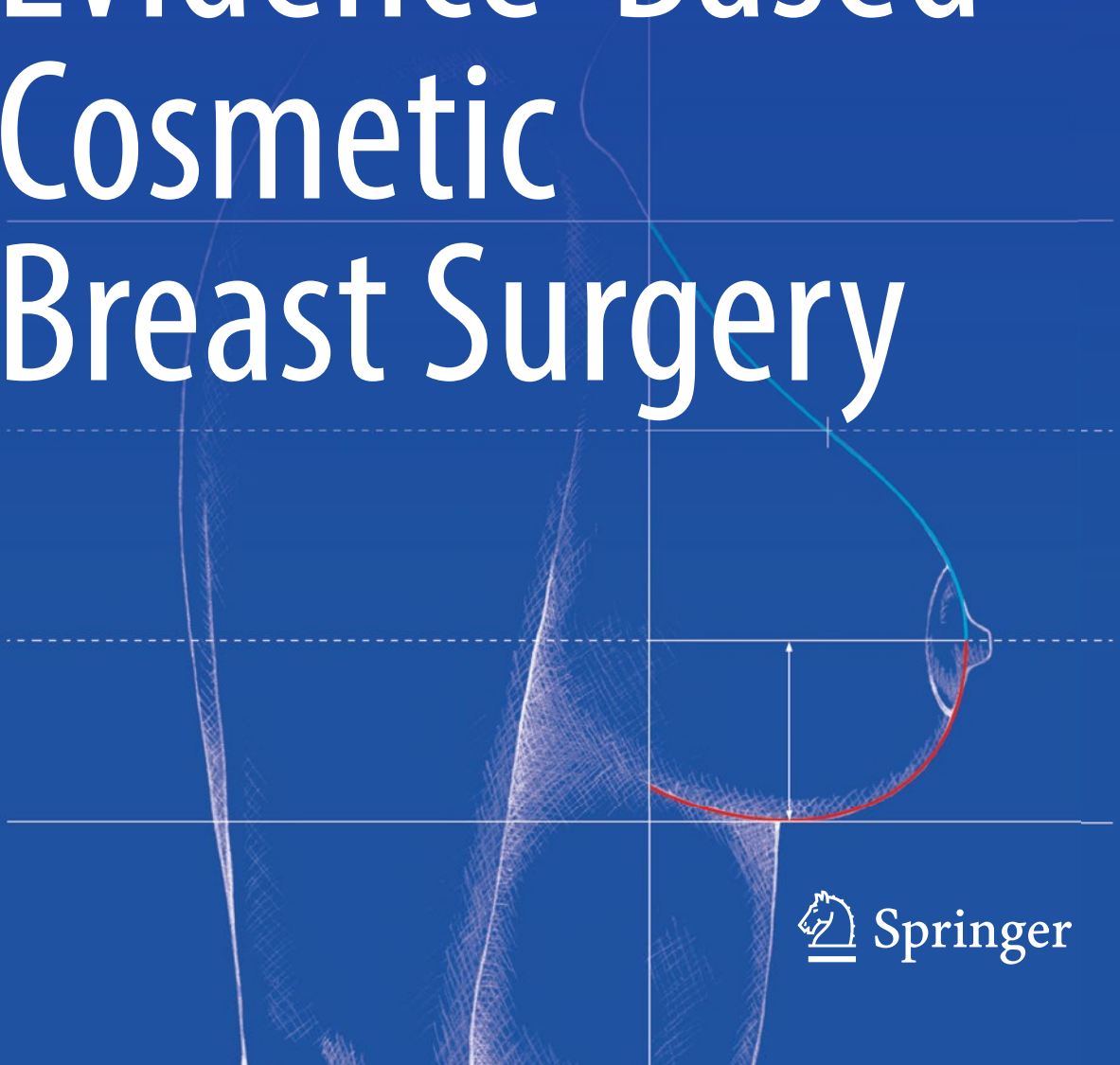
Eric Swanson

Evidence-Based Cosmetic Breast Surgery



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Eric Swanson, MD
Swanson Center
Leawood, KS, USA

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Preface

Many textbooks are titled some variation of "The Art of Plastic Surgery." This volume concentrates on the science, relying on data rather than expert opinion. The source material has been published in the major peer-reviewed plastic surgery journals. Many of the conclusions challenge the status quo.

Financial entanglement represents the single biggest problem facing plastic surgery research. Conflicts are not always financial. They can be intellectual, such as being heavily invested professionally in a certain method, such that there is no going back without a loss of credibility (in the author's mind, anyway). I can think of only a few instances of a surgeon writing, "What I said before is wrong." My opinion of that author goes up, not down, for correcting the record.

Being in solo private practice frees me from many of the constraints of academic medicine, which is often not as evidence based as one might think. All of my studies are self-funded. The only financial conflict I have is in being a plastic surgeon who believes in the value of, and profits from, performing cosmetic surgery.

As a single-author volume, this book is open to charges that it represents the experience of one surgeon. My methods frequently differ from the way plastic surgery is done at other institutions. My purpose in writing is not to recite the mainstream view but to challenge it. One surgeon, one facility, and one method eliminate many confounders that, well, confound multisurgeon and multicenter studies.

Existing textbooks are composed of many chapters written by well-known contributors describing their "How I do it" methods. One surgeon describes how to perform a breast reduction using the vertical technique, another describes the Wise pattern, and another discusses how to dissect a central breast mound and apply a mesh. This old habit makes for thick textbooks. What is the reader to make of all this often conflicting information? A breast lift is a simple concept. There are not 100 equally valid ways to do it. I use only two operations for almost all of my cosmetic breast surgery patients – implants, a vertical breast lift/reduction, or a combination of the two. Really, only one chapter on mastopexy is needed – the one that stands up to scientific scrutiny. Nonvertical methods may be discarded.

I use only two operations for almost all my cosmetic breast patients – implants, a vertical breast lift/reduction, or a combination of the two.

For generations now, plastic surgeons have described methods to lift the breast tissue using breast tissue rearrangements and "suspending" sutures. These efforts puzzled me. After all, did we not have breast implants at our disposal? Until recently, the combination of implants and a breast lift was perceived to be dangerous and at cross purposes – tightening the breast while simultaneously expanding it. Today we know differently.

It seemed to me that almost everything plastic surgeons "knew" (examples provided in Table 1) was based on clinical impressions alone. Starting in

Table 1 Things we "know" that are wrong

1. Individual risk stratification (including Caprini scores)
2. Chemoprophylaxis
3. Breast autoaugmentation
4. Textured implants
5. Form-stable implants
6. BREAST-Q
7. Acellular Dermal Matrix for cosmetic breast surgery
8. Implant sizing based on tissue measurements
9. Routine open capsulectomy for capsular contracture
10. General endotracheal anesthesia with paralysis
11. Intraoperative 14-point plan, including nipple shields, to prevent capsular contracture
12. Mosque dome preoperative nipple siting
13. Nonvertical (including inferior pedicle Wise pattern) mammaplasty
14. Nipple grafting
15. Suspension sutures
16. Mesh scaffolds
17. Breast hypertrophy after liposuction (fat redistribution theory)
18. Dual plane dissection to elevate nipple
19. Blocking sutures
20. Controlling/securing the IMF
21. Pectoralis muscle loop
22. Staged augmentation mastopexy
23. Periareolar mastopexy
24. Electrodissection
25. Ideal breast fuller in lower pole than upper pole (45:55 ratio)
26. One-breast feel
27. No-touch technique
28. Triple antibiotic irrigation
29. 5-centimeter rule to prevent pseudoptosis
30. Nipple as a marker for ptosis
31. Increased risk of combined procedures
32. Accuracy of 3-D computer simulations
33. Randomizing surgical methods
34. Internal bra/laser bra
35. 20° skyward nipple inclination
36. Sub-IMF incision siting, including ICE principle
37. No-vertical-scar breast reduction

(continued)

Table 1 (continued)

38. 24 h recovery after breast augmentation
39. External volume expansion
40. Tension shielding to improve scars
41. Repeating inverted-T dissection for secondary mammaplasties
42. Nipple transposition as opposed to reposition
43. Unreasonable expectations are more common in breast lift patients
44. Large implant sizes (>400 cc) are unsafe
45. Skin-only mastopexies
46. Cosmetic breast surgery is an art and, by its nature, resistant to scientific evaluation

2002, I launched a battery of clinical, measurement, and outcome studies to learn more. I soon realized that in order to measure results, a breast measurement system was needed, motivating me to develop a two-dimensional measurement system. After evaluating hundreds of published before-and-after photographs, the message was clear – breast autoaugmentation and fascial sutures did not work, despite all of the claims. This was the first of many "emperor wears no clothes" moments that were yet to come.

My outcome studies, based on over 1000 patient surveys, produced unexpected findings. Surgeons for years have warned patients of the dangers of implant sizes that are too large, convinced that large implants would distort the breast and that reoperations would be inevitable. My studies showed otherwise. Women treated with larger implant sizes were more satisfied and experienced no more complications than women with smaller implant sizes. These women did not have a higher reoperation rate after all. Mastopexy patients reported improvements in symptoms of neck, shoulder, and back pain, and exercise tolerance, just as my breast reduction patients did. It became clear that the old, largely insurance-driven, breast lift versus reduction (or form versus function) dichotomy was arbitrary.

Saline implants have long been considered an inferior option compared with silicone gel implants. To the chagrin of plastic surgeons, silicone breast implants were unavailable in the United States from 1992 to 2006, forcing American surgeons to gain experience with saline implants. There was a silver lining to that experience; many surgeons learned that saline implants were not such an inferior choice after all.

In 2012 and 2013, form-stable "gummy bear" implants were finally introduced to the American marketplace, having been used for decades already in Europe. Supportive studies were funded by the manufacturer, and consultants were very highly paid. (According to the Sunshine Act website, one lead author of a core study received $4.6 million in royalties in 2015.) These shaped implants were promoted as offering a more natural tear-drop shape. After all, who wants a round breast? But these implants were much firmer than their predecessors. They had to be to resist gravitational deformation, like a gummy bear. Advertisements showed a portion of the implant cut out like a piece of pie. It appeared that the material was solid and would resist forming folds and leaks. In time, magnetic resonance studies would prove otherwise. Some operators, including the author, were never impressed with

gummy bear implants. My outcome study revealed that 23% of women thought their saline and less cohesive silicone gel implants were already too firm. Why would women want even firmer implants that can rotate? What about the attractive jiggle quality of less cohesive implants?

In the last decade, we have learned that textured implants, especially the Biocell (Allergan Inc., Irvine, CA) type, are linked to a form of lymphoma that is not as rare as we first thought. Rather than implicating texturing as the cause, corporate-funded researchers promote an infectious etiology and insist that surgeons adopt a laundry list of measures to avoid infection at surgery – as if infection acquired at surgery could cause Anaplastic Large Cell Lymphoma (ALCL) to develop, on average, 8 years later. An infectious etiology has much different implications than a faulty product. The surgeon is blamed for this problem rather than the product. The causal link is obvious. After all, this problem was never reported before textured implants became available in the 1990s, and it occurs exclusively in women with textured implants.

Manufacturers do not promote saline implants for one reason – they are not as profitable as silicone gel implants, which cost two or three times as much. Silicone gel implants would likely be a historical relic if saline implants were the more profitable option.

Acellular dermal matrix, or ADM (i.e., skin that is shaved off cadavers and then processed to remove the donor cells), is widely promoted today. Some surgeons insert Alloderm (Lifecell Corp., Branchburg, NJ) at the time of a capsulectomy in an effort to prevent capsular contracture. Almost all investigators receive corporate funding and discounted products. Combining capsulectomy and ADM greatly increases patient morbidity and cost. Insertion of a second avascular product increases the potential for complications. A much simpler, inexpensive, and at least equally effective, alternative is overlooked – open capsulotomy. Its success (recurrence rate 23%) speaks against the infected biofilm theory of capsular contracture.

Recapitulating history, some plastic surgeons are experimenting with a mesh that is supposed to act as an internal bra. This 30-year-old concept has never been shown to be effective. In fact, the author's measurement study found it ineffective. The manufacturer pays its consultants, who promote the product on TV and the Internet, and funds scientific publications that blur the line between science and marketing.

Caprini scores are supposed to identify individuals who are likely to suffer a venous thromboembolism (VTE). These scores are then used to justify the use of anticoagulants (yes, Caprini received funding from virtually all the anticoagulant manufacturers) after surgery. The subtext is, if surgeons fail to follow risk stratification guidelines, they will be defenseless in court. Uninformed expert testimony compounds the tragedy of a fatal pulmonary embolus. The more I investigated risk stratification and chemoprophylaxis, the more I learned that the whole concept – the ethics, efficacy, and safety – is flawed. It was another "emperor wears no clothes" moment, but there was another silver lining. I soon learned how to reduce risk and identify affected individuals (after surgery, not before) using a superior anesthesia method and ultrasound technology.

Alarmingly, many of the concepts and recommendations that have been published in our literature are wrong (Table 1). More of what we think we know may be wrong rather than right. These shibboleths will be challenged in the chapters that follow.

> "When we meet a fact which contradicts a prevailing theory, we must accept the fact and abandon the theory, even when the theory is supported by great names and generally accepted." - Claude Bernard 1865.

A disregard of the scientific method has real consequences that affect patient care and in some cases their lives. Even the plastic surgeon's life can be devastated by wrong assumptions (in the case of VTE prevention). When it comes to evidence-based medicine, we need to walk the walk, not just talk the talk. Proper methodology is not complicated. It starts with consecutive patients, a reasonable inclusion rate, and an objective measuring device. Patient-reported outcome studies are needed, and not ones that are outsourced (i.e., the BREAST-Q).

Galileo would never have discovered that objects fall at the same rate, propelled by gravity regardless of mass, if he did not use a clock (actually an hourglass). Four hundred years later, measurements have not reached the mainstream in our discipline. Not only do plastic surgeons not measure their results, many do not wish to measure their results. They would prefer to engage in thought experiments and punditry. I call this nonscientific purgatory. Measurements are the missing link in objective analysis. In many ways, evidence-based medicine is measurement-based medicine. It is time to right the ship, for the sake of our patients and ourselves.

> In many ways, evidence-based medicine is measurement-based medicine.

Leawood, KS, USA Eric Swanson, MD

Reference

Bernard, Claude. See Cohen's Foreword to the Dover edition (1957) of Bernard's classic on scientific method, *An Introduction to the Study of Experimental Medicine*, 1865. First English translation by Henry Copley Greene, published by Macmillan & Co., Ltd., 1927; reprinted in 1949.

Author

Dr. Eric Swanson completed medical school and a residency in plastic and reconstructive surgery at the University of Toronto before starting private practice in Kansas City in 1989. Dr. Swanson is an outspoken advocate for evidence-based medicine. Dr. Swanson's self-funded clinical research has culminated in over 100 publications in the top peer-reviewed plastic surgery journals, including numerous articles and letters that challenge the conventional wisdom and offer science-based alternatives.

Dr. Swanson is a frequent lecturer and panelist at national and international meetings, and regularly provides instructional courses in cosmetic breast surgery. Dr. Swanson is a member of the American Society of Plastic Surgeons, the American Society for Aesthetic Plastic Surgery, and the American Association of Plastic Surgeons.

Contents

Evidence-Based Medicine

1

Abstract

Cosmetic breast surgery is popularly perceived as artistic. Unfortunately, this notion has allowed nonscientific concepts to persist, without proper scrutiny to establish validity. Without measurements, there is no means to test the effectiveness of surgical methods.

Existing level of evidence scales benefit from modification to include important methodological considerations. Randomization is impractical for elective surgery. However, well-done observational studies can be just as useful. Consecutive patients are needed to avoid selection bias. Prospective studies are initiated before the data are collected, not after. A prospective study among consecutive patients meeting eligibility criteria, with a reported inclusion rate, the use of contemporaneous controls when indicated, and consideration of confounders, is a realistic goal. Such measures are likely to improve study quality. Commercial bias is an endemic problem in medicine. A plastic surgeon may function as a highly paid consultant or as an impartial investigator, but not both.

Patient-reported outcomes are essential in plastic surgery because patient satisfaction is the most important determinant of surgical success. Unfortunately, plastic surgeons are not in the habit of soliciting their patients' opinion regarding the result. A proprietary psychometric test, known as the BREAST-Q, has limited clinical usefulness. Ad hoc surveys provide useful clinical information that can be used to compare operations. There is no better education than performing outcome studies on one's patients.

It is almost taken for granted today that plastic surgeons are artists [1]. Our textbooks are often titled "The Art of Plastic Surgery." Plastic surgery offices may resemble fine art galleries. With some hubris, plastic surgeons cultivate the public perception that we are artists [2]. Goldwyn [2], longtime former editor of *Plastic and Reconstructive Surgery*, joked about wishing he were wearing a beret and a paint-spotted frock when asked by a patient if he paints in his spare time.

A recent editorial asks plastic surgeons: which type of artist are you, Michelangelo or Da Vinci? [3]. In reality, the talents of these Renaissance artists might not have been well suited for surgery, which is an empirically based discipline with little use for Neo-Platonism. Being one with

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a universal force is of limited practical use when it comes to deciding how far to undermine a flap or how much fat to inject. No doubt these legends would have lacked humility, a quality bestowed by the hard experience of surgery, which imposes its own set of limitations and unpredictability on the outcome.

Importantly, neither Michelangelo nor Da Vinci was trained in the scientific method. Michelangelo rejected schooling [4]. Guided by a mystical Neo-Platonic philosophy that was in vogue in Florence at the time, Michelangelo famously claimed that he was releasing the beings captured within the stone [5]. Great as he was, few surgeons would want Michelangelo to be their surgeon, chipping away and trying to liberate a human form in their body, believing he was uniquely touched by genius and divinely inspired [1]. It is not reassuring that Michelangelo had no use for measurements, perhaps explaining why David's hands, particularly the right hand, are disproportionately large, or perhaps that was intentional (at least that is the contemporary spin) [6]. Unfortunately, by considering themselves artists, plastic surgeons may think that evidence-based medicine does not apply to aesthetic surgery. They may believe, if Michelangelo did not measure his results, why should I? [7]

Galileo, a century later, would finally decouple religion and science, famously saying that God would not have given him the capacity for reason if not for him to use it. In doing so, he helped create the scientific method. Remarkably, Galileo had the insight to reject institutional authority, the humility to subject his ideas to experiments, the diligence to see them through, and the courage to risk his life defending unorthodox findings [1]. Galileo revealed the limitations of intuition. For example, it seemed clear to everyone that a heavier object would fall to the ground faster than a light one. Galileo's experiments disproved that popular notion [8].

Artists rely on their intuition as a guide. Scientists are trained to question it, aware that the road to ruin is paved with good intuitions. The famed seventeenth-century mathematician and philosopher René Descartes famously commented that doubt is the origin of wisdom [9]. For example, it may be intuitive that manipulating breast tissue can improve upper pole fullness. Only measurements can prove otherwise [10]. Clinical decision-making based on intuition and first principles remains common today, and the need for scientific validation is no less than it was four centuries ago. Ultimately, intuition must give way to the facts.

Turning to one's inner psyche for guidance in surgery is dangerous and in fact bound to fail, humans being inherently imperfect. We need the scientific method to guide the way. Just as we want our pilots to have good instincts, we also want them to have an altimeter. It is sobering to review our literature and consider how many surgical techniques that were conceived in creative bursts remain grounded because of a lack of scientific validation. In mammaplasty, the number exceeds 100 [10]. Apathy toward science, or a willingness to let the science be outsourced, has real consequences for patients.

Art and science may not be mutually exclusive, but there is an essential difference. An artist uses a medium as a form of self-expression. A scientist seeks to uncover knowledge (and arguably beauty) that already exists, while imparting none of his or her own prejudices regarding what that should be [1]. Plastic surgeons are not really sculptors; we do not fashion marble into an artistic rendering. Our job is to model tissues to improve upon an existing template (cosmetic surgery) or to reconstruct one that has been made deficient through birth, disease, or trauma (reconstructive surgery). We are renovators, not creators. Plastic surgeons may have more in common with the restorers of the Sistine Chapel ceiling than with its creator [1]. Most of us would prefer our surgeon to be respectful of the innate beauty of the human form and not to be inspired to stamp his or her signature on it. Few people would like their nose to be recognized as the work of a particular surgeon [1].

As a product of creativity and imagination, innovation is celebrated [11]. New or repopularized techniques find an audience at meetings. So what is missing? *Measurements.* Without measurements, no rejuvenation concept is ever proved and none is disproved either, a sort of therapeutic purgatory.

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Saying that numerous techniques can deliver the same result is a familiar throwaway line at meetings. As scientists, we do not really believe that, do we? Perhaps it is more accurate to say that without measurements there is no way to ever know. Often the less scientific merit for a claim, the more passionate the proponent. Such claims often follow the lead-in, "I'm a firm believer that…" [1]

Some plastic surgeons suggest that our specialty is too subjective to permit scientific evaluation [12]. In truth, there is always a way of measuring if one puts one's mind to it. Claiming that because plastic surgery is an art, or because it is aesthetic, evidence-based medicine does not apply is no excuse for not measuring. The old axiom applies: what we measure, we improve (and the opposite is true too) [1]. Fortunately, computer imaging has made photographic standardization and measurements easy to perform. Gillies, who reportedly said that the camera was the most important advance in the history of plastic surgery [13], might feel the same way about the computer if he were with us today. Examining one's *consecutive*, standardized photographs is an educational experience for which there is no substitute. After doing so, plastic surgeons might be less inclined to promote a "natural breast implant" or an "internal bra."

Plastic surgeons attend medical school, and not a fine arts academy, for a reason [6, 7]. We need to rededicate ourselves to the scientific method. We need to use a ruler (or its computerized analog) along with a scalpel [6].

Certainly, innovation gives us a competitive advantage [11]. However, so does our professionalism. A commitment to the truth and a resistance to marketing pressures help distinguish plastic surgeons from the wannabes. If we insist on being artists, we risk separating ourselves further from the medical mainstream [14]. No, it is not time to reconsider plastic surgery as a fine art. Cross-training is fine; the importance of an appreciation for aesthetics is unquestioned. But let us not forget our medical foundation.

Evidence-Based Cosmetic Breast Surgery

Until now, no publication has been published with the words "evidence based" and "cosmetic breast surgery" in the same title. The problem is, "evidence based" has become a cliché. "Evidence-based medicine" is a phrase coined by Guyatt in 1991 [15]. Sackett et al. [16] defined evidence-based medicine as "the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients through integrating clinical expertise with the best available external clinical evidence from systematic research and the patient's values." This definition is subject to interpretation as to what exactly constitutes the best available clinical evidence.

In reviewing the plastic surgery literature, it would appear that evidence-based medicine was introduced to plastic surgery in about 2009 [17, 18]. However, physicians have known about the importance of rigorous methodology and study design for decades. These are not new concepts. They have simply been neglected. For example, Brody and Latts [19], in 1981, wrote "established techniques for the conduct of drug trials are well-described in the literature, but none of our plastic surgery writing on this subject betrays any familiarity with a controlled study." In discussing the etiology of capsular contracture, the authors [19] called for prospective studies, concurrent controls, and reproducible diagnostic criteria. They emphasized the need for "well-established, scientifically valid analysis rather than artistic 'impressionism'" (i.e., conclusions based on clinical impressions) [19].

Scientific study of cosmetic breast surgery has suffered from a lack of accepted definitions and terms relating to breast shape, and a practical

measurement system. There has been a noticeable reluctance to use measurements, or even to standardize photographs [20]. As I took my seat after a presentation at the 2016 meeting of the American Society of Plastic Surgeons, a senior co-panelist leaned to me and whispered, "too scientific." The irony is that I do not make detailed measurements that I follow precisely in surgery. I rarely adhere exactly to my preoperative markings. My final decision regarding nipple placement is made in surgery. I do not use tissue measurements to determine implant size. The time I spend making markings is just a few minutes. The system I developed is used *after* surgery, for comparison of before-and-after photographs using the same reference plane [21]. It is a means to evaluate and quantify surgical changes later, when I have an opportunity in my office to match photographs and make the measurements. This analysis is the foundation of my work to scientifically evaluate cosmetic breast surgery (Fig. 1.1). In many ways, evidence-based cosmetic breast surgery is measurement-based cosmetic breast surgery.

Levels of Evidence

The lack of science in plastic surgery is well recognized [17, 22–25]. Efforts to incorporate evidence-based medicine [15, 26] in plastic surgery are justified. Both the Level of Evidence [27] and Grade [23] concepts originated in a seminal Canadian Task Force Report published in 1979 [28]. Evidence-based medicine challenges traditional clinical practice based on unsystematic clinical observations, basic principles, common sense, experience, and expert opinions [16, 26, 29, 30]. Ironically, the Level of Evidence classification [27] itself is a product of experience and expert opinion. Evidence-based medicine is not intended to be static, but rather a dynamic, lifelong process [30, 31] that recognizes the need to evolve [16]. There is no grandfather clause that shields it from scientific scrutiny [32]. When analyzed, medical practice guidelines often fall short in meeting methodological standards [32]. About half the guidelines are outdated in 6 years [33].

Evaluating Evidence-Based Medicine in Plastic Surgery

In 2013, the author used the components of evidence-based medicine [24, 30], including "tracking down the best evidence" and "critically appraising that evidence" to investigate evidence-based medicine in plastic surgery [34]. A 2-year period of cosmetic surgery publications in the *Journal of Plastic and Reconstructive Surgery*, July 2011 through June 2013, was retrospectively evaluated. All articles with a Level of Evidence rating published in the Cosmetic Section were included. Each paper was designated a quality rating by the author using a new Cosmetic Level of Evidence And Recommendation (CLEAR) scale (Table 1.1). This classification modifies the traditional Level of Evidence ranking [7] and grade of recommendation (Table 1.2) [17, 23–25]. Table 1.3 and Fig. 1.2 compare the classifications. Table 1.4 summarizes the findings.

Forty-eight studies (55%) were designated a Level 4 using the *Journal of Plastic and Reconstructive Surgery*'s Level of Evidence rating. Three articles were assigned a Level 1. Forty-one articles (48%) evaluated consecutive patients or consecutive patients subject to inclusion criteria. Thirty-five studies (40%) consisted of chart reviews and a recording of complication and reoperation rates. Twenty-five studies (29%) reported physical measurements on patients or images. An equal number of studies (29%) featured subjective evaluations of the result by the investigators. Patient-derived data were collected in 18 studies (21%).

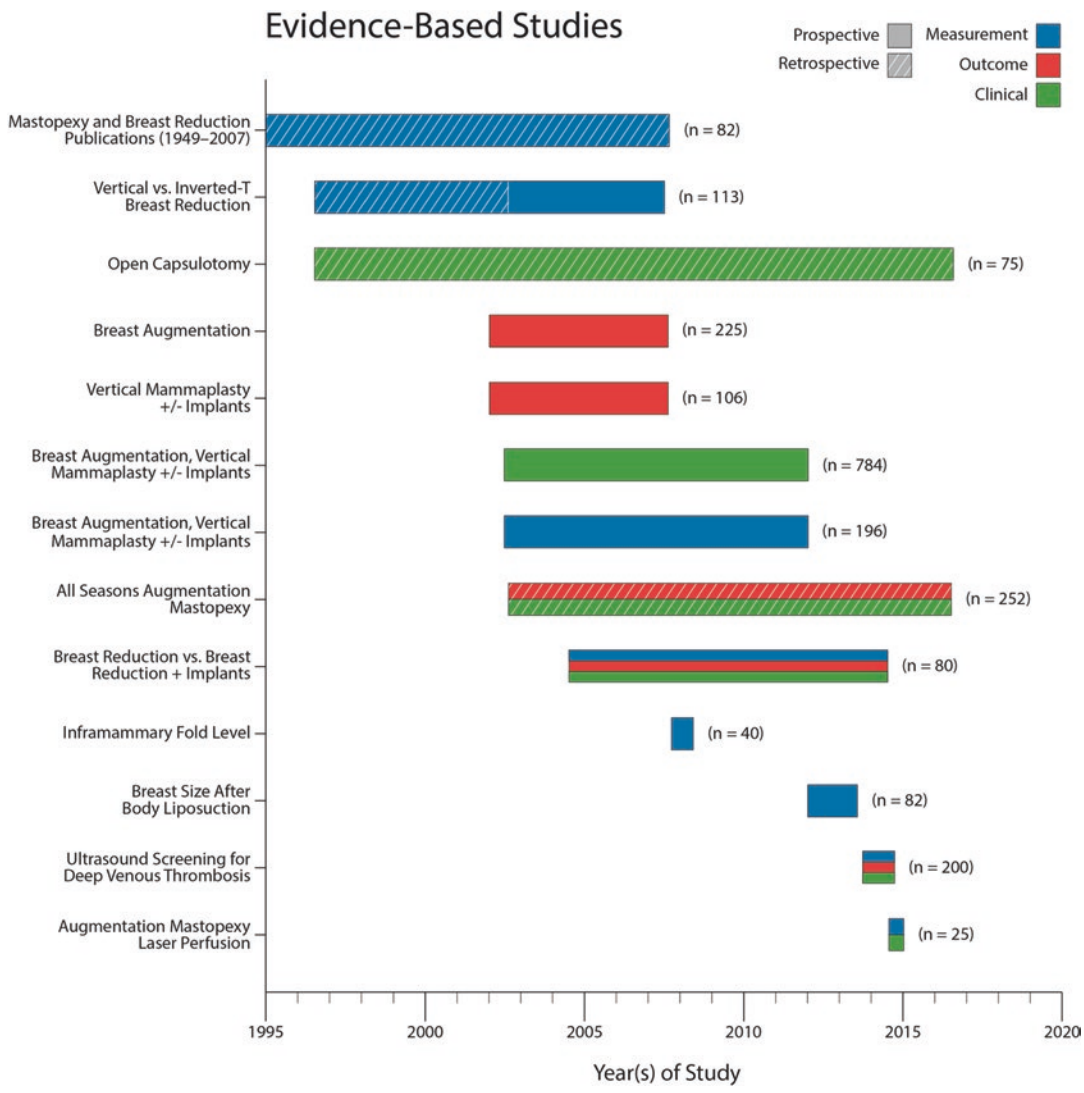

Fig. 1.1 Studies published by the author in cosmetic breast surgery patients

Table 1.1 Cosmetic Level of Evidence and Recommendation (CLEAR): description of levels and recommendations

Level	Description	Recommendation
1.	Randomized trial with a power analysis supporting sample sizes.	A
2.	Prospective study, high inclusion rate (≥80%), and description of eligibility criteria. Objective measuring device (i.e., not surgeon's opinion) or patient-derived outcome data. Power analysis if treatment effect is compared. No control or comparative cohort is needed if effect is profound.	A
3.	Retrospective case-control study using a contemporaneous control group. Prospective clinical study with an inclusion rate <80%. Prospective study without controls or comparison group and a treatment effect that is not dramatic.	B
4.	Retrospective case series of consecutive patients. Case-control study using historical controls or controls from other publications. Important confounder that might explain treatment effect.	C
5.	Case report, expert opinion, nonconsecutive case series.	D

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Table 1.2 Grade of recommendation

A	Conclusion strongly supported by the evidence, likely to be conclusive
B	Conclusion strongly supported by the evidence
C	Moderate support based on the evidence
D	Inconclusive based on the evidence presented

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Table 1.3 Comparison of Level of Evidence (LOE) and Cosmetic Level of Evidence and Recommendation (CLEAR) criteria

Parameter	PRS LOE	CLEAR
Study design		
Randomization	✓	✓
Prospective vs. retrospective	✓	✓
Control or comparative cohort	✓	✓
Methodology		
Consecutive patients		✓
Power analysis		✓
Eligibility criteria		✓
Inclusion rate		✓
Important confounder		✓
Dramatic effect		✓

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PRS Plastic and Reconstructive Surgery Journal

Levels of Evidence Hierarchy

A Level 1 study is often considered the "gold standard" of evidence [16, 29, 35, 36]. A Grade A recommendation is usually assigned to such studies [24, 31]. A Level 5 study, on the other hand, constitutes expert opinion that is often open to question. A Level 2 study is a prospective comparison of treatment cohorts, a Level 3 study is a retrospective case-control study, and a Level 4 study is a case series [24].

Grade (A–D) Recommendation

The present grade classification used by the *Journal* [24] provides recommendations based on current knowledge irrespective of the study. A deficient study could receive an "A" grade if there are existing high-level studies that support its conclusion. The CLEAR grade rates the overall quality of the study itself, regardless of conventional wisdom [34]. A low-quality study that concludes, for example, that smoking increases the complication rate may receive a low grade of recommendation, despite support in the literature. Because methodology is considered in

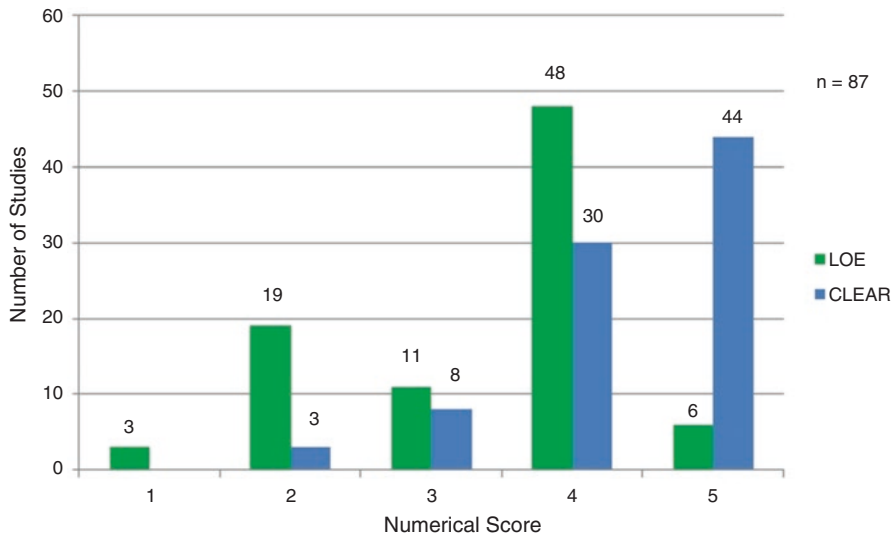

Fig. 1.2 Comparison of the assigned Level of Evidence (LOE) and CLEAR Grade for 87 consecutive studies published in the Cosmetic Section of *Plastic and Reconstructive Surgery* from July 2011 to June 2013. Two studies were unratable because of study error (Reprinted from Swanson [34]. With permission from Wolters Kluwer Health)

Table 1.4 Study characteristics by CLEAR rating

Study parameter	2A (%)	3B (%)	4C (%)	5D (%)	All studies (%)
No. of studies	3	8	30	44	85
Design					
Randomized	0 (0)	0 (0)	1 (3.3)	3 (6.8)	4 (4.7)
Prospective	3 (100)	5 (62.5)	2 (6.7)	17 (38.6)	27 (31.8)
Comparative cohort	1 (33.3)	5 (62.5)	5 (16.7)	10 (22.7)	21 (24.7)
Control	1 (33.3)	2 (25.0)	1 (3.3)	9 (20.5)	13 (15.3)
Methodology					
Consecutive patients	3 (100)	8 (100)	30 (100)	0 (0)	41 (48.2)
Power analysis	1 (33.3)	1 (12.5)	0 (0)	1 (2.3)	3 (3.5)
Description of inclusion criteria	3 (100)	8 (100)	29 (96.7)	19 (43.2)	59 (69.4)
Inclusion rate provided	3 (100)	7 (87.5)	21 (70.0)	11 (25.0)	42 (49.4)
Confounders	1 (33.3)	7 (87.5)	24 (80.0)	33 (75.0)	65 (76.5)
Inclusion rate, %					
Mean	89.4	78.9	81.9	54.5	75.1
SD	10.0	14.9	26.4	42.3	30.9
Range	80–100	65.3–100	23.6-100	1.5–100	1.5–100
Sample sizes					
Mean	150.3	612.8	371.1	332.1	361.8
SD	105.6	962.0	761.4	759.8	754.2
Range	30–225	20–2971	9–3636	5–3800	5–-3800
Other					
Discussion of limitations	3 (100)	3 (37.5)	16 (53.3)	19 (43.2)	41 (48.2)
Commercial bias	0 (0)	0 (0)	4 (13.3)	8 (18.2)	12 (14.1)
Discussion accompanying article	0 (0)	5 (62.5)	9 (30.0)	8 (18.2)	22 (25.9)

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the CLEAR numerical rating (1–5), the grade tends to be closely linked. In this study, the CLEAR Level and Grade always matched (2A, 3B, 4C, and 5D). The traditional Level of Evidence rating does not correlate well with the recommendation grade ($\rho = 0.11$, not significant) because it does not consider several important quality parameters (Table 1.3).

> The traditional Level of Evidence rating does not correlate well with the recommendation grade because it does not consider several important quality parameters.

Level 1 Studies

Only three studies were designated Level 1. Paradoxically, all three Level 1 studies arrive at unreliable conclusions that encourage the reader to needlessly (1) purchase a six-figure instrument [37, 38], (2) compromise the aesthetic result of an abdominoplasty [39, 40], and (3) deny surgery to one-third of prospective cosmetic rhinoplasty patients [41, 42]. These three Level 1 studies represent just 3% of the total number of publications, equal to the percentage of Level 1 studies published in three major plastic surgery journals from 1998 to 2007 [29]. The frequency

of highest-level studies does not appear to be increasing as hoped [29, 36]. It is reasonable to ask whether a randomized trial (the additional descriptors, "controlled" and "prospective," are redundant) is the ideal model [34].

Randomized Trials and Cosmetic Surgery

Randomized trials balance known and unknown confounders and avoid selection bias [17, 43]. In drug-testing, the need to identify a true benefit from a medication, without the influence of other factors, is well known. However, surgery is a much different discipline [29, 44–47].

Unlike a pill, a procedure is not identical from patient to patient [29, 48], placebos and blinding are usually not possible, and randomization is not well accepted by patients [29, 35, 43], surgeons [35, 43, 47], or referral sources [45]. Patients are particularly averse to randomization when the choice involves an operation with irreversible consequences [35, 36, 49]. Solomon and McLeod [50] report that most surgical questions would

> Patients are particularly averse to randomization when the choice involves an operation with irreversible consequences.

not be suitable for randomized trials, citing patient resistance, uncommon conditions, and lack of clinical equipoise as the most common reasons. Other shortcomings include a lack of external validity (generalizability) [17, 18, 43, 49], the fact that surgeons are rarely equally proficient in and enthusiastic about two different techniques [46, 49], and cost [18, 43]. Funding is an issue for cosmetic surgeons in practice [35]. Such studies need to be cost effective [50]. Lack of funding can lead to methodological compromises [51]. Randomized trials suffer from low inclusion rates and recruitment biases, and may be underpowered [18, 49]. In surgery, by the time a randomized trial is conducted, the novel procedure has often been improved [45]. Techniques evolve quickly, particularly in plastic surgery [46].

In recent years, the presumed supremacy of the randomized controlled trial has been challenged [34, 49]. Two review articles published in the *New England Journal of Medicine* showed that observational studies usually produce results similar to randomized trials, and may be more consistent and less prone to reporting contradictory results [53, 54]. Their greater homogeneity provides a broader representation of the general population [53].

Randomized trials are inflexible and do not allow modifications that might better suit individual patients [34]. Inadequate concealment of randomization and treatment assignments can cause serious bias that may exceed the magnitude of the treatment effect [56–58]. Bhandari et al. [52] report that two-thirds of randomized orthopedic trials did not use proper techniques of randomization or concealment. Reviews of randomized trials in plastic surgery uniformly report low quality [36, 59–63].

Randomized trials are beyond the capability of most plastic surgeons [34]. Fortunately, well-done observational studies can work as well or better [34]. Important considerations

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include a prospective study design, controls, and sound methodology, including consecutive patients, high inclusion rates, clear eligibility criteria, and consideration of confounders [34]. Because observational studies are less expensive than randomized trials, there is less need for outside funding, which avoids commercial bias – a major problem in plastic surgery today [55].

The CLEAR (Cosmetic Level of Evidence And Recommendation) classification includes important methodological criteria that are left out of the existing Level of Evidence classification and a grade system that rates the reliability of a

study based on its merits rather than whether the conclusions are supported by the literature [34]. A Grade A recommendation is now shared by randomized and high-level observational studies. The CLEAR classification preserves the same categories from Level 1 to Level 5, but adds overdue modifications [34]. This process is simply the application of the principles of evidence-based medicine to actual evidence-based medicine [34, 49].

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Equipoise

Ethical considerations prohibit randomization of patients into two groups, one of which constitutes a known inferior treatment [43]. Cognitive dissonance may prevent a surgeon from finding that one half of his or her randomized patients received an inferior treatment [34, 44]. The investigator may be confronted by a catch-22 [34]. If the surgeon does not believe there is an advantage for the newer method, why is he or she conducting the study in the first place? For example, two studies compared different facelift techniques on each side of the face in the same patient [64, 65]. If the investigators had found that one facelift method was superior, they would be also conceding that one side was treated inferiorly. Not surprisingly, the authors found the techniques to be similarly effective, avoiding this ethical dilemma. If the difference is so slight that there is no consistent evidence one way or the other, the study is probably pointless.

Although randomization is usually impractical for plastic surgery operations, it can be used when the intervention of interest is not likely to have irrevocable consequences [34].

Examples include the use of drains to reduce the risk of seromas and evaluation of neurotoxins and commercial fillers [34]. Most randomized controlled trials in plastic surgery evaluate nonsurgical interventions [34]. Surgical trials may compare techniques (e.g., the use of fibrin sealant or quilting sutures) that do not substantially affect the long-term result.

