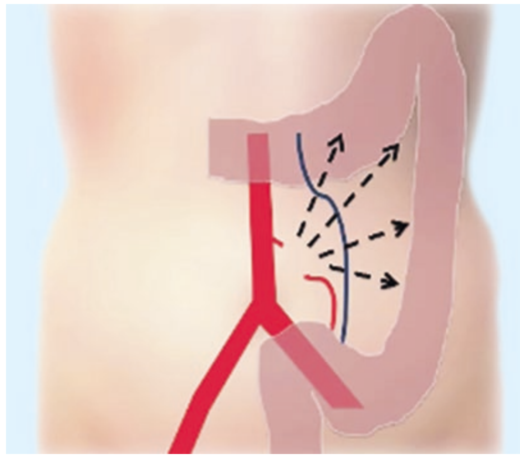


■ **Fig. 46.6** Division of the inferior mesenteric artery close to its origin using clips

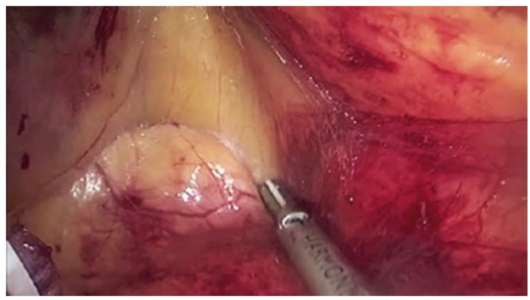
(■ Fig. 46.6). It is important at this stage not to carry out prolonged thermal dissection at the root of the IMA as this may result into injury to the main trunk of the hypogastric nerve which runs at this level near to the origin of the vessel.

Medial to Lateral Mobilisation and Ligation and Division of the Inferior Mesenteric Vein

Once the inferior mesenteric artery has been divided, the focus turns to the inferior mesenteric vein. However, we attempt to delay the division of the vein as long as possible during the medial to lateral mobilisation. The free mesentery border containing the inferior mesenteric vein can be supported by a grasper in the left hand of the operating surgeon. This creates a curtain preventing the small bowel to glide into the operating field. Furthermore, the vein is an important reference point for the retroperitoneal plane which begins just below the vein and continues from medial to lateral aspect over the fascia of Toldt (■ Figs. 46.7 and 46.8). Often, there are small and easily bleeding vessels between the two layers of fascia which should be pre-empted and sealed using harmonic scalpel as they result in staining of the retroperitoneal plane in case of bleeding. Once the dissection has been completed at the duodeno-jejunal level, the superior border of the pancreas is identified, and the lesser sac is entered from below by scoring the outer layer of the transverse mesentery (■ Fig. 46.9a, b). This step facilitates later the splenic flexure mobilisation which in most cases is necessary in total mesorectal excision. If total splenic flexure mobilisation is necessary, we place a swab on top of the pancreas, which serves as a reference point and protection of the pancreas when completing the dissection coming from the lesser sac at a later stage of the



■ **Fig. 46.7** Medial to lateral mobilisation after division of the inferior mesenteric artery



■ **Fig. 46.8** The avascular embryologic plane is dissected from medial to lateral

operation. When the dissection from medial to lateral is completed, the inferior mesenteric vein is clipped and divided just below the lower border of the pancreas and next to the duodeno-jejunal junction (■ Fig. 46.10).

Lateral Mobilisation

The lateral left colonic mobilisation is carried out by monopolar hook cautery joining a plane which has already been created from the medial aspect. The lateral peritoneal top layer is divided by holding the colon towards the right side. Care must be taken to always stay close to the colon as it is very easy to get behind the left kidney. Lateral dissection begins from the pelvic brim and continues up to the spleen (■ Fig. 46.11). The attachments to the spleen have to be divided at the turn of the splenic flexure. Care must be taken to avoid any traction on these attachments as this may result into traction injury to the splenic capsule resulting into bleeding.

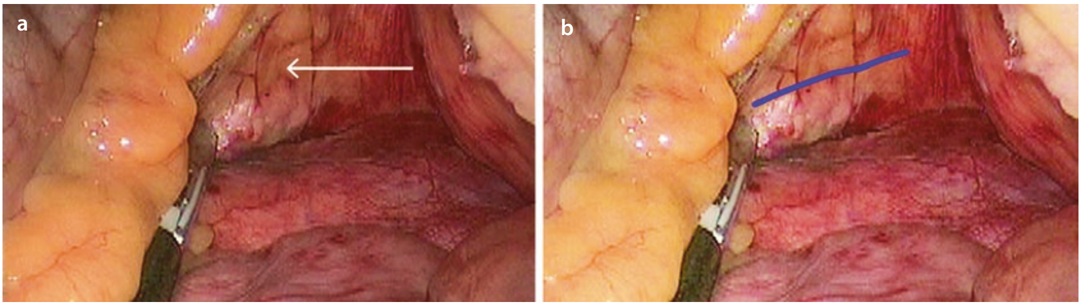


Fig. 46.9 **a** Blunt dissection continues until the pancreas can be identified (arrow). **b** Scoring of the transverse mesentery at the top border of the pancreas (blue line). After that, a swap is placed on top of the pancreas, and the transection of the left-sided transverse mesentery is completed from the lesser sac

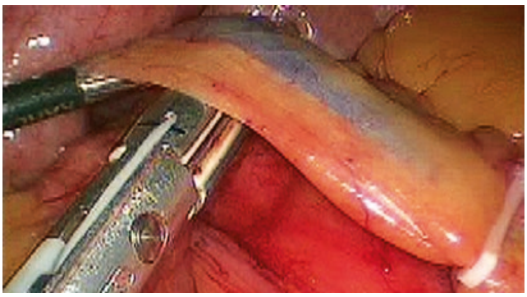


Fig. 46.10 Division of the inferior mesenteric vein at the lower border of the pancreas

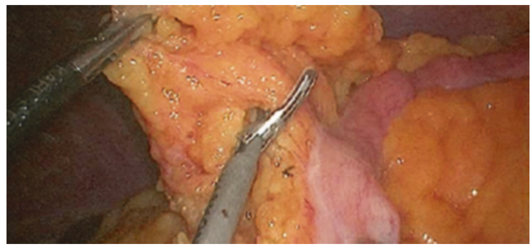


Fig. 46.12 Detachment of the omentum from the transverse colon in order to enter the lesser sac

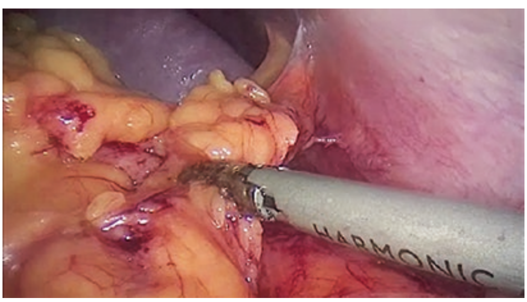


Fig. 46.11 Lateral mobilisation of the colon

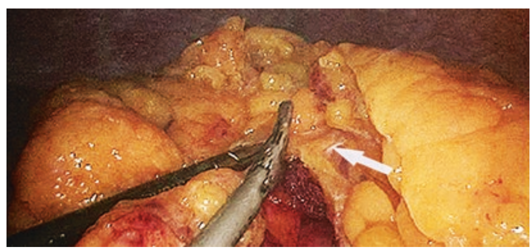


Fig. 46.13 Division of the transverse colon over the swab (arrow) which has been placed on top of the pancreas in a previous step. This avoids injury to the pancreas

Mobilisation of the Left-Sided Transverse Colon

To completely free the splenic flexure, the left-sided mesentery of the transverse colon has to be divided immediately above the pancreas. This can be achieved from below or from the lesser sac. We often choose the second option. To enter the lesser sac, either the gastrocolic ligament has to be divided, or the omentum has to be detached from the transverse colon (Fig. 46.12). After one of these steps, the lesser sac is entered and the mesentery of the transverse colon divided over the swab (Fig. 46.13) which has been placed on top of the pancreas in a previous step of the operation from below. The splenic flexure and the left colon should now be completely mobilised allowing a tension-free anastomosis.

46.7.3 Laparoscopic Total Mesorectal Excision (TME)

Step 1: Posterior Dissection

First, the correct plane of further dissection has to be identified; in fact, the correct plane is a continuation of the plane previously identified during the

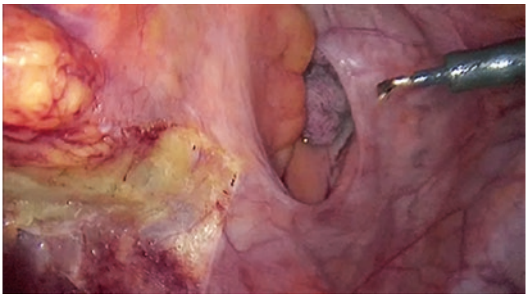


Fig. 46.14 Dissection following the angulation of the superior haemorrhoidal artery leads to the correct posterior TME plane

colonic medial to lateral mobilisation. The inferior mesenteric artery is continued to be mobilised towards the pelvis staying very close to its dorsal surface. Following the angle of the superior haemorrhoidal artery will automatically lead into the pelvis and guide to the correct embryologic plane at the top of the TME plane, allowing preservation of the nerves. The posterior dissection further down is then performed by separating the cobweb plane staying close to the mesorectal package and using monopolar hook diathermy (Fig. 46.14). The dissection always stays in front of both hypogastric nerves. The monopolar hook dissection is carried out in very small and short contacts so that no charring is produced and clear vision of the planes is maintained. Traction on the specimen is provided by a swab hold in the surgeon's left hand grasper in order to minimise trauma to the specimen itself. The posterior dissection is continued all the way down to the beginning of Waldeyer's fascia.

Step 2: Right Lateral Dissection

After having completed the posterior dissection as described above, the right lateral mobilisation of the specimen is performed by separating the right-sided pelvic attachments (Fig. 46.15). The rectum is retracted out of the pelvis, and to the left, traction and counter-traction is performed with two additional graspers at the site of hook dissection. As the plane at the lateral attachments is more difficult to identify, care must be taken not to enter the mesorectal package or to go too wide at the posterolateral side in order to avoid injury to the very close hypogastric nerve fibres at this level. The right hypogastric nerve can be visualised completely during this step. Once the attachments have been divided and the nerve fibres preserved, we complete the division of the peritoneal reflection on the right side and anteriorly (Fig. 46.16).

Fig. 46.15 Dissection of the right lateral peritoneum and attachments

Fig. 46.16 Division of the peritoneal reflection

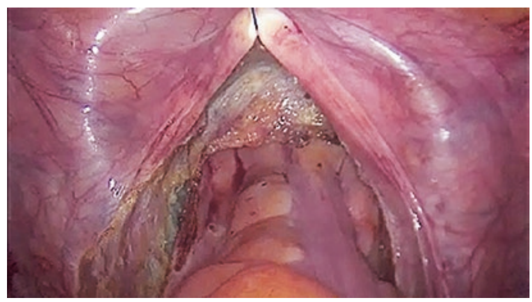
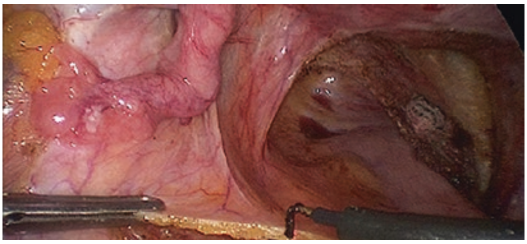


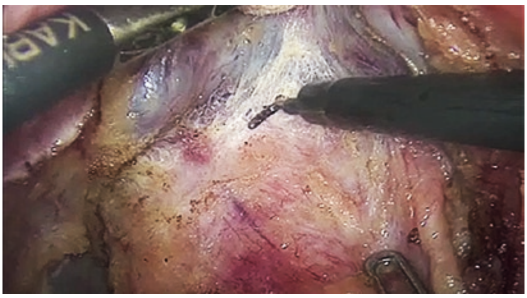
Fig. 46.17 Transabdominal hitch of the anterior peritoneal fold at the base of the bladder in a male to expose the anterior pelvis

Step 3: Anterior Dissection (Exposure)

Anterior dissection is facilitated by proper exposure of the deep pelvis. This is achieved by suturing the fundus of the uterus in female patients or the peritoneal fold at the base of the bladder in male patients (Fig. 46.17) to the abdominal front wall. For this, we use a 2-0 Prolene transabdominal suture on a straight needle. To dissect the anterior aspect, the divided peritoneal reflection adjacent to the specimen is held by a grasper in the left hand of the operating surgeon, while the left-sided assistant applies counter-traction onto the anterior pelvic wall with a pledget (a small compress).



■ **Fig. 46.18** Division of the left lateral peritoneum and attachments



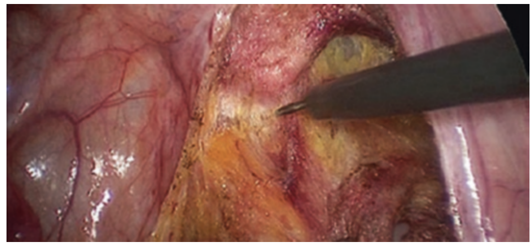
■ **Fig. 46.19** Anterior dissection between Denonvilliers' fascia and seminal vesicles in a male

Step 4: Left Lateral Dissection

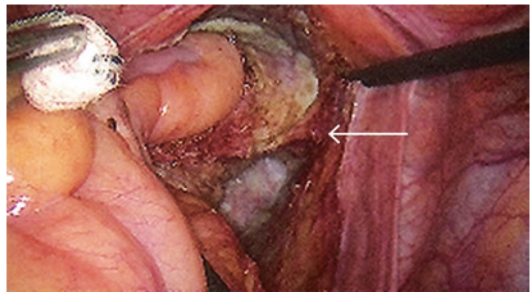
After division of the anterior peritoneal reflection and some hook dissection further down, the specimen is held in place by a thin layer of the peritoneum on the left side. This peritoneal layer is scored and the lateral attachments beneath are divided by the hook cautery (■ Fig. 46.18). Care must be taken not to go too wide on the left side while coming down into the pelvis as this may result into injury to important structures like the left ureter or left hypogastric nerve. Counter-traction is again provided by the assistant to facilitate this step.

Step 5a: Anterior Dissection in Male

The plane between the Denonvilliers' fascia and the seminal vesicles is entered anteriorly by applying dorsal traction on the specimen and counter-traction on the seminal vesicles (■ Fig. 46.19). This dissection has to be very precisely in order not to risk bleeding which would stain the cobweb plane and make the dissection a lot more difficult. As usual, this step is performed by monopolar hook diathermy under avoidance of any charring.



■ **Fig. 46.20** Anterior dissection of the vaginal back wall in a female



■ **Fig. 46.21** Nerve fibres at 4 and 8 o'clock position have to be preserved

Step 5b: Anterior Dissection in Female

The hitched uterus helps to visualise the posterior wall of the vagina (■ Fig. 46.20) from where the mesorectal fascia has to be dissected. Care has to be taken not to perforate the vagina. In case of difficulty to delineate the vagina, a sponge stick is inserted into the vagina.

Step 6: Right and Left Posterolateral Dissection, Exposure of Erigent Pillars

Before addressing the deeper lateral dissection, the anterior and posterior dissection has to be performed as far down as possible. Especially the established posterior plane serves as a reference point whenever the dissection plane becomes unclear. Both the anterior and posterior planes should be used as a constant reference for division of the lateral attachments of the specimen. Care must be taken at the four and eight o'clock position of the specimen, as the nerve fibres have to be teased off the specimen in order to avoid injury (■ Fig. 46.21).

Step 7: Completion of Dissection

Arrived on the pelvic floor, dissection is carried out using the harmonic device as traction and counter-traction may be difficult to achieve. The

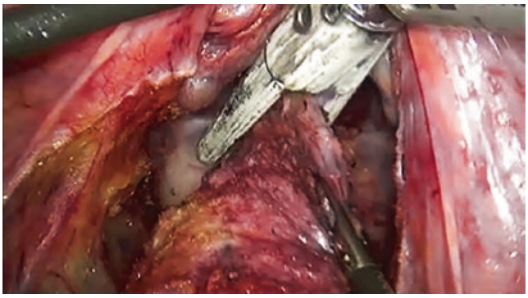


Fig. 46.22 The stapling device is inserted from lateral and rotated in a vertical position

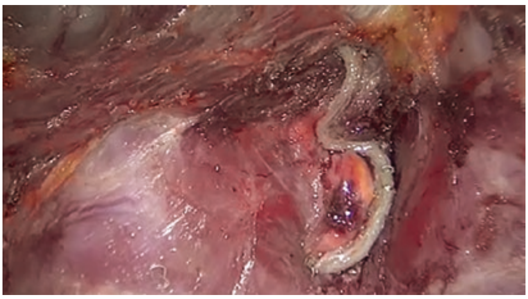


Fig. 46.23 Vertical position of the stapling device

rectal tube is dissected circumferentially in order to be able to place a stapling device. The tumour height and clearance are assessed by digital rectal examination. In case of upper rectal cancer, intraoperative flexible endoscopy may help to delineate the lower border of the tumour.

Step 8: Rectal Washout

Although there is sparse evidence, we perform a rectal washout with a cytotoxic solution (Betadine®).

Step 9: Stapler Division

A linear Endo GIA stapler (Covidien USA) is inserted through the 12 mm port. Depending on the thickness of the bowel wall, we choose a purple or a green cartridge. We prefer a cartridge length of 45 mm as it allows easier manipulation in the narrow pelvis. Normally two firings are necessary. The rectum is retracted out of the pelvis and dorsally. Then the stapler is maximally angulated and rotated in a vertical position (Fig. 46.22). This allows an anterior-posterior staple line straight at the level of the pelvic floor (Fig. 46.23). This step can be further facilitated by pushing on the perineum from below. Both staple lines should meet exactly and not cross

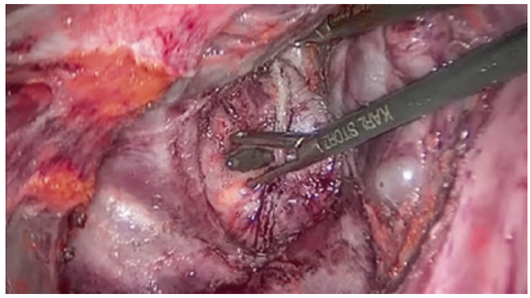


Fig. 46.24 Anteroposterior staple lines straight on the pelvic floor without overlap

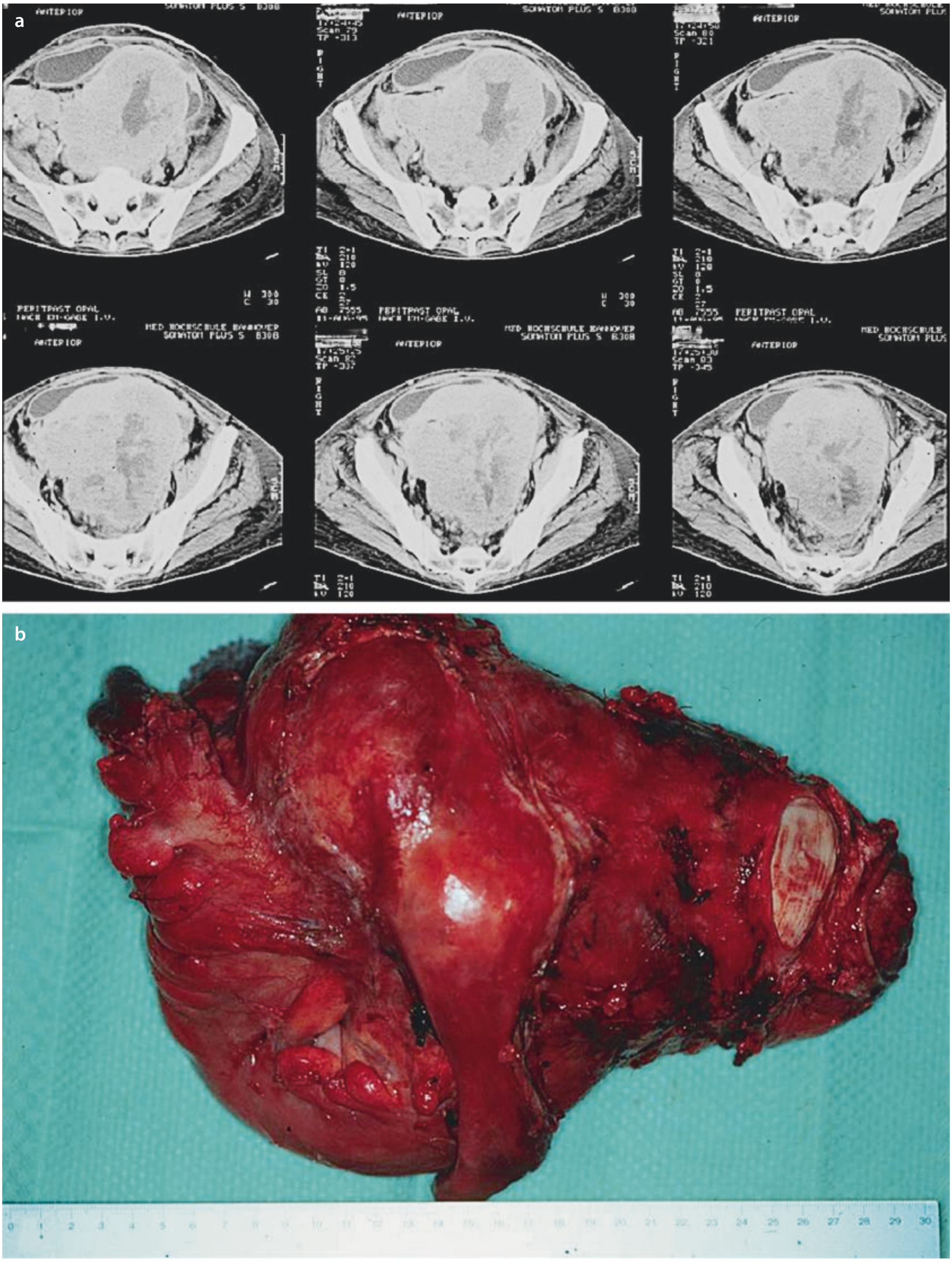
each other (Fig. 46.24). A tensionless anastomosis is crucial. A grasper is placed at the end of the dissected rectum to facilitate extraction.

46.7.4 Extraction of Specimen

To extract the specimen, the umbilical port site is extended to about 4–5 cm in the midline. We use an Alexis® wound retractor to protect the wound. The exteriorised descending and sigmoid colon and the rectum are laid out anatomically. The site of transection is marked and the mesentery divided accordingly. Before dividing the marginal artery at the level of the transection site, its pulsatile flow is assessed.

46.7.5 Anastomosis

We perform an end-to-end colorectal stapler anastomosis using a CDH 29 mm device (Ethicon Endo-Surgery). The stapler anvil is inserted into the proximal bowel end and secured with a purse-string suture. Then, the exteriorised bowel is put back into the abdominal cavity. To seal the extraction site, we pull a glove over the Alexis® retractor and use one of the glove fingers to insert the 10 mm camera port. Pneumoperitoneum is established. The descending colon is aligned anatomically to exclude any torsion of the mesentery. The proximal end with the anvil is brought into the pelvis to make sure that a tensionless anastomosis is possible. The spike of the stapler should perforate where the two staple lines meet (Fig. 46.25). The anvil of the proximal bowel end is connected with the stapler gun. Before closing the stapler, the aligning and the rotation of the left-sided colon are



■ **Fig. 46.25** The spike of the stapling device perforates where the two staple lines meet

once again checked. The stapler is closed and fired after a short time of compression. The integrity of the two doughnuts is checked. We always perform a flexible sigmoidoscopy to assess the anastomosis and the viability of the bowel mucosa from the endoluminal side. At the same time, the water test to exclude air leaks is done. A 20 French non-suction tube drain is placed into the pelvis.

46.7.6 Loop Ileostomy

After a total mesorectal excision with primary anastomosis, we always perform a loop ileostomy. An ileal loop next to the caecum is brought to the abdominal wall. The fascia of the umbilical midline incision and the 12 mm port site as well as the skin is closed. An ileostomy is performed in usual fashion.

46.8 Postoperative Care

Patients are managed according to the principles of enhance recovery as described by Kehlet [14]. Oral intake in the form of liquid diet is started in the evening of surgery followed by normal solid diet the next day. Epidural analgesia is left in place for 48 h after surgery. Before removal of the epidural catheter, oral analgesics like paracetamol and non-steroidal anti-inflammatory agents are started. Urinary catheter and pelvic drain are also removed at day 2 following surgery. Once the patient is considered to be stoma competent by the stoma nurse and meets all other criteria for discharge, they are discharged home. Our median length of hospital stay for patients undergoing laparoscopic TME surgery is 5 days.

46.9 Conclusion

Laparoscopic rectal resection with TME is safe and confers all the benefits of laparoscopic colonic surgery. With improvement in techniques, better instrumentation and increasing experience, the quality of TME and the oncological results will continue to improve. However, it is a challenging procedure to learn, requiring a stringent training programme as with the introduction of open TME. We believe that by standardising the technique of laparoscopic TME surgery, consistent results can be achieved which are at par if not better when compared to open surgery. With appropriate training, laparoscopic TME is likely to become the new gold standard for rectal cancer resection.