Limitations of Historical Controls

Studies using historical controls are predisposed to find that the newer therapy is superior to its predecessor [57, 66]. Similar to randomized trials, the conclusions are usually more dependent on the method of selection of control groups than on the therapy, and the majority differ from the results of randomized trials of the same therapy [66]. Methodological standards are commonly violated in case-control studies [67]. Chronology bias is difficult to avoid [34]. Matched cohort groups are notoriously difficult in plastic surgery, especially cosmetic surgery [68]. Recent guidelines assign a Level 4 to such studies, no better than a case series [69]. Contemporaneous controls are preferred [34].

If the treatment effect is dramatic (e.g., breast self-consciousness after augmentation), a control group is unnecessary (e.g., a control group of women not electing to have a breast augmentation). A prospective study with a dramatic effect, but no control group, can qualify as a CLEAR Level 2 study if other requirements are met (Table 1.1) [69].

Prospective Versus Retrospective Study Design

A prospective study is always preferred over a retrospective study if it is feasible [70]. Some investigators may challenge this distinction because data are always collected prospectively [71]. The difference is the vantage point – literally looking forward versus looking backward. The outcome of a prospective study is unknown when it is undertaken, making the investigator less prejudiced. A review of a "prospective" database does not qualify because the investigator is looking back to interpret data. By definition, in a prospective study, *the study is conceived before the data are collected* [71].

Selection bias and confounders are reduced by specifying eligibility criteria, encouraging follow-up appointments, standardizing and calibrating photographs and measurements, and administering contemporaneous surveys (rather than years later). An example would be a study to determine if patient gender affects seroma rates after body contouring surgery. A prospective study would take care to record patient weights on the same scales, preoperative weight loss, intraoperative use of electrodissection, and tissue resection weights. Some of these important details might be missing in a retrospective study. Prospective studies usually disclose more realistic complication rates than retrospective studies. Unavoidable confounders (e.g., a difference in mean body mass indices) may be managed using an analysis of covariance or other statistical adjustment [72].

Markers of Success in Cosmetic Surgery

Patient satisfaction and improved quality of life [73, 74], assessed using patient-derived outcome measures, are the hallmarks of successful plastic surgery. Morbidity and mortality measures are less relevant to plastic surgery than other surgical disciplines [43, 74]. Reoperation rates are unreliable markers of quality in cosmetic surgery [75].

Consecutive Patients

In 1990, Goldwyn [76] cautioned that selectively reporting better results does nothing to advance the specialty.

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Nevertheless, a requirement for consecutive patients is conspicuously absent from the existing Level of Evidence rating. This scale does not penalize the investigator for "cherry picking" patients; nor does it reward the investigator for reporting both good and bad results. Both series receive the same catchall Level 4 designation. Insisting on consecutive patients (1) sends a message to investigators to report all results and (2) prevents studies of selected patients that include higher-level design characteristics from receiving undeserved higher rankings. Like a framework built on a weak foundation, no other study attribute can compensate for an unrepresentative patient sample [34]. For example, Montemurro et al. [77] recently reported a retrospective series of 436 women who underwent breast augmentation using a technique to secure the inframammary fold using barbed sutures. The minimum follow-up was 6 months. The authors reported a very low rate of bottoming out (1.15%) and double bubbles (1.38%). However, in response to my letter to the editor, the authors conceded that this was not a consecutive series [78]. An unknown number of patients who were not seen in follow-up at least 6 months after surgery were excluded [78]. No inclusion rate was provided. Therefore, it is impossible to know whether the experience of patients keeping long-term follow-up appointments is representative of the group as a whole.

When discussing consecutive patients, it is important to be precise. A study that reports 1-year postoperative photographic findings in 100 "consecutive patients" would be unlikely because not all patients are likely to return for photographs in 1 year; the authors more likely mean "consecutive patients returning for 1-year follow-up" and the inclusion rate should be provided. Many studies would improve from a CLEAR 5 to a CLEAR 4 ranking, or higher, simply by including consecutive patients (e.g., clinical studies) or consecutive patients subject to reasonable inclusion criteria that usually include sufficient time for resolution of swelling (e.g., measurement and outcome studies) [34]. A nonconsecutive case series is just a plural form of a case report and is therefore no more deserving of a higher rank. It is not difficult to report consecutive patients. In his plea for real clinical results, Goldwyn [79] commented, "it is amazing how easy it is to be truthful if one wants to be." Correction of this bad habit represents the single

most important change to increase the overall level of evidence in plastic surgery publications. Although Level 1 studies will continue to be rare, it is realistic to expect a more balanced distribution of articles between Levels 2 and 5 [34].

Statistical Power and Alpha Level

Sample size calculation is an important part of any prospective study, whether randomized or not [43, 63, 80], but is infrequently performed (3.5% of studies) [63, 80]. Small sample sizes predispose to Type II false negative statistical errors. Although an alpha level of 0.05 is the standard (i.e., 5% false positives), most investigators prefer an alpha level of 0.01 or a Bonferroni correction to reduce the risk of Type I error when multiple comparisons are made [34].

Eligibility Criteria

Eligibility criteria are necessary to preserve the integrity of the data, avoid confounders, and respect patient privacy [34].

Inclusion Rate

Every effort should be made to avoid losing patients to follow-up. If the outcome of nonresponders is missing (e.g., dissatisfied patients may seek follow-up elsewhere, or alternatively, satisfied patients may see no reason to return), the reliability of the conclusion is jeopardized [81]. Sackett et al. [81] recommend an 80% inclusion rate as a benchmark for reliability. Cosmetic surgery patients are notoriously unreliable in keeping long-term follow-up appointments, especially for research purposes [82]. A 37% attrition rate at 1 year is typical [82].

Confounders

Most of the studies (76.5%) include extraneous factors that might correlate with the study variables. If a confounder was judged important enough to undermine the conclusion, a study was given a CLEAR Level of 4, provided it still met the requirement for consecutive patients. Plastic surgeons need to take part in evaluating levels of evidence and not delegate this task [83]. There is no substitute for clinical experience and judgment in assessing a study's validity [23].

Measuring Device

The missing link in the application of the scientific method to plastic surgery is frequently a reliable measuring device [1]. Most studies feature subjective assessments or arbitrary metrics [29]. Direct measurements on standardized calibrated photographs are preferred. Photographs should include at least one view accompanied by a ruler or measuring tape for calibration, avoiding the need for less intuitive devices such as ratios or pixel counts (e.g., rhinoplasty) [34]. Computer-assisted photographic standardization and calibration greatly facilitate such measurements [21].

The missing link in the application of the scientific method to plastic surgery is frequently a reliable measuring device.

Discussion of Limitations

All studies have limitations. However, over half (52%) did not discuss limitations. Such discussions reflect well on the investigators and improve credibility.

Commercial Bias

Corporate sponsorship affects conclusions [84]. Hall-Findlay [85] expresses a concern familiar to many experienced plastic surgeons: "We listen to the manufacturer's claims and then years later we find that we have been misled – both by the manufacturers themselves and by those surgeons who are burdened by a conflict of interest." The willingness to resist marketing pressures and prioritize science over marketing is a sign of

professionalism [1]. Many plastic surgeons look at the disclosure paragraph before reading the article. Commercial influence is particularly prevalent in breast augmentation. Most researchers receive funding from the manufacturers, or have done so in the past.

Systematic Reviews

A limitation of systematic reviews is that their validity depends on the quality of the reviewed material [86]. As overall study quality improves, systematic reviews become feasible.

Objectives

The vestiges of an artistic perspective are evident in plastic surgery publications. Plastic surgeons need to recommit to scientific scrutiny of their results [1]. Practical improvements in study design and methodology are possible. A randomized controlled trial is unlikely to be feasible or even desirable. A prospective study among consecutive patients meeting eligibility criteria, with a reported inclusion rate, and the use of contemporaneous controls when indicated, is a realistic goal. Objective measurements and consideration of patient-derived data are most useful. With attention to such basic steps, an improvement in study quality is inevitable.

Outcome Studies

Perhaps it is best to start with the question, what is an "outcome study?" In general surgery, the outcome of interest may be the removal of a gall bladder without complications. There is little need for patient input. Plastic surgery is quite different. The outcome is usually subjective. Ching et al. [73] identify patient satisfaction and improved quality of life as the most important indicators of success in aesthetic surgery. The patient's perception is a key factor [88]. An outcome study evaluates how well we are doing our job as plastic surgeons [87]. It may include questions about the patient's reasons for having surgery, the recovery experience, results, complications, and the psychological impact [89–91].

Unfortunately, plastic surgeons do not have a particularly good track record when it comes to asking patients for their feedback [87].

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Despite the ubiquity of breast augmentation, few studies ask patients for their opinion about their postoperative breast size and the firmness of their breasts [89]. Preoperative breast measurements are recommended as a scientific method to determine implant size [92], but no supportive patient-reported outcome studies are available [87]. A recent study found tissue-based measurements superior, but this study did not incorporate patient input [93] and was otherwise flawed (See Chap. 3). Reoperation rates are not reliable because these rates do not directly correlate with the quality of the result and can be confounded by the surgeon's policy regarding redo surgery [34, 75]. Breast reduction is an exception, at least in terms of measuring functional outcomes. Numerous studies document improvement in back pain and quality of life [90].

What happens when surgeons attempt to use existing scales (including the Breast-Related Symptoms Questionnaire and Short Form-36) to compare mammaplasties? Thoma et al. [94] used these scales in a Level 1 study designed to compare operations – the Wise pattern and vertical reduction mammaplasties. Unfortunately, these instruments were not designed to detect differences in the quality of the aesthetic result. No difference was found. This conclusion does not mean the techniques are equivalent. The outcome measures were simply not up to the task [95].

BREAST-Q

Alderman et al. [96] dismiss previous outcome studies [89, 97], calling them "ad hoc questionnaires, which have limited reliability and validity" [96]. Does the BREAST-Q represent a higher-level measurement device? Should all plastic surgeons adopt it? These questions take on increased importance as the FACE-Q and BODY-Q are introduced [98, 99]. Like the FACE-Q, the BREAST-Q is promoted in our professional journals [100] and on the home page of the American Society for Aesthetic Plastic Surgery website, along with the claim, "setting a higher bar in patient reported outcome measurement" [101].

The most serious problem with the BREAST-Q (and FACE-Q) is lack of disclosure of the actual study questions and scales, compromising the value of any publication based on it [102]. Users are charged for access to this device (academic users are excused) [103], and the senior author receives royalties [96]. The BREAST-Q is a proverbial black box, so complicated that the licensee must rely upon the owners to receive a "QScore" [104]. The user must sign an 11-page licensing agreement [103] mandating that the licensee include two BREAST-Q references in any publication, publish contact and copyright information for the BREAST-Q, not disclose the questionnaire itself, and provide a copy of the last version of the proposed publication before distribution for approval. Any disagreements are to be adjudicated by a court in Lyon, France [103]. Copyrighting a questionnaire sets a worrisome precedent [102]. As plastic surgeons patent their methods, their innovations become less accessible. Medical advancement depends on physicians' willingness to give as they have received [105]. To protect this freedom, patenting medical innovations is prohibited by our professional societies [105, 106].

Studies using the BREAST-Q suffer from inadequate inclusion rates, as low as 38% [88, 96, 107, 108]. The investigators believe that missing patients are likely to be highly satisfied patients [96], which may be true in many cases. However, nonresponders may also include dissatisfied patients who elect to follow-up elsewhere [102]. It is impossible to know whether the experience of a minority of patients is representative of the whole, compromising reliability [81]. The preferred inclusion rate for evidence-based medicine is 80% [81]. The BREAST-Q contains a sexual well-being module [96, 109]. Some women may object to such highly personal questions. Privacy concerns may contribute to poor patient compliance. Concise (single page) in-person interviews [89], as opposed to mailed surveys [88, 107, 109], reward the researcher with greater patient compliance and more thoughtful and complete responses. Patients fatigue easily; brevity is a virtue [102].

Surprisingly, in developing the BREAST-Q, only 12 breast augmentation patients were interviewed, 10 of whom were later contacted by phone [88]. Surveys were mailed to both preoperative and postoperative patients [88]. Responsiveness cannot be determined by comparing two different patient groups [102]. Additional problems include inconsistency of data between published studies [88, 109] and missing patients [102]. Recruited patients were nonconsecutive and chosen from multiple centers [88, 109], allowing selection bias and numerous confounders: different surgeons, protocols, techniques, and even operations, because augmentation mastopexy patients were included [109].

Pusic et al. [109] suggest that the FDA will use "psychometric performance" to judge outcomes measures. In fact, psychometric methods and Rasch analysis are not recommended or even mentioned in the FDA guidelines [110]. Although the developers claim that their method is the only one that not only meets but exceeds FDA standards [88, 109], the BREAST-Q has not been evaluated or approved by the FDA. Tests of scale correlations are offered as evidence of validity [88]. These comparisons are made at the authors' discretion and do not in themselves establish validity, which is not a test property [111]. Validity is simply the ability of a test to measure what it intends to measure [111].

Another problem with the BREAST-Q is the generality of the 0–100 scores [102]. Such overall

indices are needed in psychometric tests of intelligence (IQ score) or scholastic ability; their usefulness in plastic surgery is unclear [111]. The value of breast augmentation has been well documented [89, 96, 97, 108, 112]. It is hard to imagine what is left for this product to do other than confirm what we already knew [102].

Validity is best determined by independent (and nonconflicted) users [111]. Psychometric modeling is misapplied to plastic surgery surveys, which are intended to be questionnaires assessing surgical techniques, not psychological tests [111]. Such applications add unnecessary complexity and introduce incomprehensible psychometric jargon [111]. Ironically, the proponents of the BREAST-Q dismiss other studies for "methodological limitations" [96]. When evaluating methodology, we cannot ignore basic scientific considerations such as consecutive patients, inclusion rate, eligibility criteria, selection bias, confounders, commercial bias, and, most importantly, transparency [34].

Psychometric modeling is misapplied to plastic surgery surveys, which are intended to be questionnaires assessing surgical techniques, not psychological tests.

Outsourcing data for interpretation by the test developers is unnecessary and paternalistic. Unfortunately, insistence on psychometrics may stifle plastic surgeons' interest in performing their own outcome studies, which is a shame [111]. Outcome studies do not need to be complicated to be useful [111]. In fact, the reverse is true; simplicity is a virtue. There is no better education than conducting outcome surveys with one's patients. The only close rival is measurement studies.

There is no better education than conducting outcome surveys with one's patients.

Ad Hoc Outcome Studies

The criticism that ad hoc studies are "not validated" [96] invites a discussion as to what exactly constitutes validity, a quality that does not depend exclusively on patient interviews, focus groups, field testing, and expert panels [111]. Ad hoc questionnaires are the only outcome tools available with sufficient responsiveness to compare surgical techniques in cosmetic breast surgery [90].

Ad hoc outcome studies provide clinically useful information [89–91] that is sometimes surprising. An example is the finding that breast reductions with resection weights <300 grams per breast provide symptomatic relief [90]. Insistence on a minimum tissue resection weight is arbitrary. Fortunately, plastic surgeons are quite capable of performing their own outcome studies [89–91]. There is no substitute for rigorous methodology [34]. Such considerations, essential to evidence-based medicine, include consecutive patients, eligibility criteria, the inclusion rate, and consideration of confounders [34]. Outcome studies need not be complicated [89–91] or require psychometric training [111]. It is important to prioritize specific questions of interest to patients [89–91].

Authors may recommend the BREAST-Q without using it themselves [93, 113]. Trying to adapt existing scales, such as PROMIS (Patient-Reported Outcome Measurement Information System) [113] related to general health, which is usually not at issue in our specialty, to plastic surgery is unlikely to be productive. Such efforts may represent a distraction from our goal – evaluation of the aesthetic result itself [72, 114, 115].

The scientific method helped medicine emerge from the dark ages. However, entrenched ideas (e.g., breast autoaugmentation and Wise pattern mammaplasty) exist today just as they did centuries ago (e.g., bloodletting) [87]. We need to reconsider old methods, evaluate new ones, and resist marketing pressures. Patient-reported outcomes [89, 97] and measurements of the aesthetic result [72, 114, 115] are more useful than utility scores, general health scales, or a

flawed proprietary device [88]. The scientific method, passionless but unprejudiced, serves as our guide [87].

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A Measurement System and Ideal Breast Shape

2

Abstract

Evaluation of changes in breast shape, including upper pole fullness, breast projection, and bottoming out, has been limited by a lack of an accepted definition of these entities and no standardized system for measurements. One-dimensional methods (e.g., tape measurements) are too simple and three-dimensional imaging is too complicated for general use. The nipple is not a suitable marker for measuring glandular ptosis because its position may not align with the level of the breast gland.

A practical two-dimensional measurement system provides plastic surgeons with a means to measure their results. This system is based on a horizontal plane drawn at the level of maximum postoperative breast projection. Standardized before-and-after frontal and lateral photographs are compared. Breast projection, upper pole projection, lower pole level, nipple level, lower pole width, breast area, and areola diameter are measured. The breast parenchymal ratio, convexity, breast mound elevation, lower pole ratio, and nipple displacement may be calculated from these simple measurements.

Patients prefer convexity and a breast shape that is fuller on the top than on the bottom. The nipple should be located at the level of maximum breast projection. Areola diameters <5 cm are preferred. A semicircular lower pole contour is ideal. Lower pole ratios (lower pole width/lower pole length) greater than 2 appear boxy. Such ratios are typically produced by Wise pattern mammaplasties, which trade projection for width. In a ptotic or hypertrophic breast, the breast takes on an elliptical shape. Ideally this shape is reduced to a semicircle after an effective mastopexy. The three-dimensional shape of the ideal lower pole is a sphere that is flattened in the anteroposterior dimension, called an oblate spheroid, which is also the shape of a round (non-form-stable) saline or silicone gel breast implant.

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The Need for a Measurement System

In all areas of medicine, measurements are needed to evaluate the effects of treatment. In cardiology, an electrocardiogram has served as a valuable measurement device for decades. Even abstract qualities such as intelligence may be measured using a number of instruments, including IQ tests. Unfortunately, breast surgery has long been viewed as an art more than a science [1]. Plastic surgeons have not been in the habit of measuring their results. Regrettably, it is possible, even in 2017, for a plastic surgeon to attend a full day of breast surgery presentations without viewing any measurements on standardized photographs. Instead, surgeons show plenty of before-and-after photographs and discuss their clinical impressions. It has been said that clinical impressions are "what is left in the chair after you get up." [2] Without measurements, cosmetic breast surgery has lagged in its development. This is particularly true in breast lift procedures, which are discussed in Chaps. 6 and 7.

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Measurements used in the past have been largely one-dimensional, such as the distance from the sternal notch to the nipple, or the distance from the nipple to the inframammary fold. One-dimensional measurements are inadequate in providing the needed parameters to evaluate change in breast shape. With advances in imaging and computer software, three-dimensional systems have been developed. Three-dimensional imaging is assumed to represent the future of breast measurements. However, there are problems that have not yet been solved, including the need for a virtual chest wall template.

Aside from lack of a standard measurement system, cosmetic breast surgery has suffered from a lack of a practical definition of breast parameters, such as upper pole fullness, breast projection, and bottoming out. What do these terms mean? A definition of terms is needed.

Nipple Position Versus Glandular Position

In 1976, a surgeon from Montreal, Paule Regnault, provided a classification system for breast ptosis [3]. Her classification linked the level of the nipple to the inframammary fold. First-degree ptosis was really no ptosis. The nipple was at or above the level of this fold. In second-degree ptosis the nipple was below it, and in third-degree ptosis the nipple was down-pointing. The concept of linking nipple and glandular position to evaluate breast ptosis is also used by Mallucci and Branford in their 45:55 breast ratio [4]. Eyck et al. [5] incorporate the Regnault classification in their Rainbow scale. The central problem with this method is that glandular sagging and nipple position are two different entities. The combination of ptotic breasts and high nipples, called pseudoptosis, is really nipple overelevation, which is caused by the Wise pattern mammaplasty, the dominant method used in North American since the 1970s. Two parameters are needed – a description of glandular level and a description of nipple level – without linking the two.

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Standardized Photographs

Gillies, one of the fathers of plastic surgery, reportedly once said that photography was the most important advance in the history of plastic surgery [6]. One can only imagine trying to judge surgical

techniques before photographs were available. We need photographs because they represent the truth without relying on the surgeon's clinical impression. It only makes sense to standardize photographs. It would make no sense, for example, to take an after photograph much closer to the patient than the before photograph because such a maneuver would unfairly appear to enlarge the result. Similarly it would be unfair to have the patient tilt her chest after surgery to simulate a lift effect. Yet these maneuvers are done routinely and are discussed in detail in Chap. 5.

Zarem [7], in 1984, discussed the importance of standardized photographs. DiBernardo [8] provided guidelines in 1999. Unfortunately, these standards are still widely disregarded at meetings and in the literature [9]. Using the electrocardiogram analogy, this practice would be akin to changing the polarity of the EKG or the time scale on the printout. Such alterations would be regarded as unethical or even malpractice, yet they are tolerated in cosmetic breast surgery. Simply by insisting on standardized photographs, our journals would improve the quality of publications overnight. The number of publications with flawed methods would diminish as investigators learn for themselves the shortcomings of their methods. Plastic surgeons would learn that a breast augmentation does not elevate the nipple [10]. Proponents of the pectoralis muscle loop in mammaplasty would learn that this tunneling method does not really create upper pole fullness after all [11].

A number of points are essential when taking photographs. The focal distance needs to be constant. For this reason a fixed focal length is preferred. To maintain consistency, I have used the same Nikon 60 mm lens for breast and body photographs since I started practice in 1989, simply switching it from an analog camera to a digital camera in about 2000. The same poses are needed and the same arm positions. The chest should not be overly cropped. Care should be taken so that the patient is not tilted. A constant blue background and identical lighting are used. Shadows are avoided by using at least two light sources. A tape on the floor ensures that patients stand in the same place, in the same room.

Two-Dimensional Breast Measurements

In order to study my own patients, and to evaluate published results, I developed a new measurement system and definition of terms, first presented at the 2008 meeting of the American Society of Plastic Surgeons [12] and published in *Plastic and Reconstructive Surgery* in 2012 [13]. I have used this system to study published breast surgery articles [14] and to study my own patients [15–17]. The system turned out to be practical and reproducible. Now I had a benchmark to use to evaluate the results of others and myself. Graf [18] called it an "excellent measurement methodology" and an "important step in objectively evaluating results in breast surgery, especially at a time when there is increasing demand for evidence-based medicine." Hall-Findlay [19], in her discussion, wrote "If more of us use this type of measurement system, we can provide more 'science' to the 'art' of plastic surgery." Nevertheless, this method has not gained widespread acceptance. One lecturer at an instructional course said that if he had to perform all those measurements, he would vomit (I believe he was exaggerating). At a recent meeting, a long-retired plastic surgeon commented to me, "With all those measurements, Dr. Swanson, it's a wonder you find time to operate." The irony is that I perform my breast surgery without making any of these measurements. These measurements are made later, to evaluate before-and-after photographs, at a time of my choosing, on weekends, for example. I have found no better way to evaluate my results. Only outcome studies (i.e., soliciting my patient's opinion, not my own) rival their value.

Computer Software

Even with strict attention to focal distances and body positions, it is impossible to exactly match photographs. A difference of a few percentage points in focal distance, or a slight change in posture, can make a difference. Hence the need for computer-assisted photographic matching.

Almost all plastic surgeons own a computerized photographic archival system to store digital photographs. Canfield Scientific (Fairfield, N.J.) and other companies offer computer software to facilitate image matching. Using a cursor, two fixed landmarks are selected and the software then matches the images for size and, just as importantly, orientation. The landmarks are typically surface skin lesions (outside the surgical area) or bony references such as the sternal notch – landmarks that are unlikely to change position after surgery. Obviously, landmarks on the breasts are avoided. Photographs are calibrated by taking a photograph of the patient holding a ruler, eliminating a need for using pixel counts. Frontal and lateral images are matched [13]. Oblique photographs are not used for measurements because they are often rotated slightly and there is no method to correct for different degrees of rotation.

Lateral Views

The key to my measurement system is incorporation of a horizontal and vertical reference plane. The nipple level is not suitable because its level may or may not correlate with the level of the breast mound. Using the nipple as the reference plane was a limitation of the Regnault classification and recent updates, as discussed above.

The inframammary fold level is known to change after surgery [20], so it cannot be used either. A horizontal plane drawn at the level of maximum *postoperative* breast projection (MPost) provides an ideal reference plane (Fig. 2.1). This plane works, of course, only if both before and after photographs are available. This requirement is easily met because such comparisons are needed anyway in evaluating the effect of treatment or even no treatment. This line is easy to draw. The computer automatically makes it perfectly horizontal. It is just a matter of placing the reference line at the level of maximum breast projection, which is easy to eyeball. Next, another horizontal plane is drawn at the level of the sternal notch. This bony landmark was selected because it does not change after surgery. Its level is easy to assess on the frontal photographs. Its level is more difficult to gauge on lateral photographs. However, even if this level is labeled a little high or a little low, it is not a problem as long as the same plane is being used for comparison. A third horizontal line bisects these two. Next, a vertical line, the "posterior breast margin," is dropped at the level of the sternal notch (indicated by the higher horizontal plane). These planes serve as the grid on which measurements are then made.

The distance along MPost to the leading edge of the breast is the "breast projection." The distance along the bisecting plane to the edge of the breast is the "upper pole projection." This plane also provides a reference plane for the nipple level. Ideally, the nipple is situated at this level. Nipple displacement is defined as the vertical distance between the nipple and this plane. A positive displacement is one in which the nipple is lower than this plane; a negative displacement is caused by nipple overelevation.

The lower pole level is the vertical distance from the most inferior point of the breast to the MPost plane. Changes in the lower pole level measure the effectiveness of techniques intended to correct breast sagging (glandular ptosis). This level is preferable to the inframammary fold for several reasons. First, the lower pole level is the level that the patient sees when she looks in the mirror. Second, the inframammary fold tends to be hidden, particularly in women with ptosis. Third, the inframammary fold level can change after surgery, making it an unreliable landmark [20].

Some other measurements, calculated using these reference planes, are useful. Area calculations can also be made using the Canfield system and a cursor. The dividing plane is again the MPost plane. The ratio of the upper pole area to the lower pole area (the breast area above and below the MPost plane) is the breast parenchymal ratio (BPR). Higher ratios reflect a more "perky" appearance, preferred by most women [21]. Lower ratios appear more "bottomed out." The term "ptosis" is not used in this system so as to avoid confusion with the Regnault classification [3].

The vertical distance between the preoperative (MPre) and postoperative planes (MPost) of maximum projection yields "breast mound elevation." This is a useful measurement because it assesses the degree of upward movement of the gland itself, revealing the effectiveness (or lack of effectiveness) of a mammaplasty.

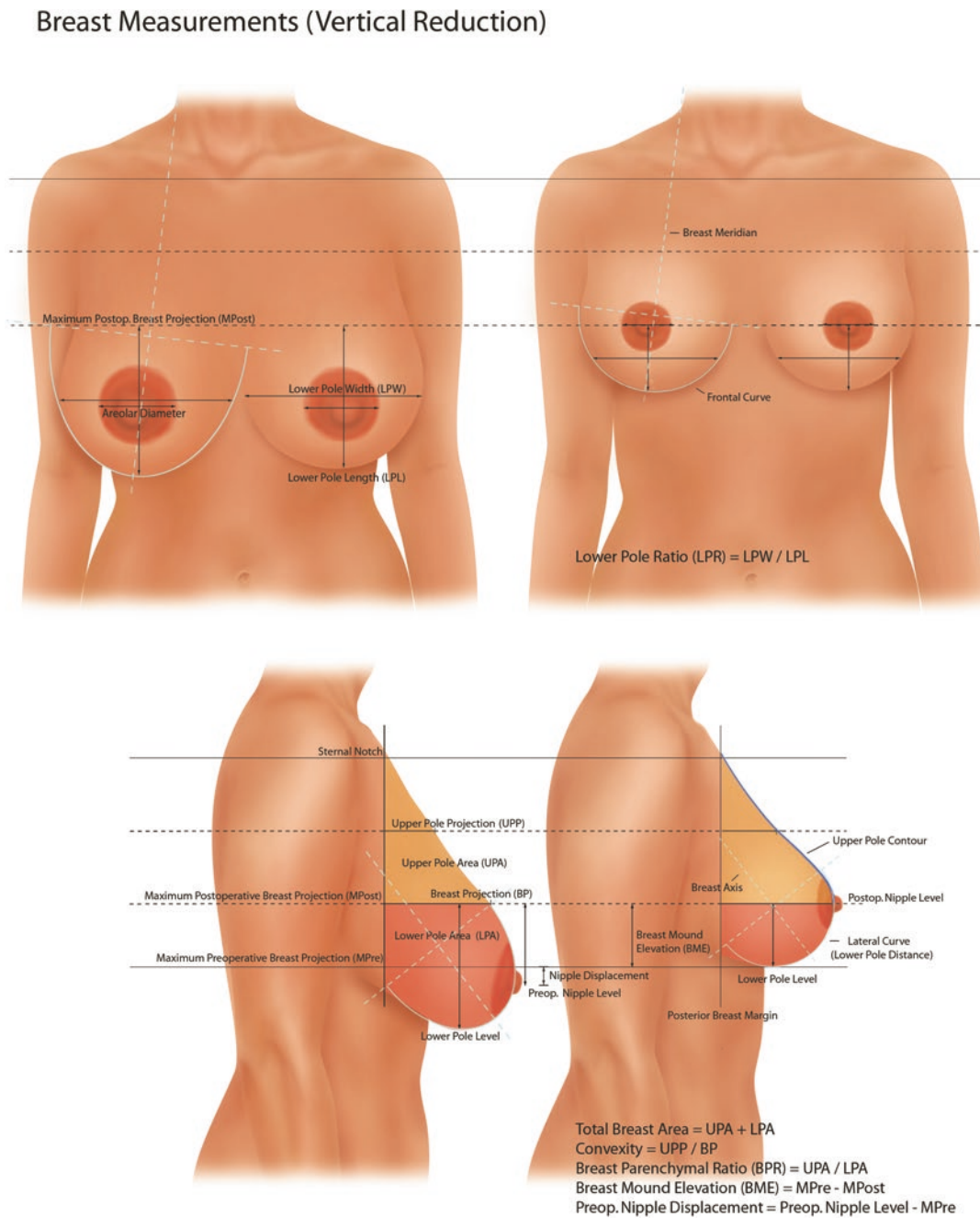

Fig. 2.1 Measurements and definitions. (*Left*) Preoperative and (*right*) postoperative illustrations depicting a vertical breast reduction. The nipple level is appropriately situated at the level of maximum breast projection. (*Above*) The breast meridian bisects the breast and courses obliquely to the junction of the neck and shoulder. Ideally, the shape of the lower pole changes from a semi-ellipse (scalene ellipsoid in three dimensions) to a semicircle (oblate spheroid in three dimensions) after surgery. There is a modest increment in breast projection and upper pole projection (Reprinted from Swanson [13]. With permission from Wolters Kluwer Health)

The upper pole contour may be linear, concave, convex, or ogee shaped (S-shaped). These are qualitative assessments. The ratio of upper pole projection to breast projection is called "convexity" and is a useful parameter to evaluate upper pole fullness. Finally, the "lower pole distance" may be measured. This parameter is less useful than the others, but can be evaluated to determine the degree of constriction of the lower pole. This is relevant to a comparison of vertical and Wise pattern mastopexies. The Wise pattern is more likely to constrict the lower pole, especially if the vertical limb is limited to 5 cm, as is commonly done.

Frontal Views

The width of the breast halfway between the MPost plane and its lower pole level on the frontal view is labeled "lower pole width." The lower pole length is simply the distance between the MPost plane and the lowermost point on the breast (same as lower pole level on lateral view). The "lower pole ratio," representing lower pole width/lower pole length, gauges the boxiness of the lower pole. The frontal view also allows measurement of the areola diameter. Frontal and lateral measurements on a typical breast augmentation patient are illustrated in Figs. 2.2 and 2.3.

Fig. 2.2 This 30-year-old nulliparous woman is shown before (*left*) and 3 months after (*right*) a submuscular breast augmentation using smooth, round, moderate plus profile saline implants (Mentor Corp., Santa Barbara, Calif.) inflated to 450 cc. Upper and lower pole breast areas (*shaded*) are measured above and below the plane of maximum breast projection. Lower pole ratios less than 2.0 indicate a nonboxy shape. The total breast area is increased 79%. After surgery, the upper pole profile is convex. The postoperative breast parenchymal ratio is 1.84. Photographs are matched for size and orientation using the Mirror 7.1.1 imaging software (Canfield Scientific, Fairfield, N.J.). *MPost* maximum postoperative breast projection, *LPR* lower pole ratio, *BPR* breast parenchymal ratio, *BME* breast mound elevation

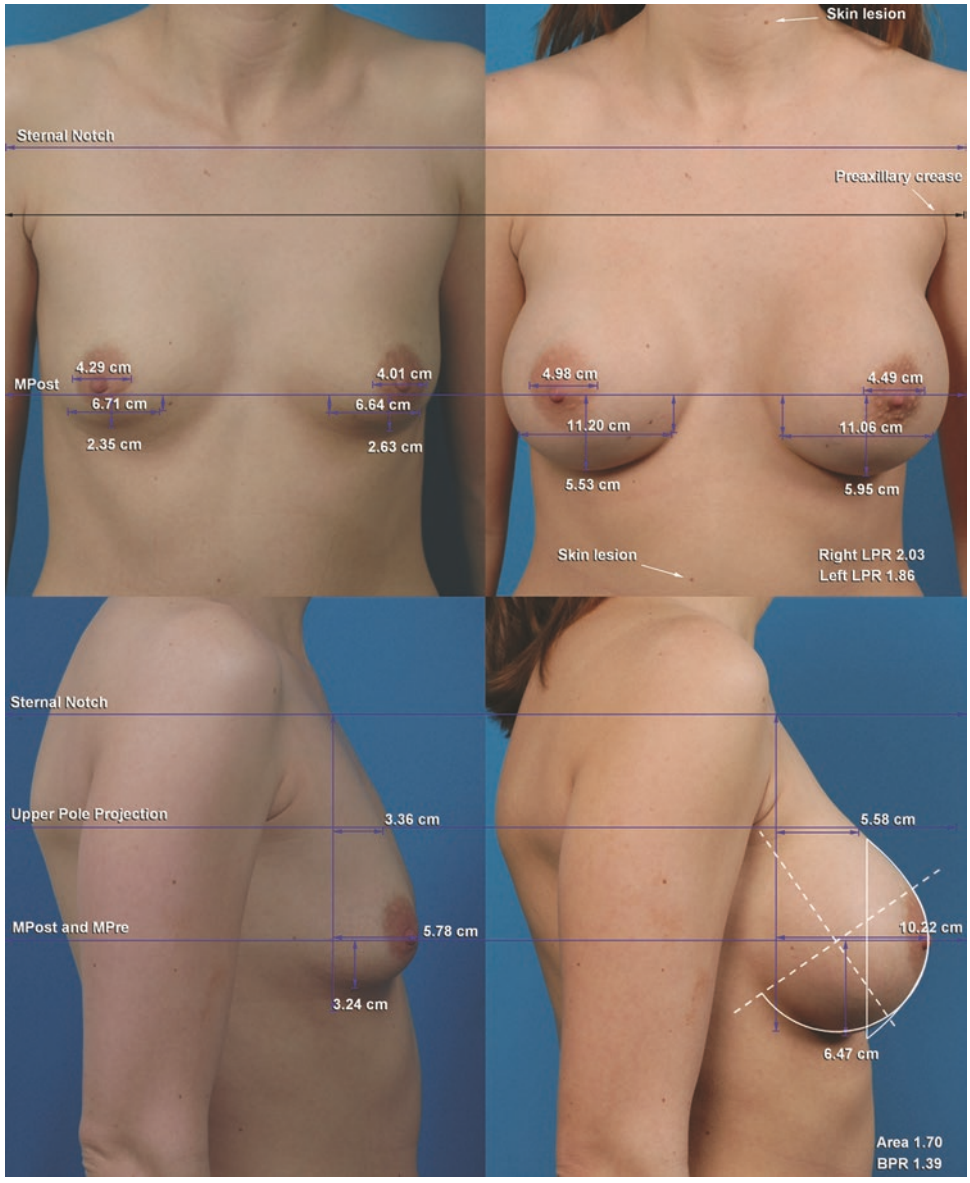

Fig. 2.3 Orientation-matched views obtained (*left*) preoperatively and (*right*) 9.4 months postoperatively of a 27-year-old breast augmentation patient treated with Mentor smooth, round, moderate plus profile saline-filled implants (Mentor Corp., Santa Barbara, Calif.) inflated to 360 cc. (*Above, right*) Although the images are standardized and matched (note the unchanged positions of skin lesions of the neck and lower abdomen), soft-tissue landmarks have changed. The shoulders and the upper extent of the preaxillary creases are lower in the postoperative frontal photograph. (*Below, right*) The lateral view shows an increase in breast projection of 4.4 cm and an increase in upper pole projection of 2.2 cm. The lower pole level drops 3.2 cm. Total breast area increases 70%. After surgery, the upper pole contour changes from linear to parabolic. The semicircular outline of the lower pole is evident. The inframammary fold is lower after surgery. The nipple level and breast mound level (maximum postoperative breast projection – maximum preoperative breast projection) are unchanged. *MPost* maximum postoperative breast projection, *MPre* maximum preoperative breast projection, *LPR* lower pole ratio, *BPR*, breast parenchymal ratio (Reprinted from Swanson [13]. With permission from Wolters Kluwer Health)

Breast References

Upper pole fullness and breast projection are discussed regularly, but have not been rigorously defined. The distance from the chest wall to the nipple [22] has been used to measure the "ideal" breast [23], but this measurement is impractical for ptotic breasts. One problem is the determination of a suitable reference plane. Breast "projection" loses its meaning if the projection is at the level of the abdomen, which may well be the case in a large ptotic breast. Furthermore, nipple position may or may not coincide with the level of the breast mound, a shortcoming of the Regnault classification [3], which does not quantify upper/lower breast proportions or the degree of descent of breast tissue.

Identifying where the breast stops and the chest wall starts has been another source of frustration for investigators. The one-dimensional system used by Mallucci and Branford [4] is weakened by the subjectivity in determining the upper margin of the breast. Most three-dimensional measurement systems share this problem. Unlike the lower extent of the breast, which is defined by the lower pole level, the upper pole level is not well defined. The sternal notch serves as a useful landmark because it is static. It is not meant to reflect a breast border. Indeed, the sternal notch level is located well above the upper margin of the breast. Consequently, the level of upper pole projection is not measured halfway up the breast, but rather just below the upper border of the breast.

Importantly, this system eliminates the chest wall as a reference. The chest wall contribution does not change postoperatively and does not affect comparisons of measurements. Any lateral breast tissue that falls behind the posterior breast margin is not clinically meaningful. This is a major advantage over three-dimensional systems that must somehow assign a dividing plane between the breast and the chest wall. A virtual chest wall template is created, introducing guesswork. Only radiological imaging such as an MRI, CT scan, or possibly ultrasound could reliably define this border. It is much better to simply eliminate the need for its determination.

The chest wall contribution does not change postoperatively and does not affect comparisons of measurements.

The frontal measurements provide a means to assess boxiness of the lower pole, a frequent criticism of the inferior pedicle inverted-T technique [24–28]. Previously, there has been no measurement to assess the shape of the lower pole, so that these observations could not be objectively evaluated.

Measuring Breast Volume

Although there are techniques for measuring breast volume, they are inaccurate and cumbersome, involving water or air displacement [29, 30], plaster molds [31], adjustable measuring cones [23, 32], and mammograms [33]. Stereo photography has been used [34]. Investigators have used laser scanners and cameras with sophisticated software to produce three-dimensional reconstructions [35–42]. In addition to the additional expense and complexity, there are substantial practical limitations to three-dimensional photography. One is the need for a virtual chest wall template. Other problems include the subjectivity involved in assigning landmarks, introducing variability and error. It can be difficult to image the underside of the breast [41, 42], especially in large and ptotic breasts [37, 38]. Small discrepancies in assigning margins can produce large variations in volume calculations [38].

Previous studies have often involved tedious or complicated measurements. One study used 21 tape measurements on each breast, plus volume measurements using adjustable measuring cones [23]. Three-dimensional computer reconstructions [35–42] can be highly technical, making them difficult for the average plastic surgeon to understand, let alone use in practice. None of these techniques has found general acceptance and – perhaps the real test of any system – none has been used to compare different techniques and aesthetic results.

Advantages of a Two-Dimensional Reference System

Interestingly, measurements of breast projection, lower pole level, breast mound elevation, and parenchymal distribution (analogous to the breast parenchymal ratio) obtained from three-dimensional analysis [39] can all be rendered using two-dimensional imaging. Even in cases of asymmetry, volume measurements are not usually necessary; a two-dimensional comparison of breast area serves effectively to compare sizes. The change in size and proportions is important for shape analysis, not the absolute volume of the breast. Because the contribution of the chest wall does not affect comparisons, there is no need for creation of a virtual chest wall template, which is a complicated software application that introduces the potential for error. Shadowing of the inframammary area is not a limitation, making the lower pole amenable to shape analysis.

The change in size and proportions is important for shape analysis, not the absolute volume of the breast.

Einstein famously commented that "everything should be made as simple as possible, but not too simple." One-dimensional measurements such as those used by Westreich [23] are too tedious, involve too much reading error, take too long to do on patients, and are hopelessly archaic in the computer age. Three-dimensional renderings are always touted as the measurement system of the future, but are still complicated. By analogy, sophisticated three-dimensional renderings of the electrical activity of the heart are available. However, these methods do not replace the utility of a two-dimensional EKG, used by cardiologists for decades and still the standard. A two-dimensional system offers a Goldilocks option, not too simple and not too complex. All relevant breast shape parameters are available. A major practical advantage is the ability to apply this system to existing lateral and frontal photographs. Retrospective studies are possible. Published photographs can be matched and evaluated. Any new claim of breast autoaugmentation can be tested (See Chap. 5).

This system is applicable to the whole spectrum of cosmetic breast surgery – breast augmentation, mastopexy, reduction, and combinations. It takes only 1 min to take the photographs. There is no need for an expensive or complicated photographic setup. Measurements may be made later on the computer. This means there is no added patient embarrassment or time commitment. As a result, patient acceptance is virtually 100%. Institutional Review Boards are likely to grant approvals or waivers for retrospective or prospective studies because there is no potentially harmful intervention and patient privacy may be maintained.

Only six breast measurements are needed, made on ordinary frontal and lateral photographs. The only hard part is matching the photographs, but this job is greatly facilitated by imaging software. It is interesting to reflect on the fact that such measurements could have been made decades ago, but it would have been much more tedious to line up the photographs and make subtle enlargements or reductions, for example, on a photocopier.

Only six breast measurements are needed, made on ordinary frontal and lateral photographs.

It is difficult to conceive of a system any simpler (in reference to Einstein's quote), because photographic standardization and matching is needed regardless of the type of measurement system that is used. This system also assists in better defining the characteristics of ideal breast shape, as discussed below.

Breast Dimensions

Only six dimensions are needed to provide an accurate representation of breast shape. The curved lines connecting these points are not arbitrary, or subject to artistic interpretation, but conform to natural (governed by the laws of physics) semicircular and elliptical shapes that are defined

with a minimum of two points and an axis (Fig. 2.1). No longer is it necessary to make 21 measurements (a disincentive for even the most patient surgeon) [23]. The six requisite measurements are:

1. Breast projection
2. Upper pole projection
3. Lower pole level
4. Nipple level
5. Lower pole length
6. Lower pole width

On the frontal view, once the lower pole length and width are plotted, and the breast meridian is drawn, the semicircular (ideal) or elliptical (preoperative) contour of the breast outline may be constructed. Similarly, on the lateral view, once the breast projection and lower pole level are known, the breast outline may be drawn, aligned along the axis of the breast (Fig. 2.1). Illustrations based on these measurements ("mammographs") allow comparison of breast shapes using different surgical techniques [14–17]. These mammographs are featured in each of the chapters (Chaps. 3, 6, 7, and 8) and provide valuable measurement-based visual aids.

The nipple should be located at the level of maximum breast projection [23]. Some traditional measurements are not needed to define breast shape. The sternal-notch-to-nipple distance is affected by the length of the torso and is not relevant to breast aesthetics [30]. The level of the inframammary fold is difficult to judge, hidden behind the breast, and is subject to considerable error when translated to the front of the breast [18, 43]. Its level is subject to change, either elevation in a vertical mastopexy [20] or lowering in a breast augmentation (Figs. 2.2 and 2.3) [20, 44], so that it cannot be used as a reliable reference plane. The distance from the areolar border to the inframammary fold may be longer than the traditional 5 cm, particularly in vertical procedures [45, 46]. Because of these limitations, one-dimensional measurements made with a tape measure [23, 44] do not provide sufficient reference data to render breast shape.

Ideal Breast Shape

In discussing ideal breast shape, patient satisfaction should be the relevant criterion, not the natural breast shape [47]. The normal breast may contain greater volume in the lower pole than the upper pole [48, 49], and the lateral profile of the upper pole may be linear or slightly concave [48], but normality is not the objective. Patients prefer convexity [21] and a breast shape that is fuller on the top than on the bottom, a finding that is hardly surprising in view of the purpose of bras. A breast parenchymal ratio of 1.5 or more, the reverse of the existing ratio in patients who present with large ptotic breasts [15], is desirable. An areolar diameter of 3.5 to 4.5 cm is considered attractive [49]. Areolar diameters <5 cm are preferred by patients [15, 50]. Women who have had breast implants tend to report very high levels of satisfaction [47]. The breast shape of such a patient serves as a useful guide in evaluating characteristics of a desirable breast shape (Figs. 2.2 and 2.3).

> Patients prefer convexity and a breast shape that is fuller on the top than on the bottom, a finding that is hardly surprising in view of the purpose of bras.

Surprisingly, few existing guidelines describe ideal or even normal breast shape. The normal breast has been described as spherical [51], hemispheric [49, 52, 53], conical [23, 52, 54–57], teardrop [23], dome shaped [58], and paraboloid [59]. However, these descriptions are overly simplified. Breast shape is first considered in two dimensions.

Frontal View

Ideally, when the patient stands and the breast settles, the "frontal curve" settles into a semicircle (Figs. 2.2 and 2.3).

A semicircle, the cross-section of a hemisphere, has a lower pole ratio of 1.73 (calculated using the Pythagorean theorem). Boxy lower poles are not

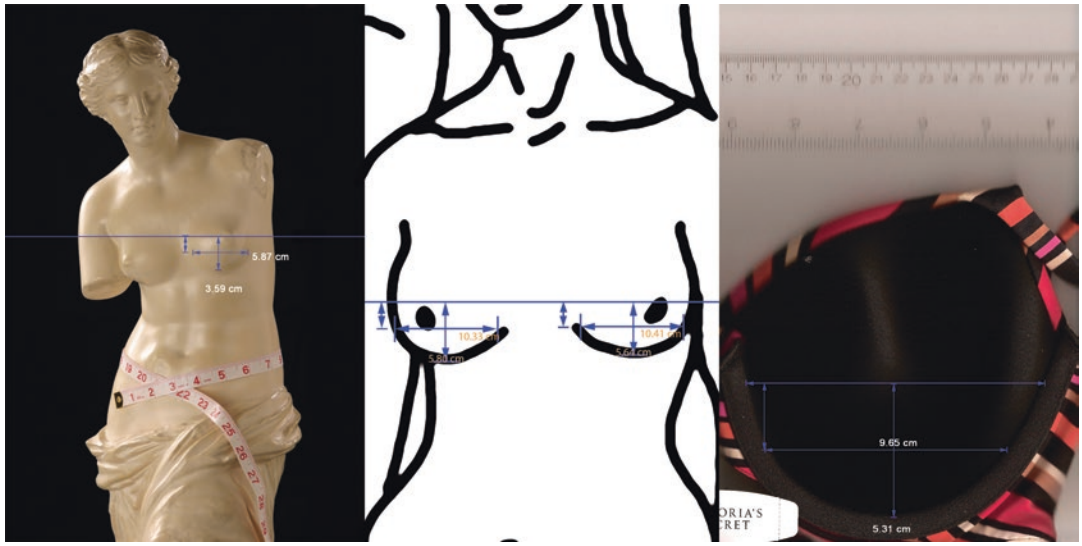

Fig. 2.4 Examples of lower pole ratios (lower pole width/lower pole length). (*Left*) The Venus de Milo statue has a left breast LPR of about 1.6. (*Center*) The female figure on the *Pioneer 10* spacecraft has an LPR of 1.8. (*Right*) The most popular Victoria's Secret (Victoria's Secret Co., Columbus, Oh.) bra, Style 1816, 34C, incorporates an LPR of 1.8

to be found in art, science [60], or contemporary culture. A ratio approaching that of a semicircle is desirable. Values much greater than 2.0 appear boxy. The left breast of the Venus de Milo statue (on the cover of every issue of *Plastic and Reconstructive Surgery*) has a lower pole ratio of 1.6. The female figure on the *Pioneer 10* spacecraft has a lower pole ratio of 1.8 [60]. The popular Victoria's Secret (Victoria's Secret Co., Columbus, Oh.) bra, Style 1816, 34C, also incorporates a lower pole ratio of 1.8 (Fig. 2.4) [13].

> Boxy lower poles are not to be found in art, science, or contemporary culture.

Lateral View

The contour of the upper pole of the breast, from the takeoff on the upper chest wall to the point of maximum breast projection, is ideally slightly convex [23, 43]. A linear or ogee-shaped upper pole contour (Fig. 2.1) is commonly found in patients presenting for a mastopexy or breast reduction [15].

The lateral profile of the lower pole ("lateral curve") is partly circular, for at least a quarter-circle, from the point of maximum breast projection to the lowest point on the breast. The lower pole level is the same as the level of the inframammary crease in an immature or hypoplastic breast; the circular profile stops after describing an arc of about 90 degrees (Figs. 2.2 and 2.3). After augmentation, which causes lowering of the lower pole [2], or in a mature, pendulous breast, the lateral curve continues its arc past the lower pole level, almost completing, or completing a semicircle (Figs. 2.2 and 2.3).

In a ptotic or hypertrophic breast, the lateral curve becomes a semi-ellipse (Fig. 2.1), the expected shape of an elastic circle that has been subjected to the uniform downward pull of gravity. Ideally, the semi-ellipse is reduced to a semicircle after surgery (Fig. 2.1).

Oblique views, which are really hybrid lateral/frontal views, are often pleasing to the eye, but can hide asymmetry, cannot be standardized because of small differences in rotation, and are therefore unsuitable for measurements.

Three-Dimensional Breast Shape

The three-dimensional shape of the upper pole is paraboloid. In the immature or hypoplastic breast, the lower pole shape is defined by the inframammary fold, which describes a semicircle on frontal projection (Figs. 2.2 and 2.3).

As the breast matures, becomes pendulous, and starts to hang below the level of the inframammary fold, or in a breast augmentation patient, the lower pole still resembles a semicircle on frontal view, but now the semicircle outlines the lower pole of the breast, not the inframammary fold. The lateral view reveals a semicircular profile of the lower pole as the lateral curve dips to the lower pole level and then rises to meet the chest wall at the inframammary fold (Fig. 2.1). The width of the breast exceeds its projection, which is why the underside of the breast is not a hemisphere. With semicircular profiles on frontal and lateral views, the three-dimensional shape of the ideal lower pole is a sphere that is flattened in the anteroposterior dimension, called an oblate spheroid, which is also the shape of a round (non-form-stable) saline or silicone gel breast implant [13].

Subject to gravity, the breast tissue sags in a symmetrical fashion centered on the breast meridian. The shape of the lower pole of the breast stretches from a spheroid to a shape resembling the lower half of an ellipsoid (Fig. 2.1). However, it is not equally elliptical on frontal and lateral views. It is more flattened in the anteroposterior dimension (like a partially deflated football), because the breast flattens as it rests on the chest wall [13].

It has been said that what we measure, we tend to improve (and the opposite is true too) [1].

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Breast Augmentation

3

Abstract

A supra-inframammary fold (supra-IMF) dissection preserves the inframammary fascial condensations. This safe dissection plane minimizes the risk of bottoming out or the dreaded double-bubble deformity. A transareola incision may be used to simultaneously correct inverted or protruding nipples. Finger dissection preserves the lateral intercostal nerve branches to the nipples. Subpectoral implant placement is preferred for optimal upper pole appearance. The lower sternal origin is released cautiously to avoid symmastia. "Dual plane" is a misnomer. Three-dimensional simulations are not yet capable of predicting postoperative appearance.

The patient's size preference is most relevant in determining implant size, not tissue-based calculations. There is no evidence that large implant sizes (i.e., >350 cc) are especially risky. An average implant size of 390 cc is typical.

The mean overall pain rating is 5.9 on a scale of 1 (worst) to 10 (best). A 24-h recovery is unrealistic. Patients report being "back to normal" approximately 25 days after surgery and being able to sleep comfortably 18 days after surgery.

Although shaped "form-stable" implants have been heavily promoted, there is no evidence for their superiority over round implants. Their disadvantages include cost, firmness, and the possibility of malrotation. Anaplastic large cell lymphoma is linked to textured implants. Wrinkling can occur with both silicone gel and saline implants.

As expected, breast implants reliably increase breast projection, upper pole projection, and breast area. The nipple level is unchanged. The IMF normally descends after a breast augmentation. Breast self-consciousness drops from 86% before surgery to 13% after surgery. Breast augmentation reliably improves self-esteem (91%) and quality of life (64%). Nipple numbness is common after breast augmentation (39%), but persistent numbness is unusual (2.3%). Almost all women (98.7%) would repeat the surgery.

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Introduction

Breast augmentation with implants is arguably the most important advance in the history of cosmetic plastic surgery [1]. Breast augmentation is one of the most satisfying procedures for both the patient and the surgeon in its almost magical ability to transform human shape. Gratification is often immediate. About one-third of all women are dissatisfied with the appearance of their natural breasts [2].

In part because of its success and popularity, no plastic surgical procedure has received as much public attention, and scrutiny, as breast augmentation. Breast augmentation decreased in popularity in the early 1990s because of media attention regarding the safety of silicone gel implants and the moratorium on silicone gel implants imposed by the US Food and Drug Administration from 1992 to 2006. In the last decade, breast augmentation has regained its popularity, replacing liposuction as the most commonly performed cosmetic surgery operation in the United States [3].

The procedure is by no means perfect. Complications are common and test the patient–physician relationship. Appropriate management of complications is important because the alternative, deflated breasts, is aesthetically unacceptable. Accordingly, this subject is given its own chapter (Chap. 4).

Patient-Reported Results

Patient-reported perceptions of the surgical result, including patient satisfaction and changes in quality of life, are essential components of any outcomes assessment [4–6]. Prospective studies of consecutive patients with high response rates are preferred so as to avoid selection bias [7, 8]. Large sample sizes increase statistical power and improve reliability [9]. Perhaps surprisingly for such a popular procedure, there is limited information available from prospective outcome studies of breast augmentation [2, 10–15]. Patient-reported outcome data are either absent [16–19] or limited to overall patient satisfaction scores [20] in published reviews of breast augmentation. It is difficult to reasonably discuss ways to optimize outcomes without such outcome data [6]. Surgeon-reported complication and reoperation rates do not provide this needed information [6].

Cash et al. [2] published the first large prospective study of 360 breast augmentation patients. Unfortunately, there was no discussion of how the participants were chosen and the inclusion rate. Banbury et al. [10] mailed questionnaires to 47 patients and received responses from 25 patients (response rate 53%). Niechajev et al. [12] compared two silicone gel implant brands in 74 patients. Recent studies using the BREAST-Q questionnaire [10, 14, 15] have important methodological limitations (discussed in more detail in Chap. 1) [21]. None of these studies evaluates consecutive patients.

The response rate for mailed surveys is typically low, in the range of 49–66% [13, 22–25], with various levels of completion. Existing generic breast questionnaires may lack sufficient specificity to assess the psychological impact of surgical changes [4, 26]. Quality-of-life measures typically focus on physical symptoms rather than on cosmetic concerns [11]. A commonly used self-esteem scale may be too generalized to detect changes related to the breasts [11, 23]. The BREAST-Q [5] provides three general indices: breast satisfaction, psychological well-being, and sexual well-being [13]. Not surprisingly, breast augmentation patients show improvements in these categories [13–15]. However, many procedure-related questions that may be of clinical interest to the patient and surgeon remain unanswered [6].

Women often inquire as to how much pain to expect and the length of recovery. Limited patient-derived information is available from published prospective outcome studies [2, 10–13]. Implant size and feel characteristics are major preoperative concerns of patients; yet, there is a lack of prospective outcome data evaluating patient satisfaction with either breast size or firmness after surgery in consecutive patients [6]. Nipple sensation is important to women but is often overlooked.

To remedy these deficiencies, the author undertook a prospective study evaluating breast augmentation from the patient's perspective [6]. Using an in-person interview, an 80% response rate was achieved, satisfying the benchmark for evidence-based medicine [7], with all questions answered in almost every survey. The average survey duration was 11 min (range 3–30 min). Remarkably, survey participation among eligible patients who returned for follow-up appointments at least 1 month after surgery was 100%.

Follow-up times in the author's study were comparatively short (mean 4.5 months) [6]. Short follow-up times were tolerated to optimize the response rate. Longer follow-up times are generally preferred so as to detect any late complications and to assess the result once swelling has subsided [6]. However, insistence on a long minimum follow-up time, for example, 6 months, lowers the inclusion rate. Cosmetic surgery patients are notoriously unreliable in keeping long-term follow-up appointments, particularly for research purposes [23]. A 37% attrition rate at 1 year is typical [23]. A lower inclusion rate invites selection bias, because the experience of patients returning in long-term follow-up is unlikely to be representative of all patients. Selection bias violates a major provision of evidence-based medicine [7]. Minimizing exclusion criteria is recommended to avoid losing essential patient data [8].

Measurement studies show that postsurgical changes in breast shape occurring after 3 months are minimal [27, 28], suggesting that at 3 months swelling has resolved sufficiently for the purpose of measurements, although settling will occur over the long term. The lack of a significant correlation between measurements of breast shape and follow-up times suggests that at 3 months the swelling has sufficiently resolved so as not to constitute an important confounding factor [28]. Therefore, 3 months would seem to represent an appropriate balance of inclusion rate and follow-up time.

Indications

The mean time that women consider a breast augmentation before having the surgery is >5 years [6], indicating that the decision for most patients is not an impulsive one. Few women (0.4%) report having the surgery to please her partner; the majority have the surgery for their own reasons [6, 22].

Anesthesia and Venous Thromboembolism Prophylaxis

Surgery is performed by the author on an outpatient basis in a state-licensed ambulatory surgery center using total intravenous anesthesia and a laryngeal mask airway. This type of anesthesia avoids intraoperative hypotension and preserves the calf muscle pump, reducing the risk of venous thromboembolism [29, 30]. Patients presenting for cosmetic breast surgery participate in a clinical trial [31] investigating the natural history of deep venous thromboses in plastic surgery patients using Doppler ultrasound screening performed preoperatively, the day after surgery, and approximately 1 week after surgery [32]. Chemoprophylaxis is not used. Patients typically receive cefazolin 1 g IV preoperatively followed by three doses of cephalexin 500 mg p.o. q12h.

The local anesthetic solution injected into the breasts consists of 50 cc of bupivacaine 0.5% with 1:200,000 epinephrine, 50 cc of lidocaine 1% with 1:100,000 epinephrine, and 100 cc saline, resulting in a concentration of lidocaine of 0.25%, bupivacaine 0.125%, and epinephrine 1:300,000 [33]. The usual volume infiltrated into each breast is 60–100 cc. No pocket irrigation is used, other than saline. Nadeau et al. [34] recently published a randomized study comparing bupivacaine with liposomal bupivacaine (Exparel Pacira Pharmaceuticals, Inc. San Diego, CA) in subpectoral breast augmentation and found that liposomal bupivacaine was marginally more effective but not worth the extra cost according to 70% of surveyed patients. A 20 cc bottle of bupivacaine

costs about $1 versus $285 for the same volume of liposomal bupivacaine [34]. Notably, the authors [34] administered these agents in the form of irrigation of the pocket prior to wound closure rather than by injection. Standard, nonliposomal bupivacaine injected in dilute form into the breast tissue is absorbed into fat cells and gradually released, acting as a "physiological pain pump [35]."

Incision

A recent survey [36] found that the majority (83.9%) of members of the American Society of Plastic Surgeons prefer an inframammary incision for implant placement. A periareolar approach is favored by 12.6% of respondents, and only 3.3% prefer an axillary approach. The umbilical approach, which cannot be used for secondary surgery [20], has few advocates (0.2%). The transareolar and trans-nipple approaches may be used in cases of coexisting nipple protrusion or inversion (Fig. 3.1).

Supra-Inframammary Fold (Supra-IMF) Incision

The inframammary incision provides optimal exposure. The ease of approach is important because the breast shape and quality of the cleavage are vital, even more important than the incision placement. In many women, the incision may be located 0.5 cm to 1 cm *cephalad to* the inframammary fold (IMF), rather than exactly in the IMF as is traditionally recommended (Figs. 3.2 and 3.3) [37]. The dissection proceeds obliquely and superiorly to the inferior border of the pectoralis muscle,

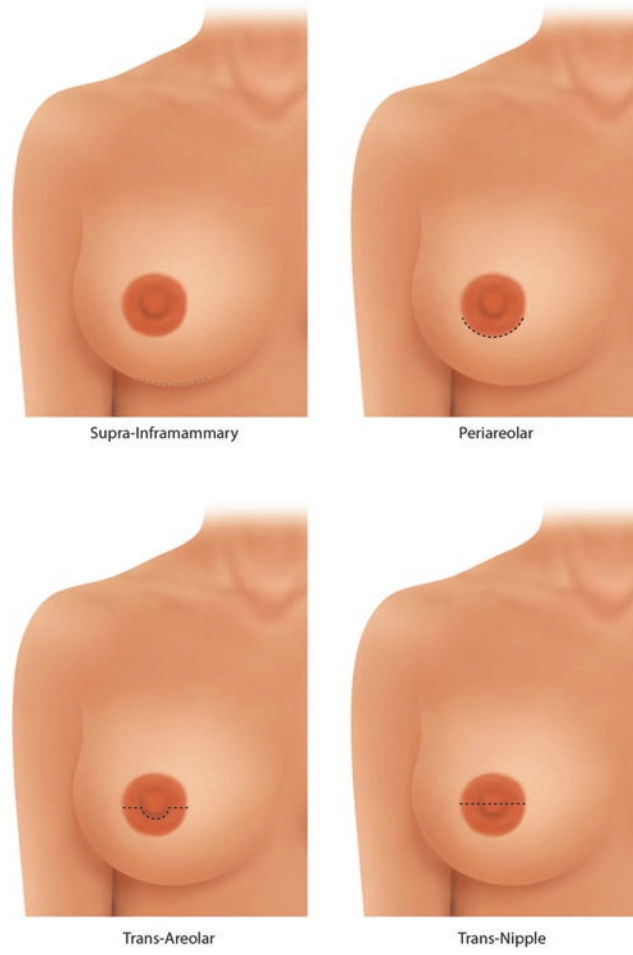


Fig. 3.1 In the majority of cases, a supra-IMF incision is used (*above, left*). The periareolar approach is an alternative (*above, right*). In patients with a protruding nipple, the nipple protrusion may be corrected simultaneously with the breast augmentation using a transareolar approach (*below, left*). In patients with inverted nipples, a trans-nipple approach is used (*below, right*) with simultaneous correction of the inverted nipples and implant insertion. The axillary approach is not illustrated

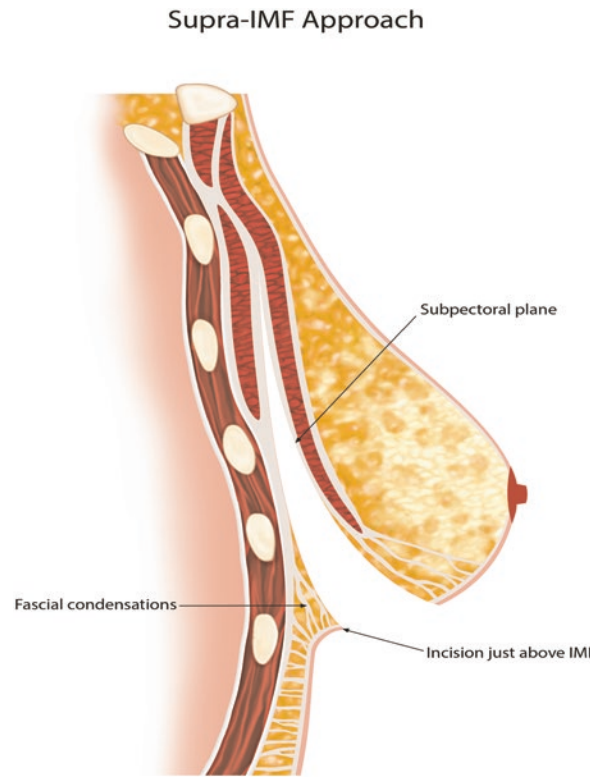


Fig. 3.2 The supra-inframammary (supra-IMF) incision is made just above the existing inframammary crease. The dissection proceeds obliquely to the free margin of the pectoralis muscle, parallel to the inframammary fascial attachments that originate from the fifth rib. This dissection preserves the fascial condensations holding the inframammary fold and avoids a need to repair them

parallel to the fascial condensations. It makes sense, whenever possible, to avoid dissection through the fascial condensations and horizontal ligaments (Figs. 3.4 and 3.5) [38] deep to the IMF by staying superior to them, rather than disrupting these attachments and then repairing them. This safe dissection plane also minimizes the risk of the double-bubble deformity, characterized by inferior displacement of the breast implant relative to the breast mound [39], which creates an unnatural second crease across the lower pole of the breast (Fig. 3.6). To reduce the risk of bottoming out, the subpectoral pocket may be dissected slightly high on the chest, anticipating descent of the implant with time (Figs. 3.2, 3.3, and 3.7) [40].

> It makes sense, whenever possible, to avoid dissection through the fascial condensations and horizontal ligaments deep to the IMF by staying superior to them, rather than disrupting these attachments and then repairing them.

The scar is still well hidden on the underside of the breast (Fig. 3.8) and is unlikely to be exposed when the patient wears a bikini top, which is an occasional problem if the scar is located too low [40]. This incision is used by the author in almost all cases (96%) [6]. Occasionally a periareolar (2%) or trans-nipple (1%) approach is used. The author rarely uses an axillary approach (1%).

Periareolar Incision

The obvious advantage of a periareolar incision is that it makes use of the natural border around the areola to hide the scar (Figs. 3.9, 3.10, and 3.11). Care must be taken to make the incision exactly at the border of the pigmented areola [20]. It is a very acceptable alternative to the inframammary incision. A 3 cm diameter areola has a 4.7 cm hemicircumference (πr), allowing insertion of small- and moderate-sized silicone gel implants; larger sizes in women with small

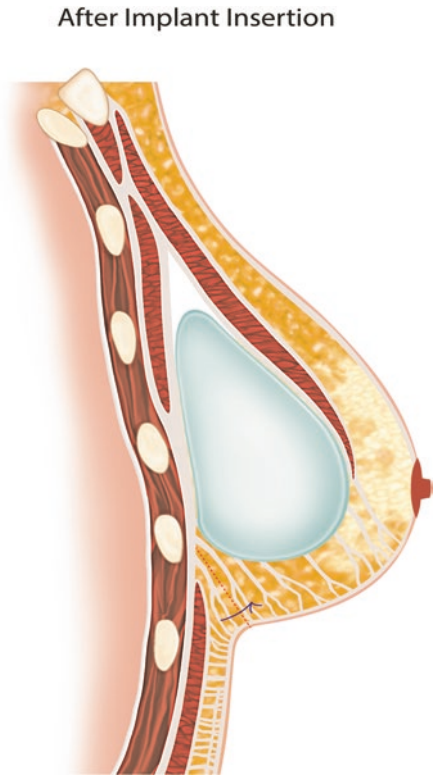


Fig. 3.3 The implant has been inserted deep to the pectoralis major. The *red* hatched line indicates the oblique dissection plane. The deep fascia is repaired using two 2-0 Vicryl sutures placed side by side (one suture is illustrated). The fascial connections to the IMF are preserved. The skin is closed using 4-0 Vicryl dermal sutures and a 5-0 Prolene intradermal suture (not illustrated)

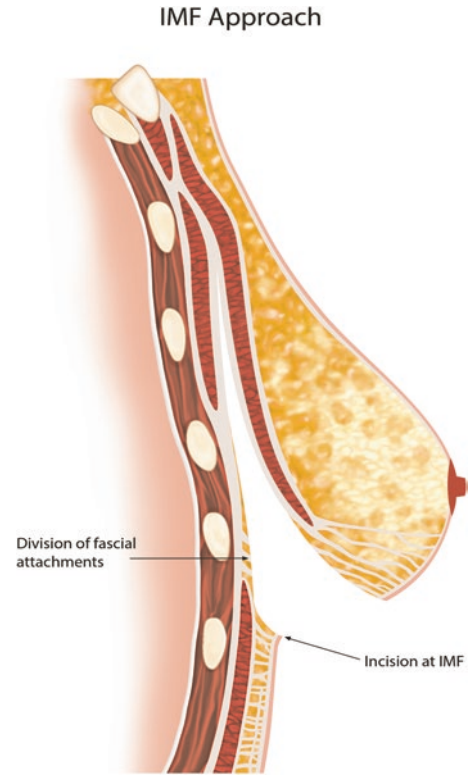


Fig. 3.4 A traditional inframammary incision is made at the level of the existing IMF, and dissection proceeds through the fascial attachments to the IMF that originate in the fascia overlying the fifth rib

areolae may be a tight squeeze. A traditional criticism of this method is the risk of nipple numbness because of the proximity of the incision to the nipple. However, several studies suggest no greater risk to nipple/areola sensation compared with an inframammary approach [41–43]. Some investigators believe that a periareolar approach increases the risk of infection and capsular contracture [44, 45], although a recent microbiological study of cultures obtained from breast skin and parenchyma at surgery found that the cultured organisms are not distinct from ordinary skin flora and that the periareolar (or transareolar) approach is microbiologically safe [46].

Axillary Incision

Avoidance of a scar on the breast has obvious appeal and can be a marketing advantage. In their chart review of 2430 patients, Gryskiewicz and LeDuc [47] conclude that a nonendoscopic transaxillary breast augmentation produces greater patient satisfaction than other approaches that leave a scar on the breast. Surveys were obtained in 28% of patients. Because the study was retrospective, only a single postoperative BREAST-Q questionnaire was obtained from each respondent. (Normally two questionnaires are administered, one before surgery and one after surgery so as to assess any change caused by the surgery [15].)

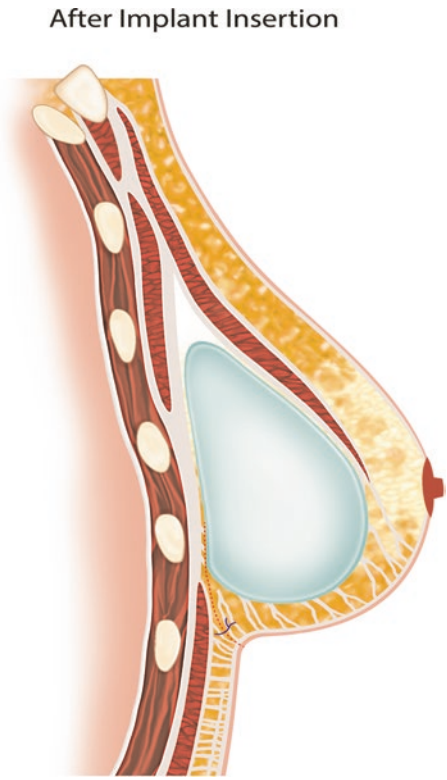


Fig. 3.5 The deep fascia is repaired, approximating the fascial attachments that have been released

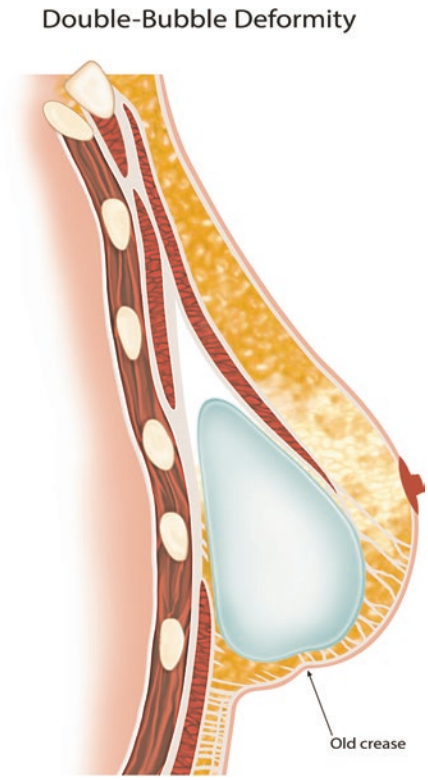


Fig. 3.6 The divided fascial attachments are unable to support the implant despite suture repair. The implant settles too far inferiorly. The original inframammary fold leaves a second crease running horizontally across the lower pole, creating an undesirable double-bubble deformity. The nipple is inclined upward. This deformity may be largely avoided by using a supra-IMF approach

This questionnaire evaluates breast satisfaction and quality of life at the time of the questionnaire, which in some cases was completed 11 years after the surgery. Clearly, other factors affecting breast satisfaction and quality of life may influence the scores. Unfortunately, the authors [47] compared transaxillary breast augmentation patients with women who had other breast incisions, including not only periareolar and inframammary incisions, but also mastopexies. Patients with ptosis, pseudoptosis, or tuberous breasts were not selected for an axillary approach. This difference in patients undermines the authors' conclusion regarding aesthetic superiority of the axillary method.

A recent Korean study [48] reports that women with an indistinct inframammary fold, which is common among Asian women, are good candidates for an endoscopic axillary approach. Patients should be aware that although there is no scar on the breast, there is a scar in the axilla. Usually this scar heals well and is inconspicuous (Figs. 3.12 and 3.13). However, there may be a visible area of alopecia in the stubble of axillary hair growth, which might be an issue for a hairdresser who constantly holds her arms up, or a beach volleyball player. (One patient told me she knew her hairdresser had implants because she could see the armpit scar).

Asymmetry of the inframammary folds is more common using the axillary approach [48, 49]. Gryskiewicz and LeDuc [47] concede that inadequate medial dissection can be a problem. Inadequate dissection may leave the implant too high [48, 50]. If the dissection extends too far inferiorly, a bottomed-out breast will be the result (Fig. 3.14) [47]. Successful management of this problem using a shoestring wrapped under the

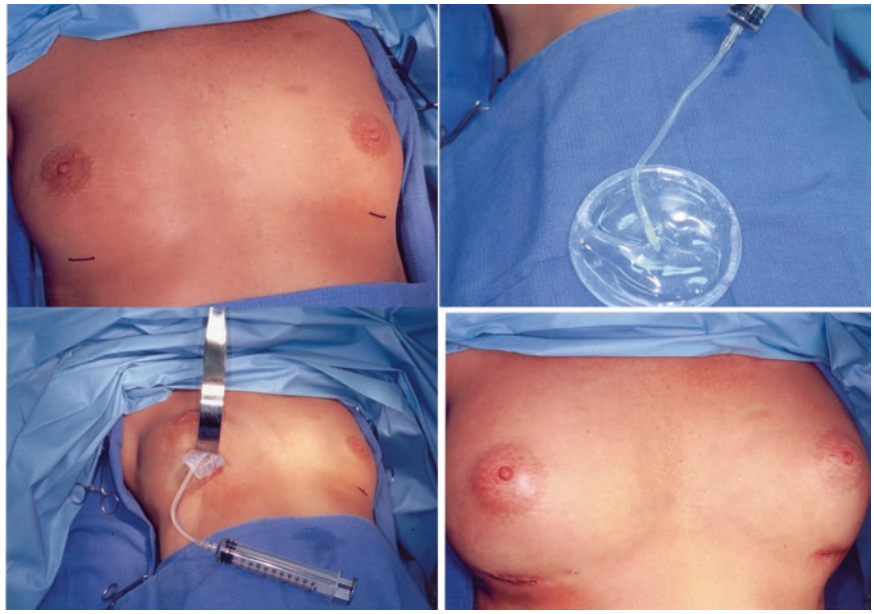


Fig. 3.7 Intraoperative photos of a patient undergoing a subpectoral breast augmentation with a saline implant. A 3-cm incision is marked just above (1 cm) the existing inframammary fold (*above, left*). A smooth, round saline-filled implant (Mentor Corp.) is prepared for insertion with an injection of 50 cc of saline and withdrawal of air in the implant (*above, right*). The implant is inserted subpectorally (*below, left*). The incision is closed using two 3-0 Vicryl sutures (Ethicon, Inc., Somerville, NJ) in the deep fascia, followed by dermal repair using inverted 4-0 Vicryl sutures and skin closure with an intradermal 5-0 Prolene suture (*below, right*)

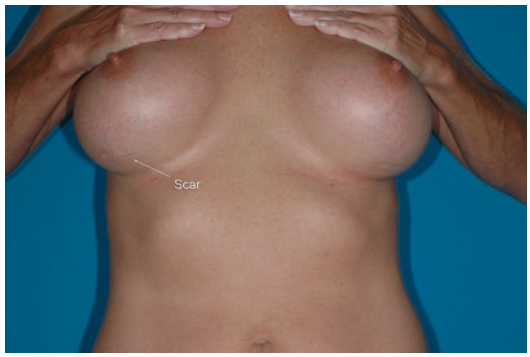


Fig. 3.8 Appearance of the scar, above the inframammary fold but still hidden on the underside of the breast 3.5 years after a breast augmentation using a supra-IMF incision and 375 cc smooth, round moderate profile subpectoral saline implants (Mentor Corp.)

breast [47, 51] seems unlikely. Some surgeons prefer endoscopic assistance to visualize the pectoralis muscle origin and optimize hemostasis [48]. Interestingly, operators using a nonendoscopic "blind" approach report low (e.g., $\leq 0.4\%$) [47, 51] hematoma rates, an observation attributed to intimal damage to the vessels caused by blunt dissection [47]. Care must be taken to avoid injury to the intercostobrachial nerve in the axilla [48, 51]. A fibrous band forming along the upper arm typically resolves spontaneously or with massage [47].

A revision or reoperation to treat a capsular contracture usually requires another incision [20, 48, 51], although Huang et al. [51] re-use the axillary incision in 60% of reoperations. A subsequent inframammary incision leaves the patient with four scars rather than two. Concerns that a transaxillary augmentation may disrupt the lymphatic channels in the axilla [52], compromising sentinel node identification in a patient who develops breast cancer, are probably unfounded [20]. Successful sentinel node biopsies have been reported in women who have developed breast cancer after an axillary breast augmentation [53, 54].

Huang et al. [53] recommend keeping the approach high and anterior in the axilla, within the subcutaneous plane. Lymphoscintigraphy in volunteers treated with axillary breast augmentation reveals minimal disruption of the axillary lymphatics [55–57].

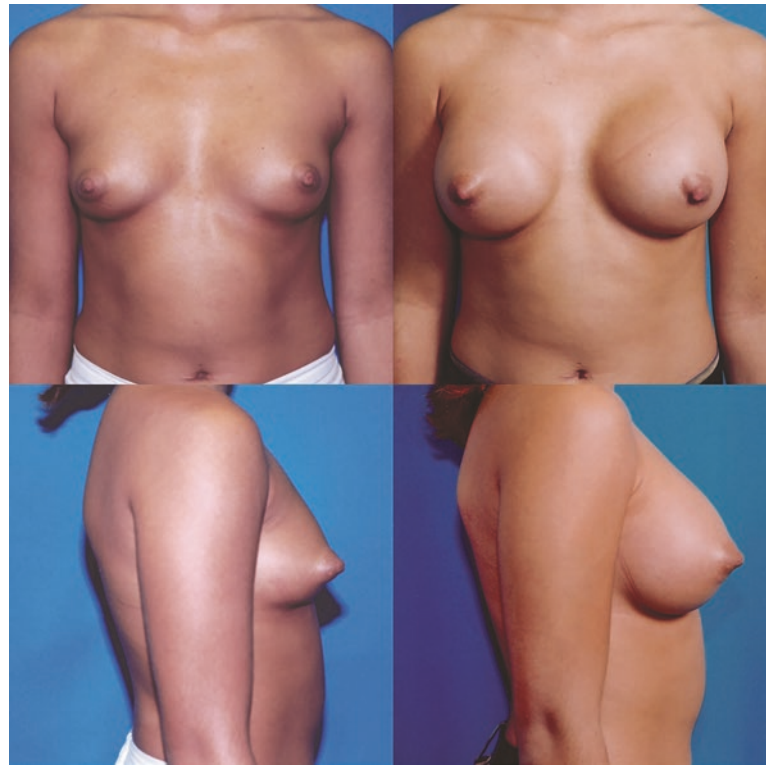


Fig. 3.9 This 23-year-old Asian female was an exotic dancer and requested a periareolar incision. She did not want her breasts to look "fake." She is seen before (*left*) and 2.5 months after (*right*) a subpectoral breast augmentation using smooth, round, moderate profile saline implants (Mentor Corp.) inflated to 330 cc on the right side and 325 cc on the left side

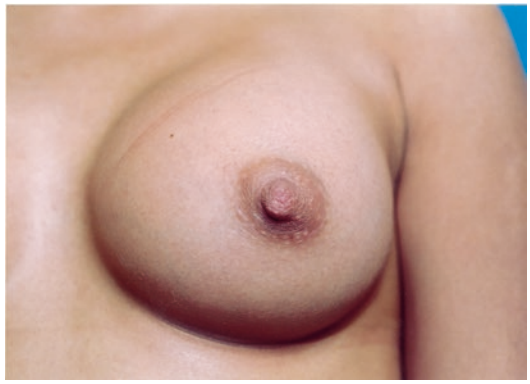


Fig. 3.10 Periareolar scar of the same patient 2.5 months after breast augmentation

Jacobson et al. [58] report an increased rate of capsular contracture after axillary breast augmentation, but the authors concede that their sample size was modest (197 breast augmentations). Gryskiewicz and LeDuc [47] note that superior implant malposition may be mistaken for a capsular contracture. Stutman et al. [59] find no correlation between incision location and five complications (capsular contracture, hematoma, rippling, infection, and rupture). Ruiz et al. [60] report no difference in reoperation rates comparing an axillary incision with a periareolar incision.