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Surgical Technique and Difficult Situations from Peter M. Sagar (Conventional, Abdomino-Sacral Resection)

Peter M. Sagar

M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations*,
DOI 10.1007/978-3-662-49878-1_47

47.1 Introduction

The incidence of rectal cancer remains high – there are 13,000 new cases each year in the United Kingdom (population 60 million). A small proportion of these cases will present with direct posterior invasion of the tumour with involvement of the sacrum. Moreover, 5–15% of patients who undergo resection with intent to cure will develop local recurrence of their tumour. Such recurrences may involve the neorectum ± the adjacent genitourinary organs, the pelvic sidewall, the sacrum or a combination of these three sites. There is, therefore, a small but definite cohort of patients with either primary or recurrent rectal cancer with sacral involvement. Those suitable for resection need careful preoperative assessment and a well thought-out and executed surgical strategy.

47.2 Composite Abdomino-Sacral Resection

47.2.1 Preoperative Evaluation

- Complete history and examination (with digital rectal examination as appropriate)
- Assessment of performance status of the patient
- Examination under anaesthesia with cystoscopy and urogynaecological examination if indicated
- Colonoscopy to assess (neo)rectal lesion and exclude synchronous colorectal pathology
- MR imaging with fat suppression and gadolinium enhancement
- Thoraco-abdominal CT imaging with PET if available to identify FDG uptake of the primary/recurrence and metastases
- Biopsy of suspicious lesions

47.2.2 Preoperative Radiotherapy

- All patients who are radiotherapy naïve should receive long-course chemoradiotherapy (5-week course) followed by a 6–8-week delay before resection with restaging at this time.
- Patients who have previously had either long- or short-course radiotherapy may be considered for a boost.

47.2.3 Preparation

- Stoma site marking by colorectal nurse specialists.
- Epidural and general anaesthesia. The anaesthetist is aware that the second stage will be in prone jackknife position.
- Central venous and arterial lines.
- Placement of bilateral ureteric stents.

47.2.4 Theatre Set-Up for First Stage

- Modified Lloyd-Davies position
- Electronic table with scope for steep reverse Trendelenburg
- Lower limbs in Allen stirrups with padding at pressure points
- Arms wrapped in padding and positioned at the sides
- Urinary catheter, nasogastric tube
- Passage of ureteric stents

47.2.5 Surgical Procedure

First Stage: Abdominal Phase

- The abdomen is entered though a midline laparotomy with complete adhesiolysis.
- Thorough laparotomy to exclude occult peritoneal metastases.
- The site of the pelvic mass is identified and the mass assessed. The main concern at this stage is the involvement of adjacent organs. As well as the suspected and presumed sacral involvement, it is important to ensure that the preoperative staging has not underestimated the anterior and lateral extent of the tumour. In order to achieve tumour-free resection margins (R0 resection), involved organs should be resected en bloc with the primary mass.
- Both ureters are identified. It is usually easier to find them in the sigmoid fossa rather than lower down on the pelvic sidewall especially in redo/irradiated cases. Once found, they can be isolated on vasiloops.
- The iliac vessels are similarly isolated (Fig. 47.1). Decisions about which of the iliac vessels need to be ligated can be left for later in the operation. When ligating, doubly ligate the internal iliac artery before the vein. Try to preserve the first branch of the vessel

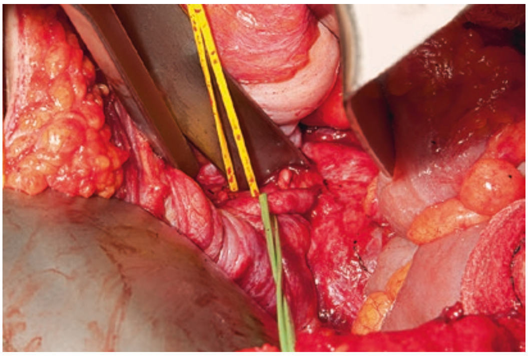

Fig. 47.1 Left iliac internal artery and vein have been looped. In difficult situation are the vessels easy to access

in order to promote skin and muscle flap healing.

- Once the ureters and iliac vessels have been identified and control is obtained, an initial dissection of the tumour can begin. It is often helpful to start relatively proximal as this tends to be a more friendly field and allows entry into the correct planes of zygosis. Early division of the colon at a site deemed likely to be appropriate for later construction of the colostomy allows the posterior plane to be entered. This tends to be a safer plane and allows the lateral plane to be developed under direct vision. Care should be taken when approaching the pelvic sidewall veins. While arterial control may have been gained by earlier exposure of the iliac vessels, the veins are part of an extensive collateral circulation. They tear easily, and, once damaged, a small hole in a vein can quickly extend with brisk loss of blood. Prompt judicious action is called for but blind aggressive clamping often worsens the situation.
- Identification of the S1 and S2 nerve roots at this stage with vasiloops helps to prevent later inadvertent damage.
- As dissection proceeds caudally, resist the temptation to dissect too close to the superior extent of the tumour. This may happen in an attempt to make the level of division of the sacrum as low as possible. Breeching the tumour mass with escape of tumour will compromise the oncological clearance.
- Dissect towards the sacrum resecting the Waldeyer's fascia.
- The tumour is mobilised anteriorly and laterally. This leaves the tumour mass only attached posteriorly. It is helpful to leave a small gauze swab paced just above the tumour pressed against the sacrum at the proposed level of division.
- It can be difficult to be certain as to the precise level of sacral division and the surgeon needs to think ahead so that he is confident that what is perceived to be the level of division when viewed from the anterior (abdominal) aspect remains the same once the sacral stage is underway. With higher levels of sacrectomy, it is helpful to place a sterilised thumbtack into the presacral fascia. This will permit identification at fluoroscopy should the need arise.
- Stomas are constructed and the abdomen is closed.

Second Stage

Sacrectomy Phase

- The patient is carefully placed into the prone jackknife position. It is important that the surgeon supervises this phase not only to ensure safe transfer from Lloyd-Davies to the prone jackknife position but also to ensure correct support and flexion of the pelvis to help minimise blood loss in the next phase of the operation. The buttocks are taped to aid exposure. The sacroiliac joints are palpated and marked with an ink marker pen (Fig. 47.2).
- A dorsal longitudinal incision over the sacrum is made extending from L5 to the perineal scar/anus. The gluteal muscles are reflected laterally (Fig. 47.3). The sacrotuberous and sacrospinous ligaments are divided to allow entry into the pelvic cavity by breaking through the endopelvic fascia (note: division of the sacrospinous and sacrotuberous ligaments BEFORE division of the sacrum helps to minimise blood loss). A finger is placed

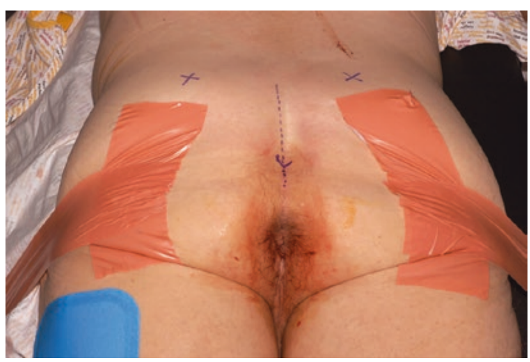

Fig. 47.2 Patient is in prone position. Lumbosacral joint and os coccyx have been marked

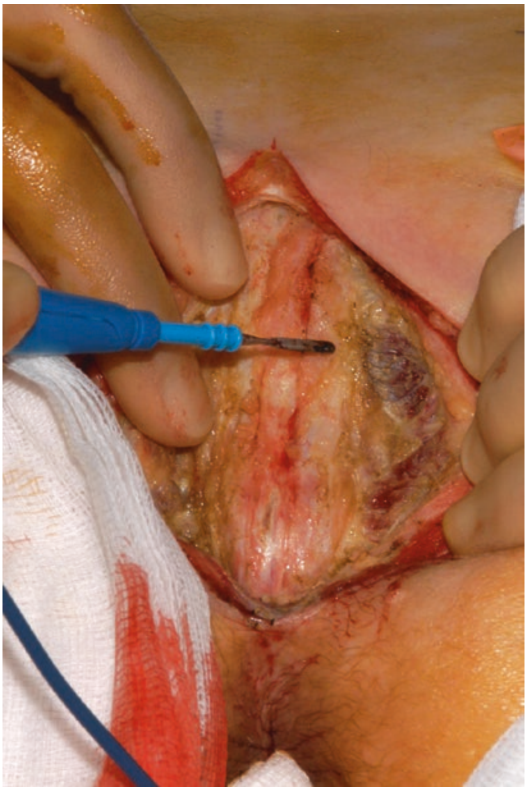

Fig. 47.3 Vertical incision along of os sacrum and lateral mobilisation of gluteal muscles

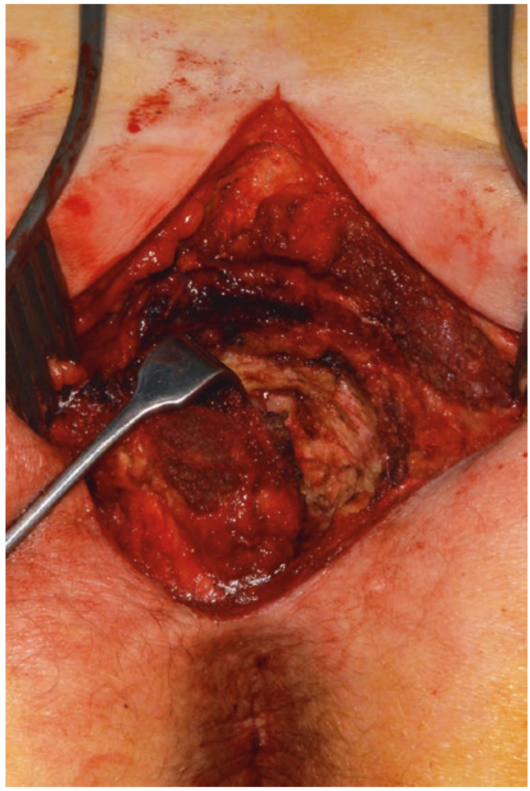

Fig. 47.4 Os sacrum has been transected and it distal part has been removed in order to provide a pelvic approach above of tumour location

into the presacral space to verify the level of sacral division.

- Laminectomy: An osteotome is used to incise the cortex and develop a plane between the sacral vertebrae. Bone nibblers are used to divide the lateral pedicles. Once the distal sacrum has been dislocated, the presacral fascia can be visualised. This is a tough structure but yields to cutting cautery on a high setting (Fig. 47.4).
- The dural sac may extend distally as far as S4 and should be ligated with a non-absorbable suture.
- The cephalad, lateral and caudal planes of dissection are joined, and any residual anterior areas of attachment (usually to the prostate or vagina) are divided to permit removal of the specimen via the sacral/perineal wound (Fig. 47.5).
- Omentum, absorbable mesh or pedicled flaps may be used to reconstruct the wound and limit the descent of small bowel into the pelvis (Figs. 47.6 and 47.7).

Extension of Tumour Above the S2/S3 Junction

- Technically very challenging with high morbidity.
- Cases may have invasion of the presacral fascia without involvement of the bony cortex and may be suitable for en bloc resection of the fascia alone.
- Anterior approach:
  - Ligate internal iliac arteries and veins.
  - Ligate the branches of the internal iliac artery along both sides of the sacrum.
  - Beware of the low division of the aorta and especially the inferior vena cava (note: right common iliac runs almost straight down to the groin and is easily damaged in this situation).
  - Anterior osteotomy (unicortical) and marked with a tack or screw.
  - Vertical osteotomy through the ileum.
  - Place a silastic mesh in front of the sacrum.

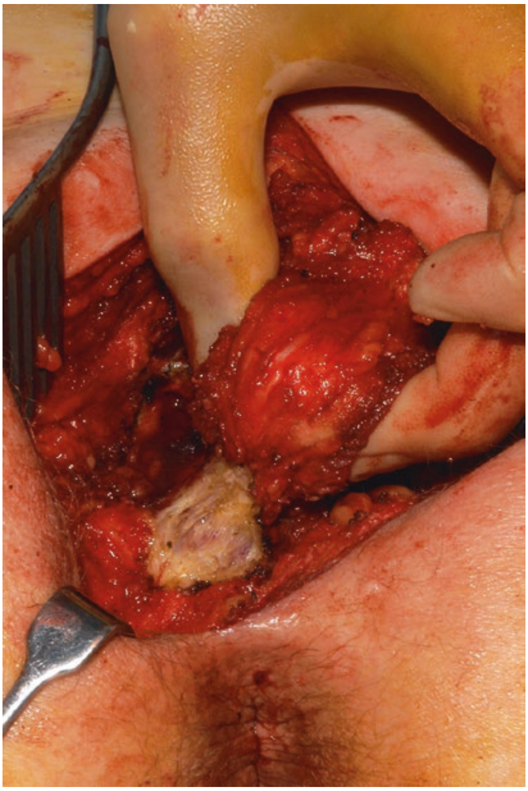

Fig. 47.5 Preparation of neorectum from sacral space

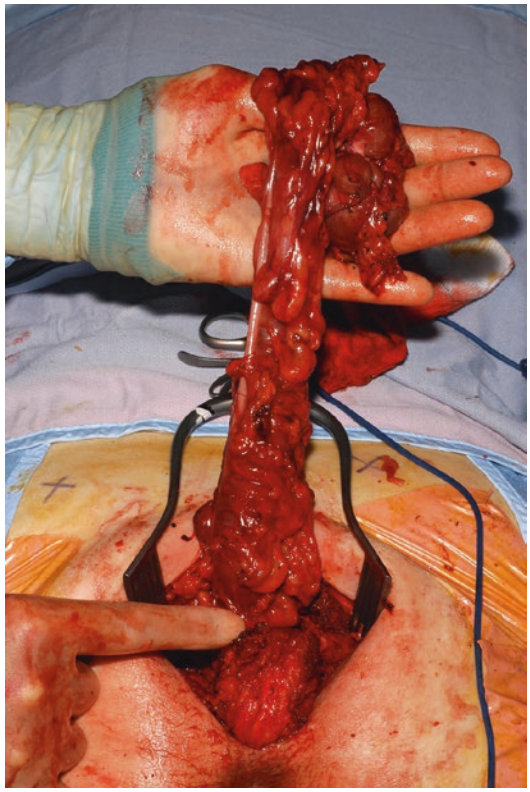

Fig. 47.6 A neorectum and distal colon are dissected completely

- Posterior approach:
  - Vertical incision over the sacrum with reflection of the gluteal muscles and division of the sacrotuberous and sacrospinous ligaments.
  - Division of the piriformis with preservation of the sciatic nerve if possible.
  - Laminectomy, ligation of the dural sac and final osteotomy.
  - High division, above S1, will require some form of stabilisation with free fibular grafts and titanium rods.

47.3 Surgical Approach If Urinary Structures Are Also Involved

The operation of total pelvic exenteration with sacrectomy adds an extra dimension to the above operation and, inevitably, is associated with increased morbidity. The additional steps relate to the abdominal phase of the procedure.

- Early ligation of the internal iliac arteries and then the veins reduces loss of blood.

Fig. 47.7 A specimen with distal sacrum (transection by S3/4) and neorectum

- Conventionally, the inferior vesical vessels are ligated and divided under direct vision. Advent of energy sources such as the harmonic scalpel or Ligasure device permits mobilisation of the bladder with sealing of the vessels without the need to dissect out each vessel.
- Anterior mobilisation of the bladder can be more difficult than expected as a result of damage from radiotherapy. Care must be

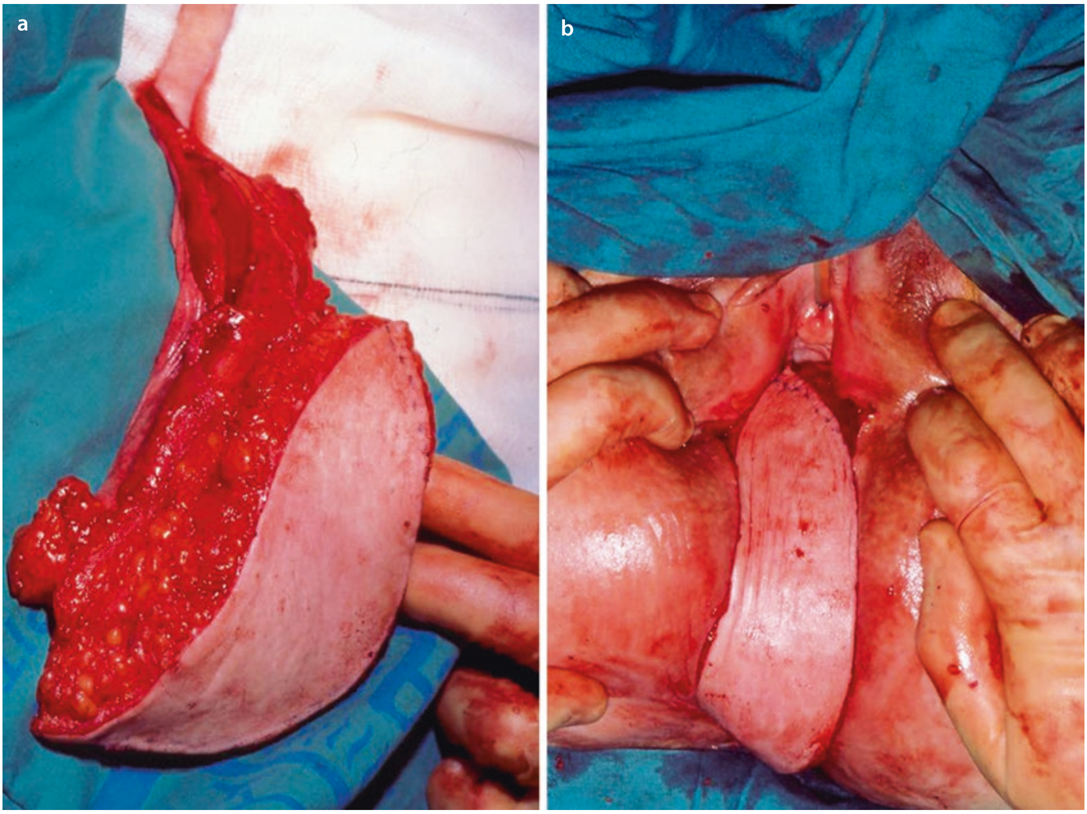

Fig. 47.8 Transpelvine myocutaneous flap of rectal abdominal muscle with inferior epigastric vessels has been used for reconstruction of perineal defect as well as for reconstruction of vagina

taken in this situation not to tear into the bladder or to traumatise the veins that run in this plane. Again, the use of the newer energy sources is advantageous.

- Division of the dorsal veins of the penis leads to a brisk bleed. The bladder and prostate need to be retracted posteriorly to allow good exposure. The veins need to be suture ligated. Inflation of a 30 ml balloon on a wide-bore catheter that is then connected to a urinary bag filled with a litre of saline to provide pressure helps reduce the risk of reactionary bleeding from these veins. The weight-providing traction can be released on the first post-operative day.

47.3.1 Reconstructive Options to Close the Perineal Defect

- The most common flaps used include the transpelvic rectus abdominis myocutaneous flap, gracilis myocutaneous flap and gluteal myocutaneous rotational or advancement flaps.
- Gracilis flaps provide less tissue for coverage and may be associated with an increased failure rate.
- A rectus abdominis flap based on the inferior epigastric vessels provides a substantial myocutaneous flap that adequately fills the gap left after sacrectomy. Care should be taken to ensure correct orientation especially as the flap is passed down into the pelvis (remember the orientation may alter after placement of the flap in the pelvis on transfer of patient between the two phases of the operation).
- Superior and inferior gluteal perforator flaps. Reconstruction of the perineal and posterior vaginal wall defects with myocutaneous flaps based on the course of the superior and inferior gluteal perforators allows replacement of the lost volume of tissue between the perineum and sacrum and allows restoration of a functional vagina. Such flaps avoid the sacrifice of functional muscle, do not interfere with formation of a colostomy and avoid the use of irradiated tissue (Fig. 47.8).

- In situations where pedicled flaps are not an option, free flaps may be used.
- Overall, closing the defect with flaps appears to decrease the rate of perineal wound complications, notably dehiscence. In a study from the Mayo Clinic, myocutaneous flap repair was compared with both primary closure and primary closure with pedicled omentoplasty. Flap repair was found to be superior to the alternatives and led to reduced wound complications and length of hospital stay.

47.4 Dealing with Unexpected/Difficult Situations

47.4.1 Bleeding

- Venous pressure is low – digital pressure allows time for thought.
- Inform the anaesthetist.
- Good exposure, lighting and assistance are crucial.
- Application of point pressure with, say, a pledget above and below the tear may allow accurate placement of a suture.
- A wider tear in a non-compliant vessel (because of previous surgery/radiotherapy) may necessitate suturing with a patch.
- Application of thrombogenic agents such as FloSeal or SurgiFlo.
- Pack and apply pressure for 15 mins and then review.
- Remove packs after first dampening the packs with sterile saline. Gradually peel the packs back with two suckers on stand-by.
- If bleeding has ceased, make a judgement about the wisdom of completing the dissection based on the patient's condition and extent of resection still to be completed. This is the best opportunity to achieve a successful oncological resection, but this has to be judged against the risk to the patient.
- If bleeding continues despite the above measures, repeated as necessary, then the pelvis should be packed and the abdomen closed. Plan to remove the packs at second-look laparotomy ideally within 48 h. Only very rarely does the bleeding continue at this stage (note: a pelvis is easier to pack effectively once the rectum/neorectum has been removed.)

47.4.2 The Correct Level of Sacral Division

This can be difficult. While low pelvic recurrences that involve the coccyx/lower sacrum alone should not present too much difficulty especially in patients where intestinal continuity and an anal orifice have been preserved, recurrences at higher levels after APER can be a problem.

- Check the preoperative imaging both before the operation and again before the sacrectomy phase of the operation.
- During the abdominal phase, count down the sacral vertebrae from the lumbosacral junction. Match this (which can mislead) with the preoperative images.
- If in doubt, and particularly with the higher tumours, insert a metallic pin into the presacral fascia immediately above the tumour.
- Be aware of how the position of the tumour changes with respect to the operative field as the patient is moved from modified Lloyd-Davies to prone jackknife. The tumour always seems further away from the perineum!
- Use fluoroscopy to check where the pin was placed and use this marker as the point of reference for sacral division.
- Avoid inadvertent entry through the sacrum and into the posterior aspect of the tumour mass. Check and recheck the level before breaking though the presacral fascia and into the pelvic cavity.

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Surgical Technique and Difficult Situations from Juergen Weitz (Conventional)

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The local recurrence rate after rectal cancer operations could be drastically reduced since the introduction of the total mesorectal excision (TME) by R. Heald. Nevertheless, the recurrence rate of low rectal carcinomas needing an abdominoperineal rectum extirpation (APE) of the rectum remained high in the literature. One of the reasons is the difficult preparation in the region of the M. levator ani. The specimen has always a waist ("coning") by performing a complete TME. This waist has to be avoided for oncologic reasons in an APE, because the tumor is mainly situated in this region. In recent years, T. Holm developed an operation technic – the elevated APE – that takes care of the special anatomic demands in the region of the low rectum.

The operation is divided into two parts, the abdominal and the perineal part. The abdominal part can be performed in the conventional open style or laparoscopically.

The preoperative preparation and placement of the patients are always important. Male patients should always receive a urethral catheter for the safe identification of the urethra during the perineal part of the operation. The abdominal part of the operation will be performed in lithotomy position.

After correct placement of the patient, preoperative administration of antibiotics, disinfection, and "team time-out," the open/conventional operation starts with the median laparotomy down to the symphysis. This is important to have the best access and view into the operation field of the low pelvis.

After exploration of the abdomen, the inferior mesenteric artery (IMA) will be ligated 1–2 cm after leaving the aorta. This distance is important to not injure the plexus hypogastricus superior with its fibers that are located pre-aortal (sympathetic innervation of the urinary bladder and the sexual organs). As an alternative, lymphadenectomy can be performed along the IMA with its resection distal the outflow of the A left colic artery. Subsequently, the mobilization of the colon descendens and sigmoideum along Gerota's fascia will be performed. The left ureter doesn't need to be leashed routinely, because it is situated one layer more dorsal than Gerota's fascia. The mobilization of the left colon flexure in an APE is not necessary, because the remaining colon descendens is usually long enough for the colostomy. The arterial blood flow through Riolan anastomosis and the needed lengths for the colostomy determine the oral resection border. The transection of the inferior mesenteric vein (IMV) on the level of the pancreatic tail – like routinely performed in an anterior resection of the rectum – is not necessary in an APE.