Trans-Nipple-Areolar and Transareolar Incisions

A trans-nipple-areolar incision is seldom mentioned in the literature. This approach has been described for the treatment of inverted nipples [61]. A trans-nipple-areolar incision can be used simultaneously for breast augmentation (Fig. 3.15). In the transareolar approach, rather than bisecting the nipple, the incision courses from 3 to 9 o'clock along the inferior hemicircumference of the nipple. Patients who request nipple reduction can be treated simultaneously with implants using the same incision, avoiding a second scar for implant placement (Figs. 3.16, 3.17, and 3.18). A circumferential "donut" of skin is resected at the base of the nipple [62],

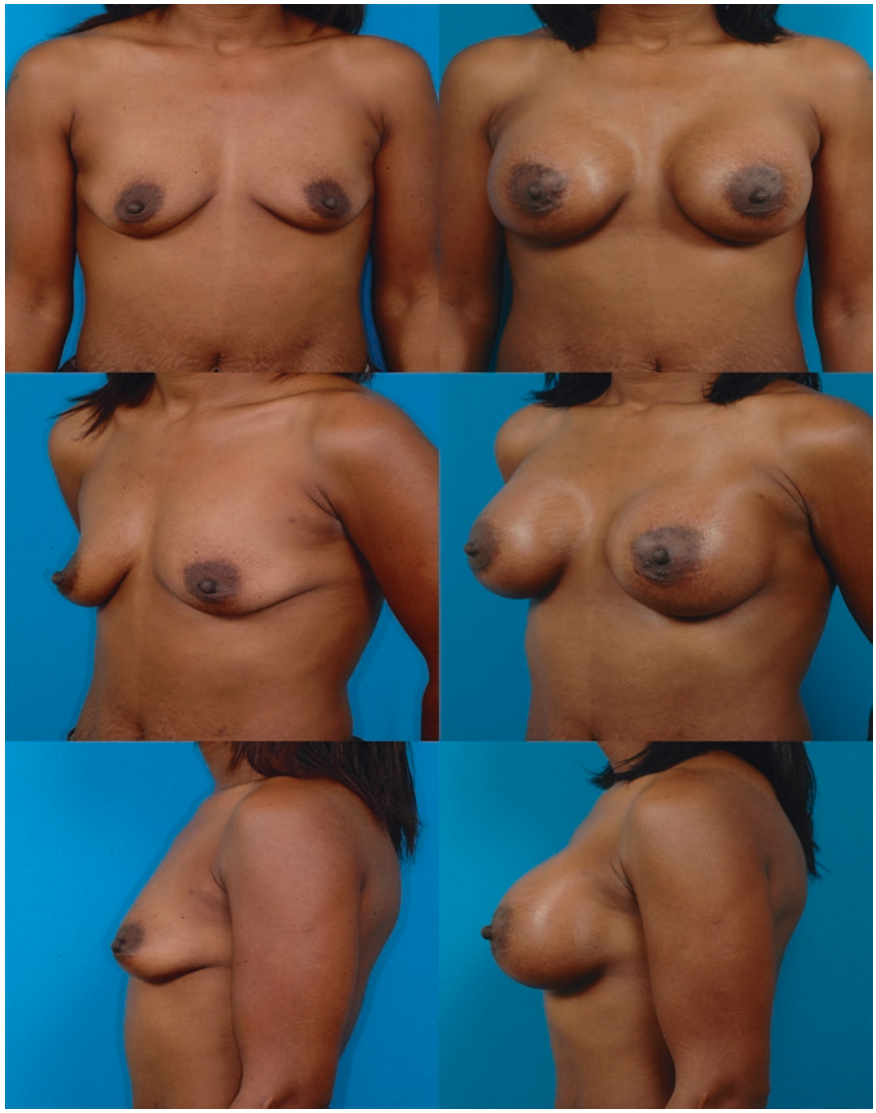


Fig. 3.11 This 33-year-old woman has deflated breasts after breastfeeding her three children (*left*), a problem corrected with 400 cc subpectoral smooth, round moderate plus profile saline implants (Mentor Corp.). Six weeks after surgery (*right*), the periareolar scar is almost imperceptible. The collapsed appearance of the areolae has been corrected, although the areola diameter is increased (*right*)

preserving the integrity of the ducts. This method is particularly valuable when the patient has little or no inframammary crease (Fig. 3.16). The scar quality tends to be excellent (Fig. 3.17). The transareolar incision may be an overlooked option for thin women with ill-defined inframammary folds, who also may be more likely to form hyperpigmented scars, such as Asian women [48]. Any scar hyperpigmentation that may develop is less visible within the confines of the areola. There is typically less room for implant insertion, depending on the areola width, so that saline implants may be preferred.

Correction of Inverted Nipples

Figure 3.15

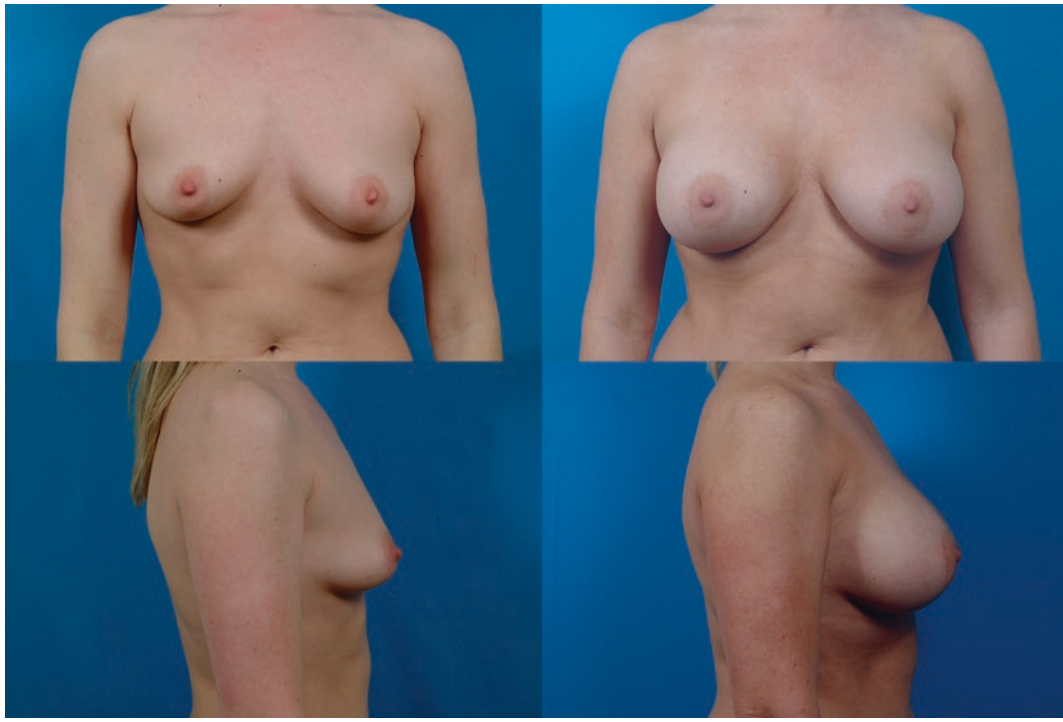


Fig. 3.12 This 28-year-old woman is seen before (*left*) and 7 months after (*right*) a transaxillary breast augmentation using subpectoral smooth, round, moderate profile 350 cc saline implants (Mentor Corp)

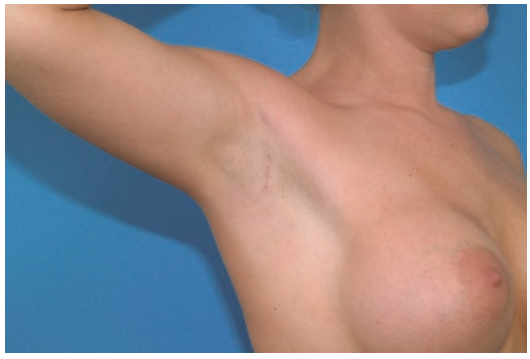


Fig. 3.13 Close-up view of the scar in the same patient 7 months after transaxillary breast augmentation

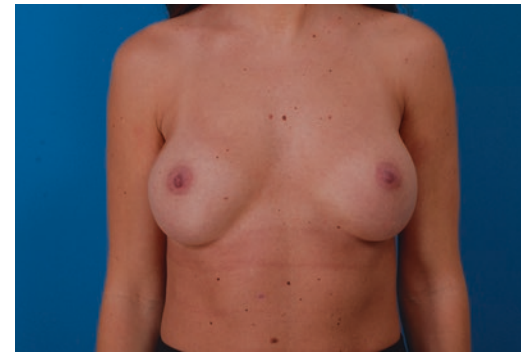


Fig. 3.14 This 28-year-old patient saw me in consultation after having an axillary breast augmentation performed by an experienced surgeon using a transaxillary approach 1 year previously. She was dissatisfied with the breast shape. She thought the implants were too low and the space between her breasts was too wide. Her observations were accurate

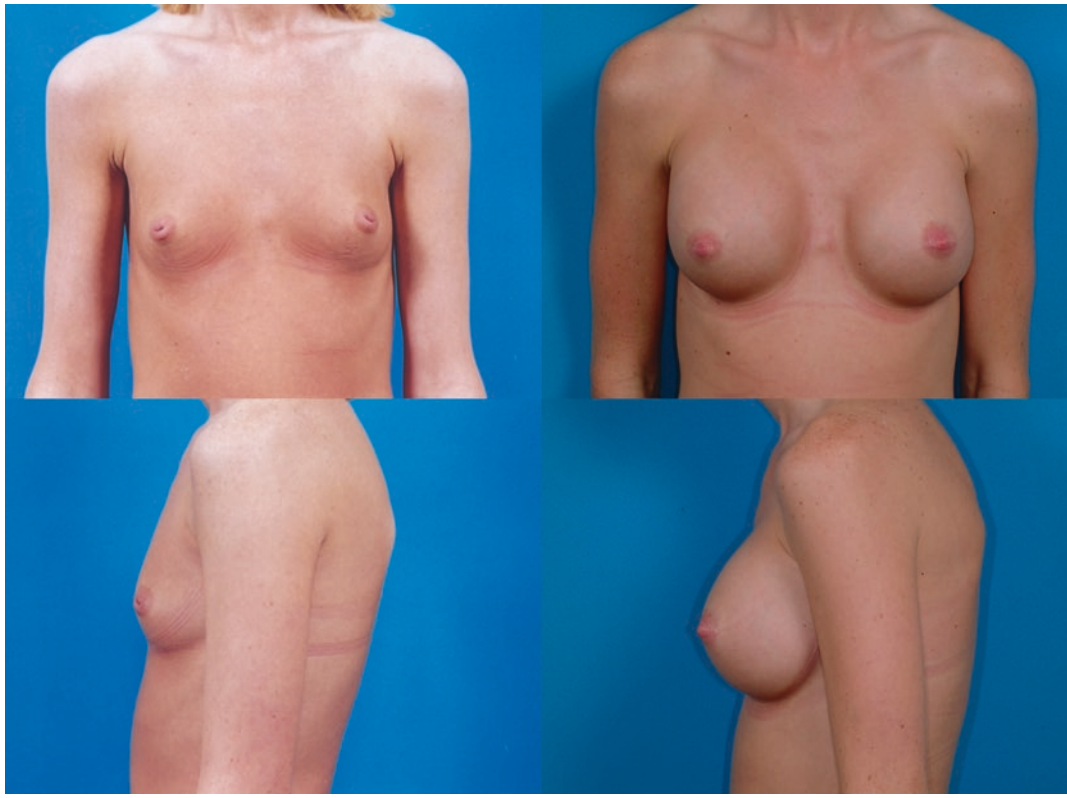


Fig. 3.15 This 24-year-old woman underwent a breast augmentation in combination with correction of her inverted nipples. A trans-nipple approach was used to repair the inverted nipples and to introduce the implants, avoiding any additional scars. She is seen before (*left*) and 2.5 years after (*right*) subpectoral placement of 380 cc smooth, round moderate profile saline implants (Mentor Corp.)

Correction of Protruding Nipples

Figure 3.16

Implant Placement

The vast majority (92.2%) of surveyed plastic surgeons prefer a submuscular pocket for implant insertion [36]. Only 5.4% of surgeons report that they most commonly use a subglandular pocket. A subfascial dissection [63], preferred by 2.4% of respondents, remains unpopular [36]. The fascia is much thinner than the pectoralis muscle, providing little additional soft-tissue coverage of the implant [63]. Most plastic surgeons partially (and cautiously, to avoid symmastia [20]) release the lower sternal origin of the pectoralis muscle (Fig. 3.19) [20, 64, 65] to avoid a wide intermammary space (Fig. 3.14).

Moderators at meetings frequently ask panelists which plane they prefer for breast augmentation. The usual choice is subglandular or subpectoral. However, many surgeons today respond "dual plane"; others (the author included) respond "subpectoral," which is synonymous with submuscular or retropectoral. "Dual plane" sounds more sophisticated. What exactly does "dual plane" mean?

When an implant is placed subpectorally, about two-thirds of the breast implant is covered by muscle; the inferolateral portion remains subglandular simply because of the triangular shape of the pectoralis major [64]. Total submuscular placement requires elevation of the serratus anterior and rectus abdominis muscles, limiting lower pole expansion, and is not recommended [20, 65]. Compared with subglandular augmentation, subpectoral implant placement achieves greater tissue coverage, a more

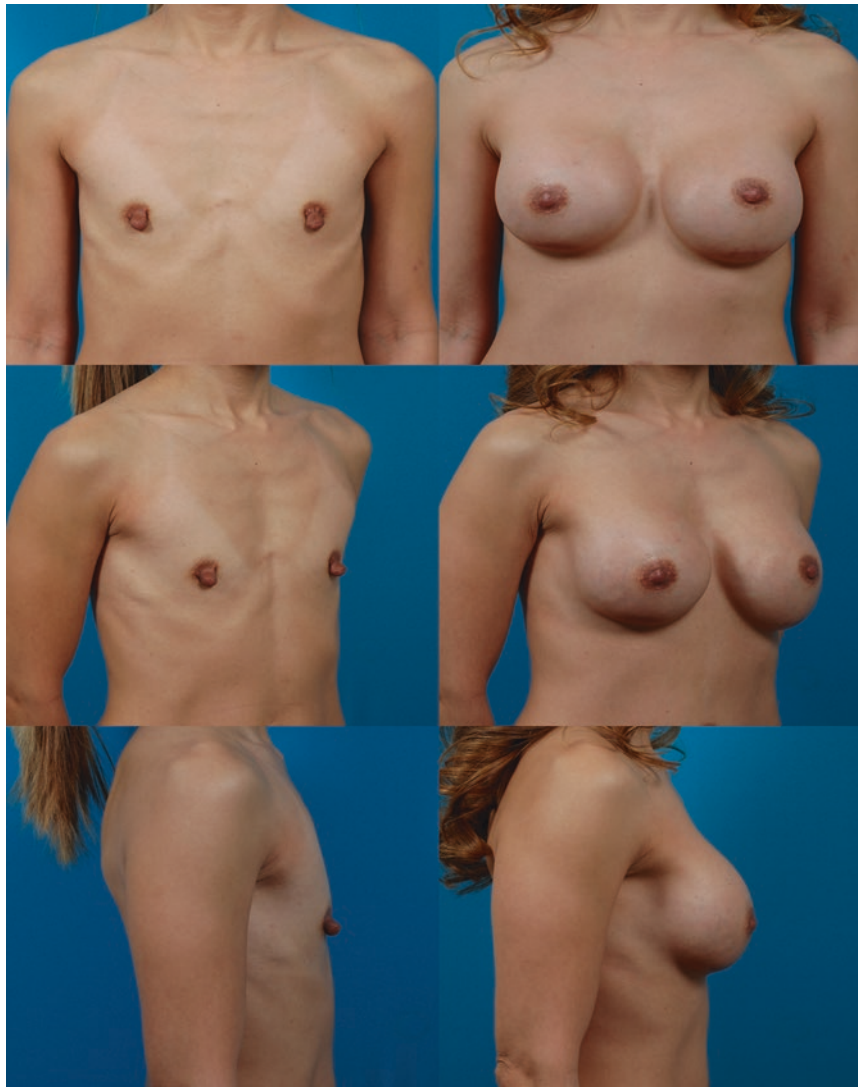
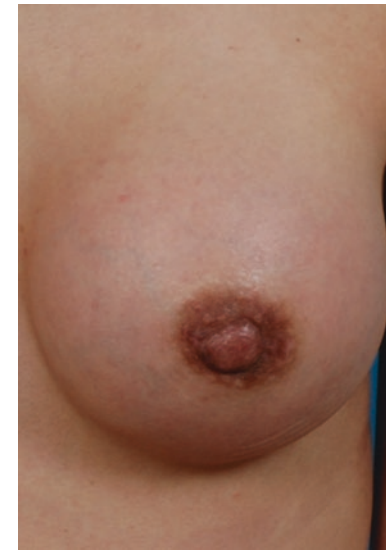


Fig. 3.16 This thin (88 lbs.) 40-year-old Asian female had virtually no breast tissue, very little body fat (body mass index, 15.1 kg/M^2), and large, pendulous nipples. The nipples were reduced by removing a donut of nipple tissue around the base, preserving the stalk. The implants were inserted subpectorally using the same incision, extended on to the areola on either side of the nipple. This incision typically heals very well with an inconspicuous scar. She is seen before (*left*) and 3 months after (*right*) a trans-nipple approach with subpectoral insertion of smooth, round moderate plus profile implants inflated to 270 cc (Mentor Corp.)

natural appearance of the upper pole [20], less wrinkling [66], and possibly less risk of capsular contracture [20, 65–67]. However, subglandular placement may be a valid alternative, particularly in women with adequate breast tissue, and it avoids an animation deformity. Distortion of the breast during pectoralis muscle contraction is common (77.5% of patients) after a subpectoral breast augmentation, but rarely severe [68]. Nevertheless, this possibility should be discussed with patients, especially those for whom daily exercise is part of their lifestyle or livelihood (e.g., fitness enthusiasts, body builders, personal trainers).

Tebbetts' dual plane modification was meant to free plastic surgeons from having to choose between subglandular and submuscular implant placement [66]. In his words, one could "combine retromammary and partial retropectoral

Fig. 3.17 Close-up view of left breast scar in the same patient 3 months after surgery



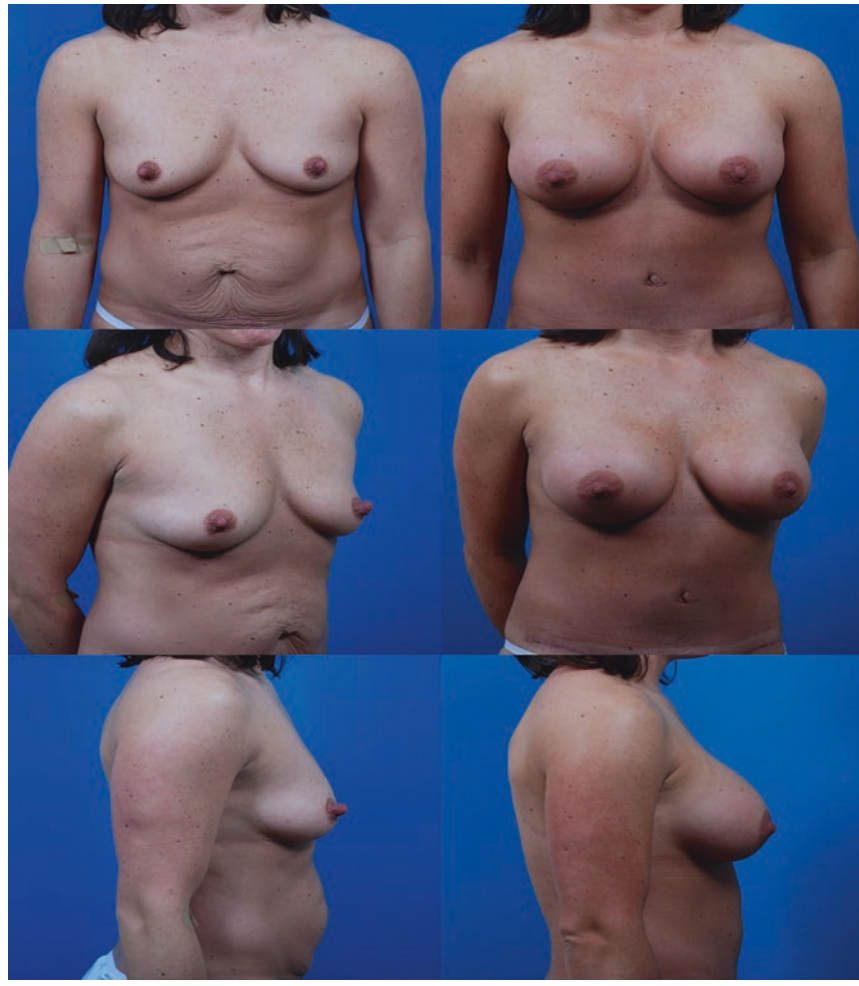


Fig. 3.18 This 43-year-old Hispanic woman underwent a breast augmentation, nipple reduction, and abdominoplasty. She was self-conscious about her protruding nipples (*left*) and would wear nipple pads to help conceal them in clothing. Three months after surgery (*right*), the transareolar scar has healed imperceptibly

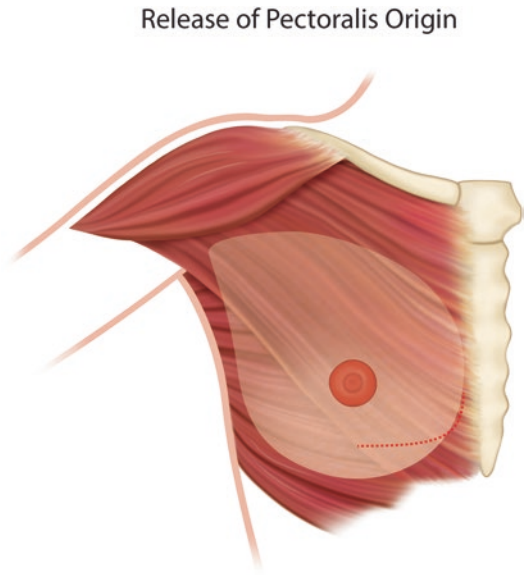


Fig. 3.19 The origin of the pectoralis muscle is released along the lower sternum and above the inframammary fold by sharp dissection (*red hatched line*). Blunt dissection is used for the rest of the dissection, taking care not to overdissect medially so as to avoid symmastia

pocket locations in a single patient to optimize the benefits of each pocket location while limiting the tradeoffs and risks of a single pocket location" [66]. In theory, surgeons could have their cake (a submuscular plane) and eat it too (still expand the breast skin envelope to treat women with glandular ptosis). In all patients, the implant is placed subpectorally. In Type 1, there is no prepectoral dissection, so that Type 1 (representing 60% of patients [66]) is not really a dual plane dissection. In Types 2 and 3, a prepectoral dissection extends around the pectoralis border to the level of the inferior (Type 2) or superior (Type 3) areola margin [66].

Conceptually, a subglandular implant might be expected to expand a deflated skin envelope without being limited by the pectoralis muscle, avoiding a snoopy deformity (sometimes inaccurately called double bubble), which is characterized by breast tissue that appears to slide off the implant [39]. In practice, however, even large implants fail to prevent a snoopy deformity in women with glandular ptosis [39]. These women are more effectively treated with an augmentation/mastopexy [28, 39].

Tebbetts [66] believes that a partial prepectoral dissection elevates the pectoralis border, improves breast shape in patients with glandular ptosis or constricted lower poles, and also elevates the nipple. Gryskiewicz [69] promotes this approach for the treatment of women with mild ptosis, the "in-between" patient. An unfilled prepectoral dissection plane is likely to scar together shortly after surgery [70]. It is possible, although unproven, that the pectoralis border moves up as a result of the dissection. It remains unclear whether breast shape is affected by elevating the pectoralis border. In a patient treated with a traditional subpectoral dissection (Fig. 3.20), horizontal and vertical breast dimensions are substantially increased, but the nipple is only slightly elevated. These changes are similar to a patient treated with a Type 3 dual plane dissection (Fig. 3.21). There is no evidence that the pectoralis muscle, released at the inframammary fold and partially released from its lower sternal origin [64], restricts breast expansion [70].

In a cadaveric study, Sanchez et al. [71] found that the width of the pectoralis muscle at its origin is variable and narrow, and its medial border is typically <1 cm from the midline, leaving little margin for error when releasing the muscle. The authors [71] recommend preserving the sternal fibers and releasing the inferior portion of the origin instead, as recommended by Tebbetts [66]. The incidence of symmastia in my own series, which included cautious release of the lower sternal origin, was 1/522 (0.2%) [72].

A recent survey [36] interpreted dual plane responses as synonymous with subpectoral; the methods do appear equivalent in their effect on breast shape (Figures 3.20 and 3.21). Dual plane, which implies two planes, is really a misnomer – the implant inhabits only one plane [70]. A plane that starts under one tissue and continues under another is not a dual plane. For example, a subsuperficial musculoaponeurotic system (sub-SMAS) facelift dissection starts subcutaneous and continues under the SMAS. Surgeons call it a deep plane, not a dual plane.

In secondary breast augmentation, the pocket is usually expanded superiorly to accommodate the new implant at a higher level on the chest wall. Implants typically settle over time, or the

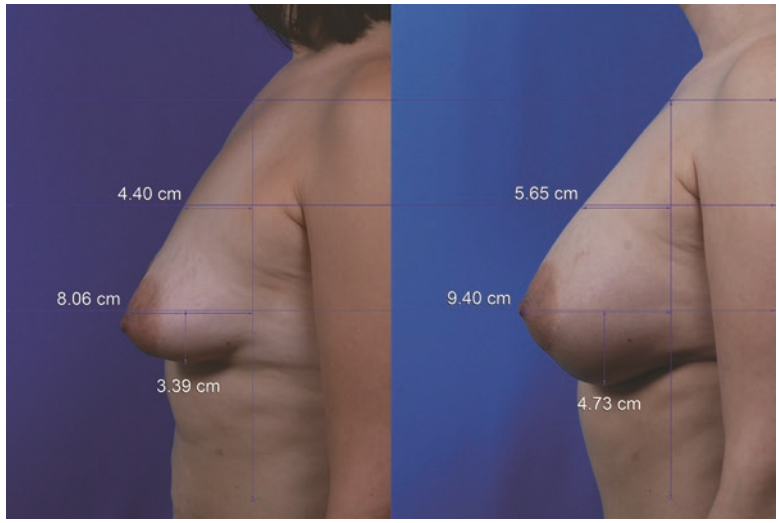


Fig. 3.20 This 28-year-old woman with two children is seen before (*left*) and 3 years after (*right*) a subpectoral breast augmentation using a 400 cc smooth, round moderate plus profile silicone gel implant (Mentor Corp.) on the left side. Her original breast shape was constricted. Upper pole projection, breast projection, and the vertical dimension of the lower pole are all increased. This case demonstrates expansion of the breast envelope without a prepectoral dissection. Parenchymal scoring was not performed. Photographs have been matched for size and orientation (Reprinted from Swanson [70]. With permission from Wolters Kluwer Health)

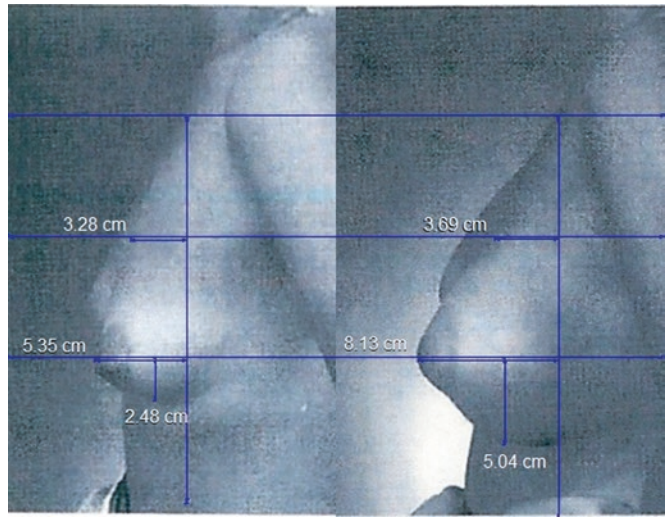


Fig. 3.21 These lateral photographs are reproduced from Fig. 18 in Tebbetts's publication and depict a 24-year-old woman with a constricted lower pole before (*left*) and 2 years after (*right*) a Type 3 dual plane breast augmentation using a 270 cc McGhan Style 468 (Allergan Inc.) textured, anatomic saline-filled implant. Photographs have been matched for size and orientation using the Canfield 7.4.1 Mirror (Canfield Scientific, Fairfield, NJ) imaging software. A 30-cm upper arm length was used for calibration (Reprinted from Swanson [70]. With permission from Wolters Kluwer Health)

patient may request a larger size. By using a supra-IMF approach and judiciously releasing the inferior and lower sternal pectoralis origin, the implant may be correctly situated slightly high on the chest and allowed to settle [40]. A common error is placement of the implant at the desired level without taking into account the normal implant settling and the expected downward migration of the inframammary fold [73]. Reoperation for implant malposition is unusual (1%) [72]. Importantly, this approach avoids the double-bubble deformity.

A common error is placement of the implant at the desired level without taking into account the normal implant settling and the expected downward migration of the inframammary fold.

"Controlling" the Inframammary Fold

Two recent studies describe suture techniques to control the inframammary fold [37, 74]. Campbell et al. [74] use 3-0 Vicryl (Ethicon, Somerville, NJ) deep fascial sutures to reinforce the IMF and report no complications in 600 patients and implant malposition in fewer than 1% of patients. Similarly, Montemurro et al. [37] describe a "stable reset" of the IMF, using Quill barbed sutures (Surgical Specialties, Wyomissing, PA). These authors [37] report that 1.15% of their 436 patients experienced bottoming out and 1.38% had a double bubble, although the patients were evidently nonconsecutive and the inclusion rate was not reported [75]. Neither study [37, 74] used measurements or compared their results with controls.

It is uncertain whether large sutures, such as slow-absorbing 0 PDO Quill [37], are beneficial. Wounds are known to heal by a "one wound" concept [76], not respecting tissue layers. Scar tissue seems to morph (cheese-wire) around sutures. At reoperation, permanent sutures are typically loose [77]. The strength of the bond depends on the scar tissue, not the suture [78].

Measurements reveal that the IMF drops after breast augmentation (Fig. 3.22) [73]. Three

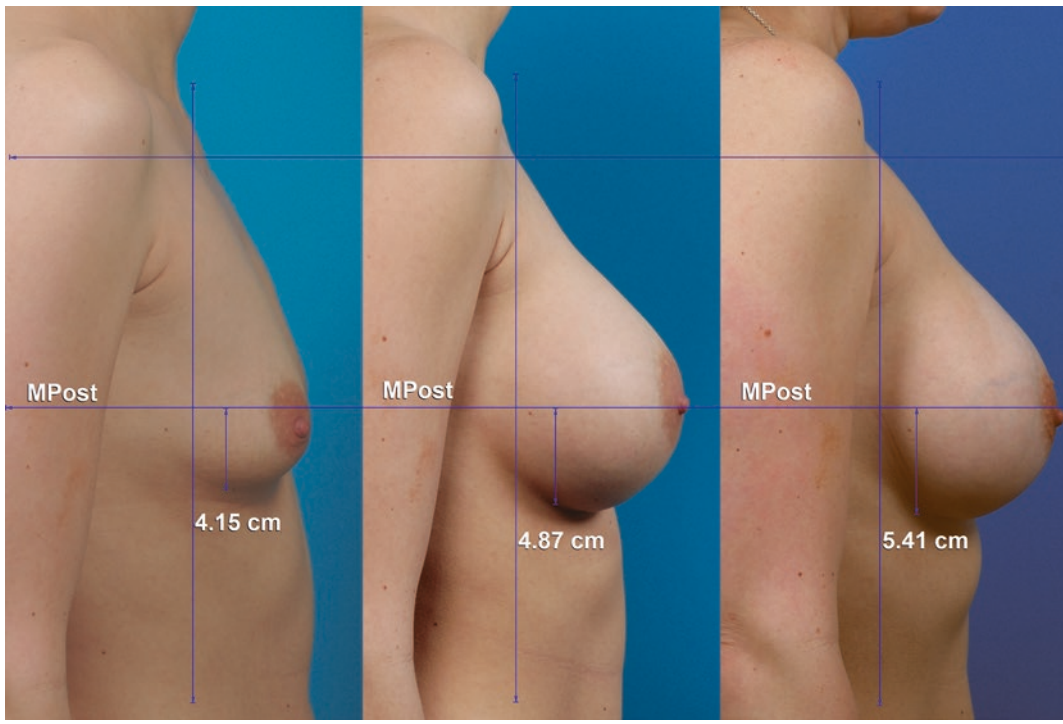


Fig. 3.22 This 27-year-old woman is seen before (*left*),1 year after (*center*), and 7 years after (*right*) a breast augmentation using 360 cc smooth, round, subpectoral saline-filled implants with a moderate plus profile (Mentor Corp.). A supra-inframammary incision was made just above the existing IMF (not visible). The wound was closed in three layers: 3-0 Vicryl sutures to close the deep fascia, 4-0 Vicryl dermal sutures, and a 5-0 Prolene (Ethicon, Somerville, NJ) running intradermal suture. One year postoperatively, her IMF has dropped 0.72 cm. Seven years after surgery, it has dropped 1.26 cm. The photographs have been matched for size and orientation using the Canfield Mirror 7.4.1 software (Canfield Scientific, Fairfield, NJ). *MPost*, plane of maximum post-operative breast projection (Reprinted from Swanson [40]. With permission from Oxford University Press)

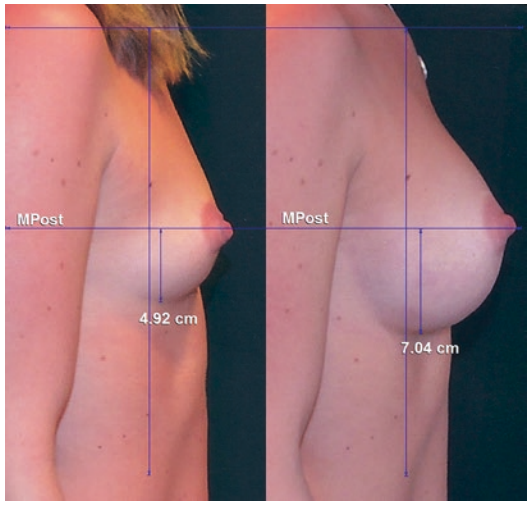


Fig. 3.23 Before (*left*) and 1-year postoperative (*right*) right lateral photographs of the 32-year-old woman depicted in the authors' Fig. 4 have been matched for size and orientation using the Canfield 7.4.1 Mirror imaging software. She has Allergan Style 410 implants, 335 cc on the right side and 320 cc on the left side. The IMF has dropped 2.12 cm despite a "stable" reset with large barbed sutures, and the use of a textured implant designed to adhere to local tissue. A 30-cm upper arm length is used for calibration. *MPost*, plane of maximum postoperative breast projection (Reprinted from Montemurro et al. [37]. With permission from Oxford University Press)

months after surgery, it has descended 0.71 cm on average (range 0.06–1.55 cm) in patients treated with smooth, round, subpectoral saline-filled implants inserted through an inframammary incision, and no extra reinforcement [73]. Textured implants are designed to adhere to local tissue and resist movement [79]. However, reports of bottoming out in some patients [37] and photographs (Fig. 3.23 and Fig. 3.27) suggest that textured implants do settle [40].

In truth, the operator may have little control over the descent of the IMF [40]. The IMF descends gradually (Fig. 3.22). A recent cadaveric study introduces rib fixation using absorbable anchors [80]. In view of the dynamic nature of the IMF [73], a static repair may appear unnatural over time. Reinforcement of the IMF potentially increases the risk of hematoma or implant damage [74], and causes more patient discomfort [37].

Breast Implant Settling After Surgery: Clinical Examples

Examples of implant settling are provided in Figs. 3.24, 3.25, 3.26, and 3.27.

Breast Implant Size

Breast size is a primary concern for women undergoing breast augmentation [6]. Limited information is available regarding patient assessment of postoperative breast size [12, 81, 82]. The mean implant size for my study patients was 390 cc (Figs. 3.28 and 3.29) [83], very similar to the mean implant volume reported by Lista et al. (385 cc) [84]. Breast implant manufacturers report that the average breast implant volume is approximately 390 cc, and most women choose a larger size when undergoing implant replacement (Sarah Eason, sales representative, May 2016, Mentor Corporation (Mentor Corp., Santa Barbara, CA), Personal communication; Jeff Shoenfeld, sales representative, May 2014, Allergan Incorporated (Allergan Inc., Irvine, CA), Personal communication). Although breast size has long been a source of controversy for surgeons [85, 86], most patients prefer convexity [87]. In my study of 225 patients (mean implant volume 390 cc) [6], only three women (1.4%) would have preferred a smaller size, versus 29 patients (13.2%) who would have preferred a larger size. By contrast, a multicenter study of saline-filled implants reported that 23.3% of women treated with a mean implant size of 275 cc would have chosen a larger volume [81]. The data clearly support the use of breast implant sizes that exceed conventional recommendations that, for example, implant size should generally be limited to approximately 350 cc, ostensibly for the patient's benefit [85]. Indeed, plastic surgeons have been paternalistic in telling patients what size is best for them, rather than having their patients inform them [6, 83]. Figure 3.29 shows the distribution of breast implant sizes in 225 patients. The bell-shaped curve reflects a normal distribution and is characteristic of many biological parameters, such as height, weight, or body mass index.

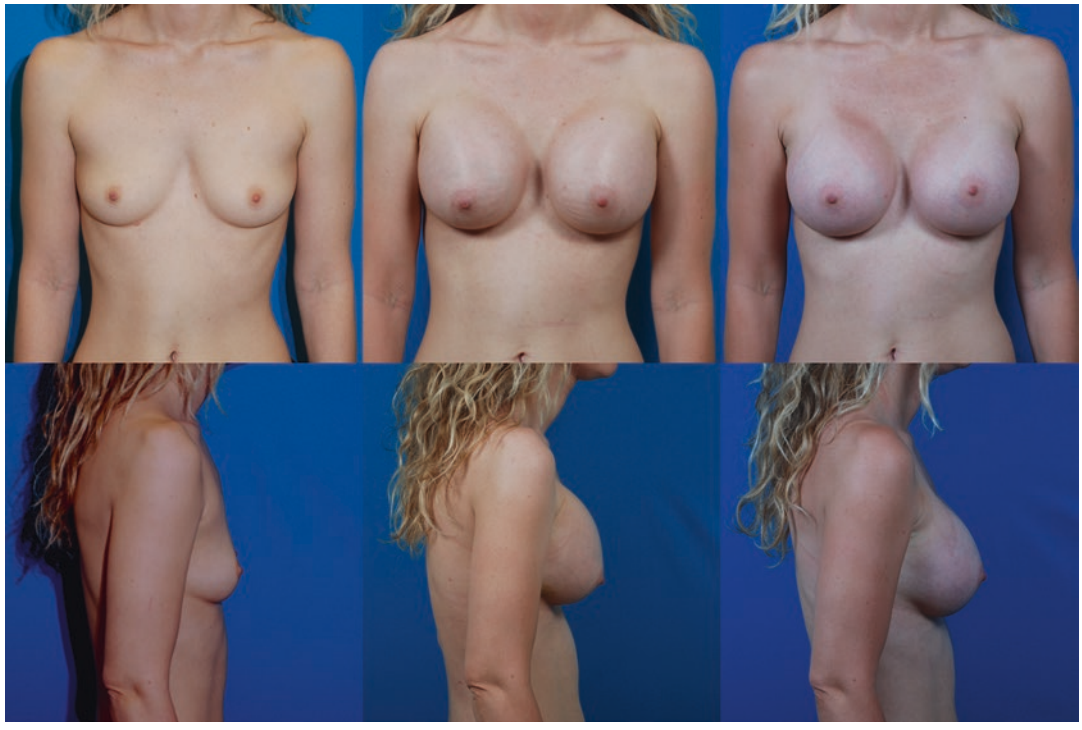


Fig. 3.24 This nulliparous 30-year-old woman had a small frame and wanted to be a D cup size. Despite her small size and the fact that her breasts had not yet been stretched by pregnancy (*left*), the desired size was achieved in one operation using 450 cc subpectoral smooth, round moderate plus profile saline implants (Mentor Corp.). The photos demonstrate the tightness of the skin after surgery and the high implant position (*center*). Three months after surgery (*right*), the skin has relaxed and the implants have settled nicely into position

Fig. 3.25 This patient's before-and-after photographs are depicted in Fig. 3.24. She is seen in these modeling photographs 5 months after surgery

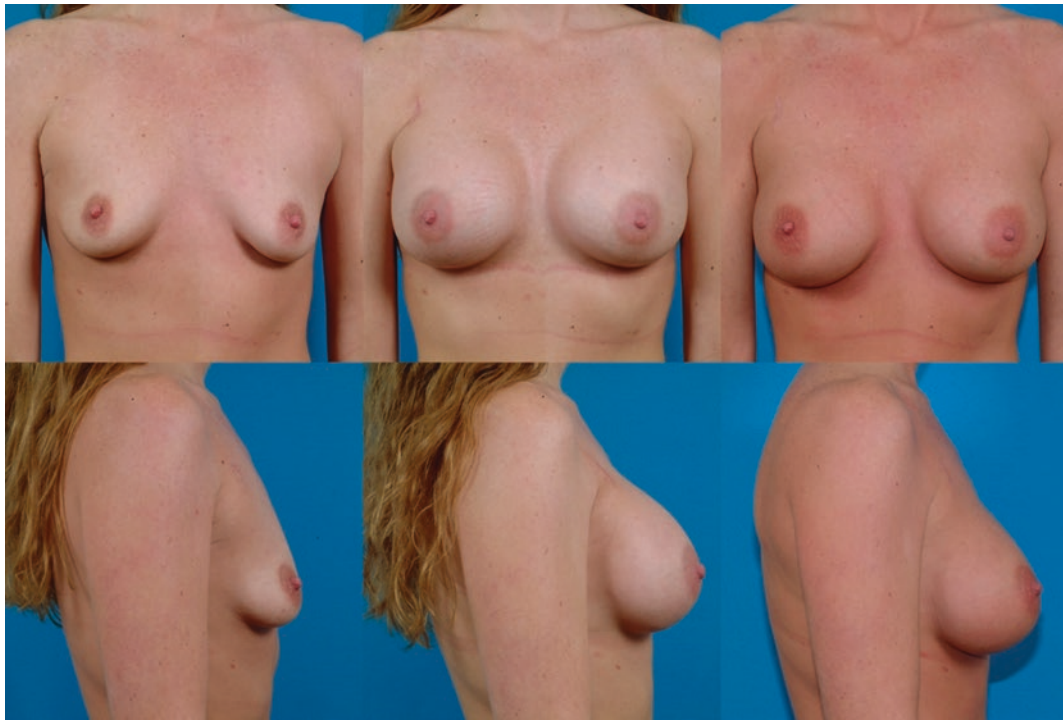


Fig. 3.26 This 33-year-old woman is seen before (*left*), 1 month after (*center*), and 1 year after (*right*) a breast augmentation using subpectoral 400 cc smooth, round moderate profile subpectoral implants (Mentor Corp.)

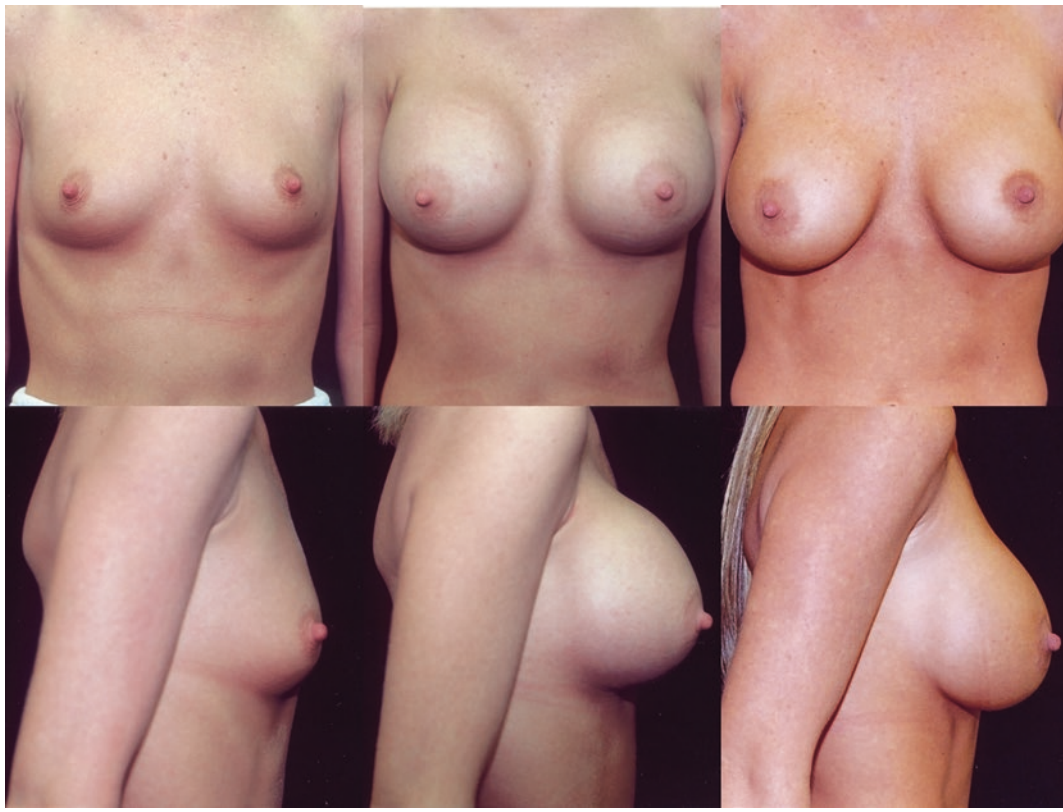


Fig. 3.27 A 26-year-old woman is seen before (*left*), 6 weeks after (*center*), and 10 years after (*right*) breast augmentation using subpectoral 400 cc textured, round moderate profile saline implants (Allergan, Inc.). She had two children, one before her augmentation and another child after surgery and before her 10-year follow-up photographs

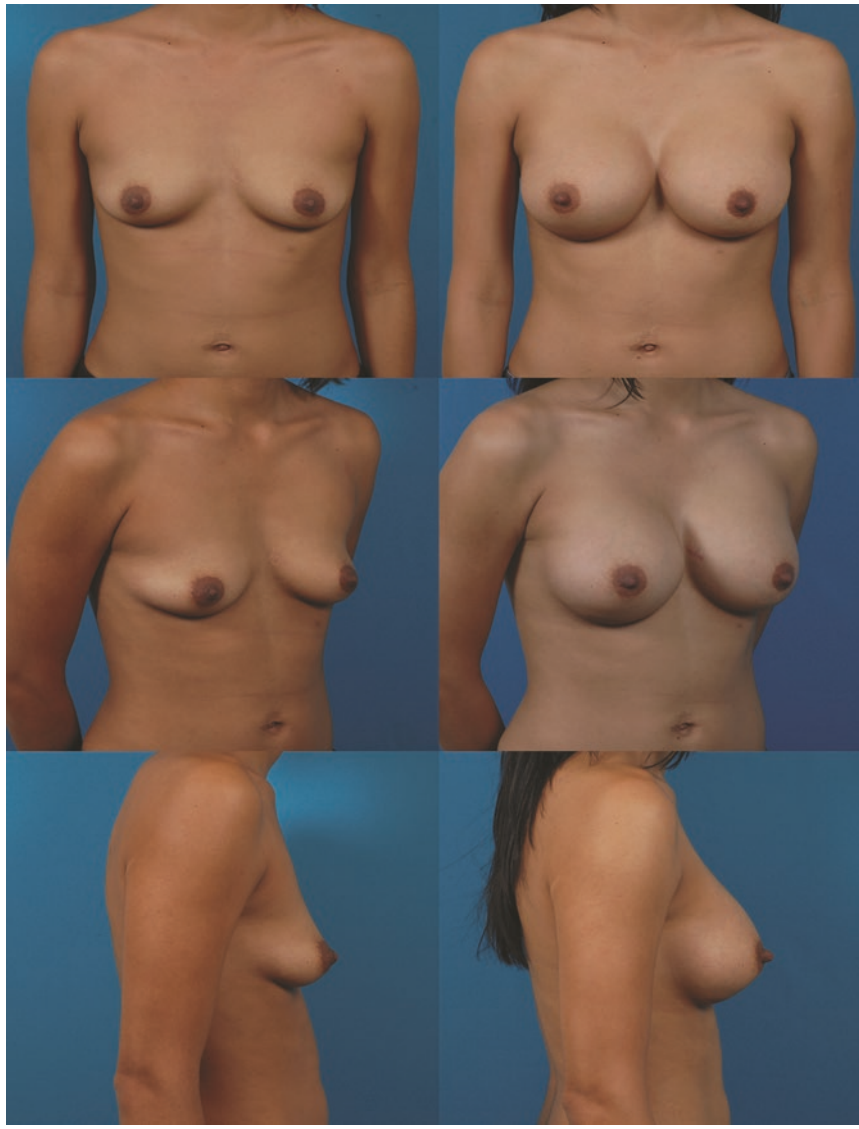


Fig. 3.28 This 24-year-old Hispanic woman is seen before (*left*) and 9 months after (*right*) subpectoral insertion of subpectoral smooth, round 400 cc moderate plus profile silicone gel implants (Mentor Corp.). This volume approximates the mean implant fill volume for patients undergoing breast augmentation

Many experienced plastic surgeons insert implant sizes as high as 800 or 900 cc in some patients [47, 84]. Approximately 1% of my patients choose implants of this size. Clinical decisions rest on the risk-to-benefit ratio. Even if there were an increased risk (which has not been demonstrated), women who desire larger breast sizes may be willing to trade more risk for more benefit. Surgeon size prejudices should not keep them from achieving their goals; it is their choice after all [83]. Of course, it may not be possible to achieve an extreme breast size in one operation. In a thin, nulliparous woman with very small breasts and no ptosis, it may not be possible to exceed a volume of approximately 450 cc [83].

Transgender patients (Figs. 3.30 and 3.31) perceive the breasts as a strong image of the female gender [88]. Not surprisingly, larger than average implant volumes are usually indicated, and a second operation may be needed to obtain the desired size (Fig. 3.31). These patients report high levels of satisfaction after surgery [88].

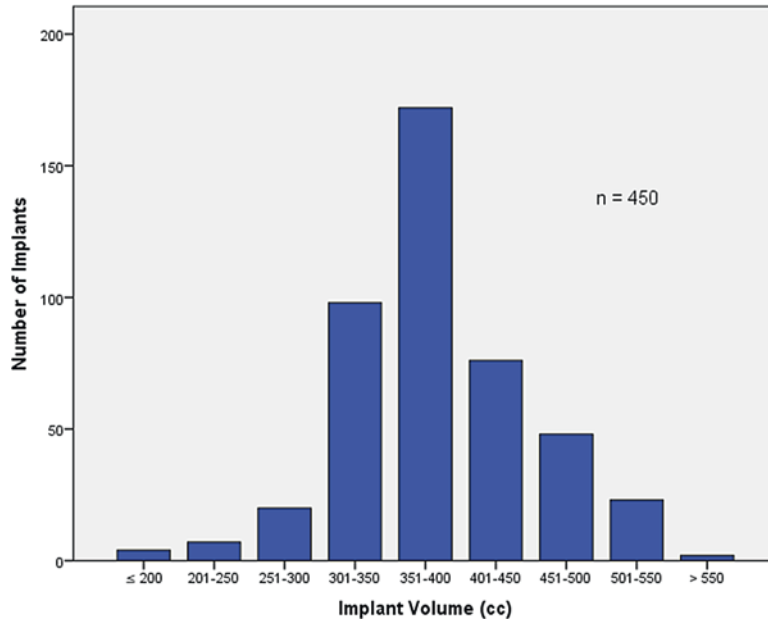


Fig. 3.29 Distribution of implant volumes ($n = 450$) in 225 breast augmentation patients (Reprinted from Swanson [83] with permission from Wolters Kluwer Health)

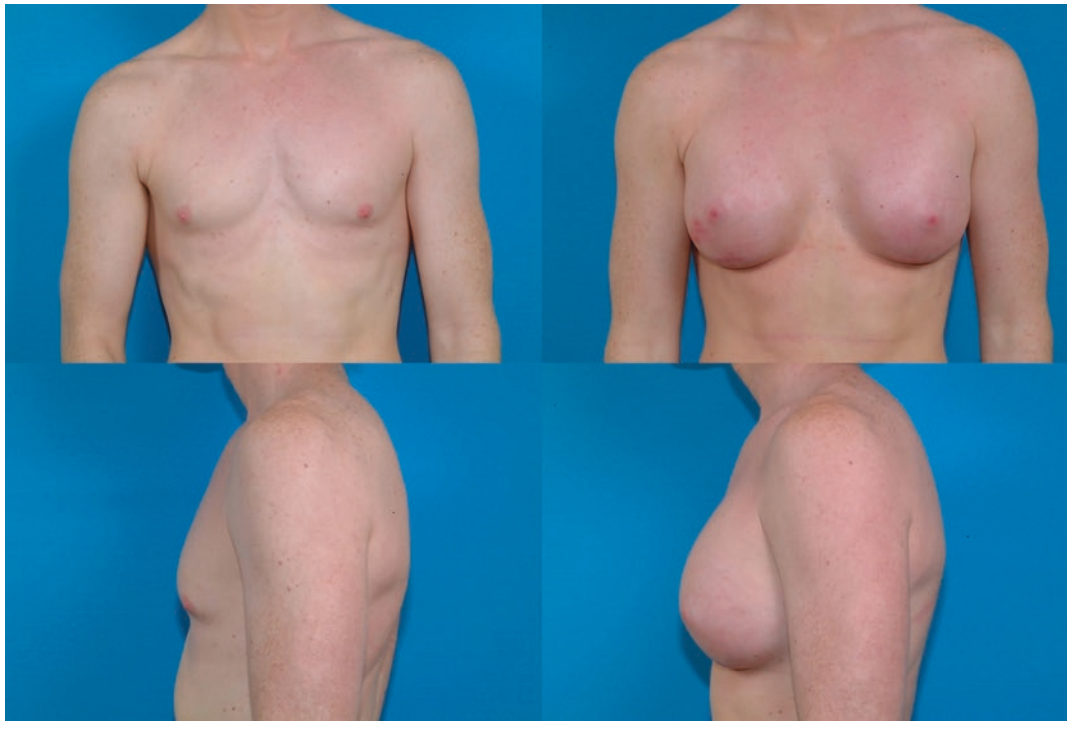


Fig. 3.30 This 28-year-old transgender martial arts instructor was treated with 550 cc smooth, round moderate profile subpectoral saline implants (Mentor Corp.). The patient is seen before (*left*) and 6 weeks (*right*) after surgery

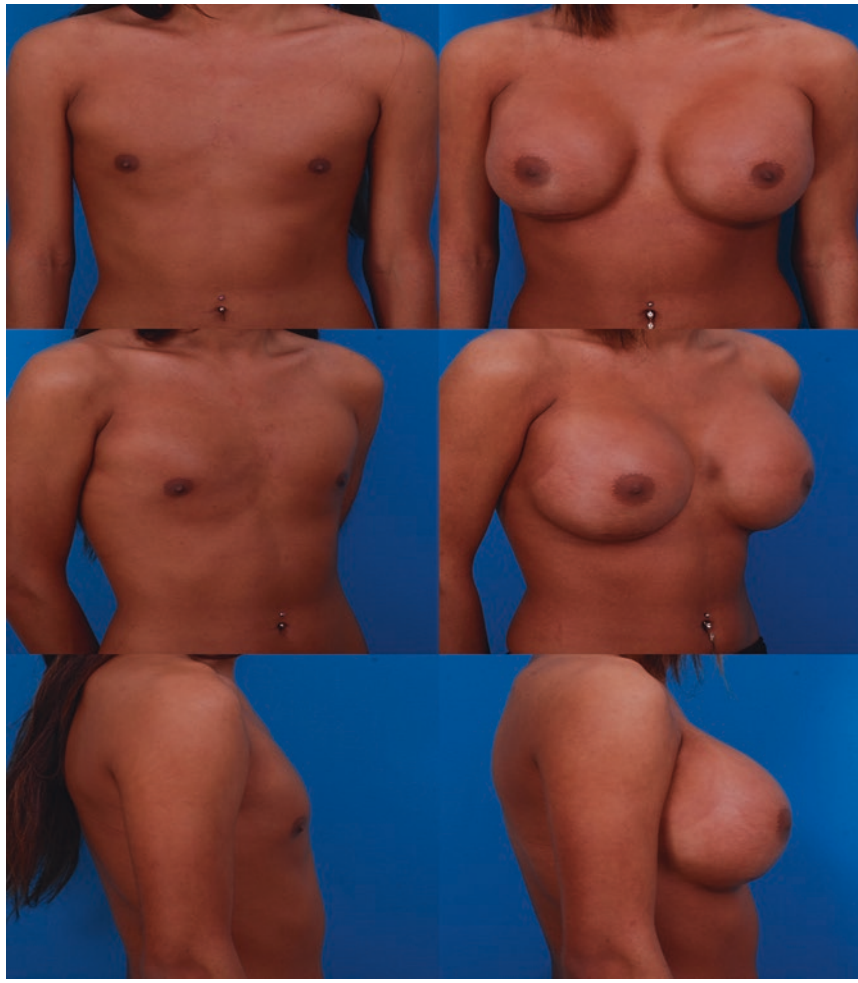


Fig. 3.31 This 23-year-old transgender male requested maximum breast size. The patient underwent breast augmentation in two stages, first using 400 cc implants, and, 4 months later, using smooth, round, high profile 900 cc saline implants (Natrelle Style 68HP) inserted subpectorally through the same inframammary incision. The patient is seen before (*left*) and 1 month after (*right*) the second operation

Conventional wisdom holds that large implant sizes are associated with higher complication rates and more reoperations [89–96]. However, this belief is not supported by evidence [83, 90].

Conventional wisdom holds that large implant sizes are associated with higher complication rates and more reoperations. However, this belief is not supported by evidence.

On the contrary, outcome studies reveal that patients with larger breast implants tend to report higher levels of satisfaction, with no increase in the complication rate [6]. Huang et al. [51] report an average implant volume of 438 cc. Counterintuitively, women with implant volumes <350 cc required significantly more secondary procedures and returned for reoperations earlier than patients with implants >350 cc [51].

Although preoperative measurements have been used in an effort to calculate appropriate implant volume before surgery [91–93], they produce relatively small estimated fill volumes

(average volume 289 cc in one study, with a maximum of 410 cc [92]). The "High Five" score sheet provides a maximum arbitrary volume of 400 cc for a patient with a base width of 15.0 cm [91], which is similar to the average fill volumes in many series [6, 84]. Adams [92] concedes that 20% of his patients voice postoperative concerns about their (small) size. Only 20% of surveyed surgeons use tissue measurements exclusively in determining implant size [36].

There are problems with basing volumes on tissue measurements [83, 94]. The base width is considered a critical dimension [91] but is overlooked if the breast is too narrow. The inframammary fold serves as a "fixed landmark"; however, it is known to drop after breast augmentation, whether by intention or not [73]. Measuring the soft-tissue thickness does not affect management if one consistently uses the submuscular plane. The skin's ability to stretch, even in nulliparous women, is well known and is usually not a limiting factor for volumes less than approximately 450 cc [83]. Ptosis is relevant to whether a simultaneous mastopexy is recommended, not implant size. An implant should not be expected to take up the slack [28].

No outcome study has been published to support the superiority of preoperative measuring systems in more accurately gauging implant size to the patient's wishes [6]. Adams and Mckee [93] recently published a systematic review of implant size selection. The authors conclude that tissue-based measurements are superior to other methods of size selection. Both Hidalgo [95] and Hammond [96], in their discussions, comment that the study rates the methodology used in published studies (favoring tissue measurements); the study does not evaluate and compare the quality of the aesthetic result itself. Remarkably, this method does not allow for patient input, which is likely to lead to patient dissatisfaction [96], and the need for redo surgery. Subordinating the patient's wishes to the surgeon's is astonishingly paternalistic, forcing many women to undergo secondary implant replacement at considerable extra cost and inconvenience. Patients are told to listen to and follow their surgeon's advice regarding the "limit of what the tissues can handle," and that failure to do so raises the risks of deformities [95]. Perhaps it is time for surgeons to listen to their patients [83, 94]. There is no evidence that the geographical area should be a guide (e.g., larger breasts in Texas and California [95]); the decision should be individualized.

Tebbetts [97] promotes a zero reoperation rate. To reduce reoperations, Tebbetts and Adams insist that their patients sign lengthy "Patient Education forms" [98, 99] that characterize large implant sizes as dangerous. Patients may elect to have a larger size (>350 cc), but in doing so they agree that the surgeon is not obliged to attend to any problems that may develop and that the patient bears full financial responsibility for any reoperations [99]. The surgeon does well to remember that if he believes an elective operation is unsafe, or ill-advised, he must decline to operate. He cannot argue "but she made me do it." No policy will excuse him from taking care of complications that develop. Reoperation rates are bound to be low if the surgeon discourages them. Reoperation rates are unreliable as a measure of patient satisfaction; the financial cost and inconvenience of implant replacement may make it impractical for many women [6].

Another technique used in an attempt to better gauge implant size is stuffing implants into a bra, an old technique that has received renewed attention [82] and one that is used by the majority of surveyed surgeons [36]. A reported advantage is that the patient takes ownership of her size selection (i.e., she does not blame her surgeon later for the wrong size) [20, 95]. Hidalgo and Spector [82] found that this method predicted an average implant size of 246 cc, less than the 276 cc mean implant volume for women who did not undergo this form of preoperative sizing. However, 16% of the patients in the referenced study would have preferred a different size, mostly larger. Implants of equal volume can fill a bra differently depending on their profile [51].

Adding to the difficulty in accurately predicting implant volume is the possibility that patients' opinions regarding desirable breast size may change after surgery [6]. All experienced plastic surgeons have encountered patients who are concerned that they might be too large shortly after surgery, only to wish later on that their breasts were larger.

Most plastic surgeons, even those performing tissue measurements, ultimately base their volume

determinations on their judgment and experience, prioritizing their patients' objectives. This clinical process is the basis of all cosmetic surgery. Volume can be a variable guiding implant selection; it does not need to be dictated by tissue measurements [96]. Most surgeons discuss implant volumes with patients rather than, for example, base width of the breast. Volumes are much more relatable.

My patients frequently show me images of celebrities and models on their handheld devices, and they review photographs of my patients with similar body characteristics and breast size. Actual photographs are most useful in managing patient expectations [100], and this is true for any cosmetic surgery candidate. Sometimes patients specify a certain size. More often we discuss a range of volumes. Photographic measurements are used later to compare pre- and postoperative breast shape and size [28], not for preoperative breast size determination. This method ("picking the size out of thin air") is admittedly not scientific. As Winston Churchill might have put it, making size determinations without any sort of measurements is absolutely the worst method possible, except for the alternatives. Clearly, any system that does not include patient choice is unlikely to achieve patient satisfaction with the result, which is the goal of cosmetic surgery [4–6]. There will always be a need for size changes. After all, women's opinions regarding breast size are known to change after surgery. Breast implants, surgery, surgeons, and patients are all imperfect. Reoperating when indicated is better than defending an unsatisfactory result and is part of postoperative care [83].

Three-Dimensional Computer Simulation

Roostaeian and Adams [101] claim that computer simulations using the Canfield VECTRA 3d camera (Canfield Scientific, Fairfield, NJ) closely resemble actual postoperative results ("98.4% accurate" in representing surface contour) and recommend that surgeons inform patients of its accuracy and promote this method to patients considering breast surgery. The experience of other investigators using the same system, however, is less favorable [100, 102]. Donfrancesco et al. [102] cite numerous shortcomings of the technology, concluding that only 18.7% of the simulations appeared equivalent to actual postoperative results. Nevertheless, these authors [102] report that 86% of patients *think* it is very accurate and recommend surgeons use it anyway to increase the conversion rate from 67% to 86%. Donfrancesco et al. [102] incautiously comment that the simulated image can appear "deceitfully good." In truth, the appearance of the cleavage area, lower pole width, breast width, and areola diameter are not accurately represented by the simulations [100, 103, 104]. This system does not reliably simulate the outlines of the lower poles on frontal views or the profile of the upper poles on lateral views [100, 103, 104]. The fundamental limitation of the present-day 3-D simulation is that this system is not based on actual measurement data. Without such data, the simulation relies on the guesstimates made by the software engineers. It is therefore not surprising that the simulations do not (and cannot) accurately depict postoperative breast shape [103, 104].

Roostaeian and Adams [101] claim that the time spent performing 3-D imaging, never more than a few minutes, is actually less than the time required for conventional photography. Hall-Findlay [100], however, finds more time is needed to manually adjust images to present a more realistic result and to explain to patients that the simulated image is not accurate. She also cautions that forcing implants to fit the existing breast base diameter will fall short of patient expectations [100].

As is so often the case in plastic surgery, 3-D technology sits squarely at the intersection of science and marketing [103]. "Three dimensional" sounds impressive. The system is expensive and looks sophisticated. Patients are likely to think their surgeon uses the latest technology. However, the simulations do not improve the reliability of implant sizing. Almost 1 in 5 patients (19%) would have preferred a different implant size, usually larger (18 of 19 patients), despite having undergone three-dimensional analysis [102]. The authors [101, 102] promote a higher "conversion rate" using this product (i.e., the percentage of patients seen in consultation that proceed to schedule surgery). Of course, our methods need to be based on proven efficacy, not just perceived efficacy. Otherwise

we risk blurring the line between scholarship and salesmanship (this subject is discussed in more detail in Chap. 1) [103].

This is not to say that computer simulation is a dead end. If real measurement data are entered with frontal and lateral references, it may be possible to develop a system that can truly simulate surgical changes and relate them to implant size. Shape may be more of a challenge. The true test will be in satisfying a patient who asks, "Show me how I will look with 300 cc implants. Now show me 350 cc." If successful, such a system would improve on perceived value and represent a real advance. In the meantime, perhaps plastic surgeons are best advised to show patients actual before-and-after photographs of women with similar breast characteristics and candidly inform them that computer simulations cannot yet accurately predict surgical changes of the breasts, and their actual result is likely to differ from a simulation [100, 103, 104].

Firmness

Another major patient concern is the feel characteristics of breast implants. In the author's study [6], 23.4% of patients reported that their breasts were too firm, similar to the findings of a multicenter study of saline-filled breast implants [81] and to a 5-year follow-up study comparing predominantly subglandular highly cohesive silicone gel implants [12].

Hidalgo [105] suggests that form-stable implants start with a Baker II level of firmness.

Whether any purported advantage of more highly cohesive silicone gel implants outweighs the potential disadvantage of excessive firmness merits investigation. Recent studies show that, despite the label "form stable," highly cohesive implants still develop folds and can cause visible rippling [106–108].

Breast Implant Selection: Silicone Gel Versus Saline

There is a general preference for silicone gel implants. Among surveyed members of the American Society of Plastic Surgery, about 80% of plastic surgeons more commonly insert silicone gel implants and 22% of these surgeons *always* use silicone gel implants [36]. Silicone gel implants have traditionally been favored for a more natural feel characteristic and possibly less wrinkling than saline implants [20, 109–111].

Handel et al. [110] compared feel characteristics among implant types, finding that textured implants, particularly Biocell, caused more wrinkling than smooth implants (10.0% versus 0.4%). The authors compared textured gel implants to textured saline implants, finding an advantage for textured gel implants. The investigators did not make the same comparison for smooth gel and smooth saline implants. Textured saline implants are well known for their increased wrinkling [111–113], which led many surgeons to make the transition to smooth implants long before other problems with textured implants became known [114].

In their study of Natrelle saline implants, Walker et al. [115] mailed questionnaires to patients regarding specific complications and satisfaction. The authors reported wrinkling in 13.7% of patients, implant palpability/visibility in 12.1%, and asymmetry in 12.2%. The authors compare these figures to 6-year core study data (1.2%, 1.6%, and 3.0% respectively) for women treated with Inamed silicone gel implants [116], finding an obvious advantage for silicone gel implants in terms of "look and feel." However, 69.5% of the saline implants were textured versus 41.0% of the silicone gel implants. Importantly, the authors evidently compared patient-reported survey responses with data reported by surgeons, undermining the validity of the comparison. All three authors were Allergan stockholders and all were either previously or currently employed by Allergan, which funded the study and was responsible for the study design and data analysis. There is no published "apples to apples" comparison of wrinkling rates between women implanted with smooth saline implants and smooth silicone gel devices.

There is no published "apples to apples" comparison of wrinkling rates between women implanted with smooth saline implants and smooth silicone gel devices.

Most women when holding both implants ex vivo will choose silicone gel. However, in vivo, in a subpectoral pocket, this difference may be negligible, particularly in a woman who has a moderate breast volume. An improved feel characteristic for silicone gel over saline has long been assumed, but not subjected to evaluation in the form of a measurement study or patient-reported outcome study. Many surgeons prefer silicone gel implants for very thin patients in whom a very small difference in feel characteristics may be more noticeable.

As a result of the moratorium imposed by the US Food and Drug Administration, only saline implants were available in the United States from 1992 to 2006. American surgeons were forced to gain experience using these implants exclusively. Many Americans felt their capabilities were compromised by the FDA decision and celebrated the return to market of silicone gel implants. In Europe, there was no such moratorium, and form-stable silicone gel implants are inserted in the majority of women [37, 117]. Many international speakers make clear their disdain for round and saline implants. English surgeons Mallucci and Branford [89] predict that the recent availability and superiority of anatomical implants will lead to a tide change in the United States.

In a 2008 counterpoint editorial, Rohrich and Reece [118] describe a number of advantages of saline implants compared with silicone gel. The incision is typically 3–4 cm, versus 5–6 cm for silicone gel implants [119]. (This is not a major advantage if the incision is still kept hidden in the inframammary crease.) If the patient with a saline implant develops a rupture, it is clinically obvious and the leaked saline poses no problem. Detection of a silicone gel implant may be unnoticed or require an expensive MRI or an ultrasound examination – imaging methods that are not 100% reliable [120]. When saline implants are used, there is no need for MRI screening examinations (although recommended, few patients follow the FDA guidelines to have an MRI scan routinely after 3 years and then every 2 years [121]).

The benefits of saline as a filler at the time of redo surgery are seldom discussed in the literature. This is highly relevant, as 10-year core studies find that 29.7–36.5% of women undergo redo surgery [67, 115, 122]. Silicone gel leaking into the capsule can increase the risk of capsular contracture [114]. A capsular contracture is more easily treated in the presence of a saline implant, usually with simply an open capsulotomy; there is usually no need for a capsulectomy, site change, or implant exchange (or acellular dermal matrix), making the revision surgery much less expensive and easier for patients [114]. The capsule around a saline implant does not need to be removed; it is gradually absorbed [123]. Satisfaction rates are >86% for both saline and silicone gel implants [6, 81, 115, 118, 124, 125]. The implants look the same [20]. Rohrich and Reece [118] conclude, "Saline implants have a proven safety record and are approved by the Food and Drug Administration. These implants have earned the right to remain a suitable and excellent option for patients desiring breast augmentation."

A relevant but seldom-mentioned factor in implant selection is profitability. Allergan stopped providing a warranty a few years ago on its saline implants but continued its warranty on silicone gel implants. A manufacturer representative told me there was "just no profit in saline implants." Similarly, a Sientra sales manager informed me that Sientra does not manufacture saline implants "because the price point just isn't there." Consequently, a surgeon using Sientra implants exclusively cannot offer this option to his or her patients. Plastic surgeons who purchase saline implants are familiar with the pained expression on the face of the sales representative when placing an order for saline implants. To its credit, Mentor Corp. still provides saline implants and a 10-year warranty at no extra charge to the patient.

Breast Implants: Smooth Versus Textured

Textured implants were designed to reduce the frequency of capsular contracture and to provide greater tissue adherence so as to avoid implant rotation, which is relevant to shaped implants [79]. However, texturing raises the risk of rippling and deflation compared with smooth implants [111–113], and several studies suggested no advantage in reducing capsular contracture rates when the implant is placed subpectorally [67, 126, 127]. Most plastic surgeons have

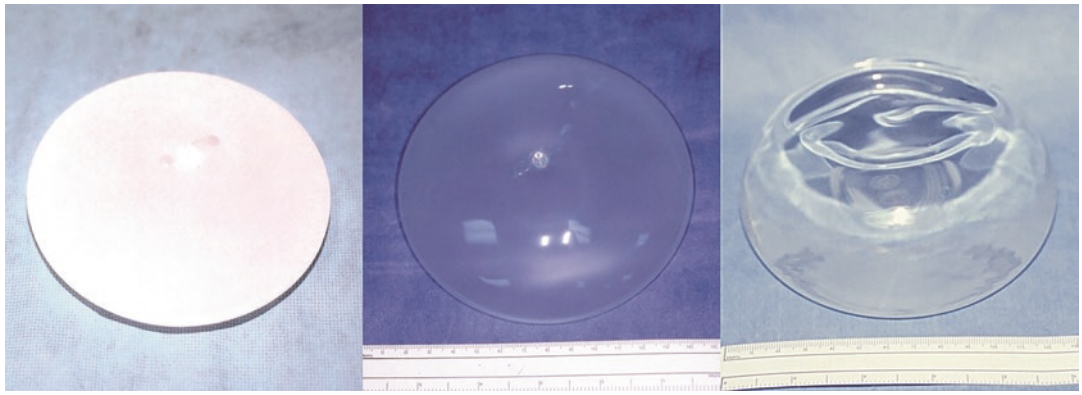


Fig. 3.32 Examples of a textured round saline implant (*left*), smooth, round saline implant (*center*), and smooth, round silicone gel implant (*right*)

returned to using smooth, round implants (Fig. 3.32) [36], limiting the use of texturing to shaped implants. Importantly, texturing has been linked to late seromas, double capsules, and anaplastic large cell lymphoma (ALCL) [113, 128].

Breast Implants: Round Versus Shaped

Silicone gel implants have evolved since their introduction in 1962 [129]. From 1962 to 1992, over 95% of all breast implants were silicone gel implants; only 5% were saline filled [130]. First-generation implants had a firm gel and a thick elastomeric shell [130]. Second-generation implants, implanted in the 1970s, had much thinner envelopes [130].

Deferring to surgeons' and patients' preference for softness (and mistaking capsular contractures for implant firmness), manufacturers made their second-generation implants with a thinner shell and a more "fluid" (or less viscous) gel (1970–1982). This implant design was notorious for leaking and the shell disintegrated within 12 years in 95% of patients [130]. In response to this problem, third-generation implants (1982–1992) featured a multilayer shell with a barrier layer, allowing less diffusion of silicone ("bleed") and a more tightly cross-linked gel, known as cohesive gel. Advertisements depicted cohesive gel implants with a piece cut out to show that it does not leak if you cut into it. Some surgeons consider silicone gel implants with refinements in the manufacturing process, sold after the FDA moratorium began in 1992 "fourth-generation" implants (1993–present), and the more cohesive form-stable gummy bear "fifth generation" implants (1993–present, 2012–present in the United States) [131].

Others consider these implant styles simply modifications of an already-cohesive gel implant, deemphasizing the incremental differences in the degree of silicone cross-linking and labeling them all "third-generation" implants. For example, the silicone gel in Mentor's gummy bear implant, the CPG, has 14.5% cross-linking, compared with 11% for the round MemoryGel implant (available since 1985), plus a textured surface [132]. (Unfortunately, the term "form stable" implies that other implants are "unstable.")

Shaped implants were introduced in the early 1990s promising a more natural breast shape. The concept was to have the breast take on the shape of the implant, which has a teardrop shape, rather than expecting the implant to mold to the shape of the breast. Some surgeons talked of a "one breast" feel [133]. The US Food and Drug Administration approved the Sientra HSC gel implant in 2012. Allergan's Natrelle Style 410 implant and Mentor's MemoryShape implant were approved in 2013. Implant firmness increases along with form stability. The Natrelle 410 implant is more form stable, and stiffer, than the MemoryShape implant, which is in turn more form stable than the Sientra HSC implant [79].

Shaped implants have long been considered to provide a superior appearance. After all, the natural breast is not round, but resembles a teardrop. Hence

the rationale for the labels "anatomic," "teardrop," "contoured," or "biodimensional" (Fig. 3.33).

Not all surgeons were convinced that shaped implants were superior to round implants. Hidalgo [134] observed that contoured implants could appear less natural than round implants, too elongated vertically (McGhan Style 468) or too wide horizontally (Mentor Contour Profile).

Al-Ajam et al. [135] compared aesthetic outcomes of round (Inspira round, Allergan Inc., Irvine, CA) and anatomic (Inamed Style 410) implants by showing pre- and postoperative photographs of 60 consecutive patients treated by a single surgeon (33 round, 27 anatomical) to 22 plastic surgeons. All implants were subpectoral and inserted using an inframammary incision. There was no significant difference in aesthetic scores. The raters were unable to accurately identify implant shape. The authors [135] found the negative findings particularly impressive because the preoperative images were also available to the panel. Al-Ajam et al. [135] recommend caution in advising patients that anatomical implants are cosmetically superior. The authors disclosed no conflicts of interest and received no financial support for their research.

Hidalgo and Weinstein [136] reported a study in which a round implant was inserted in one breast and a shaped implant of similar volume was temporarily inserted in the other breast during surgery. Patients were photographed sitting upright in surgery before the shaped implant was replaced with a round implant to complete the procedure. Ten plastic surgeons and ten laypeople rated the photographs. Plastic surgeons were unable to correctly identify the implant type in most cases, and there was no significant difference in aesthetics comparing the two implant types. This study differed from previous ones in

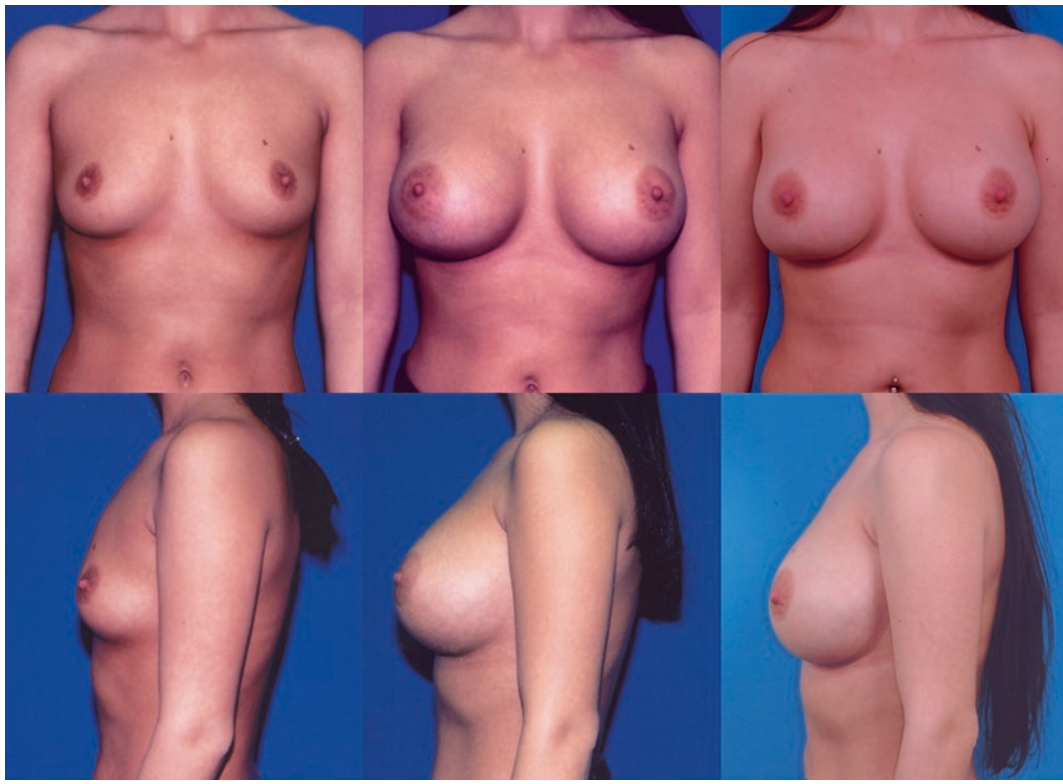


Fig. 3.33 This 22-year-old woman is seen before (*left*) and 4 months after (*center*) the insertion of teardrop-shaped, textured 460 cc saline implants (Silimed). These shaped implants were inserted during the silicone gel moratorium and are different from form-stable silicone gel implants. She was unhappy with palpable rippling (not visible in photographs). She returned 5 years later and the implants were replaced with smooth, round silicone gel implants, 500 cc on the right side and 550 cc on the left side (Mentor Style 7000). She is seen 2.5 months after the second procedure (*right*)

using the patient as her own control. It also included the opinions of non-plastic surgeons. The authors reported no financial interest with the breast implant manufacturers and no outside funding for their study.

At a recent meeting of the American Society for Aesthetic Plastic Surgery, plastic surgeons in the audience were shown patient photographs and asked to identify which patients had shaped implants and which had round [137]. The ratio of correct to incorrect responses was 45:55.

Not all comparisons find equivalence of round and shaped implants. Friedman et al. [138] surveyed laypeople and plastic surgeons who evaluated postoperative photographs. With respect to "breast beauty," both categories scored the photographs similarly. However, round implants achieved significantly higher ($p < 0.001$) scores for "naturalness" and upper pole aesthetics. Plastic surgeons were unable to reliably identify implant types.

Spear [139] recently compared the physical attributes of smooth, round implants versus shaped implants manufactured by Allergan (Style 410), Mentor (MemoryShape), and Sientra using a 1 (worst) to 10 (best) scale. He rated the feel characteristics of a smooth, round implant as 10, slightly better than the form-stable varieties, which were rated either 8 or 9, and there was no shape advantage for the contoured implants (the Style 410 and MemoryShape implants received 8s). The author does not use more cohesive form-stable implants because they have not been shown to produce a superior outcome [20, 36], and their disadvantages include firmness, malrotation, expense, and texturing [136].

Allergan Inc. recently introduced a more cohesive smooth, round, silicone gel implant (Natrelle Inspira Cohesive), with the slogan "Gummy Goes Round" [140]. The manufacturer is clearly reacting to the problems associated with textured implants. After long extolling the benefits of a teardrop shape, the manufacturer now promotes upper pole fullness (previously derided as "fake"). The manufacturer states that the highly cohesive gel "is designed to prevent downward movement, helping the implant maintain a form-stable upper pole." The mechanism for this purported advantage is unclear. The old thinking was that a textured surface helped to minimize movement [79]. The cost of a Natrelle Inspira Cohesive implant is much higher than a less cohesive silicone gel implant, and the implant is firmer, similar to a shaped form-stable implant.

Surgeons and patients may find the gummy bear implant too firm [105]. Even less cohesive non-form-stable saline and silicone gel implants may be judged too firm by patients. A surprisingly large number of women (23.4%) treated with "soft" saline implants report that their breasts are too firm; few women (0.9%) find their breasts too soft [6]. An attractive characteristic of a woman's breast, but one that is often overlooked, is the "jiggle." A durometer closer to natural breast tissue would be expected to provide more of this desirable quality.