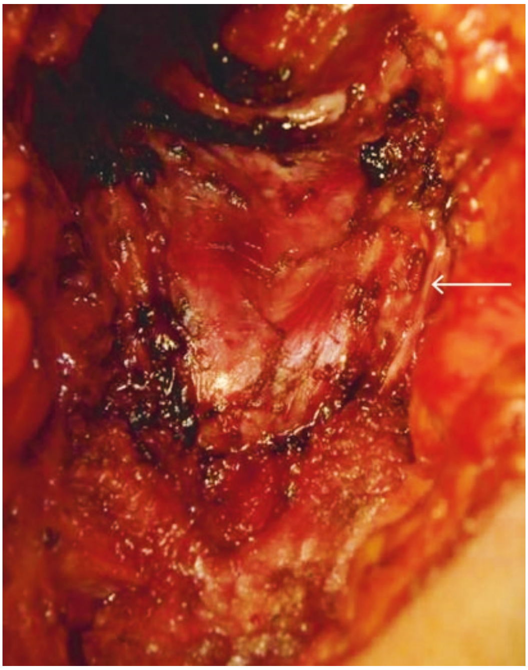
The following steps of the preparation are equal to a low anterior rectum resection with a TME. The key structure for the further aboral preparation is the dissected IMA with the mesenteric lymph nodes, the so-called pedicle package by R. Heald. Starting from right underneath the IMA, you will find the access to the "holy plane," the connective tissue outside of the mesorectal fascia. At the beginning, the caudal preparation will be conducted strictly dorsal – in own approach by diathermy. The basic principle of the TME is "traction and countertraction." With this move, you get the optimal exposition in the small pelvis. Then the lateral preparation starts, coming from dorsal. The lateral preparation is the most difficult part of the resection because of the parasympathetic Nn. splanchnici pelvici and the plexus hypogastricus inferior which have to stay intact. The ventral preparation will start ventral of Denonvillier's fascia with a U-shaped incision to protect the neurovascular bundle that is situated anterolateral to the rectum.

The main difference of an elevated APE to a TME is not to perform the abdominal preparation too far into the pelvis to prevent a coning of the specimen. The aim is to retain the M. levator ani on the specimen. The dorsal preparation should stop above the tip of the os coccygeum, lateral after the identification of the erigent pillars (◘ Fig. 48.1) and ventral at the prostate or in women the proximal third of the vagina.

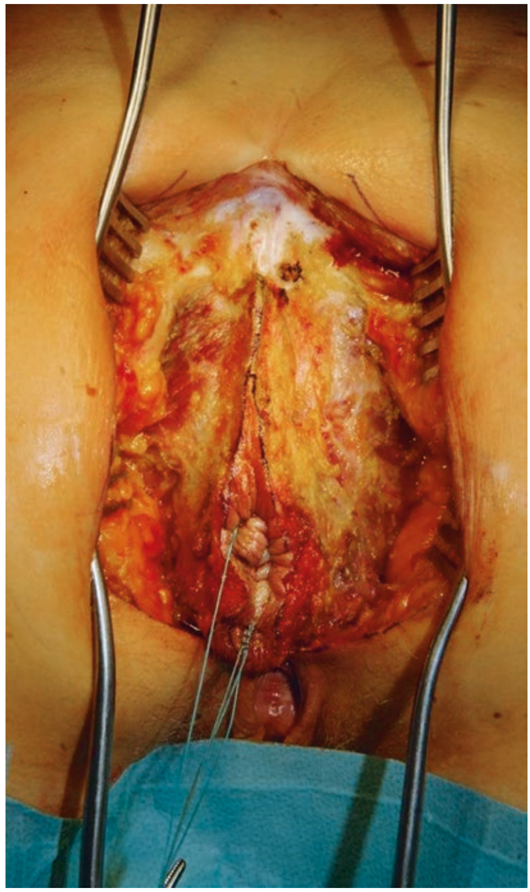
This is the end of the abdominal part of the operation. At the end, a swab will be placed dorsal at the deepest point in the pelvis. This helps to find the right layer after resection of the os coccygeum in the perineal part of the operation.

An omentum flap into the pelvis reduces the made defect and decreases the risk of an intra-abdominal infection. Finally, the descendostomy will be placed and the abdominal wall closed.

The sphincter ani and the M. levator ani will be extirpated in the following perineal part of the operation. The preparation layer can be extended, according to the indication of the APE and the size of the tumor.



◘ **Fig. 48.1** View into the pelvis. The prostate and the Nn. erigentes (*arrow*) are visible



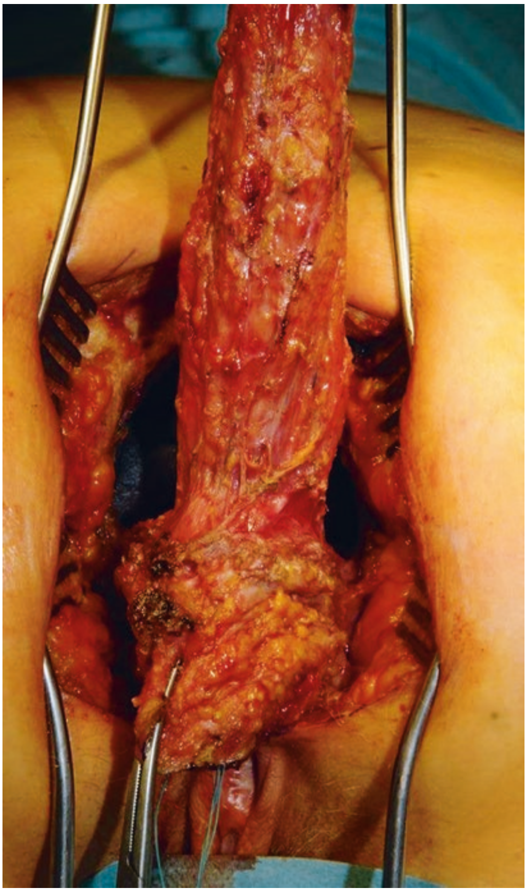
◘ **Fig. 48.2** The anus is closed and an oval incision of the skin is made. You can see the os coccygeum (whitish shimmer) and the fibers of the M. levator ani

Most of the time, the preferred preparation layer is lateral to the fascia of the M. sphincter ani externus and M. levator ani. Basically, it is possible to extend the resection of the ischiorectal fat, depending on the size of the tumor, to get a tumor-free resection margin. The legs of the patient should be spread that the surgeon can sit between them as soon as the patient is placed in prone position.

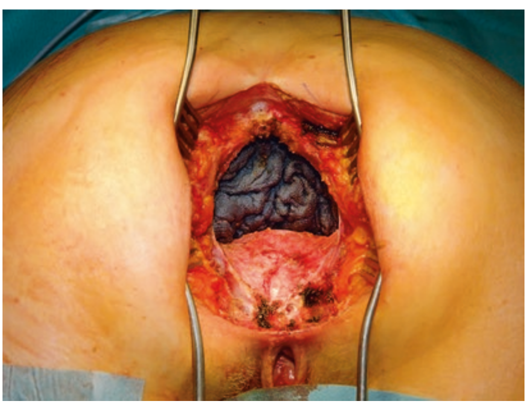
In the first step, the anus will be sutured and the sutures left for traction during the preparation left (◘ Fig. 48.2). The incision has an oval shape around the anus and will be extended dorsally up to the os sacrum that it looks like a teardrop. The preparation goes strictly outside of the fascia of the two key structures, the M. sphincter ani externus and M. levator ani (variation as described above) to the lateral pelvic wall. From there, you reach the muscle insertion of the M. obturatorius internus and the os coccygeum which will be disarticulated. The previously placed swab helps to find the right intra-abdominal layer. Afterward, the M. levator ani will be dissected circumferentially on the pelvic wall. The specimen can now be extracted (◘ Fig. 48.3). The last step is the ventral preparation along the prostate/the vagina. The ventral dissection of the M. levator ani has to be done carefully, since the Nn. erigentes are right underneath it. The ventral resection border is the M. transversus perinei superficialis, where the centrum tendineum perinei will be dissected. This is very demanding because there are no further landmarks. In male patients, the urethra at the apex of the prostate has to be preserved. The placed urethral catheter helps for the orientation. The perineal situs at the end of the APE is demonstrated in the (◘ Fig. 48.4).

If the tumor is placed ventrally, a part of the prostate/the back wall of the vagina can be resected. This is a lot easier in prone position because of the better view on the prostate compared to the lithotomy position. The surgeon should examine the specimen as an own quality control. As mentioned before, the specimen should not have a waist.

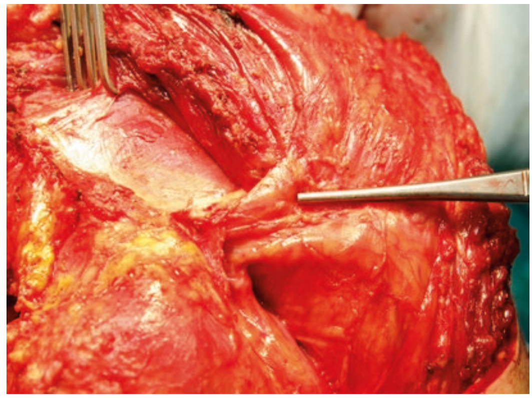
The closure of the perineal cavity can be done in various ways and depends on the size of the



■ Fig. 48.3 The specimen is only attached to the vagina. The cylindrical shape of the specimen is well recognizable

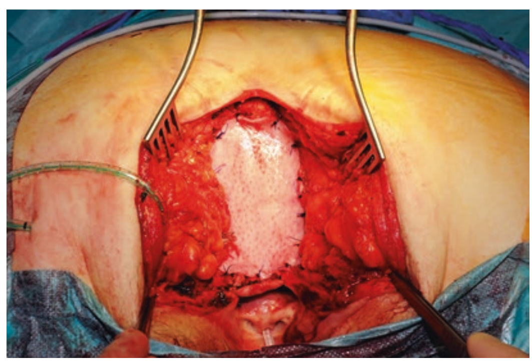


■ Fig. 48.4 View into the pelvis (prone position). The M. levator ani was resected next to the pelvic wall



■ Fig. 48.5 Unilateral muscle flap (M. gluteus maximus). You can see the A. glutealis inferior (forceps) which is needed for the blood circulation of the flap

■ Fig. 48.6 Unilateral M. gluteus maximus flap



■ Fig. 48.7 Defect cover of the pelvis with a Permacol© mesh

defect. In case of a small defect, a direct closure can be done. An alternative is the use of muscle flaps like the uni- or bilateral M. gluteus maximus (■ Figs. 48.5 and 48.6) or a VRAM (vertical rectus abdominis muscle) flap. Furthermore, a mesh (■ Fig. 48.7) can be used to avoid a perineal hernia.

48.1 Unilateral M. Gluteus Maximus Flap

For this muscle flap, the M. gluteus maximus with its subcutaneous fatty tissue and the skin will be used. The proportion is 1.5:1 (length medial to lateral). The incision will be marked after the APE. It starts on the caudal end of the perineal wound and goes like a J to lateral cranially. The incision has to be made through the subcutaneous fatty tissue down to the fascia of the M. gluteus maximus. The muscle will be divided into half after the incision of the fascia. Now the M. gluteus maximus has to be mobilized without dividing the A. gluteus inferior and the nerve (◘ Fig. 48.5). Furthermore, you have to remember that the N. ischiadicus is directly under the muscle and shouldn't be injured. The dissection can be ended at the moment the muscle is mobile enough to reach the other side. The muscle flap will be fixated in four layers: muscular, Scarpa fascia, subcutaneous, and the skin. Two drainages should be placed, one on the muscle and the second subcutaneously (◘ Fig. 48.6).

48.2 Bilateral M. Gluteus Maximus Flap

The bilateral muscle flap will be done accordingly to the unilateral muscle flap by using both sides.

48.3 VRAM (Vertical Rectus Abdominis Muscle) Flap

The right M. rectus abdominis will be mobilized out of its fascia and, cranially, on the costal arch dissected. The blood supply comes caudally out of the epigastric vessels. This muscle flap, if necessary with the skin, can now be rotated into the defect of the pelvis.

Surgical Technique and Difficult Situations from Steven Wexner (Laparoscopic)

Steven Wexner and Marc Osborne

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49.1 Difficult Situations in Laparoscopic Colorectal Surgery: Laparoscopic Low Anterior Resection for Rectal Cancer

We began applying laparoscopic techniques to colon and rectal surgery at the Cleveland Clinic Florida over 25 years ago. During those years, we have refined our approach and for many years have routinely employed minimally invasive techniques for proctectomy for rectal cancer. Our operative planning begins with a thorough preoperative assessment which includes a rectal cancer protocol synoptic report, pelvic MRI, and endoscopy to locally stage the tumor as well as a CT of the chest, abdomen and pelvis to evaluate for distant metastasis. All patients meet with an enterostomal therapy nurse for counseling and stoma marking as well as a colorectal nurse for preoperative education. All patients undergo a mechanical cathartic and oral and parenteral bowel prep.

Anesthesia considerations are individualized toward the patient's needs including the use of central venous catheters and arterial lines. The stomach is decompressed with an orogastric tube which is removed at the end of the case. According to SCIP guidelines, patients receive a dose of appropriate antibiotics just before the incision is made and continue for 24 h postoperatively. All patients wear sequential compression devices and receive chemical deep venous thrombosis prophylaxis with 5000 units of subcutaneous which is continued every 8 h postoperatively until discharge.

After induction of anesthesia, patients are positioned in a modified lithotomy position with stirrups. A bean bag and chest taping are used to secure the patient to the operating table. These steps are essential to help ensure patient safety during steep re-positioning maneuvers necessary to gain adequate exposure. Patients may undergo cystoscopy and bilateral uretic catheterization with stent placement to facilitate intraoperative identification of the ureters. The distal rectum is then irrigated with betadine prior to sterile prep and drape.

Entrance to the abdomen is gained via the Hasson technique just below the umbilicus. A 10 mm 30° angled scope is used to survey the abdomen. Two right-sided 12 mm ports are then placed under direct vision. The lower port is placed approximately 2 cm cephalad and medial to the anterior superior iliac spine. Transillumination of the abdominal wall facilitates avoiding the epigastric vessels. The upper port is placed a few centimeters below the costal margin. Atraumatic bowel graspers are used to create gentle traction to facilitate dissection. Fine dissection is done with an ultrasonic scalpel while the mesentery and omentum are transected with a 10 mm electrothermal vessel sealing device. The surgeon and the camera holder stand on the patient's right side. The camera holder will need to be able to move above and below the surgeon as the dissection progresses between the splenic flexure and the pelvis.

The procedure starts with lateral mobilization of the left and sigmoid colon. Exposure is achieved by placing the patient in steep Trendelenburg position with the patient's left side up. The peritoneum is incised along the line of Toldt distal to the iliac vessels. This maneuver facilitates entry into the avascular plane between the mesentery and the retroperitoneum. Great care is taken to identify the left ureter throughout the procedure. The left colon and its mesentery are fully mobilized to the midline, a step facilitated by frequent adjustments with the left hand to ensure proper traction.

The splenic flexure is mobilized by continuing the liberation of the proximal left colon. The patient is placed in steep reverse Trendelenburg, again with the left side up. Once the spleen is reached, the lesser sac is entered by anteriorly retracting the stomach and incising the gastrocolic omentum. The omentum is transected with the electrothermal vessel sealing device and care is taken to preserve the gastroepiploic vessels. The transverse mesocolon is then mobilized from the inferior border of the pancreas. The dissection proceeds from proximal to distal until the point of the distal dissection is reached, after which the remaining retroperitoneal attachments are incised to fully mobilize the flexure.

With the splenic flexure, left, and sigmoid colon fully mobilized, attention is then turned to the vasculature. With the patient placed back in steep reverse Tredelenburg, the distal sigmoid colon and its mesentery are retracted anteriorly and the peritoneum is incised below the superior hemorrhoidal artery. We dissect through the mesentery until the ureter is identified. In obese patients, gaining adequate traction for exposure can be difficult, and it is often facilitated by placing an additional port in the left lower quadrant in a mirror image position to the right lower quadrant port. Additionally, this port can also be used to facilitate subsequent pelvic dissection. After the ureter is identified, it is kept posterior and the mesentery is divided cephalad to the inferior mesenteric artery and caudal to the inferior mesenteric vein. This maneuver is achieved with the ultrasonic scalpel. A window above and below the inferior mesenteric artery (IMA) is created to isolate the IMA, which is transected by first applying three partially overlapping side-by-side sealings of the vessel with the electrothermal vessel sealing device and then cutting between the high and low sealings. The inferior mesenteric vein is divided in a similar way after dissection of the mesentery cephalad to the vein with the ultrasonic scalpel to isolate the vein. The IMA is transected between the aorta and the left colic artery. The IMV is transected between the edge of the duodenum and the left colic vein. Using the bipolar energy device the mesentery is transected from the level of high ligation to the sigmoid descending junction to an area free of diverticular disease. Transection of the mesentery from the high ligation to the bowel wall will facilitate specimen extraction through a small abdominal wall incision and/or through the anus.

Attention is turned towards the pelvis in which the peritoneum on the lateral sides of the rectum is incised. The presacral space is entered and the areolar attachments to the mesorectum are incised with the ultrasonic scalpel in the right hand and retraction created with the left hand. Additionally, exposure can be facilitated via retraction from the left lower quadrant port. Total mesorectal excision commences as in an open case, the dissection begins posteriorly and then commences laterally and then anteriorly. Care is taken to identify and preserve the parasympathetic nerves, the posterior wall of the vagina, and the seminal vesicles. The dissection proceeds distally to the levator muscles for any tumor in the distal two thirds of the rectum in order to ensure a total excision of the rectum and mesorectum. Manual pressure applied to the perineum can help facilitate exposure. Digital examination from below is also routinely undertaken to help assess if further dissection is needed. After complete laparoscopic mobilization, an endoscopic articulating linear cutting stapler is used to transect the rectum distally. A significant body of evidence has confirmed that as the number of stapler firings increase so does the incidence of anastomotic leakage. Therefore, great effort should be taken to try to minimize the number of stapler firings. Whenever possible one or a maximum of two stapler firings should be employed. If more than 2 stapler firings are required an even higher vigilance towards proximal fecal diversion should be employed. Great care is taken to ensure that the stapler is distal to the tumor, yet above the sphincter complex. Again, digital and/or endoscopic examination is critical to ensure proper placement of the stapler. If the stapler cannot be intracorporeally placed at a satisfactory level then we prefer a transanal approach. This approach might be either by effacing the anus and then commencing with a dissection at the dentate line or by transanal total mesorectal excision. Employing either of these modalities will allow safe completion of total mesorectal excision under direct vision as well as safe performance of an anastomosis at the level of the dentate line. In these instances we do not perform any abdominal incision but extract the entire specimen through the anus and, if technically feasible, preferentially perform a transperineal colonic J-pouch. Whether the specimen extraction will be transabdominal or transanal, the mesentery is divided from the point of high ligation to the sigmoid descending junction, again using the bipolar energy device. Intracorporeal mesenteric transection from the point of high ligation to the bowel wall facilitates specimen extraction through a smaller wound or through the anus.

A small incision is made to deliver the rectum. This extraction site incision may be made as a small pfannensteil, periumbilical, or ostomy site incision. A wound protector can be used to facilitate retrieval and delivery for the extracorporeal phase of the procedure. After the rectum is extracorporeally delivered, the proximal resection margin is chosen based both on oncologic considerations as well as length required to create a tension-free anastomosis. The mesentery is divided with the electrothermal vessel sealing device and the bowel transected with a linear cutting stapler. A 5–8 cm colonic J-pouch is fashioned whenever possible. The pouch is constructed with a single firing of the stapler through an apical enterotomy, after which, a purse string is fashioned around the enterotomy, the anvil of the chosen circular stapler is placed within the lumen, and the purse string secured. If the lower edge of the tumor is within a few centimeters of the dentate line and/or the patient has a very narrow pelvis transanal completion of the dissection may be optimal. More than 10 years ago we first employed standard anal effacement with either mucosal or intersphincteric dissection commencing at the dentate line. We and subsequently others clearly demonstrated oncologic equivalence although as Rullier has noted intersphincteric dissection can be associated with functional compromise. Nonetheless, oncologic acceptability has been clearly demonstrated. More recently, Sylla, Whiteford, Lacy, and others have championed transanal total mesorectal excision. Again, we have demonstrated that using pneumoperitoneum with a high flow insufflator and transanal operating equipment a very elegant total mesorectal excision and subsequent anastomosis can be performed. Regardless of whether the transanal dissection is accomplished with or without pneumoperitoneum and with or without specialized equipment in these instances the entire specimen is transanally delivered and if possible a colonic J-pouch is created prior to transanal coloanal anastomotic construction. These techniques completely avoid any abdominal incision other than the stab wounds for the port sites and the trephine for the stoma. Whether the colon is delivered through the abdomen or the anus proximal margin selection is confirmed by the use of indocyanine green fluorescence perfusion assessment [1]. The proximal bowel is then placed back within the abdomen and pneumoperitoneum is reestablished.

After pneumoperitoneum is re-established, circular stapler is inserted into the anus and the trocar delivered through the distal staple line. The anvil is placed onto the trocar with the assistance of a laparoscopic anvil grasper clamp. The anastomosis is created only after verification to ensure proper alignment of the bowel and its mesentery. After the stapler is closed but prior to it being fired indocyanine green perfusion assessment is again performed to verify serosal perfusion at the intended anastomosis. Laparoscopic fluorescence imaging is repeated using ICG perfusion assessment to confirm perfusion in both the proximal and distal segments to be anastomosed. Flexible sigmoidoscopy is performed to inspect the anastomosis and the anastomosis is submerged in water to perform a leak test. In addition, we have routinely employed indocyanine green (ICG) fluorescence imaging to verify mucosal perfusion after anastomotic creation. The patient is then repositioned to identify the cecum and the small bowel is inspected to identify a site for a loop ileostomy, approximately 40–60 cm proximal to the ileocecal valve. An atraumatic clamp is left on the bowel wall at this site to allow delivery of the bowel through the ostomy trephine. Prior to removing the ports, a closed suction drain is placed posterior to the pouch and is brought out in the left lower quadrant. With the loop of bowel adequately delivered, all fascia and port sites are closed after which the loop ileostomy is matured. The ureteral stents are removed prior to the patient awakening from anesthesia.

Antibiotics are continued for 24 h postoperatively according to SCIP guidelines. Patients immediately begin a clear liquid diet. We encourage early ambulation, and the bladder catheter is removed sometime between postoperative day 1–3, depending upon the surgical indication and the difficulty of the pelvic dissection.

Several key maneuvers are employed to deal with difficult situations. Meticulous attention to hemostasis allows for improved visualization and routine use of energy devices helps provide hemostasis. We primarily use the ultrasonic scalpel for finer dissection, mobilization of the left colon and splenic flexure, and for TME dissection. The 10 mm electrothermal vessel sealing device provides excellent hemostasis during transaction of the mesentery and omentum. Exposure is often difficult in obese patients, those with a narrow pelvis, and/or a large tumor. Adding a left lower quadrant port for an extra grasper that held by an assistant as well as second assistant to provide pressure on the perineum helps provide the exposure necessary to perform a complete rectal mobilization.

The performance of laparoscopic low anterior resection has evolved since we began utilizing this methodology in 1991. Numerous studies have proven the oncologic superiority of laparoscopic as compared to open total mesorectal excision. We have shown a 25 % improvement in lymph node yield using the laparoscopic technique without any compromise to the circumferential or distal resection margins or the quality of the mesorectum [1–4].

Several meta analyses and systematic reviews have supported these points, although there are some isolated studies which have suggested a lack of superiority in fact even a lack of equivalence [5–7].

We also found that the use of energy devices have allowed these operations to be performed more quickly through smaller incisions with less blood loss. Electrothermal bipolar vessel ligation improves operative time during laparoscopic total proctocolectomy: a large single-center experience [8–10].

In summary, laparoscopic low anterior resection for rectal cancer is our preferred technique for managing patients with rectal cancer.

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Pelvic Autonomic Nerve Preservation during Total Mesorectal Excision (TME) from Werner Kneist

Werner Kneist

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50.1 Introduction

According to the German guideline for "Colorectal Cancer," total mesorectal excision (TME) removes the cancer located at the central and lower thirds of the rectum and the pelvic floor while preserving the superior hypogastric plexus (SHP), the hypogastric nerves, and the inferior hypogastric plexus (IHP) (recommendation level A, level of evidence 1b, strong consensus). Intraoperative nerve damage is to be avoided to preserve postoperative quality of life with the premise of radical surgery. It is particularly necessary to preserve autonomously controlled urogenital and anorectal functions. Among other things, this presumes a fundamental understanding of current knowledge on surgical topography, neuroanatomy, and neurophysiology.

Contrary to the established assessment of the oncological quality of TME, there is thus far no generally applicable standard to verify success of nerve-preserving surgical techniques. We assessed urogenital and anorectal functions of our patients in a prospective manner. Furthermore we performed pelvic intraoperative neuromonitoring (IONM), and specific histopathology. In view of this, we will specifically provide our opinion on the complexity of situations and limitations of rectal cancer surgery in terms of preserving autonomous nerve structures.

50.2 Preoperative Aspects

50.2.1 Medical History

For the surgeon, obtaining a differential medical history on preexisting urogenital and anorectal dysfunctions is important. We document the International Index of Erectile Function (IIEF) and Female Sexual Function Index (FSFI) scores, the International Prostate Symptom Score (IPSS), and the Wexner Score.

Histories of previous pelvic surgeries and urological and (uro-)gynecological medical treatments are separately obtained and documented. Following neoadjuvant chemoradiotherapy (nCRT), we reassess the functions immediately before surgery. It must be noted that current complaints or symptoms (e.g., pain, incontinence, sexual dysfunctions) can be causally associated with the newly diagnosed rectal cancer and may therefore be postoperatively relativized (► Sect. 50.6).

50.2.2 Clinical Examination

Sphincter tone is assessed for resting pressure and squeeze pressure and documented for both qualities according to the digital rectal examination scoring system (DRESS). In particular, resting tone, primarily the function of the M. sphincter ani internus, is taken into account when determining the indication for sphincter-preserving surgery. Intraoperative compromise of the autonomous innervation may result in lessened resting tone (► Sect. 50.6).

It must be taken into account that the so-called anterior resection syndrome subsumes the problem of neurogenic incontinence. Classification remains difficult because of the variety of other causes and influences and is impossible without knowing the preoperative and intraoperative findings (among other things, interruption of intrinsic innervation, height of the anastomosis, reconstruction methods, "high tie vs. low tie," pelvic sepsis, multimodal therapy, dietary factors, concomitant disorders, and medications).

The palpably enlarged prostate deserves attention in relation to an often-known urological medical history. In prostate adenoma, unilaterally compromising urinary bladder innervation may result in a postoperative emptying disorder that requires therapy. In men without prostate enlargement and also in women, unilateral nerve damage is often compensated for. If there are corresponding abnormalities, we already provide preoperative information about the indication to placement of a suprapubic catheter. The objective is to avoid "emergency" recatheterization.

50.2.3 Imaging Diagnostics

Specific findings of sectional imaging procedures (CT, MRT) are taken into consideration when planning the surgery. Recognizable risk situations for injuring autonomous nerves are included in the individual patient informational process:

- Tumors of the middle third (► Sect. 50.6)
- Tumor infiltration in the anterior quadrant (► Sect. 50.6)
- Narrow male pelvis and voluminous mesorectum (► Sect. 50.6)

- Positive circumferential resection margin (CRM ≤1 mm) or infiltration of adjacent organs (indication for multivisceral resection) (► Sect. 50.6)
- Suspicious lymph nodes outside the mesorectum (► Sect. 50.6)

50.2.4 Neoadjuvant Chemoradiotherapy

The indication for neoadjuvant radiochemotherapy is determined from an overall view of all findings and after informing the patient, while providing them with the recommendation of the interdisciplinary tumor board. Reasons are provided for any deviations from guideline recommendations. From the surgical aspect, difficulties regarding nerve identification and preservation can definitely occure due to radiation fibrosis and inflammatory/postinflammatory adhesions, which make dissection in the correct view more difficult and place nerve preservation at risk (► Sect. 50.6).

On the other hand, dissection partly involves less bleeding and is easily possible as a result of edema in the dissection plane. In an IONM-controlled surgery series, no difference was shown between pretreated and non-pretreated patients in terms of functional nerve preservation. In local advanced tumors, nerve preservation only becomes feasible by reducing tumor size (downsizing).

The patient is informed about potential post-therapeutic urogenital and anorectal dysfunctions by the radio-oncologist. It is not easily possible to differentiate surgically related loss of innervation in view of the fact that late consequences of radiochemotherapy are also a possibility. Precise planning and implementation of irradiation as well as situation-adjusted surgical techniques to protect nerves reduce the risk of postoperative dysfunctions.

50.3 Surgery Technique

Since the update to the German guideline, intervention is more frequently performed laparoscopically after a critical indication is determined. Within the scope of our medical technology research focus “Intraoperative neuromonitoring of autonomous pelvic nerves,” intraoperative electrophysiological function tests are performed for TME, both in open and in minimally invasive procedures (► Sect. 50.4). Furthermore, we recently described the nerve-sparing potential of the transanal approach in the case of laparoscopic-assisted TAMIS (transanal minimal-invasive surgery) TME (► Sect. 50.4).

50.3.1 General and Oncological Aspects of Nerve Protection

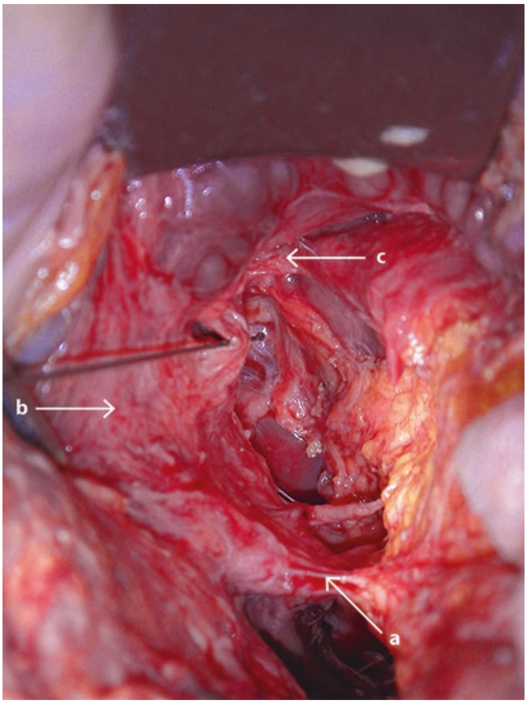
Pelvic Neuroanatomy

The autonomous pelvic nerves mark the dissection layer with their position between the visceral and parietal fascia and serve as a guideline in mesorectal excision [2]. Aside from the sacrifice of autonomous pelvic nerves by dissecting behind the parietal fascia, which is unnecessary with a sufficient lateral safety distance, nondepiction particularly involves the risk of an incomplete TME.

The pelvic neuroanatomy is highly complex and not entirely clarified. Nonetheless, intraoperative nerve preservation requires well-founded knowledge of topographic and morphological aspects. The SHP, which progresses along the continuation of the pre-aortal nerve structures caudally from the aortal bifurcation and lies on the promotorium, has numerous variants and forms the right and left hypogastric nerve (◘ Fig. 50.1).

For the nerve strands of the hypogastric nerves, which are also bilaterally bundled, information regarding their diameter (mm) and length (cm) varies. In general, it is accepted that they progress directly along the mesorectum until the IHP forms. Intraoperatively, the anatomically discussed incision or overdrawing with a “nature similar to fascial sheets” at the level of the pelvic entry and the

◘ **Fig. 50.1** Pelvic neuroanatomy – sample of the fixed pelvis (jointly with Prof. Dr. M. Herrmann, Institute of Anatomy in Ulm, excised via “surgical access”)



■ **Fig. 50.2** "TME" on the unfixed sample (together with Prof. Dr. M.A. Konerding, Institute of Anatomy, Mainz) – "lateral ligament" *a*, plexus hypogastricus inferior *b* with its fibers on the edge of the thinning Denonvillier fascia, *c* laterally from the left seminal vesicle

pelvic wall can both be equally followed. Imaging impairments result when there are pronounced retroperitoneal fatty tissues (► Sect. 50.6).

Together with the pelvic splanchnic nerves, the hypogastric nerves forms the mixed sympathetic/parasympathetic IHP from the S2–S5 (primarily S3 and S4) sacral spinal nerves (■ Fig. 50.2; [10]).

While purely sympathetic attributes of the hypogastric nerves and purely parasympathetic attributes of the pelvic splanchnic nerves are often assumed, immune histochemical staining show mixed sympathetic and parasympathetic nerves. Nerve fiber diameters that are partly less than 150 µm [1] also signify that surgical nerve protection is relative.

The regulation of the complex physiological processes takes place via macroanatomically depictable secondary, organ-related plexus with corresponding efferent and afferent nerve tracts that supply the urinary bladder, genitals, rectum, and the internal anal sphincter (IAS). The extent and location of surgical injuries of the pelvic nerve structures determine the form of organ-related dysfunctions and their combination.

Tumor Infiltration of Autonomous Nerves

It is regarded as an argument for the stage-dependent nerve dissection which is particularly practiced on advanced tumors in Japan that after pathohistological assessment of autonomous nerves, tumor infiltration were found in 4–15 % of the patients. When a local radical TME can be performed, we always aim to protect pelvic nerves and omit lateral lymph node dissection.

Following therapy according to the guidelines and corresponding quality assurance, the locoregionary failure rate is low. Furthermore, it was not shown that systematic graduated nerve dissection would improve local control, nor the prognosis that is determined by systemic recurrence. In the case of local advanced tumors (infiltration of adjacent organs, cCRM-positive situation), radicality is given priority in the presence of curative intent.

Postoperative function losses by also resecting autonomous nerves are then unavoidable in many cases (► Sect. 50.6). Extirpation of individual suspicious extramesorectal pelvic lymph nodes is considered (► Sect. 50.6).

The autonomous nerves must be shown to identify metastases in the region of these nerves. Tumor affliction is assessed as prognostically unfavorable, regardless of the expansion of the intervention. In selected cases, partial (► Sect. 50.6) or complete nerve preservation for palliative reasons is preferred over expanded resection without preserving the nerves [4].

50.3.2 Regional Aspects of Nerve Preservation

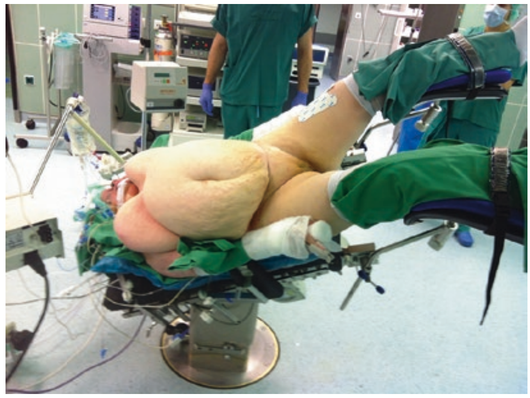
Inferior Mesenteric Plexus

These pre-aortal nerve fibers are placed at risk in the course of preliminary ligature and cutting of the Inferior mesenteric artery (IMA):

- *During open surgery,* the hypogastric nerves is initially exposed (see below).
- The mesorectal package, which is then slung with a loop just below the promontorium, is separated from the hypogastric nerves and the SHP.
- After digitally passing underneath, and ventrally tensioning the mesorectal pedicle

(with the left hand), the right-sided peritoneum is now also cut with a monopolar current.
- The package is gradually lifted off cranially on alternate sides from the pre-aortal nerve structures while maintaining "traction and countertraction." It is anatomically notable and often seen during surgery that the fiber structures that progress along the left side of the aorta are often denser.
- The IMA is then subjected to circular exposure about 1 cm distally from the aorta; it is then ligated and cut (hightic).
- This is followed by completing nerve-preserving mobilization in the same technique to the level of the centrally cut vein.

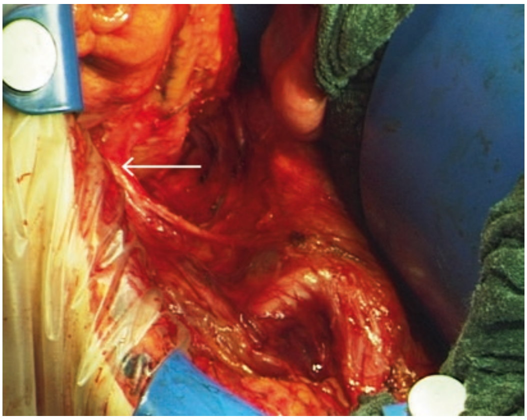
These steps are performed with sparse use of monopolar diathermy with a spade electrode (Erbe VIO 300D; auto-cut with lowest possible spark intensity "effect") and blunt preparation with the spatula or preparation swab. The countertraction is generated by the first assistant (preparation swab):
- *In a laparoscopic procedure,* two Babcock clamps are used for atraumatic exposure (10 mm working trocars: right lateral central abdomen; right paramedian epigastrium; left lateral central abdomen; 15 mm single use trocar: right lower abdomen; later removal site).
- The peritoneum is first notched on the Treitz band with the Ligasure.
- The vein is lifted with a Babcock clamp. Blunt preparation (closed Ligasure, Babcock or preparation swab) on the Gerota fascia is conducted into the cranial and left lateral directions.
- The peritoneum is then caudally notched with the Ligasure, and layer by layer, primarily blunt preparation is continued with the closed Ligasure ventrally from the pre-aortal nerve structures until the AMI is reached.
- Difficulties may occur despite extreme positioning in the event of severe obesity (◘ Fig. 50.3), transverse colon obscuring the view, the omentum majus, and particularly the small intestine convolute. Patience, early use of an added trocar, and the involvement of a second assistant can help.
- Pre-aortal dissection of the mesorectal or mesocolic pedicle takes place from the caudal into the cranial direction (► Sect. 50.3). When the a. mesenterica inferior is reached, it is cut 1 cm distally from its bifurcation between clips.



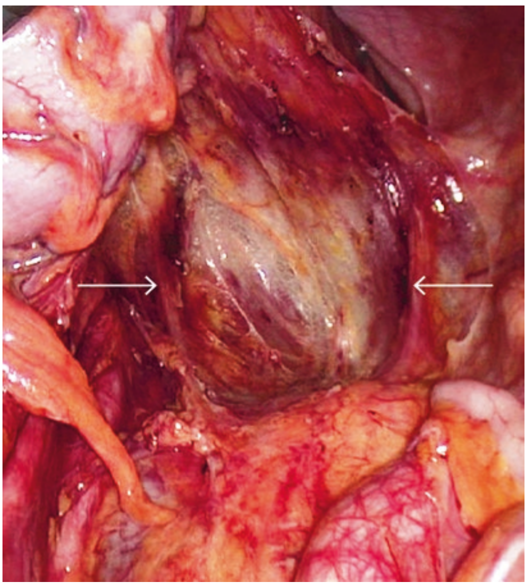
◘ **Fig. 50.3** Severe obesity – preoperative test of extreme positioning

Hypogastric Nerves and Superior Hypogastric Plexus

The risk of injury for nerve segments in this location is lower compared with that for nerve segments located farther in the pelvis minor [5]:
- In the open procedure, the left-sided ureter is exposed after centrally cutting the vein and detachment of the sigma from the embryonal adhesions.
- The rectosigmoid is then tensed, and the peritoneum is notched beyond the vascular axis pararectally toward the pelvic floor, using the monopolar diathermy spade.
- Using the blunt method with a diathermy spade or preparation swab, the dorsal mesorectal dissection layer is sought into the medial direction at the height of the promontorium. In the avascular foam layer, you can proceed in an uncomplicated manner into the central presacral direction.
- The peritoneum is further notched cranially on the right if there is good visibility, and the distal parts of the SHP and cranial pre-aortal fiber structures are shown from the right lateral direction. The same procedure is followed on the left side. Proceed further as described in ► Sect. 50.3.
- After cutting the colon, the TME is performed while permanently maintaining traction and countertraction and with corresponding use of the hook. At the pelvic entry level, the



■ **Fig. 50.4** The hypogastric nerve (*arrow*) must be separated from the mesorectum in a typical location



■ **Fig. 50.5** Hypogastric nerves (*arrows*) identified as guides for the laparoscopic TME

hypogastric nerves are fastidiously separated from the visceral mesorectal fascia, where the pelvic floor peritoneum is initially further notched on both sides.

- This is followed by blunt dorsolateral dissection bilaterally. The monopolar spade electrode (with shaft extension) is generally used for this purpose.
- Progressing from the medial to the lateral direction, the longer identifiable segments of the nn. hypogastrici are now separated from the mesorectum (■ Fig. 50.4), blunt if possible, or using the preparation shears if required.

There is a higher risk of injury with a voluminous mesorectum, narrow pelvic entry, and tumors in the middle third of the rectum (► Sect. 50.6).

In principle, the *laparoscopic procedure* is oriented to the open procedure. The dissection technique differs in terms of the instruments. The detachment of the sigma from the left lateral direction and the right lateral notching of the peritoneum is performed with the Ligasure. This instrument is used to perform the aforementioned surgical steps in the same manner – blunt, sharp, or with well-controllable diathermy (■ Fig. 50.5). Maintaining the principle of traction and countertraction by appropriate use of the instruments and a first assistant who is familiar with the surgical principles and experienced in camera control is of significant importance, also in terms of nerve exposure and nerve preservation.

Inferior Hypogastric Plexus, Pelvic Splanchnic Nerves

After pararectal incision of the peritoneal fold consistent dorsal and dorsolateral mesorectal dissection takes place. Preparation is continued by blunt means and with sparse use of the extended monopolar diathermy spatula (see above). More than one third of the mesorectal cuff can thus be dissected in a curtain-like manner to the level of the os coccygis.

In *open surgery,* extremely fine ventral branches of the sacral nerves (pelvic splanchnic nerves) often remain hidden to the unaided eye. With knowledge regarding the progression to the IHP, these nerve structures can be pushed aside dorsolaterally with the parietal fascia. There is a risk of injury with inadequately managed bleeding from the presacral venous plexus (immediate compression with a stemmed swab; corrected, once again layer oriented, continuation of the dorsolateral mesorectal preparation to obtain the required therapy space for sufficient surrounding sutures; ► Sect. 50.6). Diathermy that is extended centripetally to stop bleeding invariably results in damage to the pelvic nerves. Intraoperative blood loss correlates with the ability to show (and preserve) the autonomous pelvic nerves:

- Dorsolateral dissection that has already taken place and the hypogastric nerves that were cranially identified in the progression permit lateral dissection with a clear overview,

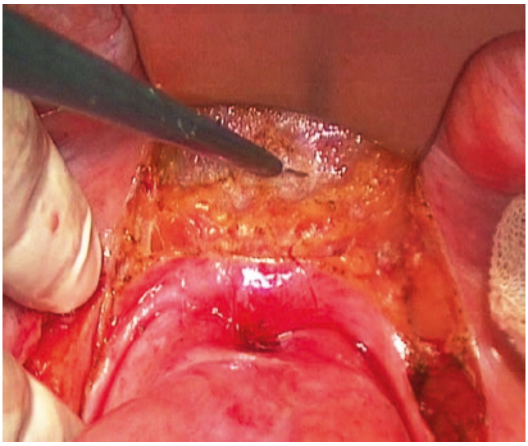


Fig. 50.6 After incising the peritoneum, the "extramesorectal plane" in front of the Denonvillier fascia is located

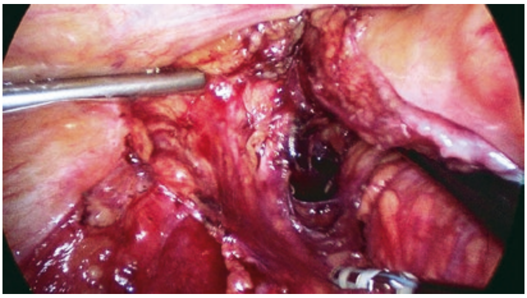
preserving the nerve segments that lead to the IHP. Traction and countertraction are successfully used to tension the ligg. lateralia (paraproctium, lateral ligament, nerve and blood vessel conducting plate, plica latum, T-Junction). A median of three (1–10) nerve fascicles extend to the central rectum from the IHP [8]. They are strictly cut near the mesorectum with the diathermy spatula.

- The ventrolateral limit of the excavatio rectovesicalis (Douglas) can be used as orientation points for the IHP, which extends along the pelvic wall.
- The pelvic floor peritoneum is incised crosswise 1 cm above the lowest point of the excavation with monopolar current.
- With accordingly corrected hook traction and sacrally directed countertraction at the rectum, the dissection plane is in front of Denonvillier´s fascia in men (Fig. 50.6).
- Using the diathermy spade, partly blunt and partly electrical, extramesorectal preparation takes place between the seminal vesicles on the rear wall of the prostate, toward the pelvic floor. If not yet done, the anococcygeal raphe (M. coccygeorectalis) is then cut dorsomedially with long shears or with diathermy if it is easily accessible.
- Originating alternatively from the dorsolateral background on the pelvic floor and the ventral preparation layer that was created in the anterior region, bilateral anterolateral dissection is performed. In terms of nerve protection, this is the most difficult step of the dissection. It requires oriented traction on the specimen by the surgeon and speedy corrections on the hooks.
- Dorsolaterally, orientation strictly follows the mesorectum; ventrolaterally, it follows the seminal vesicles. The runners of the Denonvillier fascia are laterally cut between 10 and 11 o'clock and between 1 and 2 o'clock in the circumferential direction toward the mesorectum. This preserves the IHP fibers that run in high densities laterally from the seminal vesicles.
- If required and possible in dissection, nerve fibers that anterolaterally adhere to the mesorectum are bluntly or sharply pushed off. Corresponding to the dorsal flexion of the distal rectum, a part of the fascia remains on the specimen after ventrocaudal cutting (► Sect. 50.6). Preparation ahead of the rectovaginal [sic: recto-vaginal] fascia is less difficult. It is sometimes supported by vaginal Bougie insertion, also to prevent injury to the paracervical plexus.
- Immediately on the levators, the autonomous nerves progress from the inferior rectal plexus to the cloacogenic rectum segment. Knowing this, the dissection on the pelvic floor is not unnecessarily extended. In low resections, cutting takes place with the contour stapler. Via rotary insertion of bent stapler branches that have blunt ends, the risk of injury to the pelvic floor is lessened.

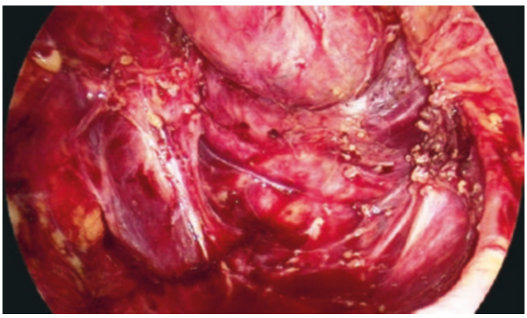
Laparoscopy provides advantages at this time as a result of better depiction of the site in the depths of the pelvis minor (light, magnification, 30° angle optics). There are restrictions because of the greater difficulty of tensing the rectum to generate traction and countertraction. There must be an option of extreme positioning at this point (see above). Various holding instruments (2nd Babcock forceps, feeler rod, preparation swab) and a second assistant are required.

The steps of the dissection are oriented to the open procedure. If risk factors that suggest against laparoscopic dissection are noted in the explorative laparoscopy or preparation at the pelvic entry level, conversion takes place.

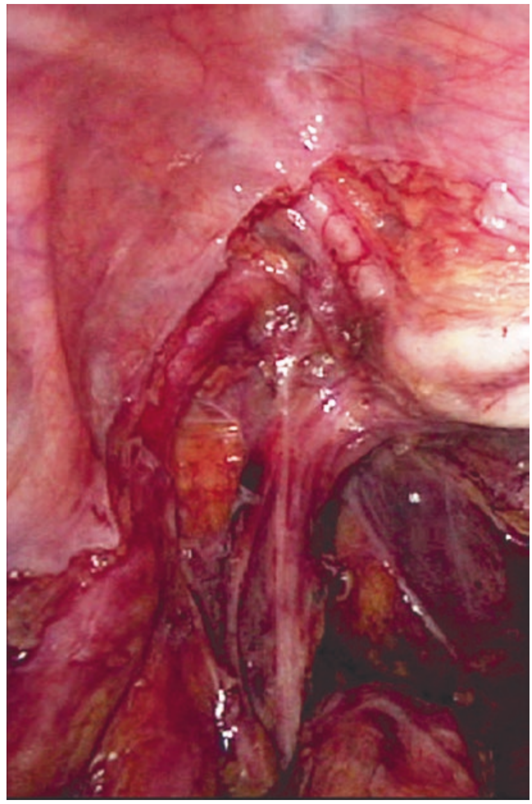
In a laparoscopic TME, the Ligasure is guided on the right side and exposed with the Babcock or preparation swab with the left hand. Dorsolateral preparation is almost entirely blunt. Neuromapping via the pelvic splanchnic nerves which are more easily shown in a laparoscopy is



■ **Fig. 50.7** Laparoscopic site with an anterolateral window. Dorsolaterally Extremely fine nn. rectales inferiores are visible in the depths



■ **Fig. 50.8** Laparoscopic site after cutting through the ligg. lateralia. *Left*: nn. splanchnici pelvici radiating into the plexus hypogastricus inferior. *Right*: status postdissection of adhesions of fascia sheets near the mesorectum, with controlled diathermy (Ligasure)



■ **Fig. 50.9** Laparoscopic site after anterolateral preparation. Dense fiber structure of the plexus hypogastricus inferior to the left of the seminal vesicle (also see ■ Fig. 50.2)

easily implemented (▶ Sect. 50.4). The pelvic floor peritoneum is notched further laterally and ventrally with the Ligasure. Near the pelvic floor, a window can be created with blunt methods from the anterolateral direction toward the dorsolaterally pre-dissected layer (■ Fig. 50.7).

Care must be taken to watch the innervation to the cloacogenic segment, both macroscopically and with the aid of the IONM. Following this, the lateral suspension can be separated with the Ligasure while maintaining a directional orientation. Herein, pressure that is oriented toward the mesorectum is exercised on the branches for maximum preservation of the IHP (■ Fig. 50.8).

The benefits of this instrument are seen in the low thermal expansion into the lateral direction (40° at a distance of 2 mm), the minimal smoke development and rapid boiling (1–2 s) of the branches, which are nonmetallic on the outside. Overall, the question regarding the ideal dissection device for preservation pelvic autonomic nerves is still unanswered [3]. With patience and teamwork, subtle preparation and exposure can show even the finest nerve structures (■ Fig. 50.9).

Nn. Rectales Inferiores

Friedrich Stelzner describes the extrinsic innervation of m. sphincter ani internus as originating from the ganglion pelvicum. He differentiates this “tangle of fibers” which runs on the fascia pelvis parietalis interna from the underlying somatic nerve structures. “It was only possible to gain our knowledge by dissection on cadavers and during surgeries.” Herein, he emphasizes the problems in terms of regional accessibility for the operating physician [11].