It may be intuitive to offer numerous implant shapes to fit the myriad of patient breast shapes and sizes, but there are practical considerations to consider [105]. Offering a patient a choice between silicone and saline, and moderate plus versus high profile already means that four different implants are needed for a specific volume. Allergan now offers 12 anatomical shapes, 3 heights, 4 projections, and 2 gel options for a total of 205 different silicone implants for one volume [141]. Doctor's offices and surgery centers cannot be expected to have thousands of implants in stock. The downside of this variety is that patients may receive a certain implant shape not because their anatomy calls for it, but because that is what is stocked. Moreover, as discussed, there is no evidence that different shapes offer superior outcomes. Simplicity can be a virtue.

Measurements

Measurements confirm the clinical observation that the lower pole level drops after a breast augmentation (Fig. 3.34) [28]. Breast mound elevation (i.e., elevation of the level of maximum breast projection) is minimal (< 1 cm). Breast implants do not significantly affect the nipple level. The mean areola diameter widens almost 1 cm [28]. Consequently, breast augmentation should not be considered an option to correct minor degrees of ptosis by "taking up the slack."

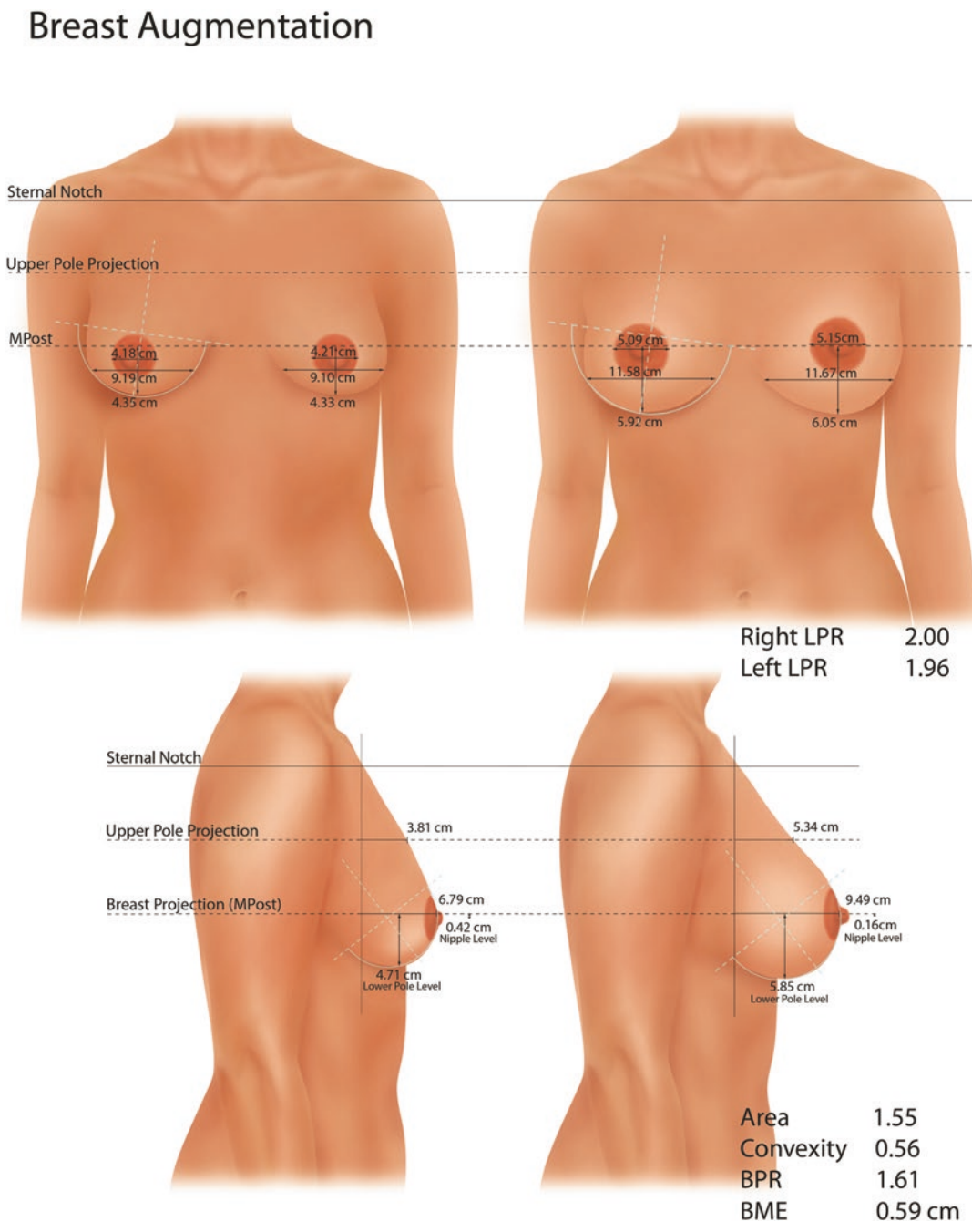


Fig. 3.34 Breast shape before (*left*) and after (*right*) breast augmentation. Upper pole projection and breast projection are increased. The lower pole level drops. Nipple position is minimally affected. The upper pole contour is linear before surgery and parabolic after surgery. The areola widens approximately 1 cm. These mammographs were created based on mean breast measurements among study patients. *MPost* maximum postoperative breast projection, *LPR* lower pole ratio, *BPR* breast parenchymal ratio, *BME* breast mound elevation (Reprinted from Swanson [28] with permission from Wolters Kluwer Health)

Patients need to be informed that implants are unlikely to change their nipple level, and their areola is likely to expand (Fig. 3.11) [28]. This information is useful for the mildly ptotic woman who already has large areolae and is considering a simultaneous mastopexy; the areola reduction provided by the mastopexy may tip the balance in favor of augmentation/mastopexy [28]. Breast area increases approximately 45% after augmentation. Volume varies as the square of area. Therefore, breast augmentation increases breast volume by 110%, on average.

> Breast augmentation should not be considered an option to correct minor degrees of ptosis by "taking up the slack."

Breast Asymmetry

Perhaps surprisingly, many women are unaware of existing breast asymmetry. They will be much more discerning after surgery. Hence the importance of pointing out asymmetry before breast augmentation. Postsurgical explanations are usually regarded as surgeon excuses. Commonly, one breast and one nipple sit lower than the other (Fig. 3.35). Many women will accept minor degrees of asymmetry if they are informed that these variations are normal. If a patient requests improvement in nipple symmetry, her best option may be vertical augmentation mastopexy, as discussed in Chap. 7.

Chest Wall Abnormalities

Two common chest wall abnormalities are a sunken chest, "pectus excavatum," and a prominent sternum, and both may be camouflaged by a breast augmentation (Figs. 3.36 and 3.37).

Tuberous Breasts

Tuberous (also called tubular) breasts are narrowly based with overly full areolae [142]. The name derives from the Greek word "tuber," which describes vegetables such as squash and cucumbers. There is considerable subjectivity in diagnosing this breast shape. Some authors consider it rare [143] and others state that it is common [144]. Fortunately, failure to diagnose this deformity, thought to be congenital [143], is seldom a problem because subpectoral implants are usually effective in expanding the base (Figs. 3.38 and 3.39), although areola fullness persists (Fig. 3.39) [142]. Patients are often gratified with the result of breast augmentation and may not be concerned about areola fullness. Treatment must be balanced against the additional periareolar scarring involved in surgical correction.

Numerous treatments of the tuberous breast are recommended, including periareolar resections, radial scoring of the breast parenchyma, parenchymal flaps, and staged tissue expansion [142–144]. It is not clear that scoring of breast tissue is necessary [145], and the postoperative areola may appear too wide after periareolar mastopexies [142, 143, 145]. The usefulness of shaped implants is open to question [105]. When the implant is placed subpectorally, the breast tissue expands and the constricted base is usually corrected. The inframammary fold drops by virtue of implant insertion without the need for additional dissection. The author prefers to remove herniated areolar breast tissue using a vertical mastopexy – essentially converting a tuberous areola to a nontuberous one [72]. A circumferential incision is combined with a conservative lower-pole skin/parenchymal resection so as to relieve periareolar wound tension, displacing it to the vertical pillar repair. This procedure, illustrated in Chap. 7, also corrects any coexistent ptosis [72].

Nipple Sensation

Almost all women (95.6%) undergoing breast augmentation report that nipple sensation is important to them [6]. Temporary nipple numbness is common (39%) after breast augmentation [6, 42, 124, 146]. However, persistent numbness is unusual (2.3%) in the author's experience (mean follow-up time 33 months) [6]. Other studies with follow-up times from 6 months to

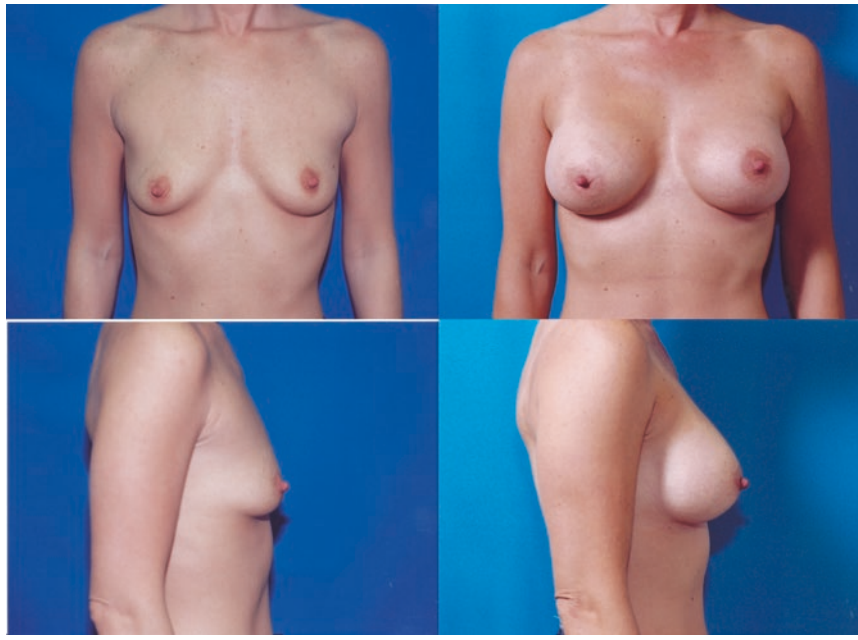


Fig. 3.35 This 38-year-old woman underwent a breast augmentation using 280 cc smooth, round moderate profile subpectoral saline implants (Mentor Corp.). She is seen before (*left*) and 5 months after surgery (*right*). Her right nipple remains lower than the left nipple

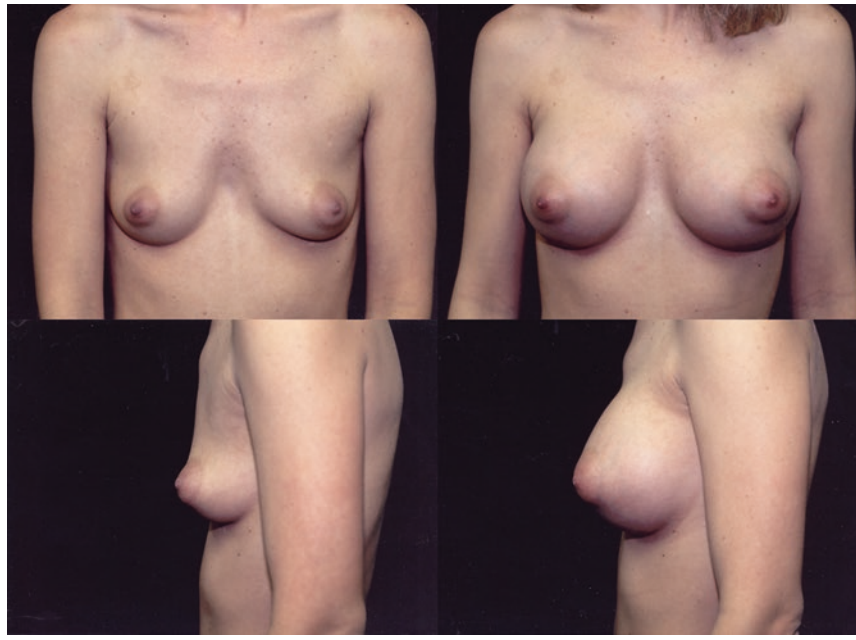


Fig. 3.36 This 32-year-old woman has a sunken chest appearance (*left*), improved by breast implants. She is seen 6 weeks after (*right*) insertion of round subpectoral saline implants (Mentor Corp.), inflated to 380 cc on the right and 370 cc on the left

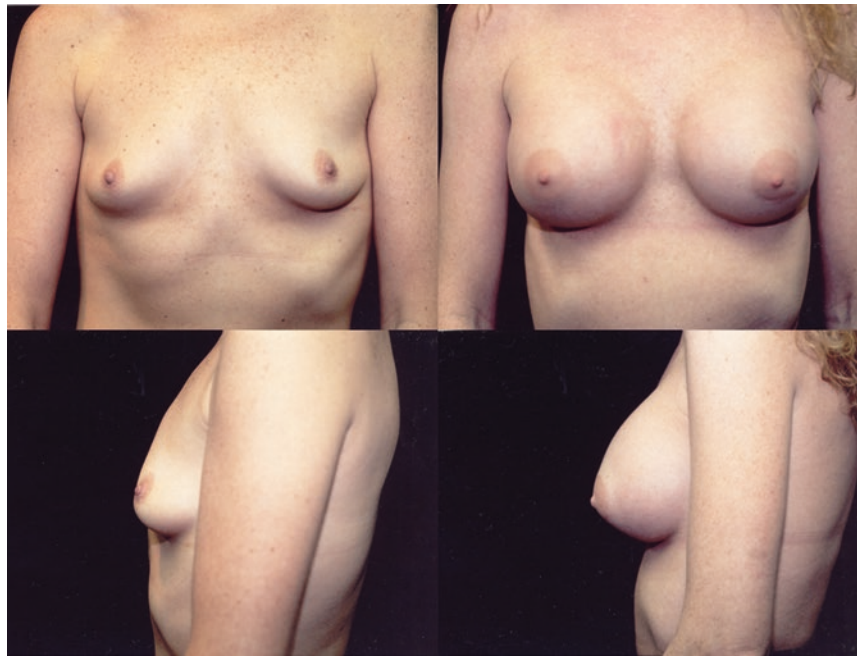


Fig. 3.37 This 27-year-old woman has a prominent sternum (*left*), which is made less obvious 7 weeks after (*right*) insertion of round subpectoral 360 cc (McGhan, now Allergan Inc.) saline implants

5 years report nipple numbness in the range of 12–20% [10, 12, 147]. The author prefers to use blunt finger dissection laterally in creating the subpectoral pocket, in an attempt to preserve the lateral cutaneous branch of the fourth intercostal nerve, which provides the dominant innervation of the nipple and areola [148].

Interestingly, studies consistently find that some women have *improved* nipple sensation after breast augmentation [6, 10, 12], with 23% of women reporting improved right nipple sensation after surgery and 26% reporting improved left nipple sensation. The physical basis for this phenomenon, also reported after breast reduction [147], is unknown. It is possible that such a subjective improvement may be caused by an enhanced self-image related to the breasts [2, 6, 10, 12, 22, 124, 125, 146]. Nipple erectile function is typically preserved, with unilateral loss of erectility in only 1% of patients [6]. Reassuringly, almost all women (98.5%) who experience at least temporary nipple numbness would repeat the surgery [6, 149].

The 2.3% rate of nipple numbness after breast augmentation compares with a rate of 9.5% for mastopexy, 4.9% for augmentation/mastopexy, and 21.5% for breast reduction [150].

Recovery

The mean overall pain rating is 5.9 on a scale of 1 (worst) to 10 (best). This pain rating compares to 4.2 for mastopexy and 5.3 for augmentation mastopexy, suggesting that most of the discomfort is caused by the submuscular dissection [150]. Patients report using prescription analgesics for an average of 5.4 days. On average, patients resume driving 5.4 days after surgery and are off work for 6.6 days. Patients report being "back to normal" approximately 25 days after surgery and being able to sleep comfortably 18 days after surgery [6]. Women often inquire as to when they can sleep on their side again. The mean response from surveys is 3 weeks [6]. Patients reported being "back to normal" 25 days after surgery, on average [6].

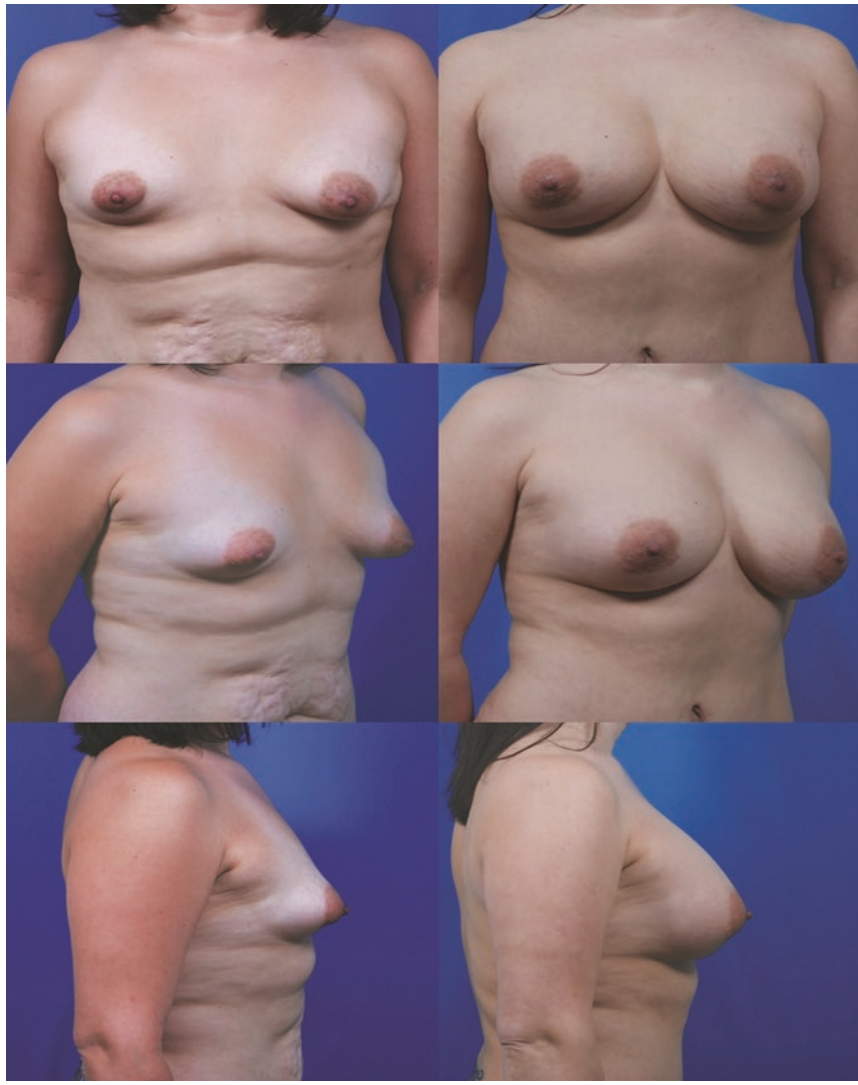


Fig. 3.38 This 28-year-old woman with tuberous breasts is seen before (*left*) and 3 years after (*right*) a subpectoral breast augmentation using smooth, round moderate plus profile silicone gel implants (Mentor Corp.) inflated to 400 cc on the left side and 425 cc on the right side. A periareolar approach was used, as requested by the patient. Left lateral photographs and measurements are provided in Fig. 3.20. This case demonstrates expansion of the breast envelope without a prepectoral dissection or parenchymal scoring. Oblique views show that the left areola fullness (*center*, *left*) is no longer apparent (*center*, *right*)

Recovery times that are not based on patient-reported outcome surveys tend to be much shorter. Tebbetts [151] and Gryskiewicz [152] claim that >90% of their patients are able to resume full normal activities <24 h after a subpectoral breast augmentation. These normal activities include lifting young children, driving a car, going shopping, going to work, being free of narcotic pain medications, and being able to lie prone on their breasts for at least 15 min [151]. Tebbetts [151] believes that reducing the surgery time to an average of 24 min helps to expedite the patient's return to normal by 80%. He espouses a regimented time-efficient style inspired by Toyota Corporation. The adoption of a commercial assembly-line method has its advocates, but most surgeons agree that patient care differs from product manufacturing [153].

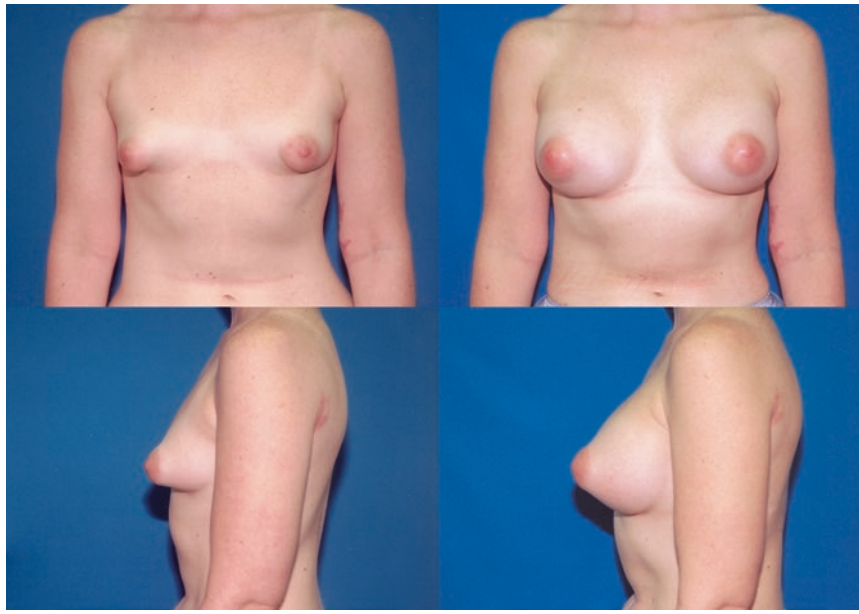


Fig. 3.39 This 29-year-old woman was treated for tuberous breasts using an inframammary approach, no different from any other breast augmentation. No parenchymal scoring was performed. She is seen before (*left*) and 14 months after (*right*) subpectoral insertion of 400 cc smooth, round moderate profile saline implants (Mentor Corp.). The inframammary fold has dropped without evidence of a double bubble. This patient was not concerned by the fullness of her areolae, which is still apparent after surgery, although made less conspicuous by implant filling the lower pole

Gryskiewicz [152] instructs his patients to perform arm exercises, lift weights up to 30 lbs., and lie prone on their breasts for 15 min pressing their breasts against a hard surface such as a carpeted floor or a cutting board under their mattress, starting the evening of surgery and continuing this practice daily for 2 years. Fortunately, few patients would submit to such an onerous daily task. Failure to comply may be used, unfairly, to blame them for a capsular contracture – did you do those exercises the way you were supposed to? Although some surgeons have their patients massage their breasts, no evidence supports this recommendation [20].

Patient Satisfaction

Breast self-consciousness drops from 86% before surgery to 13% after surgery. Improved self-esteem (92% in the author's study [6]) or self-confidence is well documented [2, 6, 10, 22, 124, 125, 154]. About two-thirds of patients report an improved quality of life [6, 155].

Not surprisingly, a significant correlation exists between the result rating (mean 9.3 on a 1–10 scale [6]) and a lack of reported complications [2, 6]. No significant correlation exists between the result rating and patient age, length of time considering surgery, smoking history, primary versus secondary surgery, bra cup size, pain rating, nipple numbness, or surgery in combination with other plastic surgical procedures. Interestingly, women with larger implant sizes tended to report higher result ratings, reaching significance ($p < 0.01$) when combined with data for augmentation mastopexy [150].

Remarkably, the *median* result rating after breast augmentation on a scale of 1–10 is 10 [6]. The 98% of patients in the author's study [6] who reported that breast augmentation met or exceeded their expectations is similar to other studies [124, 125]. Almost all women would repeat the surgery [6, 10, 124, 125] and recommend it to others [2, 6].

Complications

Such a wide range of complication rates is reported in the literature [81] that these figures lose meaning. So often the complication rate depends on how the surgeon defines a complication [6]. Perhaps the most useful definition, and one that allows inter-study comparisons, is the patient's perception of a complication, which is 10% [6]. This rate is less than the 18% rate recorded clinically for these patients [72]. Patients tend to underreport capsular contractures, implant rippling, and hypertrophic scars as complications [6]. The percentage of patients reporting scar dissatisfaction (1.3%) [6] compares favorably with other studies [12, 25, 124], confirming the adequacy of an inframammary approach. Complications of breast augmentation are discussed in detail in Chap. 4.

Fat Injection

Fat injection of the breast [156] has gained popularity over the last decade. To evaluate its effectiveness, Spear and Pittman [157] undertook a prospective study that included direct measurements, two- and three-dimensional images, mammograms, and magnetic resonance imaging in ten consecutive patients undergoing breast augmentation using autologous fat. The average volumes of injected fat were 236 cc in the right breast and 250 cc in the left breast. The mean volume change based on three-dimensional imaging was 85.1 cc (36% retention) and 98.1 cc (39.2% retention) respectively. Blinded observers found substantial improvement in only one of the ten patients.

The authors were concerned regarding imaging artifacts. Five of the ten patients required follow-up imaging. Fat necrosis is evident in up to 25% of mammograms after fat injection [158]. Oil cysts can be detected by ultrasound or mammography in 15–25.5% of patients [159, 160]. Repeated (two or three stages [160]) treatments are usually needed.

Simultaneous implant exchange with fat injection (SIEF) [161, 162] and injection of the breasts with abdominal fat have been reported [163]. Fat injection can be used as an adjunctive method at the time of breast augmentation and to treat contour irregularities [164].

Fat injection cannot duplicate the results of a breast implant, but may be the only option for the unusual patient who cannot be treated with an implant. Some women with connective tissue disease, chronic fatigue, or pain syndromes may prefer not to have a foreign body because of concerns about the immune response, whether or not there is a factual basis (breast implants have not been linked to cancer or autoimmune diseases [165, 166]). Saline implants are a good alternative for women who have concerns about silicone implants. In most cases, these concerns can be assuaged with a detailed and candid discussion of risks. Although simultaneous liposuction is a welcome side effect for some patients, contour irregularities after aggressive liposuction can occur, especially in thin patients.

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Complications of Breast Augmentation

4

Abstract

Core studies find that the rate of capsular contracture is between 8% and 19%. Some researchers claim that bacterial biofilm infections cause capsular contracture. However, there are problems with a purely infectious etiology. Positive and negative bacterial cultures from implants and capsules have been obtained from women with and without capsular contractures. If an infected capsule were the cause of contracture, capsular preservation would virtually guarantee treatment failure. Yet, open capsulotomy alone is 77% effective after one release. The recurrence rate of 23% overall after open capsulotomy (and 14% for patients with intact implants) compares favorably with recurrence rates reported after capsulectomy, which can range from 25% to 53.4%.

Some investigators use acellular dermal matrix (ADM) to reduce recurrence risk, but this material comes with additional risks, including seromas and infection. Many investigators using ADM receive financial support from the manufacturer.

Core studies using magnetic resonance imaging reveal rupture rates in the range of 13–17.7% for round and shaped silicone implants respectively, at odds with early claims that highly cohesive implants are less likely to leak. Folds still occur. Form-stable implants can be too firm, and may rotate.

Importantly, textured implants are linked to anaplastic large cell lymphoma. The patient should be informed of the added risk with texturing so she can participate in implant selection and possibly select a smooth device. Some investigators recommend a 14-point risk-reduction plan that includes nipple shields and triple-antibiotic irrigation. However, these extra measures have little scientific foundation. Saline implants should not be overlooked in view of their safety, lower cost, and high patient satisfaction.

Individual risk stratification and chemoprophylaxis do not prevent venous thromboembolism. SAFE (Spontaneous breathing, Avoid gas, Face up, Extremities mobile) anesthesia maintains pulsatile blood flow in the calves. Ultrasound surveillance is highly accurate for detecting thrombi.

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Most surgeons agree that such complications as deep venous thrombosis, hematoma, implant deflation, or an infection requiring implant removal are complications. There is less agreement regarding cosmetic concerns. Implant stiffness is an example. Even without a capsular contracture, many women find their breasts too firm after a breast augmentation [1]. Stiffer, form-stable implants may approach the firmness [2], and be difficult to distinguish from a mild, Baker II capsular contracture [3]. Similarly, superior implant malposition can mimic a capsular contracture [4]. Asymmetry is common before surgery [5] and common after surgery [6]. "Bottoming out," implant malposition, or mild symmastia may or may not be considered complications. Nipple numbness is common after breast augmentation [1] but seldom recorded as a complication.

Reoperation rates are unreliable markers of quality [1, 7]. Many factors affect reoperation rates, including convenience. Those surgeons who operate out of their own facilities may be able to make the price favorable for a patient to have a revision, and be inclined to do so to make her happy. This may not be possible for a surgeon working in a hospital or surgery center in which he or she cannot control the pricing. The surgeon's level of perfectionism is as relevant as the patient's. Some surgeons discourage reoperation, believing that low reoperation rates are a quality indicator and a sign of surgical prowess [8]. Reported complication and reoperation rates tend to be so broad that they lose any value [1]. Then of course there is the human factor. Baker [9] is fond of saying at meetings, "When a surgeon quotes a complication rate, double it, including mine." No doubt complication rates would be much higher if plastic surgeons reviewed each others' case series.

Capsular Contracture

The most common complication after breast augmentation, and the most frequent cause of reoperation, remains capsular contracture [6]. Therefore, this topic dominates any discussion of breast implant complications. Manufacturer-sponsored core studies report rates between 8.1 and 18.9% [10–14]. My own rate of 6% over a 10-year period is slightly lower than this range, possibly affected by the high percentage (94%) of patients who received saline implants [6]. Single surgeon series tend to report lower rates than core studies, which are regarded as most robust [15, 16].

A capsular contracture denotes the deformity caused by excessive pressure on the implant. The lowest surface area-to-volume relationship is a sphere, caused by the ratchet-like effect of myofibroblasts [16–21] and abnormal collagen deposition [18, 19, 22]. Regardless of the implant shape, the appearance becomes more spherical, causing an unnatural bulge (Fig. 4.1).

Baker [24] classified capsular contractures into four types. Type I is no capsular contracture. Type II is a contracture that is felt but not visible. Type III is visible and Type IV includes pain.

Etiology of Capsular Contracture

Plastic surgeons have long been puzzled by this complication. In 1981, Brody and Latts [25] half-joked that the Nobel Prize awaits two discoveries – the cure for cancer and the solution to breast capsules. These authors [25] also remarked that the mystery is not why some women develop capsular contracture but rather why so many do not, referencing wound contraction that is a normal part of the healing response in skin wounds. Its cause remains unknown even today. In the 1970s, excessive firmness was believed to be caused by the implant itself [26]. Softer implants were developed in a misguided effort to solve the problem. Unfortunately, these second-generation implants leaked more than the first-generation implants; 95% were ruptured 12 years after implantation [26]. Leaking silicone gel was frequently associated with capsular contracture. Capsular contracture rates of 40% or more were common, and they were often bilateral [27–29]. Leaking silicone gel is believed to cause inflammation and incite capsule formation [30, 31]. Closed capsulotomies, now a condemned

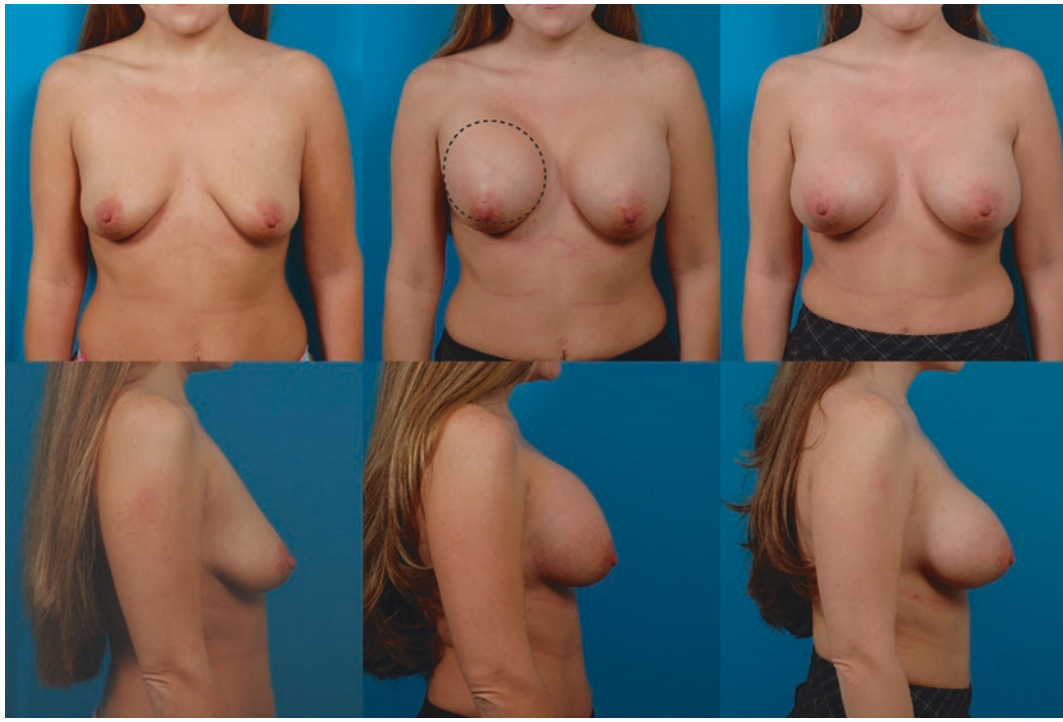

Fig. 4.1 This 29-year-old woman developed a Baker III capsular contracture after her breast augmentation using Mentor Corp. (Santa Barbara, Calif.) smooth, round, moderate plus profile saline-filled implants inflated to 420 cc. She is seen before (*left*) and 1 month after her breast augmentation (*center*). Two months after her breast augmentation she underwent a right open capsulotomy with reinsertion of the same implant in the same subpectoral pocket. The hatched line indicates the capsulotomy incision. She is seen 1 month after the capsulotomy (*right*). She had no recurrence (Reprinted from Swanson [23]. With permission from Wolters Kluwer Health)

treatment, just aggravated the problem by spilling more silicone gel [15, 17, 26]. Third-generation implants included an extra barrier layer [26, 32], which reduced implant rupture rates, and capsular contracture rates started to decline.

Infection: The Case For and Against

The conventional explanation for capsular contracture is chronic inflammation caused by a bacterial biofilm [15–18, 32–36]. Infection as a factor predisposing to capsular contracture is supported by numerous microbiological studies that have cultured organisms from the capsule [37–40]. Many investigators subscribe to an infectious etiology [32, 33, 35, 38, 41–45] and recommend numerous steps to optimize sterility at the time of implant insertion. Reaching beyond a correlation, some researchers now claim that bacterial biofilm infections *cause* capsular contracture [38–40]. Tamboto et al. [43] investigated capsular contracture using a porcine model, injecting *Staphylococcus epidermidis* around miniature silicone gel implants. Capsular contractures developed in 28 of 36 inoculated pockets (78%), but also occurred in 7 of 15 uninoculated pockets (47%).

There are problems with the theory of a purely infectious etiology [23]. Positive and negative bacterial cultures from implants and capsules have been obtained from women with and without capsular contractures [39, 40, 46–49]. Jacombs et al. [42] detected 20-fold (72-fold in vitro) more bacteria attached to textured implants than smooth implants in their porcine model, and more growth of biofilm, despite similar capsular contracture rates. Capsular contractures often

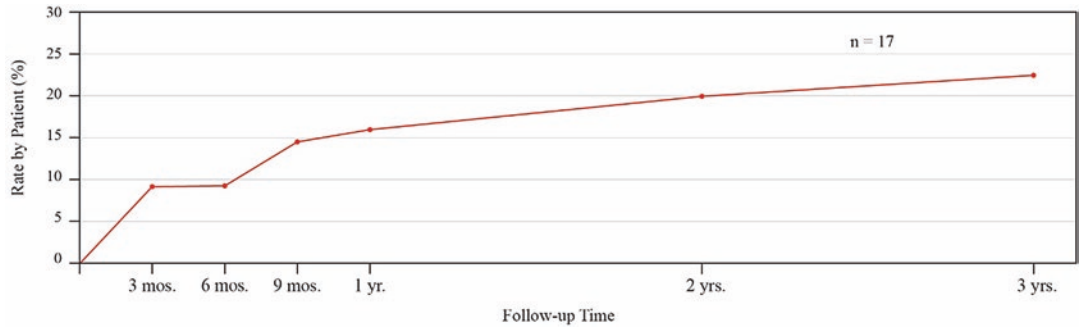

Fig. 4.2 Kaplan-Meier analysis: cumulative incidence of recurrent capsular contracture in 17 consecutive women after open capsulotomy (Reprinted from Swanson [23]. With permission from Wolters Kluwer Health)

develop years after implantation and the cumulative risk increases over time (Fig. 4.2) [17, 33, 50], which would not be expected if the cause were a bacterial infection acquired at surgery. Capsular contractures occur more frequently after breast reconstruction using implants [11, 17, 33, 50]. The source of bacteria in post-mastectomy patients is unclear. Curiously, a histological study [22] found that mast cells, the predominant inflammatory cell in hypertrophic scars, disappear as the capsular contracture becomes more severe. Poppler et al. [19], using specialized cultures and scanning electron microscopy in women undergoing expander/implant exchange, were unable to identify a correlation between biofilm formation and capsular contracture. These investigators [19] propose that stressful stimuli might lead independently to inflammation and a biofilm. Paradoxically, antimicrobial therapy may even induce biofilm formation to confer resistance [51, 52].

An open capsulotomy leaves all of the capsule (and biofilm) in the patient. If an infected capsule were the cause of contracture, capsular preservation would virtually guarantee treatment failure. Yet, in my experience, this simple maneuver is 77% effective after one release [23]. The success rate is even higher in patients with intact implants, in whom free silicone gel is not a factor; 86% had no recurrence. Moreover, there is no difference in contracture rates comparing women who received povidone-iodine irrigation at surgery with saline irrigation [23].

If an infected capsule were the cause of contracture, capsular preservation would virtually guarantee treatment failure. Yet, in my experience, this simple maneuver is 77% effective after one release

Another theory for capsular contracture is the mechanical effect of releasing the capsule [16]. It is possible, although unproven, that non-pathogenic bacteria may be protective against pathogens [47] (similar to the flora of the digestive tract) and attempts to alter the microbial environment with antibiotics may be counterproductive. Triple-antibiotic irrigation is recommended [35, 53]. However, recent studies have found no benefit in capsular contracture rates comparing triple antibiotic with saline irrigation [54, 55]. Other studies challenge the efficacy of perioperative systemic antibiotics [56, 57]. In keeping with the principle of unintended consequences, it is possible that triple antibiotic irrigation may predispose to opportunistic infections by resistant bacteria, such as *Ralstonia* (Clemens MW, 20 May 2016, personal communication), which has been cultured from breast capsules [45]. This waterborne microbe may contaminate saline and even chlorhexidine solutions used in the operating room [45].

For the period 2002–2012, the author's capsular contracture rate after primary breast augmentation was 6% [6], similar to other series

[34, 58]. This relatively low rate was achieved without following the 14-point recommendations made by Deva and colleagues [44] to reduce risk. Indeed, evidence is lacking that conforming to numerous technical recommendations [32, 44] (apart from the usual sterile technique) makes a difference in the capsular contracture rate [23, 34], further undermining the case for an infectious etiology.

Even experienced researchers can confuse a correlation with causation [59]. Its cause seems to be multifactorial [33]. Capsular contracture can develop in different circumstances. For example, a capsular contracture occurs frequently in women who have had previous radiation of the breast [60]. A hematoma raises the risk of a capsular contracture [15, 27]. A surgical aphorism holds that, if numerous treatments are recommended, none of them is particularly effective. This is certainly the case for capsular contracture. Any discussion of capsular contracture with patients should contain a healthy dose of humility. In truth, we really do not know what causes it, why it tends to occur on one side, when it will develop, and why a capsular release is usually effective. Indeed, even if the cause is not infection, but rather a myofibroblast-driven response to a surgical wound, one would expect the problem to recur. I counsel my patients, "We do not know what causes capsular contracture, but we know how to treat it" (using a capsulotomy). Better lucky than good, so to speak.

Treatment

It is always difficult to recommend a treatment when the cause is unknown, as is so often the case in medicine. Pharmaceutical methods have not been widely adopted out of concern regarding questionable efficacy [15, 61] and the risk of serious side effects, including liver toxicity with zafirlukast (Accolate, Astra Zeneca, Cambridge, UK) [61]. The "gold standard" treatment calls for a capsulectomy, along with a site change and implant exchange [16, 18, 33]. However, Wan and Rohrich [16] found little supportive evidence for this recommendation. Although capsular contracture rates are typically reported, few studies report recurrence rates [15].

A capsulectomy makes sense if the source of the problem is the existing capsule, such as might be the case if contains an infected biofilm. A capsulectomy requires greater dissection than a capsulotomy, increasing the level of difficulty, operating time, and patient discomfort [15, 36]. In some cases, the capsule is adherent to the implant and relatively easy to separate from adjacent tissue (Figs. 4.3 and 4.4). However, more often the dissection is difficult, particularly in the axilla. A total capsulectomy increases bleeding and the risk of pneumothorax [15, 17, 36].