The combination of intraoperative neuromonitoring, the laparoscopic dissection technique, and advanced video technology result in added surgical and practical knowledge.

A new technique using 3D reconstruction in combination with immune histochemistry (computer-assisted anatomic dissection) was also used to show the afferences and efferences that progress between the inferior dorsal aspect of the PHI and the cloacogenic segment/the M. sphincter ani internus with neuroanatomical differentiation. Dissection directly to the levators is only done when tumors are correspondingly deep seated because there is always a risk of damaging very fine nerve fibers at this juncture. In a laparoscopic procedure, the nn. rectales inferiores can be preserved in a more controlled manner, depending on the preparative requirements. With careful consideration of the neuroanatomy, the risk of injury is minimized when cutting with the stapling device.

In planned extirpation, the innervation to the cloacogenic segment is interrupted with circumferentially extended preparation in the intersphincteric space by reaching and exposing the levator muscles. This can be traced with IONM [7].

During the peritoneal part of the surgery, there is a risk of injury to the innervation of the urinary bladder and genitals. The goal is to precisely reach the dissection level which is reached from the abdominal direction to avoid "subsequent" injuries to the IHP and the nerves that run to and from it. With the intent to preserve function, care is taken to preserve the innervation that progresses along the apex of the prostate ("erigent pillar"). Operating in the prone position (Götze positioning) may enable better visualization. When performing cylindrical resection (Holm procedure), a higher risk of injury to the PHI is accepted.

50.4 Intraoperative Neuromonitoring (IONM)

The pelvic IONM was developed to identify and check the functions of the autonomous pelvic nerves [6, 10]. It takes place during mesorectal dissection within the scope of defined surgical segments. In electrical in situ nerve stimulation, stimulation reactions become visible on the system monitor during simultaneous processed electromyographic activity (EMG) of the internal anal sphincter and manometry of the urinary bladder (► Sect. 50.6) and can be evaluated in real time. The EMG amplitude elevation of the internal anal sphincter or intravesical pressure elevation herein results from neuromodulation with effects on the efferent and afferent nerve tracts and their superordinate regulatory circuits.

Table 50.1 Pathohistologic and immune histochemical confirmation of autonomous nerve tissues at the anterolateral resection margin after surgery in rectal cancer and comparison with the fresh anatomical sample of a plexus hypogastricus inferior (PHI) from a female pelvis

Autonomous nerve tissues	Anterolateral resection edge (*n* = 24)	PHI on the right; cadaver sample
Nerve fascicle cross-sections (maximum)[a]	30 (2–200)	101
Nerve fascicle circumference (tail segment widths)		
Maximum	52 (20–92)	80
Minimum	4 (2–15)	5
Ganglia (maximum)[a]	0 (0–17)	4
Ganglia cells/ganglion		
Maximum	48 (1–180)	84
Minimum	6 (1–40)	2

Statements: median and scatter range (four patients with multivisceral resection)
Dissection with Prof. Dr. med. M. Herrmann, Anatomy Institute at the University of Ulm
[a]Per complete cross-section

In an investigational series [8], 12 rectal resectates (four multivisceral) were anterolaterally marked with ink at the level of the IHP. Nerve fascicles and ganglia from this region were quantified. Table 50.1 shows the result with reference to an IHP that was collected from the fresh cadaver after surgical access (TME).

There is a proven association between the quantity and quality of the detectable autonomous nerve tissues and the results of the manometry-based IONM. Negative neuromonitoring is associated with a significantly higher maximum number of ganglia at the complete cross-section (Table 50.2) and bladder dysfunction (► Sect. 50.6).

According to current experience, electrical stimulation of the inferior mesenteric plexus, SHP, and hypogastric nerves generally does not result in standardizable stimulation reactions. During resections in case of local failures (recurrent rectal cancer) in IONM, stimulation of the SHP and hypogastric nerves sometimes

Table 50.2 Results of the IONM (bladder manometry) referred to the immune histochemical detection of autonomous nerve tissues on anterolateral resection margins ($n = 23$) of 12 patients with rectal cancer

Autonomous nerve tissues	Neurostimulation positive[a] ($n = 15$)	Neurostimulation negative[a] ($n = 8$)	p
Nerve fascicle cross-sections (maximum)[b]	15 (2–81)	72 (4–200)	0.190
Ganglia (maximum)[b]	0 (0–3)	5 (0–17)	0.001

Statements: median and scatter range (four patients with multivisceral resection)
[a]Positive, intravesical bladder pressure elevation >0 cm H_2O; negative, intravesical bladder pressure elevation = 0 cm H_2O
[b]Per complete cross-section

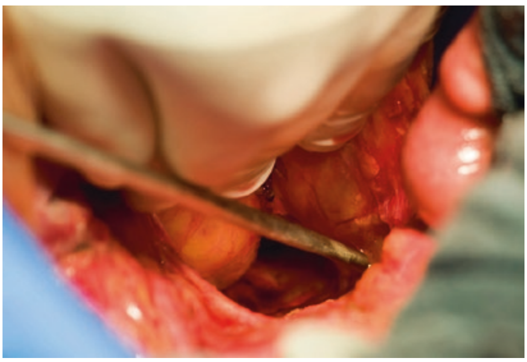


Fig. 50.10 Conventional (open) stimulation (IONM) for control after right lateral dissection

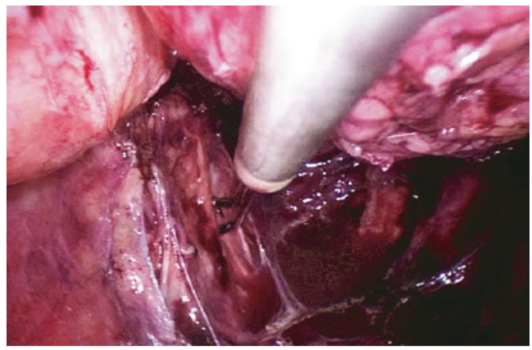


Fig. 50.11 Laparoscopic bipolar intermittent stimulation of the pelvic splanchnic nerves as they become accessible (or IHP parts) during dorsolateral preparation on the left side

led to intravesical bladder pressure changes that are otherwise expected with stimulation of the neuronal structures in the pelvis minor (pelvic splanchnic nerves, IHP). Complex neurophysiological recompensation processes, individual variations, and the probably nonpermissible simplifications when describing solely sympathetic fibers in these areas must be further discussed.

Standardized initial nerve stimulation takes place during dorsal and dorsolateral mesorectal preparation to identify the nn. splanchnici pelvici (Figs. 50.10, 50.11 and 50.12). Extremely fine neuronal branches, individual aspects, and the complex arrangement in subplexus structures render a purely macroscopic assessment of the IHP fibers impossible. In lateral and anterolat-

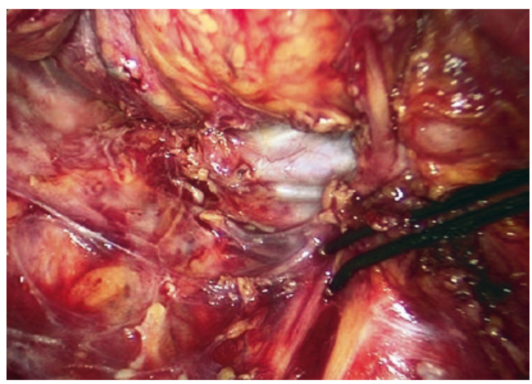
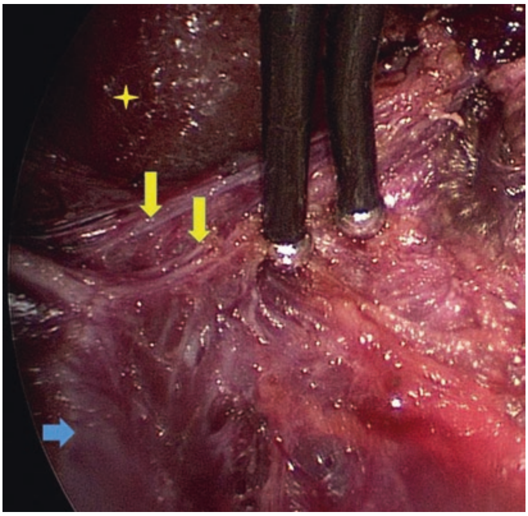


Fig. 50.12 Laparoscopic bipolar intermittent stimulation of the pelvic splanchnic nerves as they become accessible (or IHP parts) during dorsolateral preparation on the right side



■ **Fig. 50.13** Bipolar electrical stimulation slightly above IAS level (*blue arrow*) at 8 o'clock lithotomy position for verification of extrinsic innervation (*yellow arrows*) during TAMIS TME. *Yellow star* levator ani muscle ([9] *Int J. Colorectal Dis*; Springer)

eral dissection, the procedure of neuromapping is used for orientation and to monitor function in the sense of repetitive stimulations. It is used to more consciously preserve neuronal branches. The nerve end segment to the internal anal sphincter is also electrophysiologically identified and preserved insofar as possible.

The "down-to-up" procedural concept of the so-called TAMIS TME provides excellent access to the extrinsic autonomic nerves responsible for the maintenance of IAS function after ultralow anterior resection [9]. Intraoperative electrophysiological neuromapping objectified the specific in situ neuroanatomical topography (■ Fig. 50.13 and additional Case Example 50.12).

The quality of intraoperative nerve preservation is checked after the TME is completed. Its ability to predict postoperative urogenital and neurogenic anorectal dysfunctions means that the IONM result constitutes a suitable surrogate parameter. It allows well-founded, early and thereby more promising, personalized, urologic, gynecologic, and coloproctologic treatment.

50.5 Postoperative Aspects

The patient is informed about the surgeon's assessment regarding nerve preservation and aspects that must accordingly be taken into account in the postoperative progression. In case of complete pelvic autonomic nerve preservation, transurethral bladder catheter can be removed beginning on the second postoperative day. Before removing a suprapubic urinary catheter, the easily verifiable residual urine volume should be significantly less than 100 ml.

After removing the transurethral bladder catheter, residual urine is sonographically determined, no later than at the time of discharge. In the event of abnormalities, patients are sent for a urologic or urogynecologic consultation (► Sect. 50.6). A neurogenic bladder requires long-term catheterization. Nonetheless, severe bladder-emptying disorders can improve.

In preoperatively sexually active men and intraoperative suspicion of incomplete nerve preservation, a specialized urologic consultation already takes place before discharge (► Sect. 50.6).

Before a protective stoma will be closed, anorectal function should be assessed. In 1966 Friedrich Stelzner had already described internus paralysis after low anterior rectal resection:

> A further indicator is shown when the surgeon mobilizes the rectum stump up to the pelvic wall in rectum resection near the pelvic floor to obtain a better overview. When healing is complete, such patients are able to contract the sphincter upon command. But if one now removes the finger after asking the patient to loosen the sphincter again, the examiner will observe that the anal canal remains open. The request to actively tension the sphincter again is promptly followed by closure of the anal canal. This is internus paralysis. [12]

Denervation of the internal anal sphincter results in fecal incontinence. The IONM can already predict this (► Sect. 50.6).

50.6 Case Examples

Case Example 50.1

A 51-year-old patient presented with an adenocarcinoma at the 12 o'clock position in the lithotomy position, extending from the linea dentata into the anal canal. The patient had had rectum resection with simultaneous liver segment resection one year previously as a result of hepatically metastasizing rectal cancer in the middle third (ypT2, ypN0/18, ypM1[hepar], G2, L0, V1, pR0). The anastomosis appeared normal 6 cm from anal verge (3 cm above the dentate line). The patient urgently desired to have the surgery performed while maintaining his erectile function. He consented to the already recommended abdominoperineal excision. He reported that he had undergone sterilization years earlier only when the detailed medical history was obtained. After the diverting stoma was closed, he had weaker, but nonetheless sufficient, erectile function in the past half year (IIEF: 52 with EF: 20). There were no problems with micturetion (IPSS: 2; QoL: 1). A new occurrence of fecal incontinence (II° according to Parks classification) had led to diagnostics and current diagnosis. The specific medical history was documented.

He was specifically informed about the significantly higher risk of loss of erectile function and occurrence of neurogenic bladder-emptying disorders. He desired an IONM for intraoperative function control. The possibility of postoperative therapy in the interval of regenerating compromising nerves (reconvalescence) was addressed.

Intraoperative preparation conditions were difficult. The seminal vesicles were preserved. It was not definitively possible to macroscopically identify the IHP. The IONM repeatedly confirmed that the innervation of the urinary bladder remained intact. Following abdominoperineal excision (in the lithotomy position), the patient was discharged without a bladder catheter because of spontaneous urination without residual urine (pT2, pN0 (0/13), cM0, pR0, G2). According to the urologic recommendation, he initially took Cialis 20 mg twice weekly for 6 weeks to prevent spongy body fibrosis during the reconvalescence interval. The patient was preventively sent for a specialized urologic consultation. Three months postoperatively, the patient stated good sexual function while taking Viagra (IIEF: 68 with EF: 27).

Case Example 50.2

One year after his protective stoma had been closed, a 72-year-old patient presented with status post open TME as a result of rectal cancer of the central third and adjuvant Chemoradiotherapy CRT with the symptom complex of "anterior resection syndrome."

Because of a severely impaired quality of life resulting from anal incontinence that could not be conservatively managed, the patient desired the creation of a definitive stoma. Rectoscopically, the end-to-end anastomosis appeared normal 5 cm above anal verge. The rectal digital examination showed severely impaired squeezing (DRESS 1) and resting tone (DRESS 0) (◘ Fig. 50.14).

The environmental diagnostics showed no signs of relapse; therefore, the indication for a test simulation of the sacral nerves was initially determined (◘ Fig. 50.15). The postoperative test phase was successful, and a two-channel sacral nerve stimulation (SNS) system was then implanted.

◘ **Fig. 50.14** The anal canal remains open after a rectal digital examination (resting tone: DRESS 0)

◘ **Fig. 50.15** Performing SNS test stimulation as an alternative to creating a stoma (successful)

Case Example 50.3

In a low-lying rectal cancer 5–8 cm above anal verge, 4–7 o'clock in the lithotomy position, and status post radiation resulting from prostate cancer 6 years previously, an open low anterior rectum resection was performed in a 69-year-old patient (Body mass index (BMI), 29.1) with preoperatively unimpaired sphincter function (DRESS 3). The TME (MERCURY I°; pT2, pN0 (0/13), cM0, V0, L0, R0, G2) was performed using monopolar diathermy, bipolar scissors, and bipolar stoppage of bleeding.

Following dorsolateral preparation, the IONM confirmed intact innervation of the urinary bladder and the internal anal sphincter on both sides. After completion of the mesorectal dissection, the innervation of the urinary bladder was again confirmed. Innervation of the sphincter muscle was no longer electrophysiologically detectable.

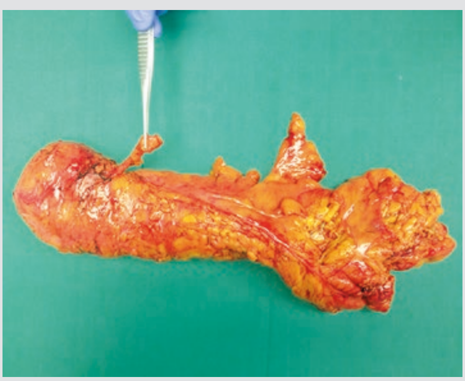
There was no postoperative bladder-emptying disorder. Three months later, with a normal laterotermінal anastomosis (3 cm above anal verge, immediately above the linea dentata), impaired voluntary tone (DRESS 1–2) and resting tone (DRESS 1), but a positive holding attempt, the protective stoma was moved back. Eight weeks later, a colostoma was created because of limp sphincter tone (DRESS 1/1), anal incontinence, and therapy-resistant perianal eczema and proctitis (◘ Fig. 50.16).

◘ **Fig. 50.16** Therapy-resistant perianal eczema with anal incontinence after stoma closure

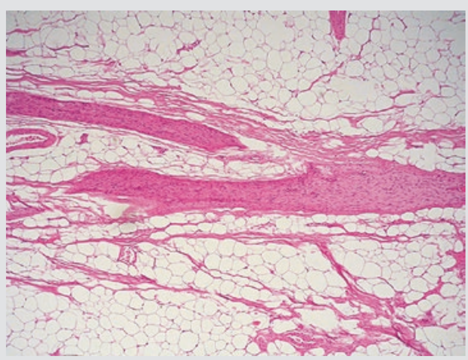
Case Example 50.4

In a 65-year-old obese (173 cm, 105 kg, BMI: 35.1) and multimorbid patient (status post stent implantation because of coronary heart disease, insulin-requiring diabetes mellitus, chronic obstructive pulmonary disease (COPD)), rectal cancer was diagnosed 10–13 cm from and verge at the 2–4 o'clock in the lithotomy position (cT2, cN–, cM0). There were no functional urogenital or anorectal abnormalities. Open, low anterior rectum resection was performed with a laterotermінal descendorectostomy 5 cm above anal verge (pT2, pN0 (0/14), cM0; G2; L1, Pn0, pR0; MERCURY I°).

During dissection in the confined pelvic entry level, the left hypogastric nerve was identified too late because of a voluminous mesorectum and fat-coated SHP and accidentally cut (◘ Figs. 50.17 and 50.18). With stimulation of the nn. splanchnici pelvici, the IONM still showed innervation of the urinary bladder and m. sphincter ani internus even after complete mesorectal dissection. Bladder function and anal continence were not impaired postoperatively. In terms of genital function, impairments (IIEF 29/75 postoperatively; 69/75 preoperatively) were stated for erection and ejaculation.



◘ **Fig. 50.17** Hypogastric nerve accidentally cut at the pelvic entry level and then resected to the plexus hypogastricus



◘ **Fig. 50.18** Detection of a normal nerve fascicle (n. hypogastricus, clinical information; HE, 50× magnification, PD Dr. med. T. Hansen, Pathology Institute)

Case Example 50.5

In a 50-year-old patient with stenosing, hepatically metastasizing rectal cancer 10 cm above anal verge, 2–6 o'clock in the lithotomy position, an open low anterior rectum resection was initially performed.

The TME was unusually difficult because of Bechterew's disease, even with an extended median laparotomy (◘ Fig. 50.19).

An injury to the presacral venous plexus at the S3 level was treated with a suture following compression (1200 ml blood loss). In particular, the left-sided and anterolateral preparation was complicated because of a poorly visible site and peritumorally inflamed tissue reactions. Because of the situation and for oncologic reasons, the capsule of the left seminal vesicle was included in the resection. The final IONM confirmed only right-sided innervation of the urinary bladder and the IAS.

An end-to-end descendorectostomy was performed 5 cm above the anal verge, and a suprapubic urinary catheter was created (pT3, pN1b (2/36), cM1 (hepar), G2, minimal circumferential distance 0.6 cm; MERCURY I°).

There was a postoperative need for long-term catheterization. Following left lateral liver dissection because of a metastasis in segment III, the stoma was closed back 4 months after the initial intervention. The bladder-emptying disorder was transient and no longer present (IPSS: 2). Anorectal function was not impaired (Wexner Score: 1). In regard to genital function, the patient stated impairments even with intermittent use of Viagra (IIEF 29/75; preoperative: 71/75). Fifteen months after the initial intervention, segment I was resected because of a newly diagnosed liver metastasis.

◘ **Fig. 50.19** Impaired positioning options with spondylitis ankylosans – TME and nerve preservation are complicated

Case Example 50.6

In a 50-year-old obese patient (180 cm; 104 kg, BMI: 32.1) with circular stenosing rectal cancer with hepatic and pulmonary metastases 4 cm above the anal verge, low anterior rectal resection was initially performed after an neoadjuvant chemoradiation therapy (nCRT).

The resection of a liver metastasis from segment VI and radiofrequency ablation (RFA) of a central metastasis in segment VIII was simultaneously performed (ypT3, ypN0 (0/15), pM1 (hepar), L0, V0, pCRM-negative, MERCURY I°; ◘ Figs. 50.20 and 50.21). Continuity was realized with a coloanal stapler anastomosis. Left-sided mesorectal dissection was unusually difficult because of a narrow pelvis and voluminous mesorectum. The final IONM confirmed only right-sided innervation of the urinary bladder and the IAS.

The suprapubic urinary catheter was removed on the seventh postoperative day. There were no urination problems in the long run (IPSS: 2). Three weeks following the initial intervention, a right- and left-sided lower lobe metastasis was resected via mini-thoracotomies.

Eleven months after the initial intervention, adjuvant chemotherapy was followed by closing the protective transversostoma. Even in advance, the patient took Viagra as recommended. Three months after stoma closure, there were no signs of fecal incontinence (Wexner Score 0, DRESS 3 for resting and voluntary tone). Genital function was only moderately impaired with intermittent therapy with Viagra (IIEF 49/75; preoperative: 62/75).

◘ **Fig. 50.20** TME (MERCURY I°), left lateral carbonization traces – due to possible thermal damage, also on the PHI, this must be discussed as a cause of consecutive unilateral negative IONM and postoperative genital functional impairments

◘ **Fig. 50.21** Parts of Denonvillier fascia, central and symmetric on the specimen

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Case Example 50.7

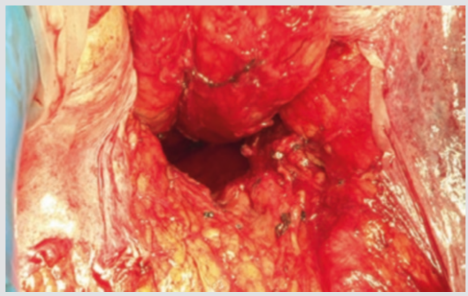
Following a cutaneous nCRT in the case of low rectal cancer 4–6 cm from the anal verge, 7–11 o'clock in the lithotomy position, an open low anterior rectum resection was performed in a 56-year-old patient. The patient was small in stature (140 cm; 56 kg; BMI: 28.6) and had a narrow pelvis (◘ Fig. 50.22).

Due to a relatively voluminous mesorectum and the fact that the SHP was surrounded by retroperitoneal fatty tissues (◘ Fig. 50.23), it was unusually difficult to expose the hypogastric nerves.

Controlled nerve-oriented preparation in the depths of the narrow pelvis was scarcely possible and was made additionally difficult because of intentionally sharp preparation by a relatively bloody situs (700 ml blood loss).

Following completion of the mesorectal dissection, it was possible to place the contour stapler beneath the tumor (ypT3, ypN1b (2/24), cM0; L1; ypR0; MERCURY I°). The laterotерminal anastomosis was implemented with a circular stapler at the level of the dentate line, about 3 cm above anal verge. The IONM confirmed that the innervation of the urinary bladder remained intact. It was no longer possible to make a valid statement concerning the innervation of the IAS. There were no postoperative problems urinating. Voluntary tone was good prior to discharge (DRESS 3).

◘ **Fig. 50.22** Boy-like pelvis; marked distance: 8.42 cm

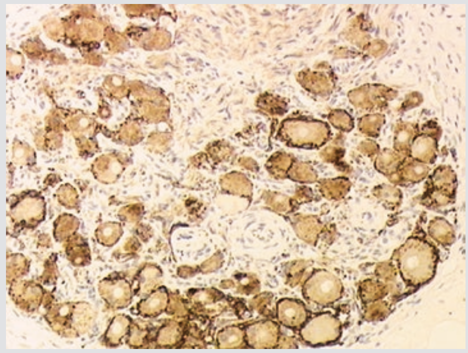


◘ **Fig. 50.23** Increased retroperitoneal fatty tissues with embedded autonomous nerves; relatively voluminous mesorectum

Case Example 50.8

Following multivisceral abdominoperineal rectum extirpation (wide excision anterolaterally with en bloc resection of the uterus and its adnexa and dorsal wall of the vagina) in a 63-year-old female patient with locally advanced rectal cancer 3.5 cm from anal verge (pT4, pN2(5/14), cM1 (hepar, pulmo), G2), the lateral resection margin was pathohistologically and immune histochemically examined after being marked with ink at the level of the IHP. In representative steps, greater than 400 cross-sections of nerve fascicles were identifiable in combination with 27 ganglia (max. 180 ganglia cells per ganglion) (◘ Fig. 50.24).

Postoperatively, a neurogenic bladder developed, requiring a catheter and therapy-resistant (cholinergics) secondary stress incontinence resulted due to urethral closure insufficiency.
The patient was instructed in intermittent self-catheterization.



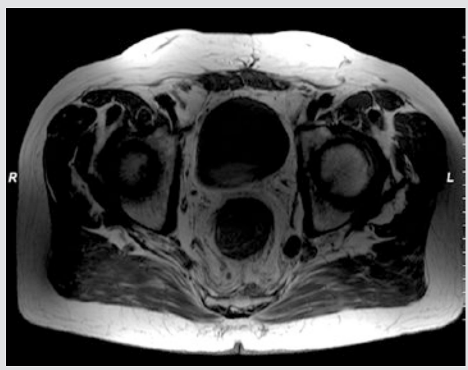
◘ **Fig. 50.24** Ganglion from the plexus hypogastricus inferior at the level of the cervix uteri (Frankenhäuser ganglion), immune histochemistry with S-100 (PD Dr. med. H. Radner, Pathology Institute)

Case Example 50.9

In mucinous rectal cancer 4–13 cm anocutaneously (cT3, cN+, cM0), an nCRT was performed in a 73-year-old patient. The medical history showed a nephrectomy on the right side and a prostatectomy resulting from a malignoma. Sphincter function, bladder function (IPSS 11), and genital function (IIEF 5/75) were preoperatively impaired; imaging showed a suspected lymph node metastasis in the pelvic wall.