Open Capsulotomy

To avoid morbidity, a lesser procedure is preferred. However, open capsulotomies are typically regarded as inadequate, and more disposed to recurrence of a capsular contracture [16]. This opinion is based on old studies evaluating women treated with leaky second-generation silicone gel implants implanted in the 1970s [27–29]. Many of these patients had also been treated with closed capsulotomies, adding to the risk of implant rupture [15, 17, 26]. Although open capsulotomies were commonly performed in the 1980s [62], this procedure was largely replaced by capsulectomy [63] after investigators implicated bacterial biofilms [37, 38].

My study [23] was undertaken to determine the efficacy of open capsulotomy alone as a treatment for capsular contracture in breast augmentation patients treated with modern, third-generation breast implants, including saline implants that were not evaluated in early studies [27–29, 64–66]. This is an important clinical question because saline implants were used almost exclusively in the United States from 1992 to 2006 during the silicone gel moratorium, and continue to be a popular choice among patients [15], representing approximately 30% of breast augmentation patients in the United States in 2016 (Courtesy of Mentor Worldwide LLC, 2 May 2016, personal communication). A retrospective chart review was conducted from 1996

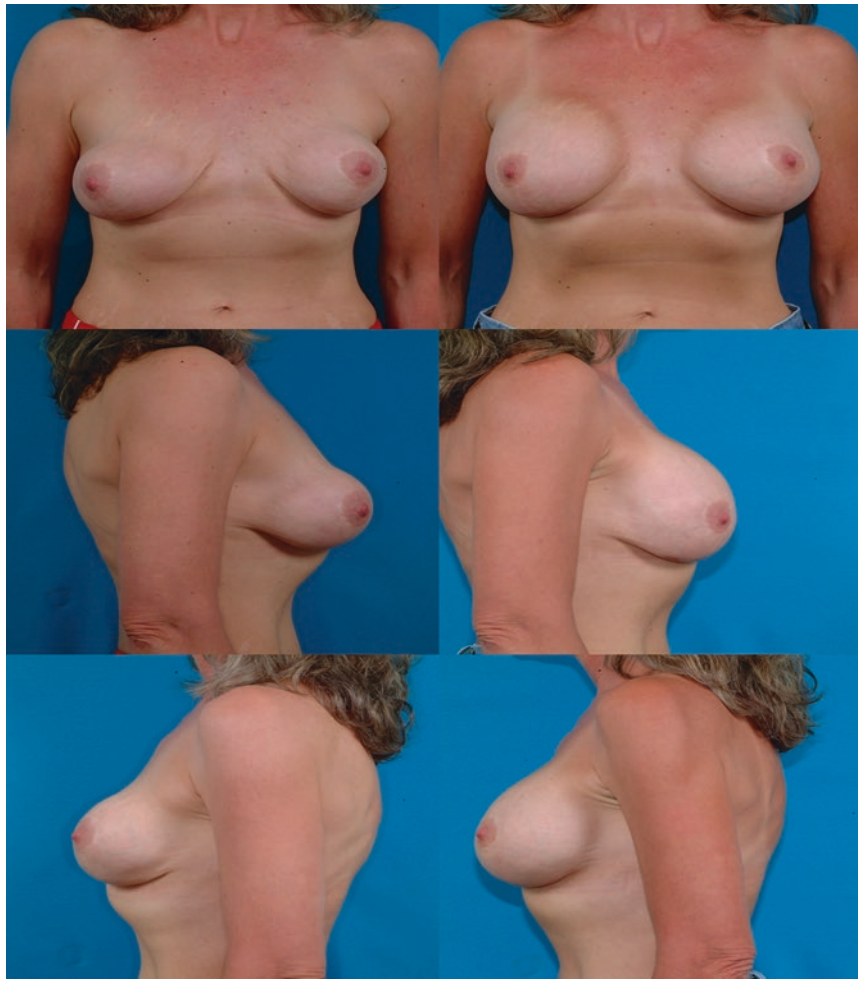

Fig. 4.3 This 49-year-old woman presented with Baker IV capsular contractures, a complication of her old silicone implants inserted 30 years previously. She also had an old mastopexy procedure. Her deformity might be described as a "rock-in-a-sock." The right breast was larger and more ptotic than the left. She desired a natural cleavage and soft breasts. She understood that a secondary mastopexy would be needed to correct her breast sagging but she deferred this procedure. At surgery, her capsules were found to be heavily calcified. The old implants were subglandular. The implants were removed along with the capsules (Fig. 4.4). New implants were inserted in a new subpectoral pocket. A smooth, round, moderate profile saline implant (Mentor Corp.) was inflated to 375 cc on the right side and 425 cc on the left. Her breasts were soft after surgery. She did not develop a recurrent capsular contracture

to 2016 [23]. All women who underwent an open capsulotomy were included. Drains, nipple shields, implant funnels, and acellular dermal matrix (ADM) were not used.

The procedure is approached much like a breast augmentation, using total intravenous anesthesia and local anesthetic infiltration (see Chap. 3). The existing capsule is circumferentially incised either partially or totally (Fig. 4.1). In patients with an existing subpectoral pocket, the original (expanded) pocket is re-used, with no attempt to dissect a new tissue plane. When the original implant is subglandular, a new submuscular pocket is developed whenever possible [15, 16], with no attempt to remove or suture the original capsule. The new subpectoral pockets are created using sharp dissection to release the inferior pectoralis origin, and blunt dissection of the pocket.

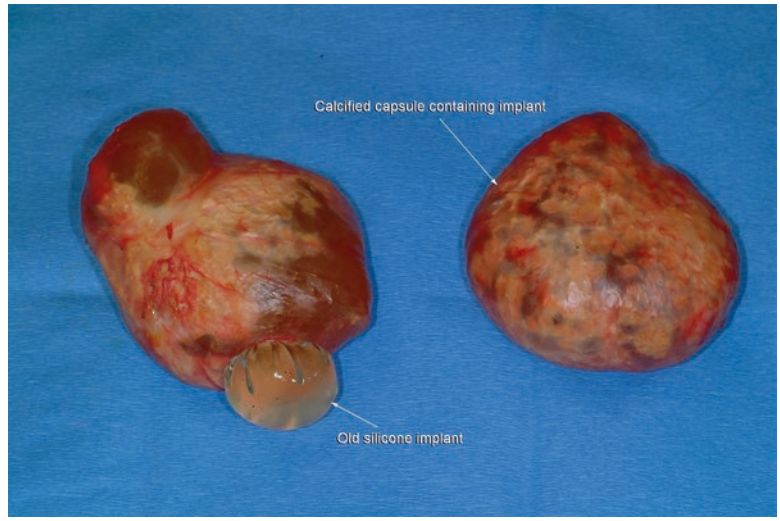

Fig. 4.4 This figure shows the patient's implants encased in a calcified capsule. The left implant has been opened to expose the old silicone gel implant

Seventy-five women with Baker III/IV contractures underwent open capsulotomies during the 20-year study period [23]. Seventeen patients (23%) returned with a recurrence (Fig. 4.2). Fifteen women were re-treated; two women elected not to have additional surgery. Two patients (2.7%) returned with a third capsular contracture; neither patient elected to have it treated.

Replacement of a leaking silicone gel implant significantly increased the risk of a recurrent contracture ($p = 0.01$) compared with intact implant replacement [23]. There was no significant difference comparing recurrence rates in patients with implants that were reinserted (6/48 patients, 12.5%) versus intact implants that were replaced (2/11 patients, 18.2%). My approach to capsular contracture is presented in an algorithm (Fig. 4.5). Over the 10-year period of the study, I performed only three complete capsulectomies. None of these three patients developed a recurrence. Two of these patients are shown in Figs. 4.3 and 4.6.

Capsulectomy Versus Capsulotomy

A capsulectomy involves much more dissection than a capsulotomy [67]. There is less remaining tissue to provide implant cover and a greater potential for nerve injury [68]. A drain may be needed [15]. It can be technically difficult, and dangerous, to remove capsular tissue from the axilla and the chest wall [17, 67, 69]. Accordingly, an anterior capsulectomy may be recommended [67], although this recommendation begs the question, is a capsulectomy really necessary if part of the capsule is left in the patient? [23]

A unilateral open capsulotomy typically requires 20–30 min versus 1 h or more for a capsulectomy [67]. Recovery room stays are usually 30 min. Because there is minimal submuscular dissection (unless a new subpectoral pocket is created), there is little discomfort. Patients return to their usual activities within a few days. Even in the event of a recurrence, the patient has experienced minimal cost (depending on the surgeon's policy) and morbidity. The recurrence rate of 23% overall after open capsulotomy (and 14% for patients with intact implants) compares favorably with recurrence rates reported after capsulectomy, which can range from 25% to 53.4% [14, 34].

In the case of thin, noncalcified capsules, there seems to be no harm in leaving the capsule in the patient [70]. The capsule around saline implants is usually absorbed [71]. The low seroma rate (1.3%) indicates that leaving the capsule in situ rarely leads to fluid accumulation [23]. A capsulectomy, either partial or full, may be reserved for thick, calcified capsules (Figs. 4.3, 4.4, 4.6, and 4.7) [16].

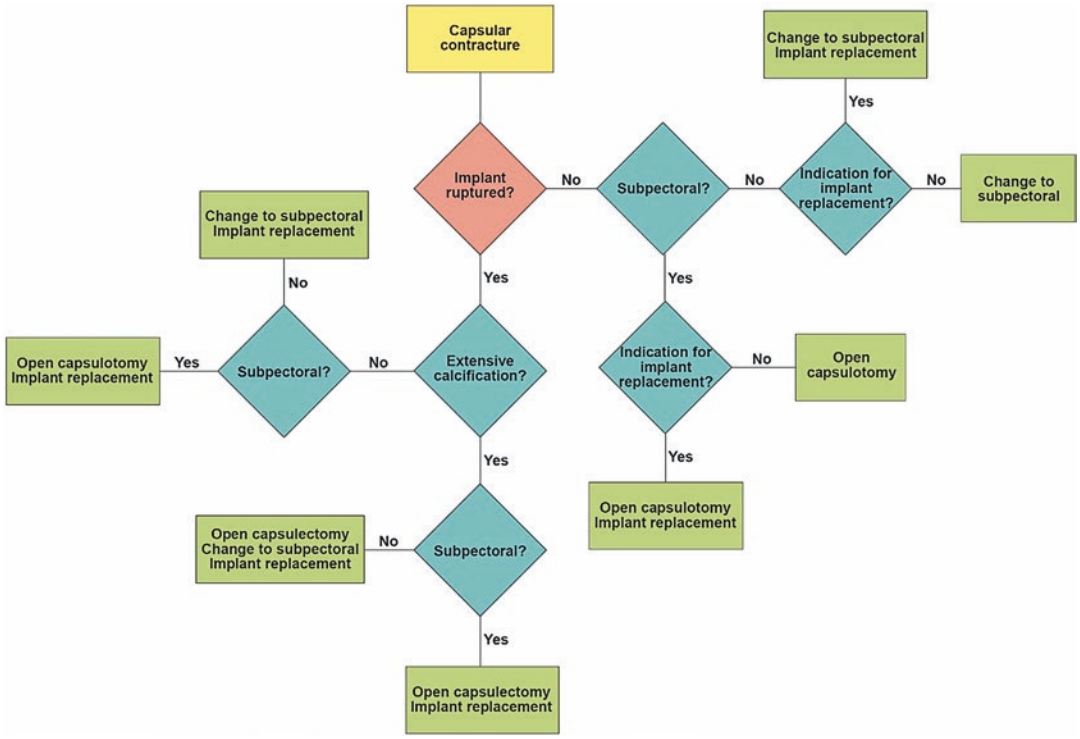

Fig. 4.5 Treatment algorithm for a capsular contracture. Indications for implant replacement, apart from rupture, are subjective and include old implants (usually >10 years), size change, preference for a saline-filled or smooth implant, a deflation on the contralateral side, and warranty renewal. Implant manufacturers now provide free replacement implants for variable periods (3–10 years) after implantation (Reprinted from Swanson [23]. With permission from Wolters Kluwer Health)

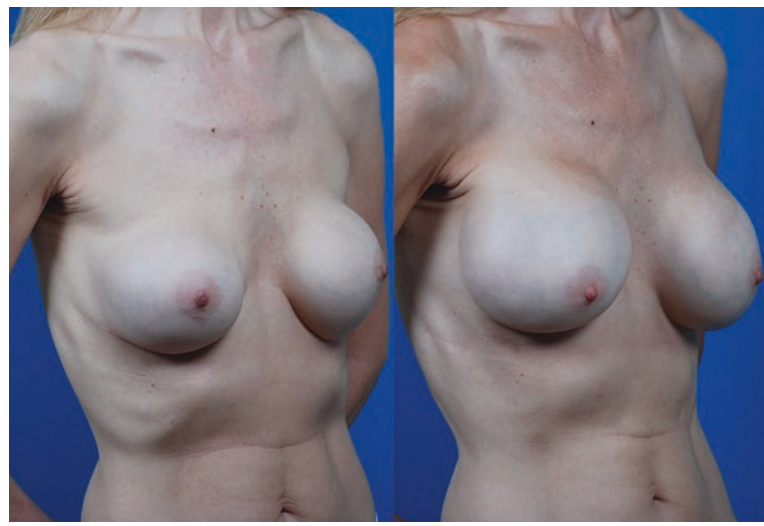

Fig. 4.6 This 51-year-old woman had silicone gel implants inserted many years previously. She complained of hardness of her breasts (Grade III contracture). Because of this problem she avoided hugging people and was concerned that not embracing her family and friends made her seem aloof. Her breasts had a rock-in-a-sock appearance (*left*). At surgery, her subglandular silicone gel implants were found to be ruptured (Fig. 4.7) with dense circumferential calcification of the capsules, which were removed. Her new smooth, round, moderate plus profile saline implants (Mentor) were inserted subpectorally (right 460 cc; left 480 cc). She is seen 3 months after surgery (*right*). She had no recurrence

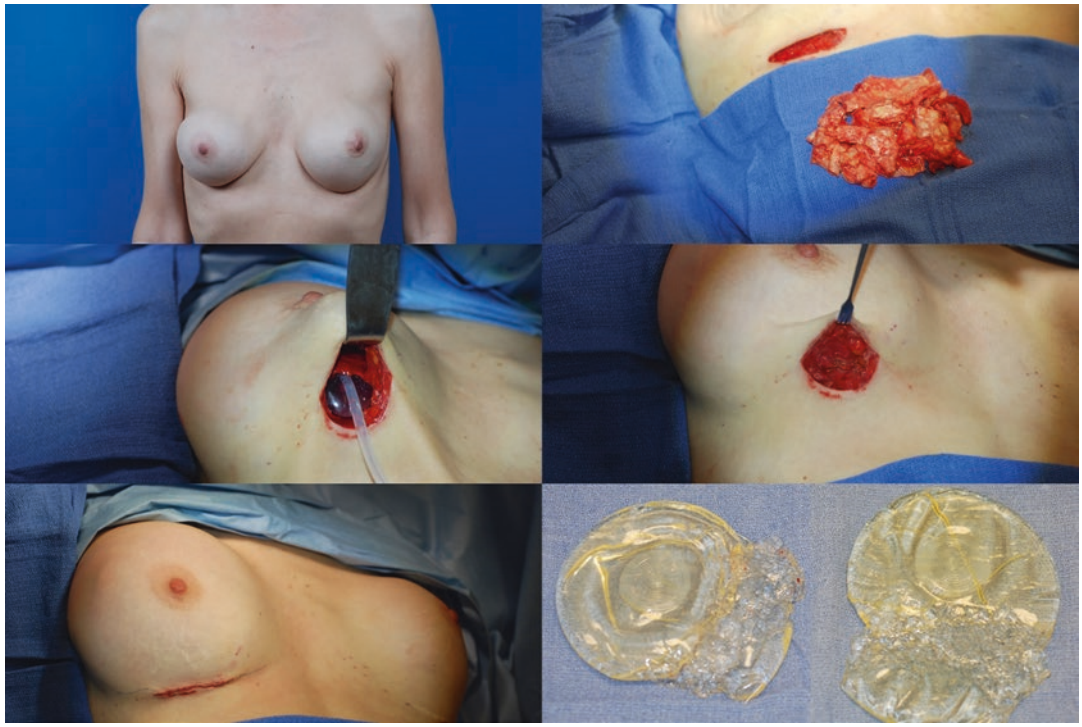

Fig. 4.7 (*Above, left*) The patient depicted in Fig. 4.6 is seen before surgery. (*Above, right*) A right total capsulectomy is performed with piecemeal removal of calcified tissue. (*Center, left*) The new implant is inserted subpectorally. (*Center, right*) The muscle is repaired over the implant. (*Below, left*) Breast appearance after skin closure. (*Below, right*) Ruptured silicone gel implants

Removal of all calcification is unnecessary [70]. Capsular calcifications are not usually a source of confusion for radiologists [67]. Acellular dermal matrix is thought to reduce capsular contracture by serving as a barrier and reducing inflammation and scarring [72]. This objective is also accomplished with a capsulotomy. If lining tissue is preserved, there is no need to replace it.

Unfortunately, aggressive treatment and retreatment of capsular contracture can leave a patient with a scarred, misshapen breast. A cosmetic patient becomes a reconstructive patient [59]. Occasionally, such patients require large flaps of tissue to reconstruct the breast, much like a post-mastectomy patient after breast cancer, or the patient may require fat injection in an effort to regain volume (also called domain) [59]. The reconstructive ladder (Fig. 4.8) is well known to plastic surgery residents. In general, lesser options that have a reasonable chance of success are chosen before resorting to more aggressive treatments. Treatment of capsular contracture is a case in point. An open capsulotomy is on the lowest rung of this ladder [59].

Site Change

A neopocket refers to the development of a new plane adjacent to the existing capsule [69, 73, 74]. Typically the new pocket is made anterior to the existing one, but still subpectorally. The logical basis is that the old capsule is not re-used, but the subpectoral location is preserved. However, this approach opens a sizable new wound.

An open capsulotomy limits the wound area and theoretically minimizes inflammation and fibroblast activity by preserving the existing capsule [23]. The subpectoral location is at lower

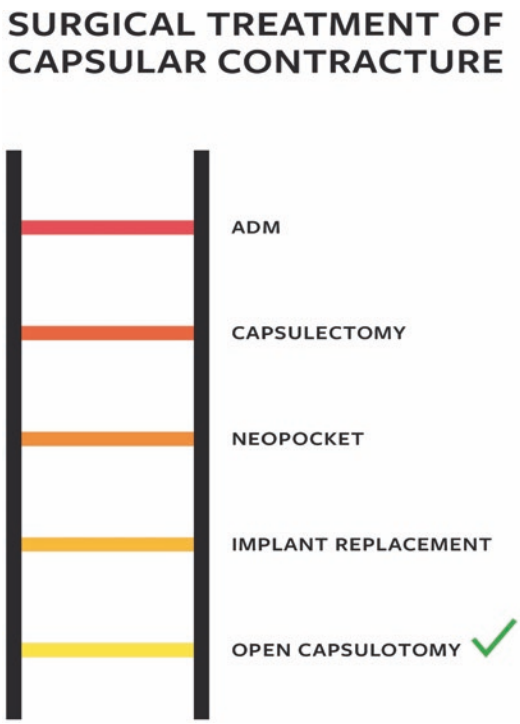

Fig. 4.8 Open capsulotomy represents the simplest surgical treatment of capsular contracture. It is the first rung on the ladder. It may be repeated. *ADM* acellular dermal matrix

risk for capsular contracture [13, 15, 17, 35, 62], a finding often attributed to more separation from nonsterile breast tissue [17, 35, 37, 38], although there is still plenty of contact. Regardless of capsular contracture risk, replacing a subglandular implant in the submuscular plane provides additional tissue cover and optimizes upper pole aesthetics [15, 16].

Acellular Dermal Matrix (ADM)

At the 2016 meeting of the American Society of Plastic Surgeons [59], plastic surgeons in the audience were informally polled regarding their treatment of capsular contracture. Eighty-four percent responded that they would use ADM either for a first or second capsular contracture. Only 16% of respondents said they never use acellular dermal matrix (including the author).

Acellular dermal matrix is a popular tool in reconstructive breast surgery [75]. ADM is now used by many plastic surgeons treating or attempting to prevent complications of cosmetic breast surgery, including bottoming out, implant malposition, rippling, skin flap deficiency, and capsular contracture [34, 76, 77]. Its use has not been limited to secondary surgery. Hester et al. [34] incorporated Strattice (Lifecell Corp., Branchburg, N.J.), a porcine ADM, in some primary breast augmentation and augmentation mastopexy patients. ADM is viewed as a barrier to reduce inflammation and scarring [72] that would otherwise take place in a raw tissue bed. Early studies report low capsular contracture recurrence rates [76, 77]. Salzberg et al. [75] report a 0.8% rate of capsular contracture in breast reconstruction cases using ADM, and a 1.9% contracture rate in irradiated breasts. These results do seem extraordinary.

However, there are serious drawbacks. Acellular dermal matrix (e.g., AlloDerm, Lifecell Corp.) is usually a human biological tissue, obtained from cadavers [78]. Although ADM has received FDA approval, this approval is not specifically for use in the breast. In 2015, the FDA issued a warning letter to Lifecell Corp. regarding marketing of their Strattice product for breast reconstruction rather than its approved use as a soft tissue patch, such as in hernia repairs [79]. Recovery techniques and locations may be limited by the donor families' wishes or funeral arrangements [78]. Suppliers must obtain proper consent, and if this is not done the product is subject to recall [80]. There are risks – skin necrosis, infection, hematoma, seroma, and recurrent deformity [76, 81–84]. When used adjacent to a breast implant, non-vascularized ADM contributes to a hypovascular environment [82]. The product is expensive, costing $3500 or more for sufficient material to treat one breast [85]. Donors are screened for communicable diseases [78, 85]. Nevertheless, Hartzell et al. [85] inform their patients of the risk of transmission of viral hepatitis and the human immunodeficiency virus, although there have been no reported cases. Some products, including aseptic freeze-dried AlloDerm (Lifecell Corp.), FlexHD

(Ethicon, Somerville, N.J.), and BellaDerm (Musculoskeletal Foundation, Edison N.J.), are not sterilized, but aseptically processed to retain favorable properties of the dermis, such as its scaffold structure, collagen and elastin composition, host fibroblast cell attachment, and mechanical strength [78]. These properties may be compromised by terminal sterilization with e-beam radiation, used for the pre-hydrated AlloDerm Ready-To-Use (RTU) product [78].

In their systematic review and meta-analysis, Ho et al. [81] report a higher rate of seromas (6.9%), infection (5.7%), and reconstructive failure (5.1%) in ADM-assisted breast reconstruction compared with non-ADM-assisted cases. ADM-assisted breast reconstructions are almost four times as likely to be complicated by seroma, nearly three times as likely to become infected, and three times as likely to have a reconstructive failure [81]. The meta-analysis by Kim et al. [82] produced similar findings for ADM-assisted submuscular tissue expander or implant breast reconstructions. These investigators [82] documented a greater risk of overall complications (15.4%), seromas (4.8%), infection (5.3%), and flap necrosis (6.9%). Relative risks were 2.05 for complications, 2.73 for seroma, 2.47 for infection, and 2.80 for reconstructive failure [82]. ADM may incite an inflammatory response known as red breast syndrome [82]. Weichman et al. [83] report significantly more infections (20%) using aseptic AlloDerm (20%) for consecutive breast reconstruction compared with subsequent patients who received sterile ready-to-use AlloDerm (8.5%). Mendenhall et al. [86], in their microbiological study, cultured bacteria from both sterile and aseptically processed acellular dermal matrices.

There is also the matter of financial conflicts. Many investigators using ADM receive financial support from the manufacturer [75–77, 84, 87]. This remuneration can exceed $100,000 [88]. Writing support and statistical analyses may be provided by the manufacturer [84]. Financial entanglement is known to influence how results are reported [89–92]. Lopez et al. [89] found that reported surgical complications were significantly lower in studies with conflicts of interest when acellular dermal matrix was used for implant-based reconstruction. However, when this product was not used, complication rates were similarly reported by authors with and without conflicts of interest. In general (not just acellular dermal matrix), plastic surgery studies that disclose a financial conflict of interest are seven times more likely to report a positive outcome over a negative outcome compared with studies with no financial conflict of interest [92]. Indeed, plastic surgeons can function as impartial investigators or highly paid consultants, but not both [89–92].

When considering the possible role of ADM in treating or preventing capsular contracture, its possible benefit must be weighed against any ADM-related complications. The bottom-line question is whether the surgeon would be willing to have it implanted, or use it in a family member undergoing cosmetic breast surgery. Regardless of the possible role of ADM, open capsulotomy should remain a treatment option [23]. An open capsulotomy leaves all other options available, and avoids creating a deformity that will require reconstructive options later on.

Patient Considerations

The risk of capsular contracture is listed on consent forms and mentioned in any discussion of complications. However, the patient who develops a capsular contracture will often be unhappy regardless and wonder why her girlfriend, who went to another plastic surgeon, did not have the same unfortunate outcome. Many patients are young women who have made a substantial financial sacrifice to have the surgery. They may now be confronted by paying a similar amount again for the surgeon, anesthesia, and surgery center, and possibly more for ADM.

Most plastic surgeons charge for their services to treat capsular contracture, reasoning that they are not responsible for this known complication. This approach does little to assuage an unhappy patient. My own practice is to keep management as simple as possible [59]. The patient only pays for the surgery center and anesthesia. There is no

surgical fee and nothing is billed to insurance. The financial cost is therefore tolerable. This approach helps to keep patients happy [59]. I perform about four open capsulotomies per year. The lost income is likely to be recouped by one or two referrals from these patients.

Some plastic surgeons do not discuss their financial policy for managing complications at the time of the consultation. The policy may be buried in paperwork. Such discussions are well received by patients and may place the surgeon at a competitive advantage when the patient selects her surgeon. Sforza et al. [93] go a step further, offering 3 years of free revisions in case of capsular contracture, implant rupture, or even an unsatisfactory aesthetic result.

Implant Replacement

In my study [23], the subgroup of patients whose ruptured or leaking silicone gel implants were replaced had a significantly greater risk of recurrence than patients whose intact implants were replaced, underscoring the increased risk associated with silicone gel leakage [30, 31].

Perhaps counterintuitively, patients whose (intact) implants were not replaced were at no greater risk of recurrence than women whose intact implants were replaced. This finding contrasts with a recent core study of Sientra (Santa Barbara, Calif.) breast implants, which found a reduced recurrence risk in women whose implants were replaced [14], although confounders may have affected this conclusion [23].

Although implant exchange is generally recommended [14, 16, 18, 32, 33, 35], the recipient site is not sterile [17, 35, 47, 94]. A new implant is likely to be quickly colonized by the bacteria already present in adjacent breast tissues [47]. Nevertheless, other indications for replacement include a size change, warranty renewal, or to replace textured implants with smooth devices. Implant manufacturers provide free replacement implants for patients developing capsular contractures within 3–10 years of implantation [95–97]. Smooth implants may reduce the recurrence rate when used as replacement implants. A recent core study with a 10-year follow-up identified the lowest capsular contracture rate in patients treated with smooth subpectoral implants inserted through an inframammary incision [13].

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Treatment Recommendations

Recommendations to avoid recurrence include capsulectomy, site change, new implants, bloodless dissection, antibiotic irrigation, glove change, covering the incision site with an adhesive barrier, form-stable implants, a sleeve or funnel, nipple shields, and acellular dermal matrix [15, 32, 33, 35, 44]. In 1981, Brody and Latts [25] lamented the lack of controlled studies leading to a "shotgun approach using every means ever reported," commenting that "the enthusiastic espousal of circumstantial evidence becomes dogma." In the years since, investigators have frequently noted the lack of scientific data [16, 98, 99] and the shortcomings of treatment dictated by clinical impressions alone [22, 98].

In 2012, Hester et al. [34] observed that breast-pocket irrigation, site changes, and submuscular or dual plane implant placement had minimal identifiable effect on the rate of capsular contracture. Despite capsulectomy, site change when appropriate, and implant replacement, these experienced surgeons reported a recurrence rate of 53.4%, prompting them to start incorporating ADM.

A recent survey [36] and review articles [15, 32, 36] do not include open capsulotomy as a treatment option. Twenty percent of plastic surgeons use silicone gel implants exclusively [36]. Although silicone gel implants are thought to have a more ideal feel characteristic [15], this difference may be negligible when the implant

is placed submuscularly. The appearance of saline-filled implants is the same [15]. Implant deflation is easier to detect, and treatment of a capsular contracture is likely to be uncomplicated and successful [23]. Saline implants are less expensive than silicone gel implants and patient satisfaction is very high (87.5–98.1%) with both devices [1, 13, 62, 100, 101].

When considering the pros and cons of silicone gel versus saline implants, management of capsular contracture is not typically considered. The capsule around a saline implant is never exposed to silicone gel and rarely becomes densely calcified. The risk of a capsular contracture is 6%, and the risk of a recurrent capsular contracture is a tolerable 23% [23]. Perhaps plastic surgeons should reconsider saline implants based on the full profile of pluses and minuses. Patients should be given all of this information and not simply directed to silicone implants "because they are more natural." In my practice, most patients still choose saline despite the full availability now of silicone gel implants. A silver lining to the silicone gel implant moratorium is that many American plastic surgeons have learned that the alternative (saline implants) is not such an inferior option after all [1, 36, 100].

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Hematoma

Low hematoma rates are reported in breast implant core studies, in the range of 1.2–2.9% [11, 12, 102]. In my experience, hematomas develop within 24 h in almost all cases and most occur within the first 12 h (Fig. 4.9). A telltale sign is the inability of the patient to abduct her arm without pain on the affected side. Today patients often send selfies on their cellphones if they develop excessive swelling. This practice prevents some needless visits to the clinic.

Diagnostic ultrasound can be helpful in making the diagnosis if this device is available (Fig. 4.10). Occasionally (perhaps once a year) I use ultrasound in the recovery room in cases of unilateral swelling. All breast augmentation patients return to the office the day after surgery. Out-of-town patents remain in the area (< 1 h) for at least 24 h so that they do not have to travel far for treatment. If a hematoma is detected early and treated promptly, the outcome is usually not compromised, although there is more bruising and a higher risk of capsular contracture [15, 27]. This problem is largely mitigated by thorough evacuation of the clot and wound irrigation.

Infection

Strict sterility is particularly important for cosmetic breast surgery because an infection can require implant removal and delayed replacement (most surgeons allow at least 3 months), which is onerous for patients. Accordingly, the surgery should be performed only at a properly credentialed facility that adheres to infection prevention guidelines. When combining surgical procedures, it makes sense to start with the breast surgery to optimize sterility, which may be compromised later in the case during liposuction or other body contouring procedures.

It is important to differentiate between cellulitis or a yeast infection, which usually responds to local wound care and oral antibiotics, from a deep infection around the implant. Implant-related infection is signaled by increased discomfort, redness, and swelling of the affected breast, and a fever (Fig. 4.11). Exquisite tenderness is elicited by gentle compression anywhere on the breast, as opposed to just in the area of the wound in the case of a surface skin infection. An allergy to adhesive strips or neomycin can sometimes be confused with cellulitis.

Breast implant core studies report infection rates of 0.9–1.7% [10–12, 14, 102]. The responsible organisms are usually gram positive bacteria, likely skin flora, although gram negative infections rarely occur. Sforza et al. [93] cultured methicillin-sensitive *Staphylococcus aureus* from

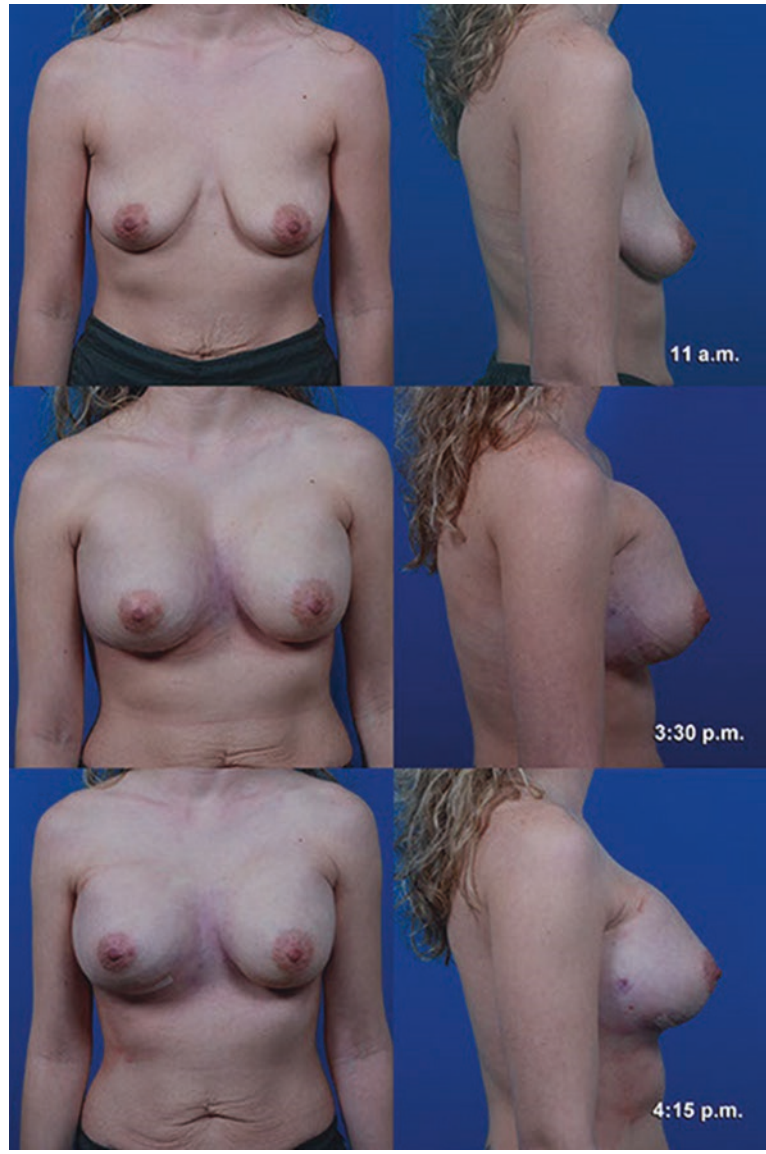

Fig. 4.9 This 27-year-old woman underwent a breast augmentation at 11 a.m. Her 390 cc smooth, round, moderate plus profile saline implants (Mentor Corp.) were inserted subpectorally using an inframammary incision. Four hours later, at 3 p.m., she called the office to report increasing swelling and pain on the right side. She returned to surgery promptly for treatment. Because there was no delay in recognizing and treating this complication, she had minimal bruising on the right side. The pain was relieved immediately. She is seen before surgery (*above*), later in the afternoon after surgery after developing a right breast hematoma (*center*), and immediately after evacuation of the hematoma (*below*) on the same day. She did not develop a capsular contracture

nine patients, methicillin-resistant *S. aureus* from two patients, *S. epidermidis* from two patients, mixed flora from three patients, and *Pseudomonas aeruginosa* from one patient. All the bacteria were sensitive to ciprofloxacin.

Nontuberculosis mycobacteria can also be responsible for breast implant infections. Scheflan and Wixtrom [103] reported an outbreak of a new species of mycobacterium in breast augmentation patients. Patients presented 3–6 weeks after surgery with a serous drainage, minimal redness, no fever, and negative standard bacterial cultures. The identification of the responsible organism was extremely difficult. It was eventually identified as a new mycobacterium (named *Mycobacterium jacuzzii*), cultured from the water in a garden hot tub used by the surgeon at this home in Israel. The investigators concluded that dandruff shedding from the surgeon's skin and eyebrows during surgery was the likely source of infection. Patients were effectively treated with ciprofloxacin, implant removal and pocket irrigation, followed by delayed reimplantation. One-stage salvage was unsuccessful.

Fig. 4.10 This 68-year-old woman underwent replacement of breast implants and mastopexies. Approximately 12 h after surgery (5 a.m. the following morning), she called to report increasing pain and swelling of the right breast. She and her husband were instructed to return promptly to be evaluated. The physical examination was equivocal for the presence of a developing right breast hematoma. An ultrasound examination clearly showed the saline-filled breast implant, the muscle layer, and subcutaneous tissue, with no evidence of a fluid collection outside of the implant

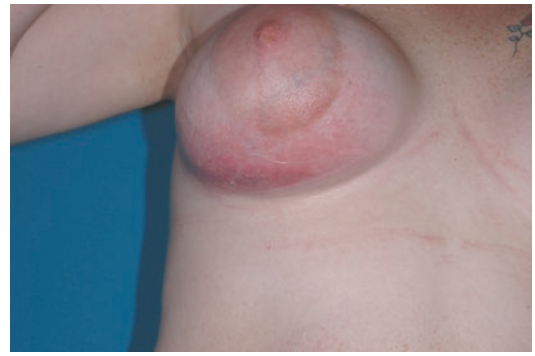

Fig. 4.11 This 32-year-old woman developed tenderness, a burning sensation, fever, and redness of the lower pole of her right breast 6 weeks after surgery. There was minimal improvement after a course of oral antibiotics. Her symptoms resolved quickly after removal of the implant. The capsule was left intact. She returned 3 months later for insertion of a new implant

The authors [103] recommend mycobacterial cultures when infection is suspected, particularly in cases of late-onset serous drainage and minimal symptoms (and operating personnel should avoid using hot tubs). This cautionary tale will make any reader less complacent about sterility.

Some investigators have recommended additional methods to reduce infection risk. Deva et al. [44] insist on a 14-point plan that includes nipple shields and triple-antibiotic irrigation. However, these extra measures have little scientific foundation [23]. Triple-antibiotic solution may actually predispose to infection with resistant organisms, such as *Ralstonia* (Clemens MW, 20 May 2016, personal communication). Despite using saline alone for irrigation and no nipple shields, my infection rate after breast augmentation is 0.4% [6], very similar to the rate reported by Sforza et al. (0.28%) [93]. My practice is to routinely administer cefazolin 1 g I.V. immediately before surgery and three doses of cephalexin, 500 mg p.o. bid after surgery [23]. Longer courses of antibiotics are not known to be more effective in preventing infection, but do raise the risk of unwanted side effects such as vaginal yeast infections.

Sforza et al. [93] report a 100% success rate in treating breast implant infections in a single stage. The authors [93] excise the wound margins and perform an aggressive sequential cleansing of the pocket using chlorhexidine, half-strength hydrogen peroxide, copious irrigation with saline, and finally a povidone-iodine scrub. New implants are inserted and additional antibiotic irrigation is injected through a drain. Systemic antibiotics are administered in the form of cefuroxime and gentamicin, followed by a 10-day course of ciprofloxacin. Sforza et al. [93] limit the implant exposure time to a maximum of 48 h when attempting single-stage salvage.

Spear and Seruya [104] report a 93.9% salvage success rate for patients with mild infections using systemic antibiotics, wound edge debridement, capsule curettage or capsulectomy, pulse lavage, site change (e.g., subglandular to subpectoral), device exchange, and occasionally flap coverage. By contrast, the authors' [104] success rate was only 26.3% for patients with severe infections, defined as persistent warmth, redness, and swelling despite antibiotics, purulent drainage, and atypical organisms on wound culture (e.g., methicillin-resistant *S. aureus*, gram negative rods, mycobacteria, or yeast), or sepsis (high fever, hypotension). Device salvage does not seem to increase the risk of capsular contracture [93, 104].

Nipple Numbness

It is important to preserve the intercostal sensory nerve branches, particularly the deep lateral cutaneous branch of the fourth intercostal nerve, by using gentle finger dissection of the subpectoral pocket during surgery [1]. Almost 40% of women experience some degree of nipple numbness after surgery [1]. Fortunately, few patients (2.3%) experience persistent loss of feeling in one or both nipples after breast augmentation if care is taken to avoid nerve injury [1]. Almost all patients (98.5%) would repeat the surgery, despite any experience of nipple numbness [1].

It is important to preserve the intercostal sensory nerve branches, particularly the deep lateral cutaneous branch of the fourth intercostal nerve, by using gentle finger dissection of the subpectoral pocket during surgery.

Implant Rupture

The true rupture rate for silicone gel implants is difficult to evaluate because of the usual lack of clinical signs and the inaccuracy of imaging methods. Collis et al. [105] report that magnetic resonance imaging is 90% sensitive but only 43% specific for capsular contractures (i.e., false positives are a problem) [105].

The 10-year implant Kaplan-Meier rupture rate for Allergan Natrelle round silicone gel implants determined by magnetic resonance imaging is 13.0% [13]. Collis et al. [105] calculated an 11.8% rupture rate for subglandular Mentor Siltex round silicone gel implants at 13 years based on their magnetic resonance study, with no extracapsular ruptures. In their magnetic resonance imaging cohort, Maxwell et al. [12] reported a 17.7% rate of suspected and confirmed Natrelle 410 implant ruptures at 10 years, all intracapsular. Some patients with suspected ruptures did not undergo surgery. The rupture rate confirmed at surgery was 10.2%. Previously, Hedén et al. [106] had reported a <1% rupture rate for Natrelle 410 implants on magnetic resonance imaging scans.

Collis et al. [105] believe that prolonged intracapsular rupture might lead to extracapsular spread with the possible risk of silicone migration and formation of silicone granulomas in the breast parenchyma. Whether more cohesive silicone gel is less likely to migrate, as claimed [106], is unknown. Traumatic insertion is a well-known factor increasing the risk of rupture or gel fracture. Attempts to reinforce the inframammary fold with additional suturing may increase the risk [107].

Such high rupture rates for form-stable implants are at odds with early suggestions that cohesive gel implants are more solid than their predecessors and less likely to deform or leak [10, 106, 108]. Weum et al. [109] demonstrated ripples in magnetic resonance studies of patients with Style 410 implants in the prone position. Hammond [110] detected folds on upright magnetic resonance imaging and concluded that the gel, despite its cohesivity, is not sufficiently firm to support the shell in certain positions. Wrinkles and folds can create stress points, possibly leading to implant rupture [110].