Abdominoperineal rectum excision and the excision of an easily palpable lymph node from the left-sided pelvic wall (lymph node metastasis) were performed as well as a second lymph node from the right-sided pelvic wall (mucin-containing lymph node without vital tumor cells; ◘ Fig. 50.25), (ypT3, ypN1a (1/18), G3, M0, ypR0, MERCURY I°).

Before commencing the perineal section, the IONM no longer detected innervation of the urinary bladder and the IAS. A suprapubic urinary drain was created and remained in long term.



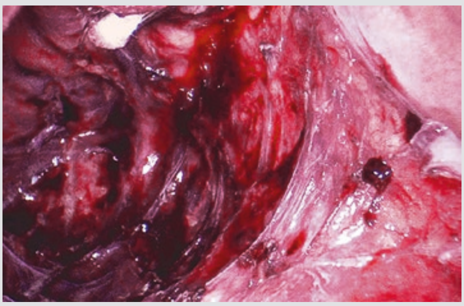
◘ **Fig. 50.25** Extramesorectal lymph node metastasis on the left side

Case Example 50.10

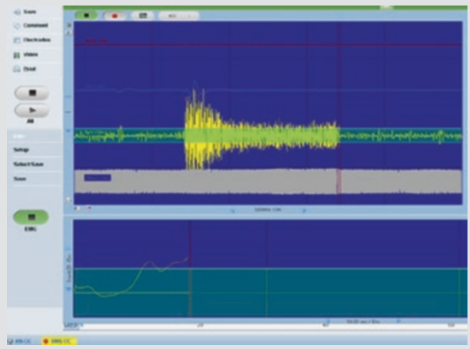
Following nCRT in rectal cancer 9–14 cm from the anus, 11–3 o'clock in the lithotomy position, laparoscopic low anterior rectum resection was performed in a 74-year-old man (video at www.xxx.de). Intraoperatively, a most likely postradiogenically related fibrotic adhesion of the mesorectum with the pelvic wall was already seen during dorsolateral preparation (◘ Fig. 50.26).

Directly at the height of the T-junction, separation was carried out with the Ligasure directly at the IHP. Dissection was simpler on the left side. The intermittently performed IONM confirmed that the innervation of the urinary bladder and the IAS was preserved on both sides (◘ Fig. 50.27). Continuity was restored by a lateroterminal descendorectostomy 5 cm from the anal verge (ypT2, ypN0 (0/13), M0; pR0, MERCURY I°).

Bladder function was postoperatively unimpaired. After the protective stoma was closed, there were no changes in ano-neorectal function as compared with the preoperative findings. According to the patient, his ability to have an erection and ejaculate was preserved.



◘ **Fig. 50.26** Postinflammatory fibrotic adhesion on the right lateral pelvic wall

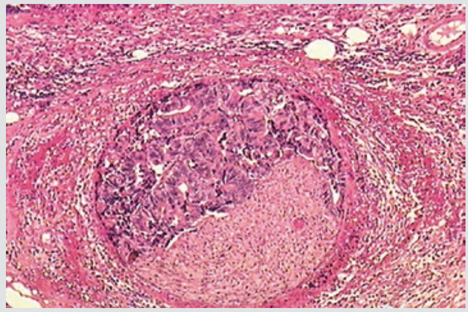


◘ **Fig. 50.27** Following stimulation of the pelvic splanchnic nerves, audiovisual detection of positive IONM signals, that is, intact innervation of the urinary bladder and m. sphincter ani internus (*yellow curve* at tope: processed muscle signal with amplitude elevation; *lower yellow curve*: intravesical pressure elevation)

Case Example 50.11

In a 70-year-old patient with palliative resection resulting from cancer in the central third of the rectum (pT3, pN2, pM1(hepar), L1, G3, R2), the right-sided hypogastric nerve was resected because of a suspected tumor infiltration (◘ Fig. 50.28). The suspicion was histologically confirmed (◘ Fig. 50.29). Numerous nerve fascicles were found, and ganglia cells were only found in the distal dissection area. The proximal and distal resection margins were free of the tumor. The completely excised mesorectum showed perineural cancer spread. According to the results of the IONM, bladder innervation via the pelvic splanchnic nerves remained bilaterally intact. There were no postoperative micturition problems.

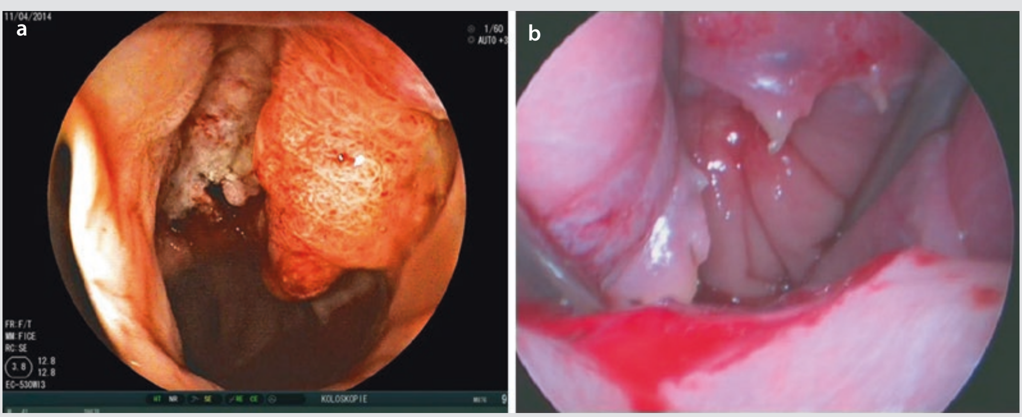
◘ **Fig. 50.28** Resected hypogastric nerve (45.0 × 22.0 × 4.0 mm). A central, tumor-suspected node (10 × 4 mm) was macroscopically detectable (PD Dr. med. H. Radner, Pathology Institute.)



◘ **Fig. 50.29** Nerve fascicles, enlarged by cancer complexes (HE; PD Dr. med. H. Radner, Pathology Institute)

Case Example 50.12

In a 42-year-old male patient with rectal cancer, 4.5 cm from anal verge and 0.5 cm from the dentate line involved the anterior quadrant (◘ Fig. 50.30a). Staging results in a cT3, cN,+cM0 situation. After neoadjuvant CRT restaging revealed downsizing and downstaging (◘ Fig. 50.30b). A nerve-sparing laparoscopic-assisted TAMIS TME was performed. The IONM confirmed that the innervation of the urinary bladder and the IAS remained intact. The lateroterminal coloanal anastomosis was hand sewn at the level of the dentate line, about 3.5 cm above anal verge (ypT2, ypN0 (0/12), cM0, R0, pCRM-negative, MERCURY I°). There were no micturition problems postoperatively. Erection and ejaculation was not impaired, neither before nor after stoma closure. After stoma closure no fecal incontinence occurred.



◘ **Fig. 50.30** **a** Rectal cancer detect with endoscopy. **b** Proctoscopy: downsizing after neoadjuvant CRT

Table 50.3 Degree of intraoperative difficulties in terms of the identification and preservation of autonomous nerves in patients with rectal cancer

Grade I: ideal patient	Operation is technically simple, each surgical method is unproblematic	Female cT1-2 Normal weight No nCRT No previous pelvic surgery
Grade II: not entirely ideal patient	Moderate technical difficulties, some surgical methods may be more difficult than others	Male Abdomino-perineal excision (CT1-2)
Grade III: more problematic patient	Difficult operation, some surgical methods may be substantially more difficult than others	Local advanced tumor in the mid-rectal third Male + CT3 + anterior quadrant involvement mrCRM-positive, nCRT Previous pelvic surgery Narrow male pelvis with voluminous mesorectum Bloody situs Severe obesity Supra-anal (type I) and juxta-anal (type II) tumors Indication for extralevator abdominoperineal excision Palliative surgery (consideration)
Grade IV: very problematic patient	Each surgical step is very difficult	Emergency Adherence/infiltration of adjacent organs (cT4) Recurrent rectal cancer

50

50.7 Classification of Intraoperative Difficulties

We classify intraoperative difficulties in terms of the identification and preservation of autonomous nerves in rectal cancer surgery, as shown in Table 50.3.

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Individual Surgery for Rectal Prolapse

Contents

Introduction

Michael Korenkov, Christoph-Thomas Germer, and Hauke Lang

M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations,*
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Patients undergoing surgical treatment of rectal prolapse can be divided in following groups:

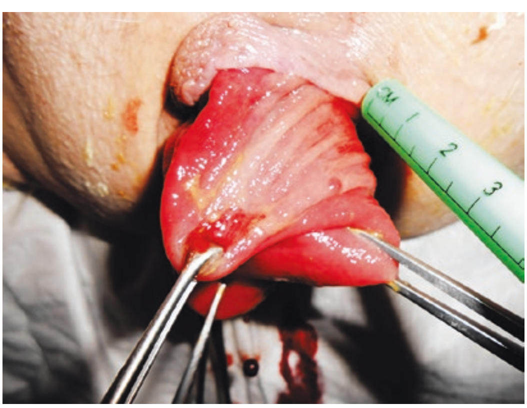
- Patients undergoing surgery via a perineal approach
- Patients undergoing surgery via an abdominal approach

Because of the numerous varieties of surgical procedures and technical modifications, situations requiring difficult decisions can occur prior to choosing the proper surgical approach. These difficulties are rooted in generic and local patient factors. The local factors include the length of prolapse, combination of rectal prolapse with other forms of pelvic floor descending (genital prolapse, rectocele, cystocele, descending perineum syndrome, etc.), special constellation of the rectal anatomy (very thick rectal wall; very dilated rectum with a big caliber difference between rectum and sigmoid colon), as well as previous pelvic surgery, and anal mucosal prolapse.

51.1 The Length of Prolapse

For external rectal prolapse shorter than 10 cm, we recommend an abdominal approach for elderly patients (personal preference). We believe that such constellation is not appropriate for the Altemeier procedure (■ Fig. 51.1).

The ideal condition for the Altemeier procedure is the so-called rectosigmoidal prolapse, which consists of the inner cylinder from intact or diverticulum but not a swelled sigmoid colon wall. Under such conditions will be creation a sigmoidoanal anastomosis and postoperative healing mostly uneventful. For an external rectal prolapse shorter than 10 cm consist the outer and the inner cylinders from a swelled fragile rectal wall; that is why the creation of a rectoanal anastomosis is more difficult compared with the rectosigmoidal prolapse. Accordingly, it increases the risk of postoperative complications such as postoperative bleeding, pelvic hematoma, or abscess.



■ **Fig. 51.1** Rectal prolapse <5 cm – not appropriate for the Altemeier procedure

51.2 Combination of Rectal Prolapse with Other Forms of Pelvic Floor Disorders

A combined rectal and vaginal prolapse will in many cases be operated on simultaneous with a gynecologist. In the event an Altemeier procedure is chosen, the extent of cul-de-sac resection should be discussed with the gynecologist prior to surgery, otherwise resectioning the cul-de-sac too extensively can lead to deficiency of peritoneal tissue for the posterior colporrhaphy.

51.3 Special Constellation of the Rectal Anatomy

Technical problems and situations requiring difficult decisions can occur in patients with a pronounced dilated rectum and thick rectal wall. Both of these situations can increase the risk of a stapler line leak. Additionally, using cartridges with longer staple heights (4.5 mm, green cartridge) may not be sufficient for adequate closing. In some cases of where the rectal wall is thick, it is better to perform a "pure" rectopexy instead of using resectioning procedures.

51.4 Previous Pelvic and Perineum Surgery

For patients who have undergone previous pelvic and perineum surgery can have an influence on the choice of surgical procedure. Such situations always require an individual decision.

51.5 Classification of Intraoperative Difficulties

The surgical difficulty for an Altemeier procedure can be classified as summarized in ◘ Table 51.1.

◘ **Table 51.1** Operative difficulties for an Altemeier procedure

Grading	Case type
I (ideal cases) It is easy to operate; every surgical technique is technically unproblematic	Prolapse longer than 10 cm No anal stenosis
II (not quite ideal) Some minor technical difficulties may occur; some surgical techniques can be more difficult than others	Moderate obese patient (BMI around 35 kg/m^2), otherwise similar to grade I
III (problematic) Difficult to operate, some surgical techniques are considerably more difficult than others	Overweight patient (BMI >35 kg/m^2), combination with other forms of pelvic floor disorders Anal stenosis Recurrent rectal prolapse
IV (very problematic) Every surgical step is difficult	Extreme form of grade III factors

Surgical Technique and Difficult Situations from Karl-Hermann Fuchs (Laparoscopic Resection Rectopexy)

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M. Korenkov et al. (eds.), *Gastrointestinal Operations and Technical Variations*,
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52.1 Introduction

A frequent problem in pelvic floor disorders is internal or external rectal prolapse situation. The operative treatment for these functional anatomic changes has been established by laparoscopic resection rectopexy. The selection of patients for these operations requires an extensive diagnostic workup to verify the indication for surgery precisely. The diagnostic workup should consist of a proctologic investigation; endosonography; to verify the status of the anal sphincter system, an anorectal manometry; a Hinton test; and, to verify a possible coexistence of a slow-transit constipation, dynamic MR defecography.

The traditional laparoscopic rectal resection rectopexy has the following operative steps:

- Dissection and mobilization of the rectum under preservation of the rectal peritoneal tissue
- Deep mobilization and dissection of the retrovaginal area toward a possible rectocele in order to lengthen and fully mobilize the scar tissue, which has been created by the rectal prolapse over the years
- Dissection of the redundant sigmoid colon for resection
- Traditional laparoscopic sigmoid resection and circular stapling for the descend rectostomy
- Pexy of the pararectal peritoneum at the promontorium using non-resorbable suture material and peritoneal adaptation

52.2 The Concept of NOTES

Since pure NOTES procedures are currently rather unfeasible because of lacking adequate instruments and endoscopes, Hybrid-NOTES procedures could provide the necessary bridging between traditional laparoscopic techniques and NOTES procedures.

The principle of NOTES is the use of a natural orifice as entry port into the abdominal cavity and prevent additional access trauma through the abdominal wall. Since endoscopic technology is not available to perform complex operations such as a colon resection inside the abdomen exclusively via a natural orifice such as the mouth or the anus, a Hybrid solution has emerged.

This Hybrid technique uses the natural orifice for instruments and tasks, which need a larger diameter of access (>5 mm) to the abdominal cavity and at the same time allows for a laparoscopic assistance via limited-sized ports in order to avoid access trauma and morbidity.

The transanal approach, initially limited to rectal disease, can be used today for NOTES Hybrid colorectal surgery. From TEM via TEO, the technique has been moved to transanal minimally invasive surgery (TAMIS), as it is called in the USA recently, or Transanal Hybrid Minimal Access Natural Orifice Surgery (ta-MANOS).

As a consequence alternative instruments were tested with smaller diameter to evaluate the possibility of reducing the size of the "transanal trocar." The passage of specimens as well as stapler and instruments was tested, and the transanal endoscopic applicator (TEA) was developed first as a prototype and evaluated. Finally, it became clinical evident that a diameter of 3 cm is enough to use the device for the assistance in Transanal Hybrid Colon Resections.

52.3 Patient Preparation

The patients underwent a preoperative bowel preparation in order to have a clean bowel during the operation, when intra-abdominal opening and manipulation of the bowel were necessary. Prior to surgery, prophylactic IV antibiotics (cephalosporin and metronidazole) were given. General anesthesia was performed, and the patient was brought in supine position for the operation.

52.4 Operative Technique

After establishing a capnoperitoneum via a Veress needle and after necessary safety tests, a periumbilical port was introduced in the abdominal cavity. Two additional 5 mm ports were brought in the right lower quadrant for dissection of the colon and rectum. Via these ports also, the dissection of the anastomotic site, all necessary hemostasis, and all energy delivery were applied. The dissection of the mesentery was stepwise performed under careful laparoscopic control to ensure that the pelvic nerve plexus was not in danger and the dissection planes could be followed.

In case of sigmoid resection for prolapse surgery, the colon lumen was clamped at the level of the descending segment, and a sigmoidoscopy was performed to make sure that this bowel segment was clean, which was clarified by rinsing of the rectum and colon. After removal of the scope, bougies of the sizes 25, 28, and 33 were introduced into the anus, rectum, and sigmoid colon. A careful bougienage of the rectum facilitates the following maneuvers.

Then the anvil of a 28 mm circular stapler was introduced into the TEA and rectum with a special grasper and maneuvered more proximal up to the descending colon to the future anastomotic site.

The next step was the transanal introduction of a transanal endoscopic applicator (TEA), which allows for safe introduction of endoscopes, linear staplers, grasping devices, and specimen removal. This was followed by an incision of the colon – usually the distal sigmoid – at the distal anastomotic site. Here, a transanally introduced linear stapler can exit the colon into the abdominal cavity and was used to transect the proximal end of the sigmoid segment, which needs to be resected (◘ Fig. 52.1).

Via the transanal-positioned TEA instrument, the application, removal, and change of stapling cartridges were technically rather easy to be performed. At the proximal colon stump, the intraluminal anvil was grasped through the bowel wall and stabilized. The central pin of the anvil was penetrated through the bowel wall at the stapled line to be available for later anastomosis. The penetration of the pin was facilitated by performing a small hole at the stapled line with the ultrasound cutting device.

◘ **Fig. 52.1** The transanal endoscopic applicator (TEA), a multifunctional transanal trocar, is used to get access with larger instruments into the abdominal cavity

Once the sigmoid segment was resected and free of detachments, a grasper was advanced via the TEA to reach for the specimen in the abdomen. Then the specimen was pulled through the luminal opening at the distal rectosigmoid stump, via the rectal lumen and via the TEA transanally to the outside.

After removal of the specimen transanally, a purse-string suture was placed at the distal rectosigmoid stump in order to complete the anastomosis with the circular stapling device. The TEA was removed, and a circular stapler was inserted transanally and advanced to the distal rectosigmoid opening, carrying the purse-string suture. The central pin was opened, and the purse-string suture was tied down around the central pin. Furthermore, the anvil was connected to the stapler, followed by approximating and firing the device in the usual manner under laparoscopic visual control. Thus the actual anastomosis could be performed under the same optimal conditions that laparoscopic surgery can provide.

In case of a rectal prolapse, a rectopexy was added in the usual technique with nonabsorbable sutures between the peritoneal, the pararectal tissue, and the sacral bone at the promontorium using the 5 mm ports, straight needles, and mini-instruments.

In case of slow-transit constipation, subtotal colon resection was performed by dissection and severing of the complete colon mesentery with the 5 mm energy device usually via two 5 mm ports, occasionally added by another 3 mm grasper without trocar for assisting and better exposure. The ileum as well as the sigmoid colon was transected via a transanal linear stapler. Then the complete colon was removed transanally. The anvil was advanced transanally to the distal ileum and inserted into the lumen, followed by penetration of the central pin through the antimesenteric ileal wall for later anastomosis. The ileum was closed via a transanal linear stapler. The tissue remnant was removed transanally. The ileosigmoidostomy was performed similar as described above.

After the control of hemostasis, inspection of the anastomosis, leak test with air and water, as well as placement of a drainage, the procedure was finished by removal of the three ports.

The patients could drink water and tea on the evening of the operation and were given fluids including protein drinks on the first postoperative days. Usually on the third postoperative day, enteral feeding started with soup, semisolid food, and, if they tolerated it well, subsequently also solid food.

The initial clinical experience of the past years shows a safe introduction of this NOTES-associated technique into clinical practice.

Surgical Technique and Difficult Situations from David Jayne (Laparoscopic Ventral Rectopexy)

Jim Tiernan and David Jayne

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53.1 Introduction

This chapter describes the authors' approach to laparoscopic ventral rectopexy along with technical tips to avoid difficulties and complications. For the sake of clarity, the below description assumes a female patient.

53.2 Technique

53.2.1 Patient Selection

- All patients with full-thickness rectal prolapse are suitable for laparoscopic ventral rectopexy except for the very old and infirm in whom the risk of general anaesthetic is considered to be too great.
- There is an argument for avoiding pelvic dissection in the young male, in whom injury to the autonomic nerves carries the theoretical risk of erectile and ejaculatory dysfunction.
- The presence of full-thickness prolapse should be elicited on history and confirmed, if possible, by clinical examination. Preoperative workup should include a flexible sigmoidoscopy as a minimum to exclude a colorectal lesion. Anorectal physiology and proctography are performed at the surgeon's discretion.

53.2.2 Preparation

- No preoperative bowel preparation is necessary.
- Prophylactic broad-spectrum antibiotics are administered at induction of anaesthesia.
- General anaesthesia is employed and the patient placed securely on the operating table in the reverse Trendelenburg position.
- A urethral catheter is placed to decompress the bladder.

53.2.3 Operative Technique

- Pneumoperitoneum to 15 mmHg is established using a Veress needle in the left subcostal position.
- An Endopath® Xcel® Optiview® (Ethicon Endosurgery, USA) 12 mm port is placed halfway between the umbilicus and the xiphisternum and a few centimetres to the left of the midline.
- Further ports are placed under direct vision and include a 5 mm port medial and superior to the right anterior superior iliac spine, a 12 mm port in the right lateral position and level with the umbilicus and a 5 mm assistant port in the left iliac fossa.
- With the patient in a head-down position and tilted slightly to the right, the small and large bowel is lifted out of the pelvis. If necessary, a redundant sigmoid colon is suspended to the lateral abdominal wall with the use of laparoscopic tacks placed through suitably bulky appendices epiploicae, taking care not to injure the bowel wall or any diverticulae.
- If necessary, a bulky uterus can be suspended ventrally by a suture placed through the anterior abdominal wall of the uterine fundus.
- The pelvic anatomy is identified to guide dissection; note is made of the sacral promontory, the right ureter and the right iliac artery.
- Dissection of the right mesorectal reflection commences at a level just above the sacral promontory, extending down the right mesorectal gutter and across the anterior rectum at the level of the Pouch of Douglas (Fig. 53.1). Care is taken not to extend the dissection too far posteriorly for fear of compromising the autonomic innervation of the rectum; similarly, dissection is kept to a minimum at the anterolateral aspect rectum at the Pouch of Douglas.
- The recto-vaginal septum is entered. Here, dissection is aided with the use of a retractor

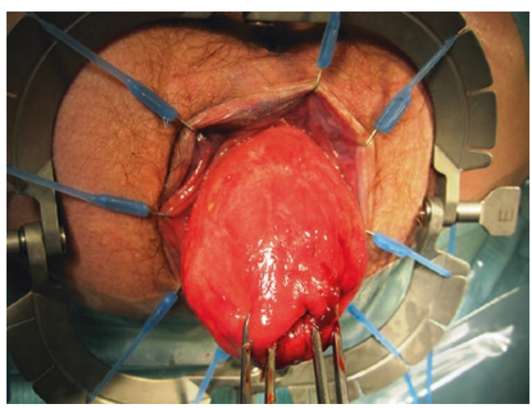
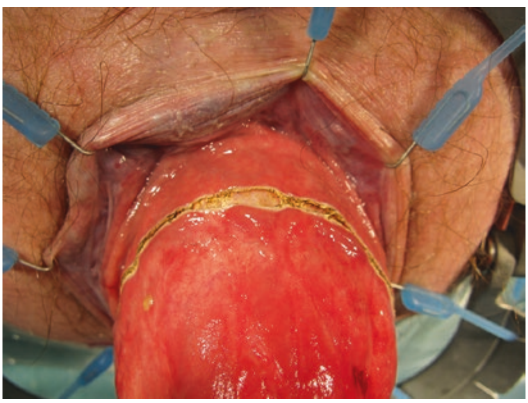


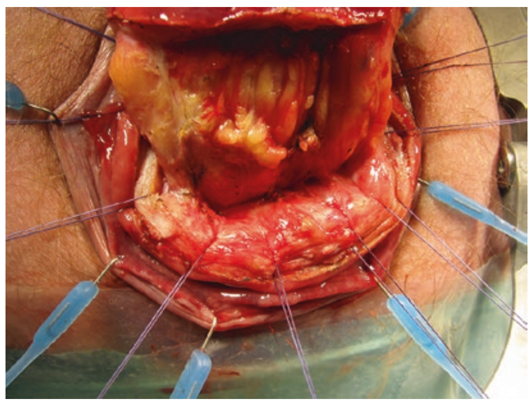
Fig. 53.1 Dissection of the right mesorectal reflection

inserted per vagina to lift the vaginal vault ventrally. Dissection in the recto-vaginal plane is continued as low as possible and can be checked by insertion of a digit into the rectum (◘ Fig. 53.2); a laparoscopic instrument should be easily palpable just above the ano-rectal junction.

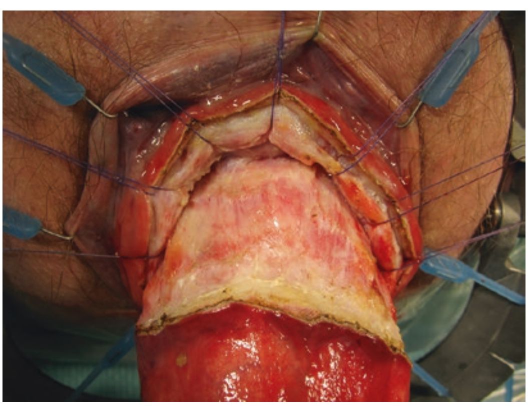
- A 3 × 20 cm strip of mesh is fashioned. It is the authors' preference to use a composite, semi-absorbable mesh, such as Vypro II® (Ethicon Endosurgery, USA), which provides the initial support necessary for repair whilst avoiding problems with mesh erosion and migration that has been associated with heavier prosthetic meshes.
- The mesh is inserted into the dissected recto-vaginal septum, as low as possible, and sutured to the anterior rectum with ×4 non-disposable sutures, such as 3/0 Ethibond® (Ethicon Endosurgery, USA) (◘ Fig. 53.3). For convenience, the authors use an extracorporeal knot-pushing technique.
- X2 sutures are next inserted to secure the mesh to the posterior vaginal vault.
- The mesh is then pulled loosely up to the sacral promontory, where it is either secured to the sacral promontory with ProTack® (Covidien, USA) or 3/0 Ethibond® sutures. Any excess length of mesh is trimmed and removed (◘ Fig. 53.4).
- Haemostasis is checked and the Pouch of Douglas and pelvic peritoneum reconstructed with a continuous dissolvable suture (◘ Fig. 53.5).
- The operation is completed by releasing the sigmoid colon (if suspended), deflating the abdomen and closing the fascial defects at the 12 mm port sites (◘ Table 53.1).



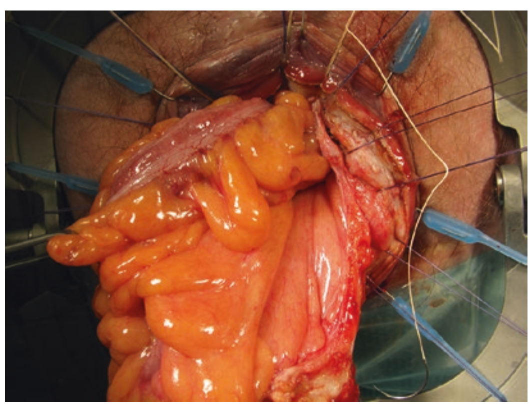
◘ **Fig. 53.2** Dissection of the recto-vaginal septum



◘ **Fig. 53.4** The proximal mesh is secured to the sacral promontory



◘ **Fig. 53.3** The mesh is inserted into the dissected recto-vaginal septum and sutured to the anterior rectum with four non-absorbable sutures



◘ **Fig. 53.5** The pouch of Douglas and pelvic peritoneum are reconstructed with a continuous non-absorbable suture

Table 53.1 Patients classified by operative difficulty: 'ideal' = easy to operate with no expected problems; 'not quite ideal' = some minor difficulties may occur; 'problematic' = difficult to operate, some operative steps are considerably more difficult than others; 'very problematic' = every operative step is difficult

Type	Description	Examples
I	Ideal	Female No previous hysterectomy Virgin abdomen Low BMI
II	Not quite ideal	Obesity Large redundant sigmoid Previous hysterectomy Mild adhesions
III	Problematic	Scarred abdomen Moderate adhesions Previously failed rectopexy procedure Other coexistent abdominal or pelvic pathologies
IV	Very problematic	Multiply scarred abdomen Dense adhesions Multiple failed rectopexy procedures

53.2.4 Postoperative Care

- The patient is encouraged to drink, eat and mobilise as soon as possible after surgery. The urethral catheter is removed as soon as convenient.
- Postoperative medications include a stool softener and bulking agent for 7 days to prevent constipation and straining at defaecation.
- In the authors' practice, around 50 % of patients are discharged the day following surgery, with the remainder on postoperative day 2.

53.3 Difficult Situations and Intraoperative Complications

- *Vascular injury*: vascular injuries include possible injury to the left internal iliac vein and bleeding from the middle sacral vessels at the sacral promontory. The left iliac vein is at risk during the initial dissection to lift the mesorectum off the sacral promontory if the dissection is carried too far to the left side. It is only necessary to clear the sacral promontory such that most of the anterior aspect is free, and if dissection is restricted to this extent, then major vascular injury will be avoided. Bleeding from the middle sacral vessels during fixation of the mesh to the sacral promontory can be avoided by careful inspection for the vessels and placement of the fixation sutures/tacks appropriately. Should bleeding be encountered, it can usually be controlled by tying off the sutures combined with pressure applied via a gauze swab. Other potential bleeding points include the lateral pelvic sidewall and the posterior vagina and are avoided by keeping the dissection in the correct mesorectal plane.
- *Autonomic nerve injury*: this is an injury caused by the dissection straying out of the correct mesorectal plane. Vulnerable points include initial dissection at the sacral promontory and the anterolateral aspect of the rectum at the Pouch of Douglas.
- *Mesh complications*: there are reported cases of mesh migration and erosion into the vagina and rectum with associated pelvic sepsis [1, 2]. This is probably more frequent with the use of heavy, prosthetic mesh. In the authors' experience of over 200 cases using lightweight, semi-absorbable mesh, this has never been experienced. Because of the concern regarding mesh erosion with prosthetic mesh, there is an interest in the use of biological meshes for rectopexy, and preliminary data suggests that it is effective at least on short-term follow-up [3, 4].
- *Small-bowel obstruction*: in laparoscopic rectopexy this may be associated with incomplete

reconstruction of the Pouch of Douglas and pelvic peritoneum. Attention should be paid to ensuring complete closure of the peritoneum, without any gaps for small-bowel herniation.

- *Dyspareunia*: this is reported in all procedures that involve dissection of the recto-vaginal septum and may be more frequent with the use of heavy, prosthetic mesh. The reported incidence is around 2.5 % following laparoscopic ventral rectopexy. It is often difficult to treat and referral to a gynaecologist is recommended.
- *Lumbar discitis*: this has been reported after laparoscopic ventral rectopexy and is presumably a result of the fixation method of the mesh to the sacral promontory [5]. In the authors' experience, lower back pain for a few days is not an uncommon complaint following mesh fixation to the sacral promontory with ProTack, but is rarely described following sutured fixation.
- *Recurrent rectal prolapse*: failure of the rectopexy with recurrent rectal prolapse is reported to occur in 3.4 % of cases (range, 0–15.4 %) [1]. The most frequent cause of failure is detachment of the mesh from the sacral promontory and is usually amenable to redo procedure. In a minority of patients (8 % in the authors' series), the patient may have evidence of residual mucosal prolapse rather than full-thickness prolapse recurrence. This may be a result of the mesh being placed to high in the recto-vaginal septum, but it some cases it is a reflection of an incompetent, patulous anal sphincter, when it is largely unavoidable.

Case Example

Situation

A 65-year-old female presents with full-thickness rectal prolapse, defaecatory urgency and tendency to faecal incontinence. Flexible sigmoidoscopy is normal. The patient undergoes laparoscopic ventral rectopexy without complication, but represents to the clinic at 6 weeks postoperative complaining of mucous discharge and bleeding on defaecation. Proctoscopy reveals obvious rectal mucosal prolapse, but without full-thickness prolapse.

Dilemma

How to deal with symptomatic residual mucosal prolapse following mesh rectopexy?

Solution

The patient underwent transanal resection of the mucosal prolapse using the STARR (stapled transanal rectal resection) technique. Theoretical concerns regarding incorporation of the mesh in the transanal resection are largely unfounded, as long as resection is limited to the area of prolapsing tissue.

Outcome

Resolution of symptoms

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Surgical Technique and Difficult Situations from Antonio Longo (Different Techniques)

Antonio Longo

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The rectal prolapse can be classified as internal and external. The internal rectal prolapse can be of the mucosal type (5–10 % of cases) or full thickness. Both types can cause hemorrhoidal prolapse. The internal rectal prolapse may occur as an intussusception or, under straining, can dilate forming also a rectocele or a megarectum.

The hyperdescending perineum and enterocele are frequent alterations associated with internal rectal prolapse because they are secondary to straining induced by obstructed defecation. The presence of an enterocele must be well assessed preoperatively to prevent serious intraoperative complications.

The external rectal prolapse is commonly classified according to the length that comes out compared to the anal verge: procidentia, rectal prolapse, and rectosigmoid prolapse. We believe this classification is inadequate because it does not take into account anatomical and structural damage of the rectum. We have observed that often the rectum is stretched due to weakness of the muscular tunics resulting in obvious loss of compliance.

This could explain the high percentage of constipation after rectopexy, with any technique undertaken, including the so-called anterior rectopexy. For this reason and for other complications, we have abandoned traditional rectopexy. In cases of external rectal prolapse without structural damage and lengthening, from 2007 we have proposed a novel approach: soft intraperitoneal rectosuspension (SIR).

In the case in which the prolapsed rectum presents elongation and thinning of muscular tunic, we prefer to amputate it via the perineum according to Altemeier technique but making the anastomosis with the PPH stapler at least 4 cm above the dentate line.

The full-thickness rectal prolapse, internal or external, may be primary or secondary to genital prolapse. We have demonstrated, through MRI dynamic pelvigraphy, that a genital prolapse always induces a rectal prolapse and that conventional techniques adopted by gynecologists, both transvaginal and colposacropexy, do not correct the associated rectal prolapse.

In cases of rectal prolapses, internal or external, associated with genital prolapse greater than one degree (Baden & Walker), we perform the POPS technique. The protocol of our surgical choices regarding the various types of rectal prolapse is shown in ◘ Table 54.1 and ◘ Fig. 54.1.

54.1 Stapled Hemorrhoidopexy

54.1.1 Description of the Technique

After lubrification of the anal canal, the circular anal dilator (CAD) is introduced. The introduction of the CAD causes the reduction of the hemorrhoidal prolapse and anoderma. As it is transparent, the CAD allows visualization of the dentate line, allowing the surgeons to check the correct positioning. The CAD is then stitched to the perineum with four stitches, at the cardinal points. After removing the obturator, the prolapsed mucosa falls into the lumen of the CAD and may be evaluated through the Parks maneuver.

◘ **Table 54.1** Types of external rectal prolapse and related surgical indications

Types **External rectal prolapse**	**Clinical and structural alterations**	**Suggested procedure**
Primary	Procidentia – not significant enterocele	Perineal resection by contour
	Procidentia – associated to deep Douglas or enterocele	Soft intraperitoneal rectopexy (SIR)
	Rectal prolapse without structural alterations of the muscular layer and elongation	SIR
	Rectal prolapse with rectal elongation and thinned muscular layer	Altemeier
Secondary to urogenital prolapse	Genital prolapse associated to external rectal prolapse	POPS ± STARR or SIR

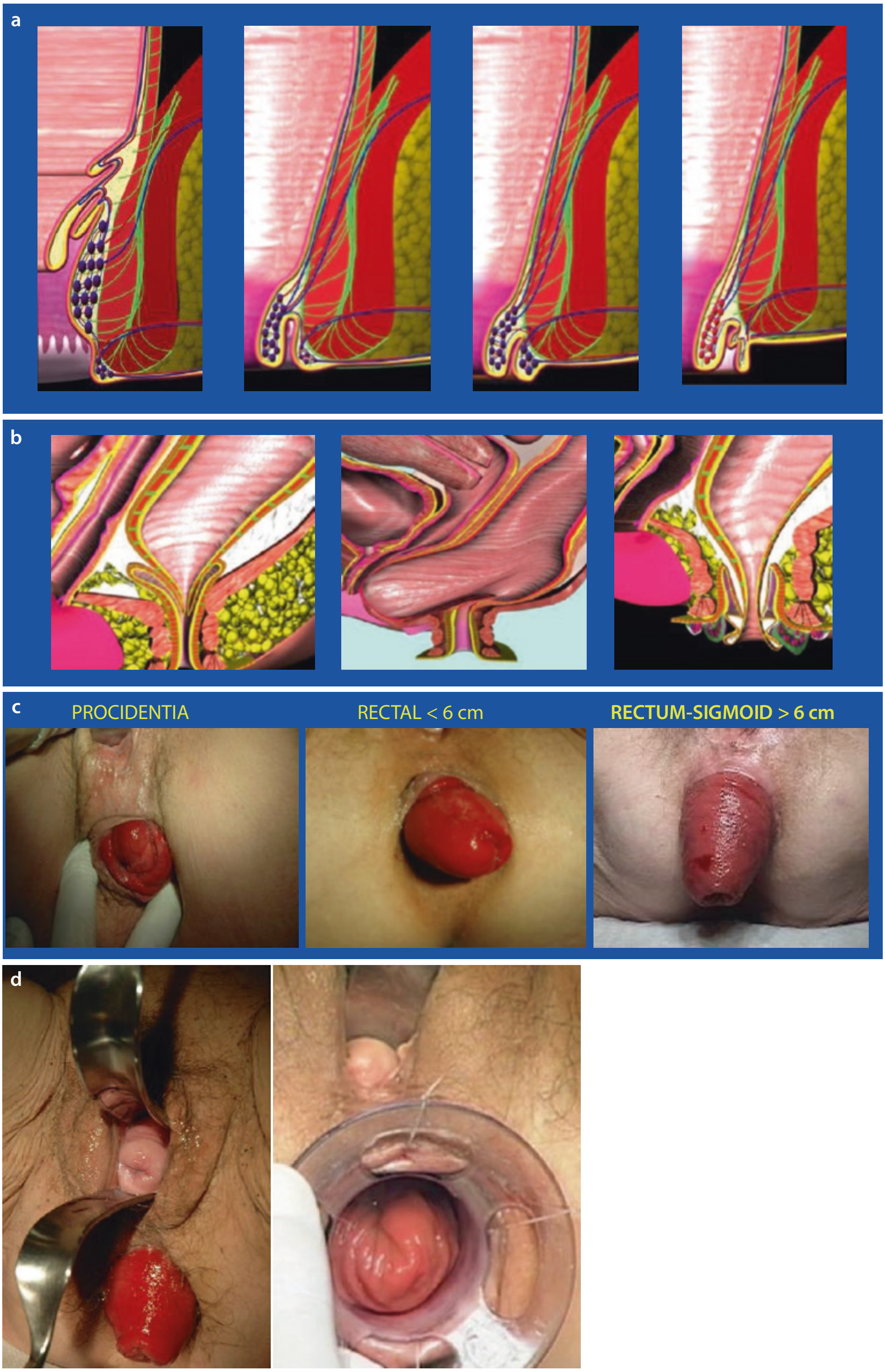
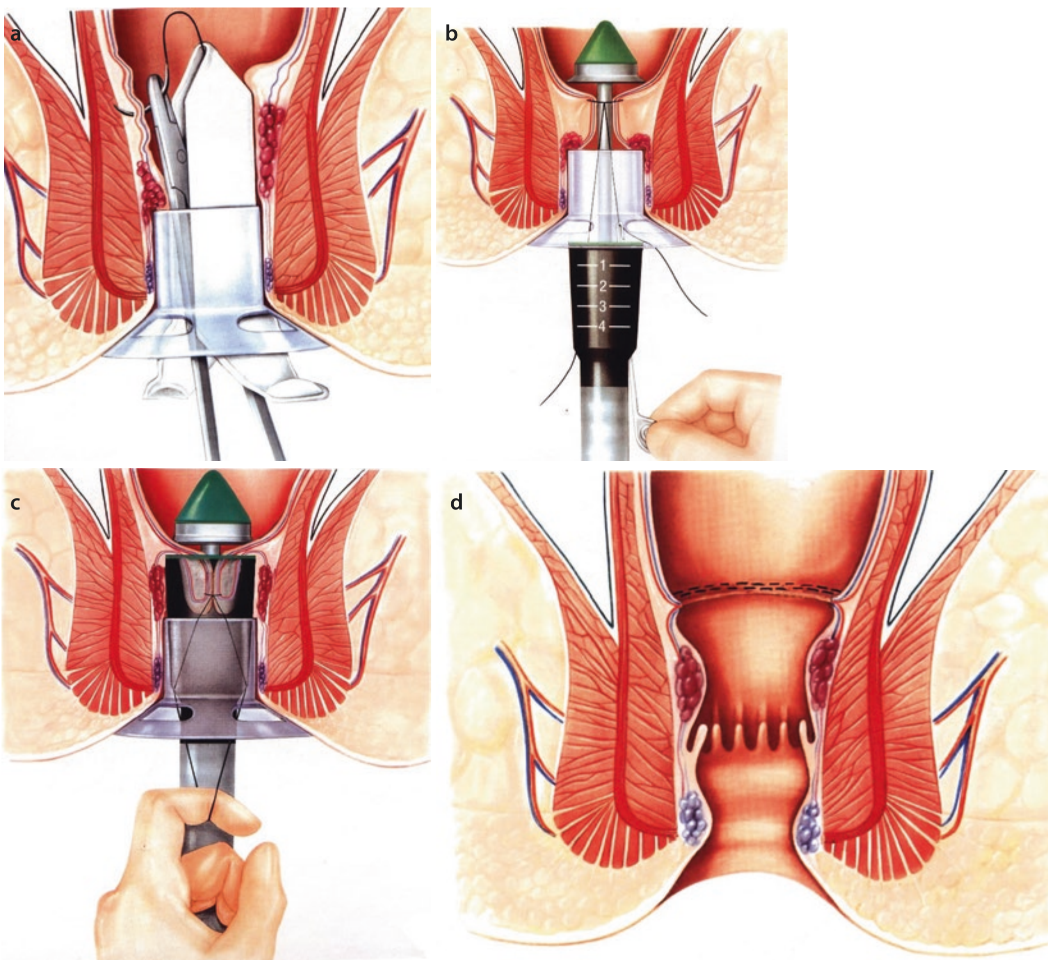


Fig. 54.1 **a** Stapled anopexy. Rectal mucosa prolapse with hemorrhoidal prolapse. **b** STARR. Full thickness internal prolapse and/or rectocele with or without hemorrhoidal prolapse. **c** Modified Altemeier. SIR (soft intraperitoneal rectosuspension). **d** POPS ± STARR (pelvic organ prolapse suspension). Genital prolapse associated to external or internal rectal prolapse and/or rectocele

The purse-string suture anoscope is introduced through the CAD. This instrument will move the mucous prolapse along the rectal walls along a 270° circumference, while the mucosa that protrudes through the PSA window can be easily contained in a suture that includes only mucosa and submucosa. This suture must be carried out at least 2–3 cm above the apex of the hemorrhoids (◘ Fig. 54.2a), the distance to be increased in proportion to the extension of the rectal prolapse. By rotating the PSA, it will be possible to complete a purse-string suture around the entire anal circumference.

The circular stapler is opened to its maximum position. Its anvil is introduced beyond the purse-string (◘ Fig. 54.2b). The PPH is slightly withdrawn, enough to ensure the purse-string can be visualized. The purse-string is then tied with a single closing knot. With the help of the suture threader, the ends of the suture are pulled through and out of the lateral holes of the casing. The ends of the suture are knotted externally or held by a clamp. The casing of PPH is introduced into the anal canal. During the introduction, it is advisable to partially tighten the stapler.

Via a moderate traction on the purse-string, the prolapsed mucosa is accommodated into the casing (◘ Fig. 54.2c). The instrument is then tightened to the end. If the patient is a woman, check the posterior vaginal wall to be certain that it has not been incorporated in the staple line. The stapler is then fired. The PPH is slightly opened



◘ **Fig. 54.2** Steps of stapled hemorrhoidopexy **a** https://www.dict.cc/englisch-deutsch/purse-string.html purse-string https://www.dict.cc/englisch-deutsch/suture.html suture must be carried out at least 2–3 cm above the apex of the haemorrhoids **b** The circular stapler is opened to its maximum position. Its anvil is introduced beyond the purse-string **c** Via a moderate traction on the purse-string, the prolapsed mucosa is accommodated into the casing **d** finished stapler line (one-half to the three-fourths revolutions) and extracted (◘ Fig. 54.2d). Finally, the staple line is examined using the PSA.

Inspect the staple line for bleeding, and if necessary reinforce it with hemostatic stitches using 2-0 absorbable suture. In order to ensure four checks for post-op bleeding, a long wet swab (25 cm), with a suture anchored at the lower end, is completely inserted above the staple line. The swab is normally removed after 4–5 h. Inspect the specimen to confirm that the technique has been properly performed. Accessory procedures (e.g., tag or papilla excision) can be performed either before or after stapling.

Ideal Case

Patient without previous anal surgery with internal mucosa prolapse less than 4 cm, reducible hemorrhoidal prolapse, without skin tags.

Not Quite Ideal Cases

Patients with previous hemorrhoidectomy, with anus not very dilatable that impedes the introduction of the CAD.

▪▪ Technical variant

you can practice two lateral incisions on the anoderma such that the CAD may be introduced. The incisions are sutured after the rectal resection.

Problematic Cases

1. Anal canal with very long massive hemorrhoids occupying the anuscopio obscures the view of the rectal mucosa and makes it difficult to perform the purse-string suture.
2. Patient with voluminous skin tags that make the hemorrhoidal prolapse not reducible. Variation of technique: excision of skin tags through the incisions and detach the anoderma from the anal sphincter to make it mobile and reducible. At the end of the intervention, the wounds can be sutured, and if they are too many and wide, and if there is a risk of stenosis, small sliding skin flaps can be made.

▪▪ Technical Tip

enter in succession into the holes of the CAD a spatula 2 cm wide that goes beyond the internal edge of the CAD; move the hemorrhoids laterally making it possible to stitch the rectal mucosa.

Very Problematic Case

Patient, 46 years old, male, underwent hemorrhoidectomy 2 years previously. Frequent rectal bleeding, daily use of laxatives, and enemas.

Severe anal stenosis extended the whole length of the anal canal. The defecography, performed with very fluid barium, showed significant rectal mucosa prolapse.

▪▪ Intervention

patient in lithotomic position. Dilation of the stenosis by Hegar. Two lateral and longitudinal incisions are carried out on all the stenotic anal canal. With curved scissors and dissector, the anoderma is dissected from the anal sphincters. It is noted that the rectal prolapse occupies the anal canal. The anal dilatation obtained allows the introduction of a PPH but not of the CAD. A purse-string suture is made 8 cm from the anal verge. A node on the purse-string is carried out without tightening. The ends of the threads are brought outside through the holes of the stapler. The casing stapler is inserted up to 6 cm. The stapler head is opened and pushed just above the purse-string. Seen through the holes that the prolapse occupies the casing, the resection is carried out. Hemostasis is checked.

Two rotating skin flaps are prepared to correct the anal stenosis.

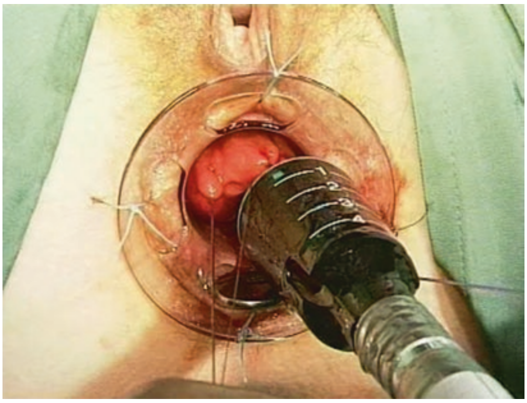
Postoperatively, the patient reports no more bleeding and obstructed defecation. For about 3 months, soiling and dermatitis is reported and is subsequently improved. The postoperative ultrasonography shows absence of smooth sphincter in the posterior and left side replaced by fibrotic tissue.

54.2 STARR

54.2.1 Description of the Technique with 2 PPH 01

The lithotomic position is mandatory. Spinal anesthesia is advantageous because it achieves a constant sphincter relaxation and the patients don't have postoperative pain for 4–5 h.

The CAD introduction maneuver is similar to the stapled hemorrhoidopexy. The edge of the prolapsing rectal cylinders must be captured by three stitches passed at 10 – 12 – 2 h. The tail end of the central stitches are tied together with the right and left ones. In order to avoid the inclusion of posterior prolapse in the anterior resection, a



■ **Fig. 54.3** STARR technique: a spatula is introduced in the posterior window of the CAD to avoid resection of posterior rectal prolapse. PPH stapler is introduced in maximum opening. The stitches in the edge of anterior prolapse are passed

spatula, 2 cm large, must be carefully inserted 8–10 cm through the posterior hole in the flange of the CAD. A PPH 01 stapler head, at its maximum opening, is inserted and positioned just beyond the sutures (■ Fig. 54.3). The suture threads are pulled through the casing holes and knotted together. Keeping the head of the stapler just above the stitches, start to close the stapler. Before the complete closure, in women, a vaginal valve is placed in the posterior fornix and with two fingers; it is checked that the vaginal wall isn't trapped in the stapler. After having fired, the stapler is removed.

Normally, two dog-ears, connected with a mucous bridge, will be observed. After removing the spatula and interrupting the mucosal bridge, one stitch for each dog-ear is passed through and one more in the middle of the edge of the posterior prolapse (they are the lateral end of the posterior prolapse). Having introduced the spatula in the anterior window of the CAD flange, the posterior resection is made as well as the anterior one. At the end of the procedure, two small dog-ears can be observed; it can be removed or sutured using Vicryl 00.

54.2.2 Description of the Technique with Transtar

Patient in lithotomic position. A new device, a rechargeable CCS-30 Contour Transtar stapler kit (Ethicon Endo-Surgery), is the dedicated device utilized. After CAD introduction and fixing, on the edge of the prolapsing rectal wall, five short running sutures must be apposed circumferentially, like parachute cords (■ Fig. 54.4a), to obtain total control of the prolapsing rectum. A stitch must be apposed at 3 o'clock involving the entire length of the prolapse and is knotted tightly. Keeping this stitch in traction, the stapler was positioned transversally and the first shot fired.

This maneuver opening longitudinally the rectal prolapse (■ Fig. 54.4b) allows the start of the circumferential resection by subsequently firing cartridges stapler (■ Fig. 54.4c, d). After firing the last shot and removing the specimen, eventual bleeding can be stopped by stitches.

Ideal Cases

Patients without previous anorectal operations and/or hysterectomy. Internal rectal prolapse full thickness with rectocele but not megarectum, normotrophic vaginal wall.

Not Quite Ideal Cases

The following conditions make surgery less simple and require special care:

1. Substenosis anal skin tags with non-reducible hemorrhoidal prolapse
2. Prior STARR or stapled hemorrhoidopexy
3. Obesity

Problematic Cases

1. Megarectum
2. Hysterectomy with short vaginal stump

Very Problematic Cases

Technique by Two Staplers

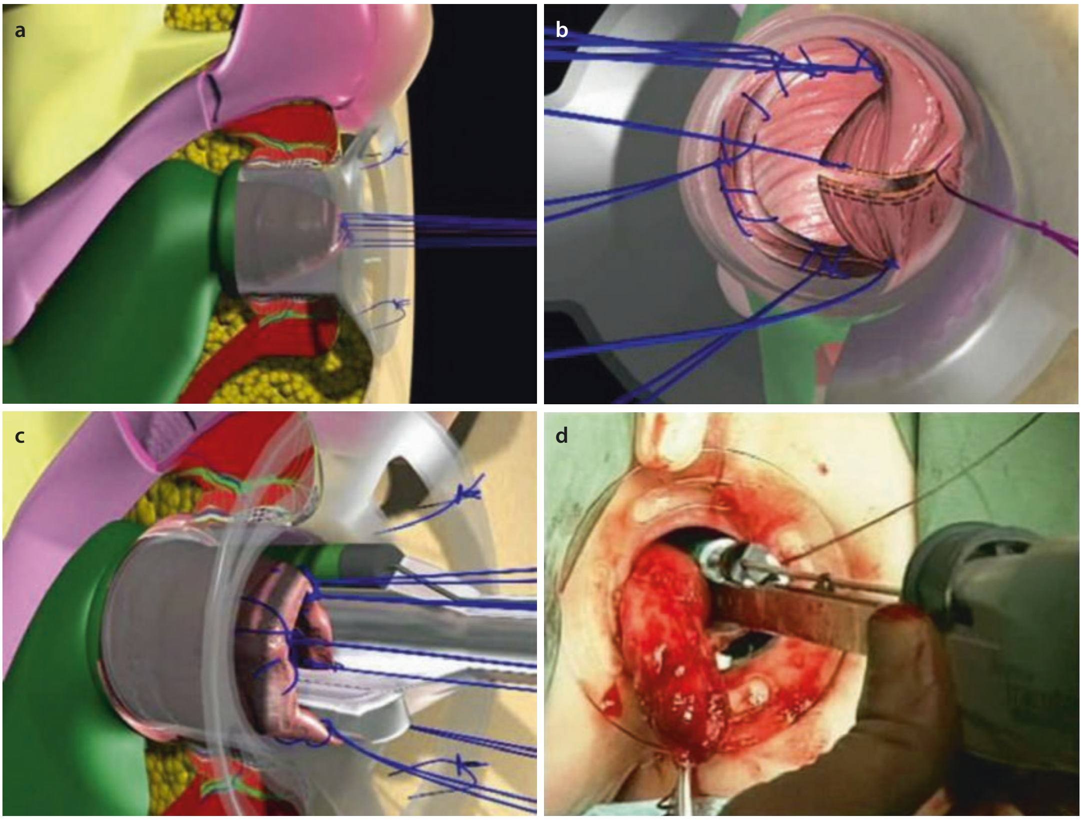
A 43-year-old woman with severe constipation and frequent rectal bleeding (Hb 9.2). Defecography shows 5 cm deep rectocele, recto-anal prolapse, and deformation due to retraction of the posterior rectal ampoule.

The colonoscopy shows an ulcer 3 × 2 cm on the posterolateral rectal wall, 3 cm above the hemorrhoidal apex.

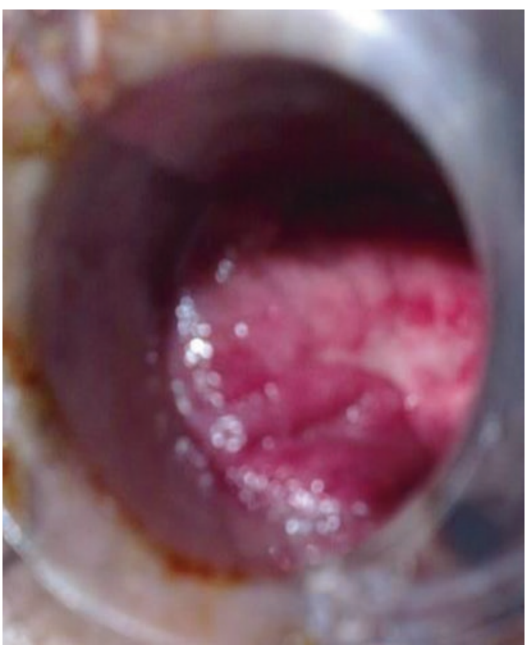
Histological examination: likely solitary ulcer of the rectum.

■■ Intervention

After the insertion of the CAD, inspection of the rectal ampoule confirms endoscopic data. The solitary ulcer covers the posterolateral edge of the



■ **Fig. 54.4** **a** introduction of CAD and fixing on the edge of the prolapsing rectal wall **b** five short running sutures have been apposed circumferentially like parachute cords to obtain total control of the prolapsing rectum **c**–**d** the circumferential resection by subsequently firing cartridges stapler



■ **Fig. 54.5** Solitary ulcer of the rectum

prolapsed rectal cylinder (■ Fig. 54.5). The tactile feel is of a hard fibrous type.

Resection of the anterior prolapse with PPH 01 is not difficult. Three stitches are applied to the posterior prolapse; the central and left ones include the ulcer.

Miss the characteristic sound of device during fire. Having extracted the stapler, the tissue is cut, but not sutured. Massive bleeding from the wound impedes vision of the wound and suturing. Tamponing of the wound and strong digital pressure. The blood pressure of the patient was 145/100. We ask the anesthetist to lower it pharmacologically. After 10 min the pressure has dropped to 95/60. We check the specimen and it is found that the ulcer is only partially resected. A deep continuous full-thickness suture of the wound is performed, using Prolene 00, to obtain a good hemostasis. Then, starting from the left side, the continuous suture en block with the residual solitary ulcer and rectal prolapse is removed gradually using diathermy and the wound sutured by separated stitches, Vicryl 00. Postoperatively Hb is

7.7. The course is characterized by fever (37.2–38°) which is resolved on the third postoperative day after the evacuation of blood clots. There are no other complications. Constipation and solitary ulcer were cured.

Very Problematic Case

Technique by Contour Transtar

Nulliparous woman, 35 years old with a history of severe anorexia. On clinical examination, posterior anal fissure, rectocele and rectal prolapse, and uterine retroversion with genital prolapse degree I (B. & W.) were assessed. Under straining: hyperdescending perineum, small rectal procidentia. The MRI dynamic pelvigraphy, showed under straining; loop rectocele with sigmoid-rectal prolapse, hyperdescending perineum, horizontalization of the vagina with retroverted uterus, deep Douglas.

Intervention: evaluation with wad of gauze shows a rectal prolapse that exceeds 1 cm of the outer edge of the CAD. Past the stitches of traction, the prolapsed cylinder was divided in two flaps, anterior and posterior ones, by two linear staplers.

The prolapse was removed using five cartridge shots. Since the cylinder removed along 5 cm, it means it has been removed 10 cm of prolapse.

The inner lumen of the CAD appeared occupied by tense introflexion and rounding of the anterior rectal wall. To the touch and with bimanual palpation of the rectum and vagina, we realize that it is a question of a hyper-retroflex uterine body, in such as the cervix is placed upside down on the anterior vaginal fornix.

Raised with a vaginal spatula, the uterine body, the sigma prolapsed in the CAD and leaks out to about 2 cm.

The patient was placed in the Trendelenburg position, a purse-string suture is made 1 cm above the mechanical suture, and the purse-string is tightened. Circumferentially, full thickness, the rectum was incised just below the stapled line.

The sigmoidectomy was carried out with the pull-through technique (about 35 cm of sigma). The sigma was closed proximally by ligation and pushed, through the open Douglas, into the abdominal cavity. This creates a sufficient space to pass, bilaterally, a Prolene 00 stitch piercing the round ligament first on insertion into the uterus and then from about 10 cm. The maneuver was facilitated with Klemmer pulling down the ligament itself. With the stitches knotted, a satisfactory suspension of the uterine body with correction of retroflection is obtained. Taking again the sigmoid stump was opened at as slant and a purse-string was made. A purse-string was made on the rectal stump too and the anastomosis was performed by PPH stapler.

The postoperative course was excellent. The postoperative MRI dynamic pelvigraphy showed the correction of all the anatomical abnormalities, except for an obvious postsurgery enterocele. Regression of ODS and urgency after about 1 month. Despite the good result, the intervention presented some technical difficulties and was made possible thanks to the small size of the uterus. Patients with a history of anorexia often show similar situations to the one described. Probably the hyper-uterine retroflexion, pushing the sigmoid against the sacrum and forming a barrier, impedes the manifestation of a complete external prolapse. Therefore, the extent of the prolapse was underestimated preoperatively. Currently in cases where defecography shows a sigmoid-rectal prolapse, especially in young patients with uterus retroflexed, we prefer a minimally invasive abdominal approach: the soft intraperitoneal rectosuspension (see below).

54.3 Treatment of External Rectal Prolapse

As shown in ◘ Fig. 54.1 and ◘ Table 54.1, in patients with external rectal prolapse, in which the muscular structure of the rectum and therefore compliance are not compromised, we have been practicing, since 2007, a new procedure which we have called soft intraperitoneal rectosuspension (SIR).

The procedure is based on the simple principle that the external rectal prolapse is caused by a force vector (straining), directed downward, on the Douglas pouch, which slipping down drags with it, inevitably, the rectum. In fact, the pelvic peritoneum is the only anatomical structure that supports the upper rectum in the correct anatomical position. The clinical defecographic demonstration is that the external rectal prolapse is always accompanied by a deep Douglas or an enterocele. Another confirmation is that the genital prolapse, leading a low dislocation of Douglas, always causes a rectal prolapse, internal or external one. This occurs because the rectum cannot be detached from the pelvic peritoneum being tenaciously welded to the perirectal fascia. It follows that pulling up and setting the Douglas peritoneum can achieve the suspension of the rectum in anatomical site.

54.4 SIR Procedure

The SIR procedure consists in fixing a V-shaped Prolene mesh to the posterior vaginal fornix and the lower peritoneal pouch, and then the strips of the mesh are threaded through two subperitoneal tunnels and after are fixed to the lateral muscle of the abdomen.

The laparoscopic approach is almost always possible. One trocar of 1 cm and two trocars of 0.5 cm of diameter are sufficient. The V-shaped mesh has two 30 cm long and 2 cm large strips. A uterine manipulator is useful.

Making a small incision, 2 cm above and 2 cm posterior to the anterior superior iliac spines, cutting the fascia, and disassociating the muscular fiber up to the subperitoneum, a curved laparoscopic forceps (Cuschieri, Storz) is introduced. Following, under laparoscopic vision, the tip of the forceps, a subperitoneal tunnel can safely be carried out. The tunnel is performed 2 cm above the peritoneal reflection of the colon. Having reached the third lateral of the round ligament, the forceps passes through the broad ligament of the uterus, which is tractioned upward and laterally to facilitate the maneuver. A spatula introduced into the vagina exposes the posterior vaginal fornix. Having opened the posterior peritoneum of the broad ligament, on the branches of the forceps, a strip of mesh is grasped and moved outward. The same steps are performed on the opposite side.

The passage through the broad ligament allows crossing well above the iliac vessels and the ureter, avoiding risks of lesions. Reducing the rectal prolapse using a gauze (◘ Fig. 54.6a) mounted on a clamp, we achieve an optimal intrapelvic visualization of the Douglas (◘ Fig. 54.6b). This facilitates the packing of a peritoneal tunnel, where the mesh is placed, which includes by three stitches the posterior and lateral vaginal fornix, the peritoneum covering the rectum, and the redundant Douglas (◘ Fig. 54.6c, d). The suspension of the rectum is modulated pulling the strings (◘ Fig. 54.7). The mesh is sutured on both sides to the external oblique muscle, and at least 5 cm of strip is tunneled under the muscular fascia, obtaining a soft and dynamic organ suspension.

The totally intraperitoneal approach has the advantages of avoiding rectal dissection, correcting, at the same time, the deep Douglas. The suspension is soft because the rectum isn't fixed to the sacrum but to the soft structure: the abdominal muscle.

In man, the procedure is feasible by varying the technique. If lifting up the Douglas forms a peritoneal fold that laterally crosses the external iliac artery, the lateral tunnel is stopped 2–3 cm before reaching the external iliac artery; then, through a small incision on the peritoneum, the forceps grips the strips and brings it out.

If the fold of Douglas does not override the iliac artery, it uses a V-shaped dual mesh: this allows you to leave a portion intraperitoneally with a Gore-Tex surface exposed to the viscera. In these cases, it is necessary to perform a running suture between the lateral edges of the mesh and the peritoneum in order to avoid internal herniations. The dual mesh can also be used in women who have undergone a hysterectomy with bilateral ovariectomy and removal of loose ligaments. For brevity, we report below the technique pelvic organ prolapse suspension (POPS), conceived and practiced by us in 2001 but published in 2007 after a long follow-up. The technique POPS is recommended for rectal prolapse associated with or secondary to genital prolapse and/or cystocele. The technical difficulties of SIR and POPS are very similar so I'll cover them together.

54.5 POPS Technique

POPS differs from the SIR because the mesh is sutured to the anterior and lateral fornices of the vagina or to the posterior and lateral, according, respectively, to the prevalence of cystocele or posterior colpocele (◘ Fig. 54.7). In hysterectomized patients, the mesh is passed through a tunnel made on the vaginal vault. In some cases to the mesh anchored to the anterior fornix, another mesh (length about 10 cm) is sutured to the posterior vaginal fornix and to the Douglas, in the same way described for the SIR procedure and then bilaterally sutured to the anterior mesh through two smaller incisions made in the posterior peritoneal page of the broad ligament.

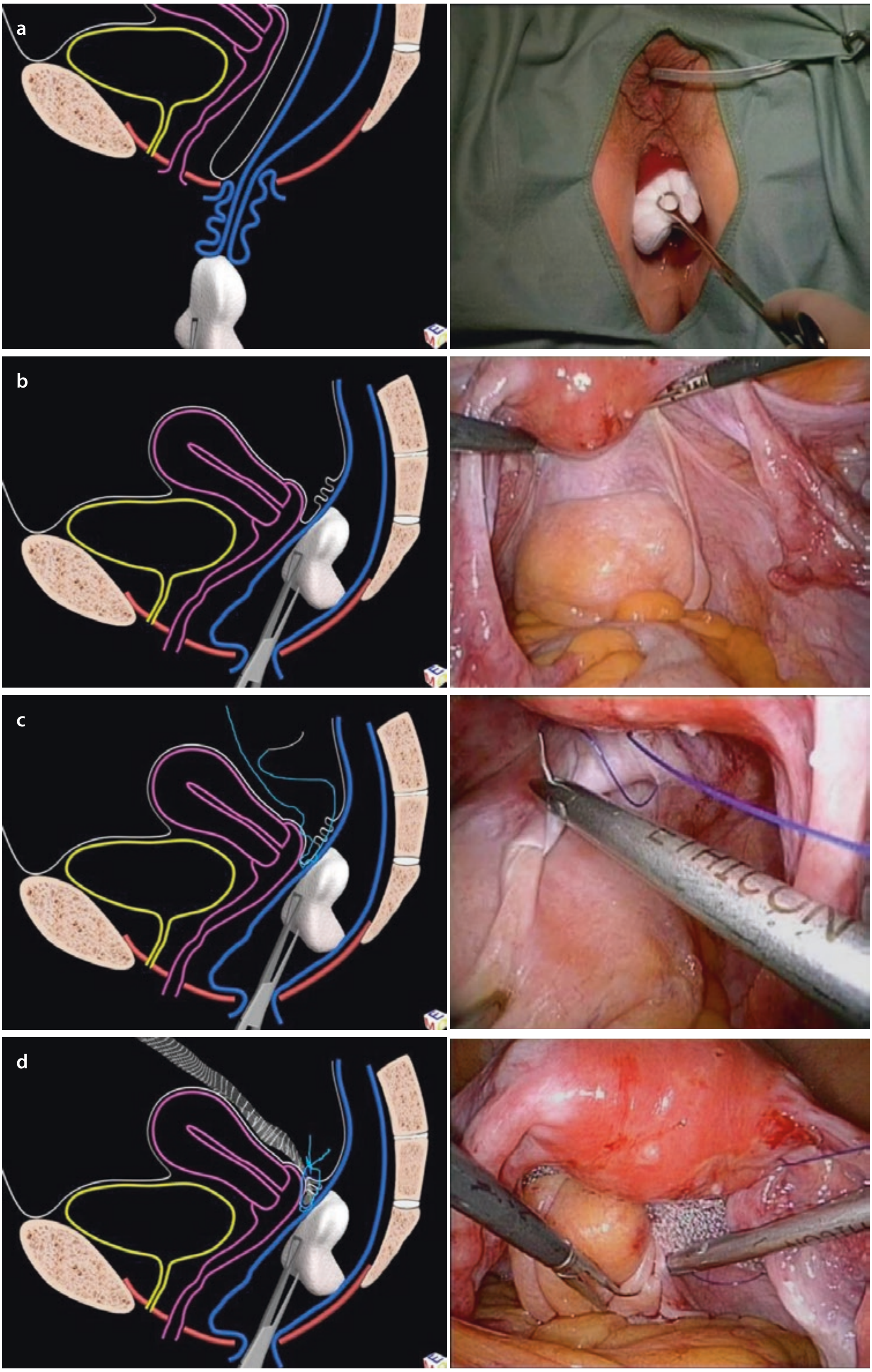


Fig. 54.6 SIR: surgical steps. **a** Reduction of the rectal prolapse using a wad of gauze. **b** The peritoneum covering the rectum and the Douglas pouch are pushed into the pelvis. **c** The semicircular suture includes the posterior and the lateral vaginal fornices; the lower peritoneal fold that cover the upper rectum; the redundant Douglas. **d** A prolene V-shaped mesh is wrapped in the semicircular sutures

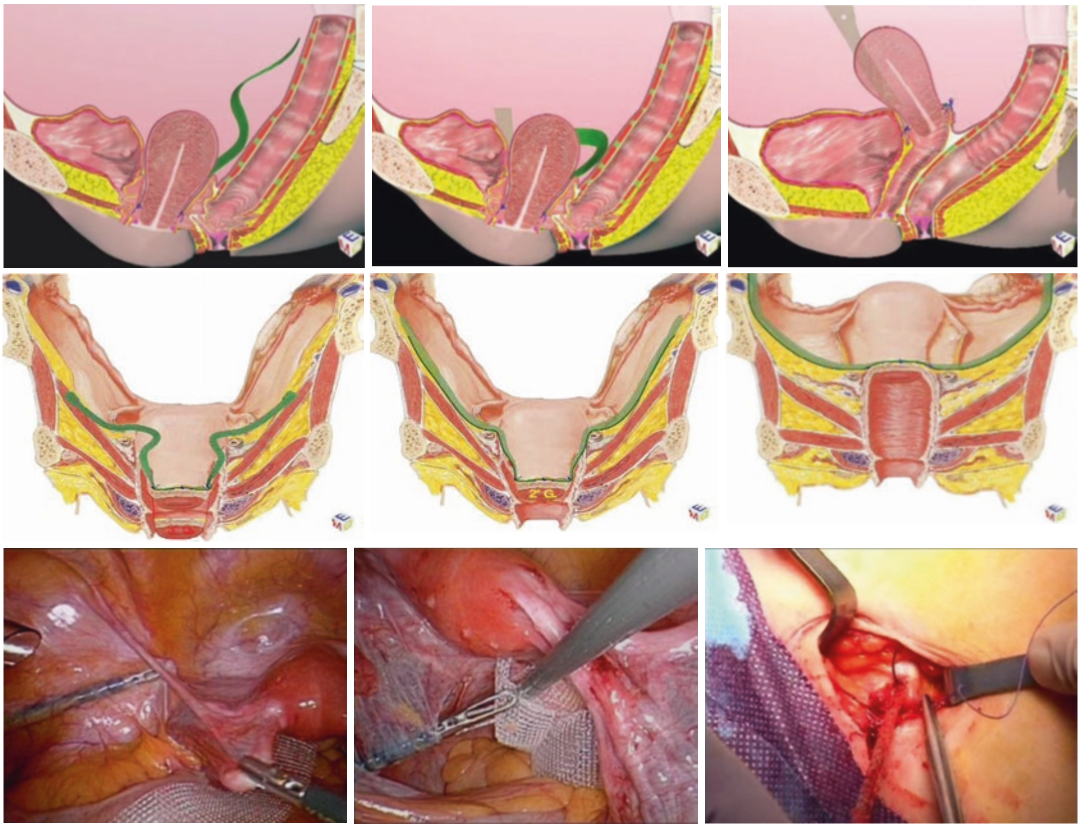


Fig. 54.7 Similar surgical steps of POPS and SIR procedure. A V-shaped mesh is fixed to anterior and/or to posterior vaginal fornices (POPS), or to the Douglas (SIR). In both procedures, through two lateral subperitoneal tunnel, the strips are pulled out and sutured to the lateral muscle of abdomen

Ideal cases	Female patients without previous abdominal or pelvic operations and normal size uterus
Quite ideal cases	Male patients Patients with hysterectomy and adherence between intestine and pelvic peritoneum
Problematic cases	Patients with large uterus that need hysterectomy
Very problematic cases	Patients with hystero-ovariectomy with absence or fibrosis in pelvic peritoneum. Tenacious adherence between the viscera and pelvic peritoneum

54.5.1 Very Problematic Case

Parous woman, 65 years old, previous myocardiac infarct, diabetes, obesity. Previous surgery for appendicitis with peritonitis. PAP test negative, complete pelvic prolapse with: cystocele degree III, non-reducible genital prolapse of degree III with vaginal erosion. External rectal prolapse (Fig. 54.8). Urinary incontinence, chronic constipation, and active fecal incontinence. Marked anal hypotonia.

The MRI cinedefecography shows massive hysterocele. Colonoscopy shows sigmoid diverticulosis.

■ **Fig. 54.8** Total pelvic organs prolapse: cystocele III°; not reducible genital prolapse III°; external rectal prolapse

54.5.2 Description of the Intervention

Laparoscopic exploration of the abdominal cavity shows that the pelvis is totally occupied by the sigma which has tenacious adhesions with the pelvic peritoneum, the cecum, and the right parietal peritoneum miss for about 5 cm. The adhesions between the sigma and cecum and the parietal peritoneum are removed. Dissection of pelvic adhesions turns out to be extremely difficult, and during dissection, accidentally, the sigma was open (probably the patient had previous perforation of diverticulum). The small perforation was sutured. Due to the extreme difficulties to dissect the pelvic rectum, we changed the strategy: placement of two lighted ureteral stents.

Via perineal, not without difficulty, we performed a rectosigmoid mobilization (Altemeier procedure). In this way the dissection of the sigma from the posterior vaginal wall and the uterus was possible. Given the importance of the sigmoid diverticulosis, we decided to remove all the sigma. After mobilization of the left colon flexure, via perineal, we removed all the rectosigma and made a mechanical anastomosis L-T 4 cm from the dentate line. After this step has been possible to reduce the uterus-bladder prolapse. A POPS was performed, anchoring the subperitoneal mesh to the anterior vaginal fornix. The right lateral peritoneal gap, where the mesh of Prolene remained uncovered, was repaired with a patch of Gore-Tex. Finally, a plastic shortening of the round ligaments was performed to straighten the uterus, which tended to retroflex in the small pelvis. Two pelvic drainages were positioned. The patient was kept in TPN for 6 days. The postoperative course was good. At the checkup after 30-day substenosis, we noted the anastomotic substenosis that was dilated with a balloon. After frequent recurrences of substenosis, 6 months after surgery, without anesthesia (because persistence of anal hypotone) we practiced a surgical correction by three incisions and suturing of the stenotic ring. One year after the intervention, anal tone was 25 mmHg and the patient was said to have regained anal and urinary continence.

Supplementary Information

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