Such high rupture rates for form-stable implants are at odds with early suggestions that cohesive gel implants are more solid than their predecessors and less likely to deform or leak.

Walker et al. [101] report a saline implant deflation rate of 13.8% at 10 years. However, in this study, 69.5% of implants were textured, which are known to be at greater risk of deflation [50]. Cunningham et al. [111] found that if iatrogenic or traumatic causes, and an implant group particularly susceptible to rupture (Surgitek), are excluded, the risk of deflation is greatly reduced (4.3%). In my 10-year study of patients treated with predominantly (93.9%)

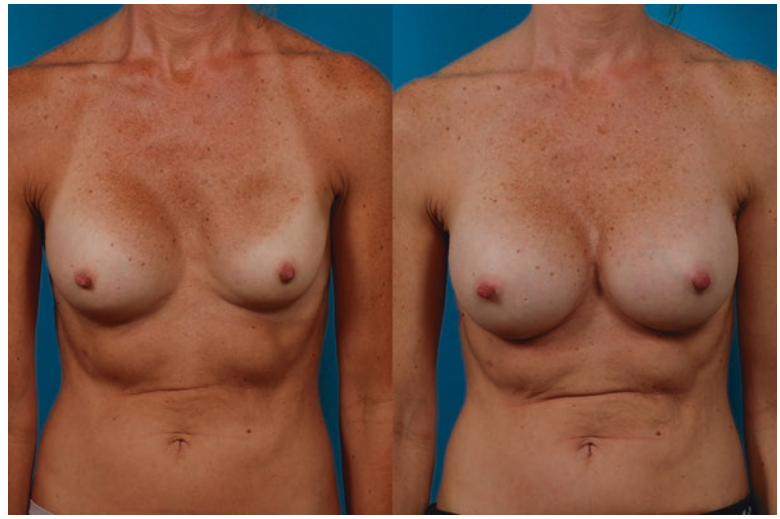

Fig. 4.12 This 43-year-old patient returned with a left implant deflation 12 years after insertion of 300 cc contoured, textured, saline implants (McGhan, Biodimensional). This patient chose larger implants for her replacements. She is seen before (*left*) and 2.5 months after (*right*) replacement with smooth, round, moderate profile saline implants inflated to 390 cc (Allergan Inc.). The existing submuscular pocket was re-used

saline and exclusively smooth, round implants, the overall complication rate was 17.6%. However, only 4/522 breast augmentation patients returned with a deflation (0.8%) [6]. Figure 4.12 depicts a patient with a deflation 12 years after insertion of shaped, textured, saline implants. The leak is likely at the site of a fold (Fig. 4.13).

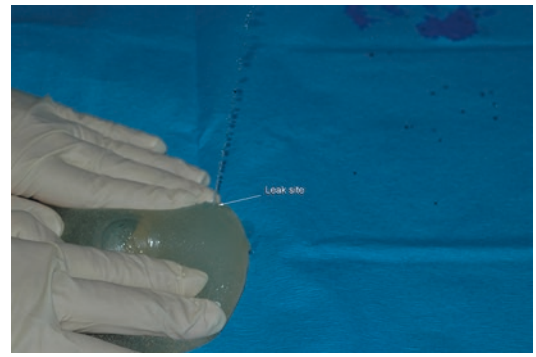

Fig. 4.13 Ruptured textured implant with leak site identified on compression. This type of leak was common in old textured saline implants

> In my 10-year study of patients treated with predominantly (93.9%) saline and exclusively smooth, round implants, the overall complication rate was 17.6%. However, only 4/522 breast augmentation patients returned with a deflation (0.8%).

Wrinkling (Rippling)

Usually it is possible to feel, but not see the rippling in the envelope. This is especially true on the lateral underside of the breast, where the implant is not covered by muscle, but wrinkling can be visible, especially in thin women (Fig. 4.14). Wrinkling rates are difficult to compare because of the subjectivity involved. Core studies report wrinkling rates of 0.9–2.7% [12–14, 102]. By contrast, Jewell and Jewell [112] report visible or palpable rippling in 37.3% of Mentor CPG implants and 7.6% of Natrelle 410 implants. The edges of a Natrelle 410 implant may sometimes be visible or palpable [108, 113].

Saline implants are believed to be at greater risk for wrinkling than silicone gel implants [15], but this problem can occur with both devices. Handel et al. [114] compared textured saline implants (risk, 7.3%) with textured silicone gel implants (risk, 2.1%), finding in favor of silicone gel implants. Handel et al. [114] report a wrinkling rate of only 0.4% for smooth implants (saline and silicone gel). However, these investigators did not compare smooth saline implants with smooth silicone gel implants. Textured

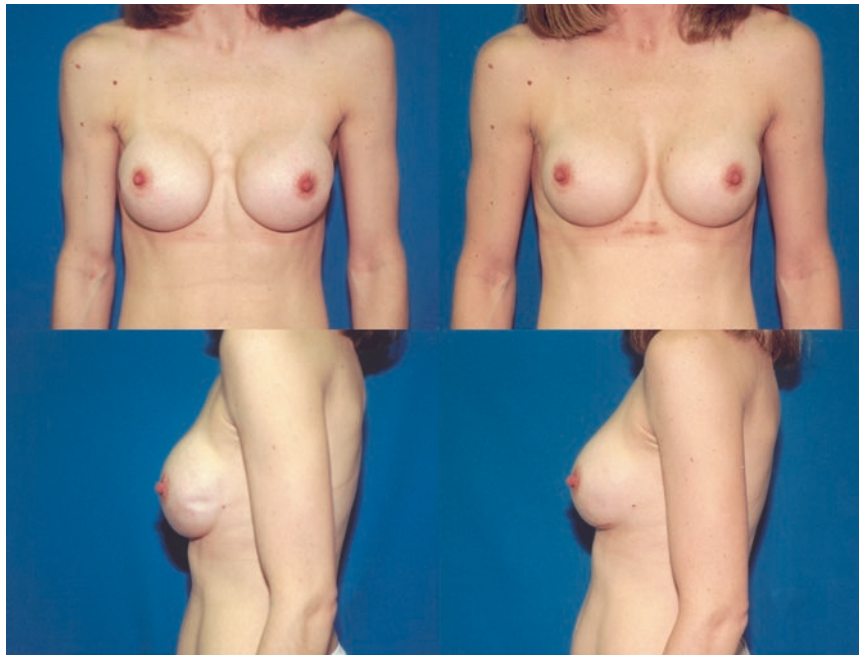

Fig. 4.14 This 30-year-old competitive runner underwent a previous subglandular breast augmentation with saline implants (manufacturer unknown) performed elsewhere. She was unhappy with the unnatural "stuck-on" appearance of her breasts and visible rippling on both sides (*left*). A periareolar approach had been used originally. She preferred a B-cup size. The old implants were situated slightly too low. The implants were removed and replaced in a submuscular location using an inframammary incision. Smooth, round, moderate profile saline implants were inflated to 275 cc (Mentor Corp.). This patient was treated during the silicone implant moratorium. Her wrinkling was corrected. She resumed running only a few weeks after this surgery. She had a heat rash from her bra when the after photographs were taken 2 months after surgery (*right*)

saline implants are particularly associated with wrinkling [50, 114, 115] but are seldom used today in favor of smooth implants. Wrinkling and localized contour deformities may be treated with fat injection [116]. Hartzell et al. [85] use ADM for surface contour irregularities, but find its high cost a deterrent.

"Ball in Sock" Deformity

A "ball in sock" (or a "rock in a sock" when a severe capsular contracture is present) appearance may be treated by implant replacement, typically with a larger size, in a subpectoral pocket (Fig. 4.15). In cases of skin laxity, a mastopexy is recommended.

Symmastia (Synmastia)

Symmastia, or medial confluence of the breasts, is a dreaded complication (Fig. 4.16). Patients find their breasts resemble buttocks. The deformity results from overdissection of the medial pocket [117]. The surgeon must be cautious when dividing the origin of the pectoralis muscle from the lower sternum. Dissection under direct vision is advantageous [118]. Treatment involves capsulorrhaphies [117, 118], but recurrences are a problem [117]. Spear et al. [117] create a neopocket, dissecting a new plane between the existing anterior capsule and the posterior aspect of the muscle so as to create new tissue margins and reduce reliance on plicating sutures. Parsa et al. [118] find this dissection

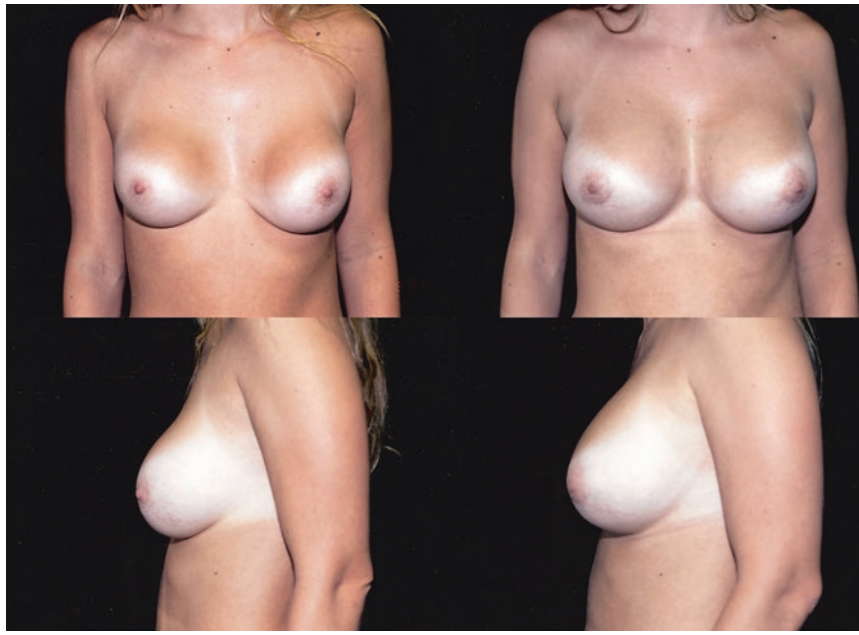

Fig. 4.15 This 30-year-old woman had a "ball-in-a-sock" appearance and capsular contractures on both sides (*left*), causing excessive firmness 7 years after insertion of her original silicone gel implants performed elsewhere. She requested a larger implant size. Her original periareolar incision was re-used. Her old implants were subglandular and the right implant had disintegrated (manufacturer unknown). The loose silicone gel was removed from the pocket on the right side, and the still-intact left implant was also removed. New subpectoral pockets were created. Textured, round, moderate profile saline implants (Mentor Corp.) were inflated to 375 cc. She is seen 6 weeks after surgery (*right*). This patient was among the last treated by the author using textured implants. Today, smooth implants are preferred

technically difficult and instead use a posterior capsular flap. ADM is used by some surgeons to reinforce the repair [119].

Implant Malposition

Core studies report malposition in 2.7–6.8% of patients [12–14]. Implant malposition is best prevented by accurately dissecting the pocket. A cautious release of the pectoralis origin is performed along the lower sternum and inframammary fold. A supra-inframammary fold (Supra-IMF) approach is used to preserve existing IMF fascial attachments (see Chap. 3 for details) [120]. Although some surgeons describe correction with nonoperative methods such as a cut-out bra or shoelace wrapped around the neck [4], most surgeons find surgical treatment necessary (Fig. 4.17). The existing capsule is released (usually superiorly and medially), and plicated where reinforcement is needed (usually inferiorly and laterally).

Malrotation

Malrotation is unique to shaped implants and therefore a problem avoided entirely by using round implants. Baeke [121] reported a 14% incidence of malrotation in women treated with shaped saline implants, which are rarely used today. A 10-year core study of Natrelle 410 implants reported a 4.7% incidence of implant malposition (the study did not specify the number of malrotations) [12]. In their retrospective chart review of a single-surgeon experience with subglandular Natrelle 410 implants, Lista et al. [113] reported that 5.2% of their patients experienced this complication. Interestingly, most cases were successfully managed by manually repositioning

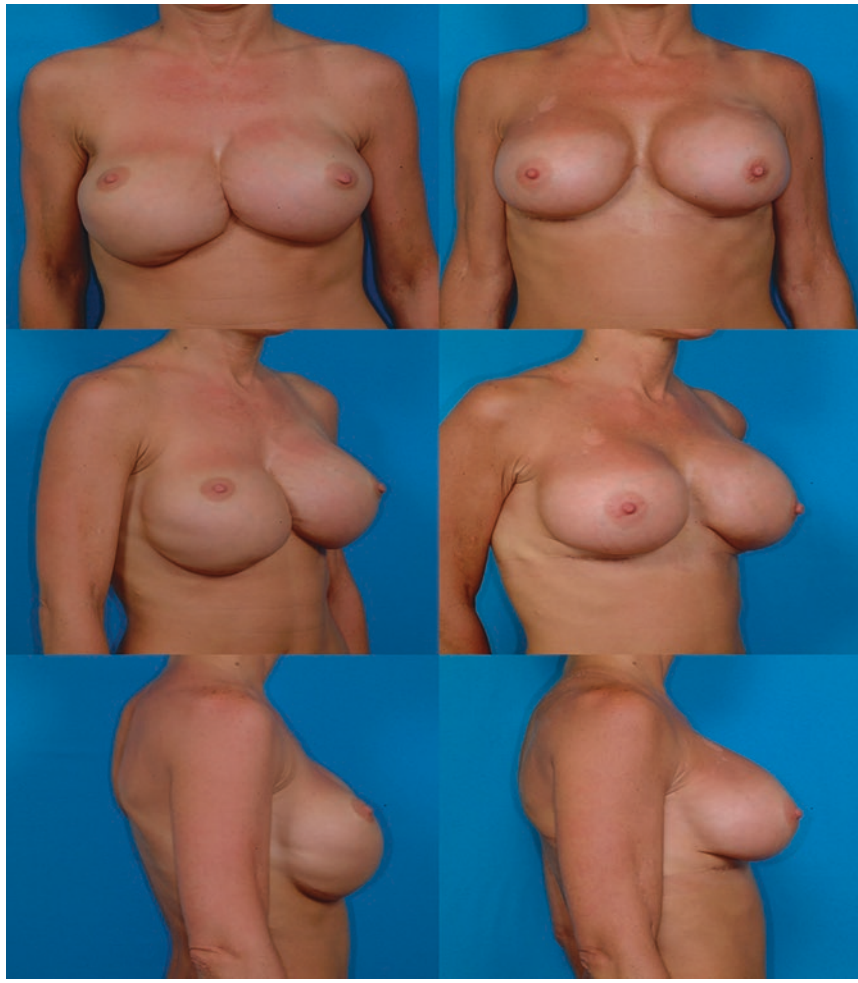

Fig. 4.16 This 36-year-old woman had several previous breast augmentations performed elsewhere. Her silicone gel breast implants had bottomed out and she had visible wrinkling. She also had a symmastia deformity. The patient requested saline implants and wanted to keep a large breast size. She understood that there was a risk of wrinkling, especially in view of her lack of body fat. She is seen before (*left*) and 1 month after (*right*) replacement of her old 616 cc McGhan (Allergan Inc.) silicone gel implants with new 575 cc smooth, round, moderate profile saline implants (Mentor Corp.). Open capsulotomies were performed and the existing subpectoral pockets were preserved. Capsulorrhaphies were performed medially and inferiorly

the implant and then having the patient wear a tight-fitting bra for 6 weeks. Only three women (0.7%) required reoperation for malrotation.

Double Bubble Deformity

The double bubble is characterized by two creases running horizontally across the lower pole of the breast. The superior fold represents the original inframammary fold and the lower fold represents the level to which the pocket was dissected at the time of surgery or to which the implant has descended. This problem can occur if the pocket is overdissected inferiorly, disrupting the inframammary fascial attachments. This problem may be largely avoided by using a supra-IMF approach with precise pectoralis muscle release but no inferior dissection through the fascial condensations of the IMF [120]. Handel et al. [122] propose a number of techniques to treat this deformity, including site change to submammary,

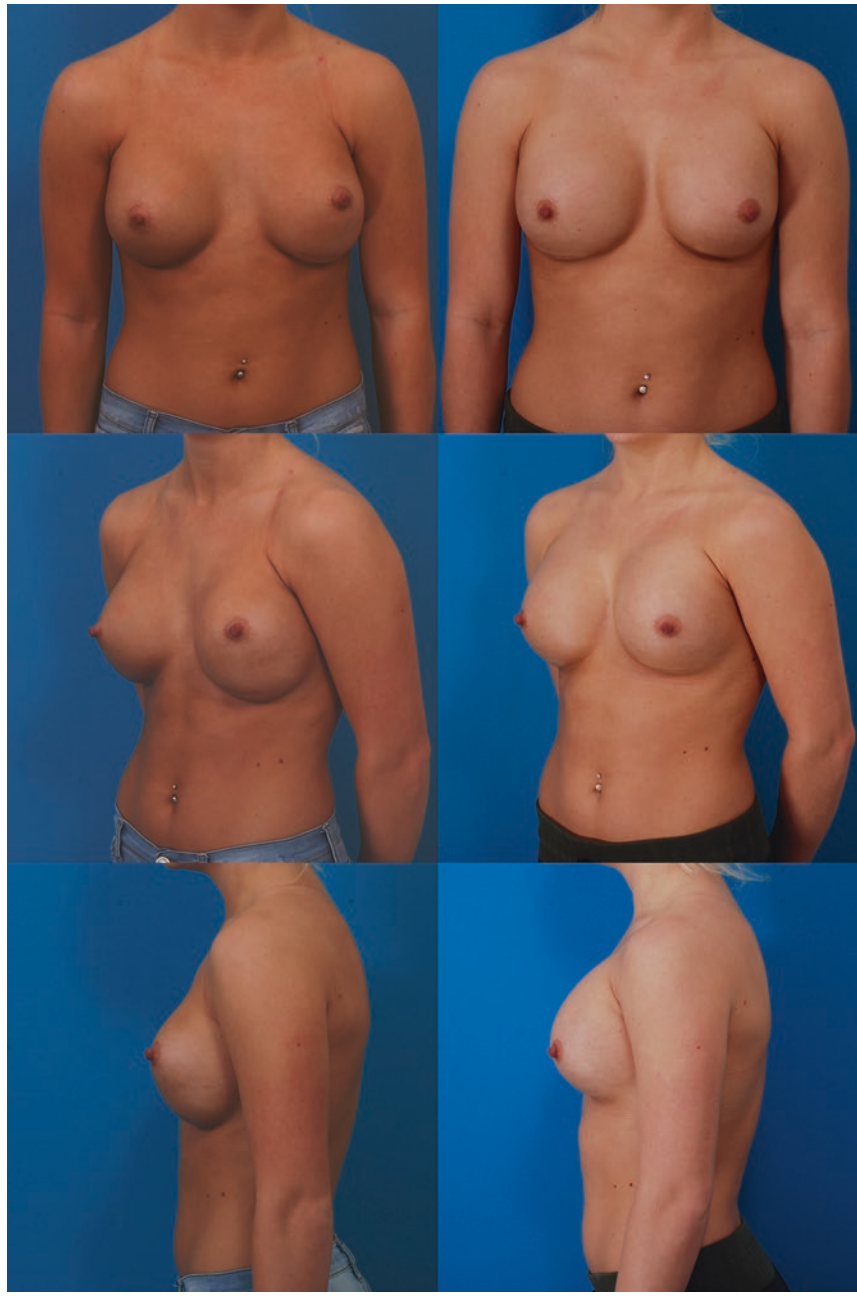

Fig. 4.17 This 22-year-old woman had undergone a previous breast augmentation and a revision performed elsewhere. She was dissatisfied with the bottomed-out appearance of her left breast. She also requested a fuller cleavage. Her original smooth, round saline implants (right, 370 cc; left, 380 cc) were replaced with 457 cc smooth, round Natrelle Style 15 silicone gel implants. The existing subpectoral capsules were opened medially and superiorly. A capsulorrhaphy was performed on the left side, plicating the existing capsule with 2-0 Vicryl sutures. She is seen before (*left*) and 3 months after surgery (*right*). The nipples appear more symmetrical

a neopocket, capsulorrhaphy, and ADM for patients with very thin tissues or failed previous attempts at repair. This problem is different from a snoopy deformity, which is characterized by breast tissue that appears to slide off the breast (usually requiring a simultaneous mastopexy) [123], and to bottoming out, in which the lower pole descends without the appearance of a double crease (Fig. 4.17).

Implant Exposure

Implant exposure is rare in healthy non-irradiated primary breast augmentation patients. Exposure of the implant may be related to the adequacy of the layered closure, or to excessive tissue tension. A wound dehiscence may occur in the presence of infection, leading to implant exposure [93].

Late Seromas and Double Capsules

Rarely (<1% of breast implant cases [124]), a seroma forms months or even years after a breast augmentation. This fluid collection may be aspirated or evacuated intraoperatively. Bengtson et al. [124] recommend imaging (magnetic resonance or ultrasound, not mammography) to diagnose the seroma and visualize the implant, and ultrasound-guided aspiration to obtain fluid for culture, cell count, and cytology. The fluid needs to be tested for the presence of a CD30 marker on the cells, which is pathognomonic for ALCL [125]. Tissue specimens alone are inadequate because in 30% of ALCL cases the lymphoma cells are found only in the fluid [125].

Hall-Findlay [115] reviewed 626 consecutive primary breast augmentation and augmentation mastopexies in whom 105 patients (17%) received Biocell-textured implants. She found double capsules in 14 women. In addition to the usual periprosthetic capsule, a second capsule was observed directly on the implant. She had not observed this problem in 23 years of practice before she started using Biocell implants. These double capsules formed only in women with Biocell-textured implants, leading her to conclude that a link exists between texturing and double capsules. Three of these patients also had a late seroma (>1 year after surgery), which she attributes to mechanical separation of the capsule from the implant, presumably from a shear stress. She suggests that this problem does not occur in smooth or less aggressively textured implants because there is no true adherence of the capsule to the implant. The problem may be effectively managed by removal of the existing implants along with any adherent capsule and replacement using smooth implants.

Spear et al. [126] report a similar experience in their 5-year multicenter retrospective review. Late seromas were identified in 25 patients (three were bilateral), on average 4.7 years after surgery. In 27 of 28 affected breasts (68% cosmetic and 32% reconstructive) a Biocell implant had been used. One seroma occurred in association with a smooth implant (p <0.0001). A variety of treatments were successfully used, including antibiotics alone, aspiration alone, and operative seroma drainage with or without implant replacement, and with or without capsulectomy. The investigators [126] recommend using smooth implants at the time of replacement. All cultures and cytology studies were negative, leaving the authors with the conclusion that its cause is usually idiopathic. Mazzocchi et al. [127] reported 13 women with late seromas; nine had implants manufactured by McGhan-Allergan. All implants were textured.

By contrast, McGuire et al. [128] report a seroma rate of only 0.06% among primary breast augmentation patients (n = 5059) receiving Natrelle 410 implants. The authors caution that their results relied upon the consistent reporting of complications by the investigators. Only one double capsule was anecdotally reported. The authors explain that recognition of this entity was not well-recognized when their study was initiated.

Anaplastic Large Cell Lymphoma (ALCL)

Since about 2000, an increasing number of women with breast implants have been diagnosed with ALCL. The US Food and Drug Administration (FDA) now lists 258 medical device reports of

ALCL on its website [129]. A recent survey found that 7% of plastic surgeons had seen a case of ALCL in their practice [36]. Clemens [125] reports that the individual lifetime risk is 1:30,000 in a woman with a textured implant. McGuire et al. [128], in their study of 17,656 women undergoing cosmetic or reconstructive breast surgery using Natrelle 410 implants, identified four cases of ALCL (1 in 4414), diagnosed between 3.5 and 11.6 years after implantation.

Alarmingly, nine women are known to have died either from the disease or its treatment [125]. Implants textured with the Biocell "lost salt" method [130] are at much greater risk than the Siltex imprint method [130] used in manufacturing Mentor MemoryShape implants [125].

Based on their microbiological study, Hu et al. [45] conclude that bacterial infection leads to ALCL. The authors [45] insist that all surgeons implement a 14-point intraoperative plan [44] to reduce the risk of infection (e.g., nipple shields, antibiotic irrigation). Hu et al. [45] concede that there was no difference in the number of bacteria comparing capsule specimens from ALCL patients with nontumor specimens. The bacterial count was higher on the affected side, but the number of samples was very limited ($n = 3$).

Textured implants are not just "overrepresented" [45] in cases of ALCL. Brody et al. [131] report *no* cases of ALCL in women treated solely with smooth implants. Similarly, Clemens [125] reports no confirmed cases of ALCL in patients treated only with smooth implants, although implant histories are missing in many cases. Seemingly at odds with his co-authors [45], Brody [132] believes that texturing is the likely trigger, not infection.

In view of this serious risk, why are textured devices still being used? [133] Texturing promotes tissue adherence so as to avoid implant malrotation [8]. However, there is no evidence that shaped implants are superior to round implants for cosmetic breast augmentation; in fact, there is evidence to the contrary [36, 134]. Superiority over round devices has even been questioned for breast reconstruction [135].

Patients are uninformed of the link between textured devices and ALCL. This strong, possibly universal [125, 131], association is still not mentioned in manufacturer brochures [136] or the American Society of Plastic Surgeons consent forms [137]. The reader would think that ALCL is a rare complication of any breast implant, not just textured implants. She should be informed of the added risk with texturing so she can participate in implant selection and possibly select a smooth device [133]. Clemens [138] recommends including ALCL in the informed consent discussion. However, the possibility of ALCL developing with a smooth implant is so unlikely it falls below the threshold for foreseeable risk – the criterion for inclusion in the informed consent process [139].

> The patient should be informed of the added risk with texturing so she can participate in implant selection and possibly select a smooth device.

This discussion leads directly to conflict of interest [133]. Most researchers receive financial support from breast implant manufacturers, including Hu et al. [45]. Textured, form-stable silicone gel implants are much more profitable for the manufacturer than smooth gel and saline-filled implants. However, a transition to smooth, round devices would improve patient safety. The industry can adapt, as it has in the past. The problem, and its resolution, could not be clearer.

Fortunately the prognosis is usually favorable [125]. Removal of the implant and capsule is sufficient for women with disease limited to the fluid or capsule. In women with more advanced disease that has spread beyond the confines of the capsule, there is now an effective immunotherapy that is likely to be curative [125].

Deva [140] believes that there should be no rush to stop using textured implants and recommends waiting for more science. By science he means more investigation of the role of infection, which his group considers the real cause of ALCL [45]. Blaming this late complication on infection acquired at surgery has much different implications than blaming a faulty implant design.

In defense of a wait-and-see approach, some plastic surgeons ask, what are we going to tell our patients who already have textured implants? and, what are we going to tell plastic surgeons who prefer shaped implants – that they cannot have them anymore? The answer should be clear enough. Women who already have textured implants should be informed of their 1 in 30,000 lifetime risk of ALCL [125]. They can decide for themselves whether to have their textured implants replaced with smooth ones. This might be a useful point to consider for women who are thinking of having additional breast surgery anyway, such as a breast lift, or changing to a different breast size. Honesty, uncluttered by commercial influence, is the best policy. Ignoring the problem risks painting all breast implants with the same brush.

Venous Thromboembolism, Doppler Ultrasound, and Total Intravenous Anesthesia

Venous thromboembolism has received a great deal of attention in the last decade, with concentrated efforts to identify individuals at risk and treat them perioperatively with anticoagulants. The author has challenged the efficacy, ethics, and safety of this approach, suggesting that the risks outweigh the benefits [141, 142].

In their recent systematic review and consensus conference, Pannucci et al. [143] recommend that all plastic surgery patients should be risk-stratified using a 2005 Caprini score. For patients with Caprini scores >8, the authors [143] recommend that surgeons consider chemoprophylaxis on an individual basis. In making this recommendation, the authors rely on only two studies of hospitalized patients [144, 145]. Neither study was a controlled trial. The Level 3 Venous Thromboembolism Prevention (VTEP) study [144] compared an untreated historical control group with a prospective cohort of plastic surgery inpatients who received enoxaparin. The study by Bahl et al. [145], co-authored by Pannucci, was a retrospective chart review comparing VTE risk in otolaryngologic surgery patients (11% undergoing plastic surgery procedures) treated with or without heparin.

Bahl et al. [145] report that patients who received chemoprophylaxis experienced a 1.2% risk of VTE versus a 1.3% (difference nonsignificant) for patients who did not receive heparin, almost identical to the 1.2% rates for both treated and untreated patients in the VTEP study [142]. Bahl et al. [145] also compared risk-stratified patients with Caprini scores >7, finding a higher percentage of VTE in the nontreated patients, but the difference was not significant. Despite its title, the VTEP study [144] also found no significant treatment benefit for risk-stratified patients. Nonsignificant differences ($p = 0.08$ for combined patients with Caprini scores >8 [1]) do not count as evidence [146].

Shaikh et al. [147] attempted to find a significant risk difference using numerous Caprini scores as threshold values. The VTE risk in "high-risk" patients with Caprini scores between 5 and 8 was 1.5%, the same as the overall risk [147]. Counterintuitively, all 36 patients with extremely high Caprini scores >10 experienced no cases of VTE [147].

Risk stratification models consistently provide a dismal 97% false positive rate [144, 147, 148], much too high for a screening test [142]. These findings should not be surprising. Caprini scores were not conceived scientifically and do not correlate with known relative risk values [149]. Moreover, Caprini scores do not consider the anesthesia method, an important risk factor [143]. If there is no significant difference in risk [147], and no significant treatment benefit even among patients with higher Caprini scores [144, 145], why calculate Caprini scores? [146]

> Caprini scores were not conceived scientifically and do not correlate with known relative risk values. Caprini scores do not consider the anesthesia method, an important risk factor.

Anticoagulation increases the risk of bleeding, hematomas, wound dehiscences, and unplanned blood transfusions [142]. Although Pannucci et al. [150] previously claimed that anticoagulation

does not significantly increase reoperative hematoma rates, Pannucci et al.'s recent analysis [143] does find evidence for increased bleeding. Bahl et al. [144] reported higher rates of bleeding in anticoagulated patients (p <0.001), similar to other studies in plastic surgery patients using either enoxaparin or rivaroxaban [151–154].

It is time to move beyond making ineffective predictions. Studying venous thromboembolism without ultrasound technology is analogous to studying arrhythmias without the benefit of electrocardiograms. The first sign of a venous thromboembolism is sudden death in 10% of patients [155]. Doppler ultrasound offers a highly accurate and noninvasive method to detect deep venous thromboses. Patient compliance is almost 100% [156].

Fortunately, thromboses do not tend to develop intraoperatively in plastic surgery patients treated with total intravenous anesthesia [156]. When they do develop, thromboses tend to form distally in the calves, where they are not as dangerous (2% risk of pulmonary emboli vs. 50% in the thigh [156]). By administering anticoagulation to affected individuals, it may be possible to resolve the thrombus before it propagates. The emphasis should be on early detection and treatment of affected individuals rather than no detection (clinical diagnosis being notoriously unreliable [156]) and treatment of a large number of unaffected individuals [141, 142, 146]. The author's practice is to screen patients with Doppler ultrasound before surgery, on the first day after surgery, and approximately 1 week after surgery [156].

The emphasis should be on early detection and treatment of affected individuals rather than no detection (clinical diagnosis being notoriously unreliable) and treatment of a large number of unaffected individuals.

Pannucci et al. [143] recognize the importance of the calf muscle pump, recommending "alteration in anesthetic management, especially using anesthesia that preserves the calf muscle pump, as a mechanism for deep venous thrombosis prevention." Numerous studies document a lower risk of deep venous thrombosis in plastic surgery patients treated with intravenous anesthesia [142]. SAFE (Spontaneous breathing, Avoid gas, Face up, Extremities mobile) anesthesia is likely to improve patient safety [142]. Unfortunately, a randomized trial is impractical; equipoise is unlikely, particularly when the risk may be existential [146]. Is there any physiological evidence that total intravenous anesthesia may better preserve the calf muscle pump function during surgery?

Fortunately, hemodynamic data are available to compare anesthesia methods in plastic surgery patients [157]. Kenkel et al. [158] examined the cardiovascular effects of general endotracheal anesthesia using a bolus of propofol (2 mg/kg) at induction, sevoflurane as the continuous inhalational agent, and rocuronium (50 mg) to facilitate intubation in five liposuction patients. These investigators [158] reported a significant (P <0.01) reduction in mean arterial blood pressure after induction, from a mean pressure of 95 mmHg to 73 mmHg, and then to 67 mmHg (−30%) over 1–2 h without a return to baseline during surgery or immediately postoperatively. Sustained hypotension and paralysis (>2 h) are linked to valvular hypoxia [157]. Using this method of anesthesia, a 2.8% risk of deep venous thrombosis (5% after abdominoplasty) was reported among 347 patients undergoing excisional body contouring procedures, including belt lipectomies, despite the use of enoxaparin in 39% of patients [152].

These findings may be contrasted with liposuction and abdominoplasty outpatients treated with a 2 mg/kg bolus of propofol followed by a propofol infusion delivered at a rate of 160–200 μg/min, and no inhalational agent or paralysis [159]. Mean heart rates and blood pressures did not fluctuate significantly from baseline during surgery or in the recovery room [159]. One case of deep venous thrombosis occurred among 551 consecutive liposuction and abdominoplasty procedures (0.2%) [160]. The risk was 0.6% (1/167) after abdominoplasty [160]. Moreover, in 200 consecutive plastic surgery outpatients, no deep venous thromboses were detected on Doppler ultrasound scans performed the day after

surgery [156]. Maintaining a normal blood pressure and preservation of the calf muscle pump seem to be effective in reducing the risk of deep venous thrombosis [156].

With propofol it is quite easy, by adjusting the rate of infusion, to maintain stable hemodynamics [157]. During the maintenance phase of anesthesia, the cardiovascular effects of both propofol and inhalational agents are minimal in healthy patients. However, a propofol infusion leads to more rapid recovery than inhalational agents, a significantly lower risk of nausea and vomiting, earlier discharge from the post-anesthesia care unit, and earlier ambulation. A disadvantage for general endotracheal anesthesia is the need for muscle relaxants and positive pressure ventilation, which may reduce venous return. Preservation of the calf muscle pump reduces the risk of venous stasis by maintaining pulsatile flow and avoiding hypoxia in the valves of the deep veins of the lower extremities, where thrombi originate [157].

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Sequential Compression Devices

The use of sequential compression devices (also called intermittent pneumatic compression) is often considered an essential part of venous thromboembolism prevention [161]. A widely cited 2005 meta-analysis [162] evaluated 15 randomized studies comparing sequential compression devices with no treatment and concluded that their use reduces the risk of deep venous thrombosis 60% (relative risk, 0.40). Curiously, there was no reduction in the risk of pulmonary embolism. In fact, the relative risk of pulmonary embolism was slightly (although not significantly) higher in patients treated with sequential compression devices (relative risk, 1.12).

Patients are told, "these devices squeeze your calves and prevent blood clots," which is certainly intuitive [161]. In truth, there is no evidence that these devices affect the frequency of deep venous thromboses in plastic surgery patients. Is there a reason not to use sequential compression devices? Indeed, there are two negatives, and both are insidious. One problem is that by wrapping these devices around the calves, the surgeon may think that this intervention is effective on its own and will be disinclined to incorporate other modalities that may be equally safe but more effective, such as SAFE (i.e., spontaneous breathing, avoid gas, face up, extremities mobile) anesthesia [142] and ultrasound surveillance [156]. Another negative is the medicolegal implications [161]. Today, these devices are often considered part of the standard of care. The plastic surgeon may be unfairly blamed for a fatal pulmonary embolism that may have occurred regardless of whether these devices were used in surgery. One always needs to be careful in testifying as to the standard of care when the factual support is at least open to question (the same is true for risk stratification and chemoprophylaxis).

Other Complications

Osborn and Stevenson [163] reported a surprisingly high rate of pneumothorax in among surveyed plastic surgeons. One in three respondents had experienced at least one case of pneumothorax while performing a breast augmentation. The suspected causes are intraoperative puncture of the pleura (43%), needle puncture from injection of local anesthetic (37%), ruptured pulmonary blebs (16%), and high ventilation pressure (3%).

Some patients develop breast striae [164, 165]. Veins may appear more prominent [166]. Studies reporting a higher risk of suicide fail to identify a cause-and-effect relationship [167].

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The Myth of Breast Autoaugmentation

5

Abstract

Over 100 publications claim to increase upper pole fullness or breast projection without a breast implant. However, there is no objective evidence that these efforts are effective. A recurring concept is "autoaugmentation," a technique of repositioning a glandular pedicle in an attempt to restore fullness to the upper pole of the breast. In one technique, a parenchymal flap is tunneled through a loop of pectoralis muscle. The authors claim that this method simulates the effect of a 100–200 cc implant. However, comparison of standardized photographs reveals no benefit in upper pole projection or breast projection. Measurements show that techniques using fascial sutures to suspend the breast are also ineffective. Claims of greater breast projection and avoidance of postoperative ptosis using implantable mesh, sometimes called an internal bra, are not supported by measurements on matched photographs. Today this old concept is being repopularized by plastic surgeons with financial ties to the mesh manufacturer.

Despite long-standing recognition of its importance, photographic standardization is ignored. Typically, the after photographs are magnified or tilted in such a way as to suggest a treatment benefit that does not exist.

Negative measurement findings should not come as a surprise. No manipulation of breast tissue can create a net gain in breast volume. Only a vertical mammaplasty can reliably increase breast projection and upper pole projection, and then only modestly (1 cm), by trading width for projection. A Wise pattern does the opposite. A breast implant is needed to substantially boost upper pole projection. Implants can be inserted safely at the time of a mastopexy if a vertical method is used. Implants hold their shape more reliably than natural breast tissue. There is no need to resort to ineffective breast autoaugmentation.

E. Swanson, *Evidence-Based Cosmetic Breast Surgery*, DOI 10.1007/978-3-319-53958-4_5

Introduction

Numerous techniques have been published that claim to preserve or improve breast projection and upper pole fullness after mastopexy or breast reduction [1]. However, there is no objective evidence that these efforts are effective. A recurring concept is "autoaugmentation," a technique of repositioning an inferiorly based (or sometimes superiorly based) glandular pedicle in an attempt to restore fullness to the upper pole of the breast.

The concept of autoaugmentation has a long pedigree, dating to Ribeiro's 1975 description [2] of an inferiorly based parenchymal flap transposed to the upper pole in an effort to simulate a breast implant. Subsequently, over 100 articles have claimed to increase upper pole fullness or breast projection without an implant. In 2011, I published a retrospective study [1] evaluating 82 published mastopexy and reduction techniques that contained suitable photographs for comparison. The measurement system featured an unchanging landmark, the sternal notch, and a consistent horizontal reference – the plane of maximum postoperative projection (see Chap. 2) [3].

In 1976, McKissock [4] commented prophetically (in that dozens of such papers have been published since and this is a perpetual topic of discussion at meetings today) on "an awesome bibliography without a justifying sense of progress," and concluded: "We are still awaiting the paper entitled "Finesse in Mammaplasty" and are still getting the papers entitled "A New Approach to Mammaplasty." He called attempts at autoaugmentation "cabinetmaking fantasies" [5]. McKissock [6] considered the idea of suturing the inferior pedicle to the chest wall to suspend the breast for a prolonged period of time "naïve" and an idea that has "lured generations of surgeons as intelligent as ours into a period of trial and acceptance that will take another generation to undo." He also considered the possibility that "perhaps its intrinsic seductiveness is so great that plastic surgery is doomed forever to repeat cycles of this idea" [6]. McKissock made these observations in 1980.

Graf et al. [7] and Graf and Biggs [8] published a method tunneling a parenchymal flap through a loop of pectoralis muscle, claiming that this method simulated the effect of a 100–200 cc implant (Fig. 5.1).

Graf et al. [9] recently published their 10-year follow-up study, concluding that their method provides "comparable breast shape and upper-pole projection to an implantable prosthesis with less comorbidity to the patient." However, once the authors' photographs were corrected for differences in tilt and magnification, there was no evidence of a change in upper pole projection and a slight decrease in breast projection for both treated and control patients (Figs. 5.2 and 5.3). A comparison of convexity (upper pole projection/breast projection) favored the patient that was *not* treated with the muscle loop. A muscle loop may compress the parenchymal flap against the chest wall, accounting for concavity of the upper pole – the opposite of the desired effect [10].

Artist illustrations typically depict a substantial increase in breast projection and upper pole fullness (Fig. 5.4) [11]. These drawings more

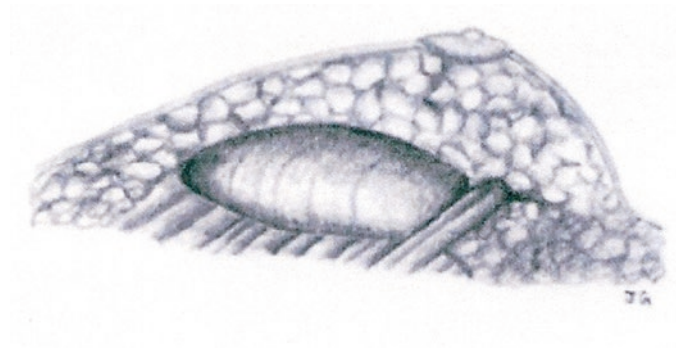

Fig. 5.1 Schematic view of thoracic wall flap technique. The authors claim the size of this flap is similar to a 100–200 cc implant, boosting the volume of the upper breast pole (Reprinted from Graf et al. [7]. With permission from Springer Verlag)

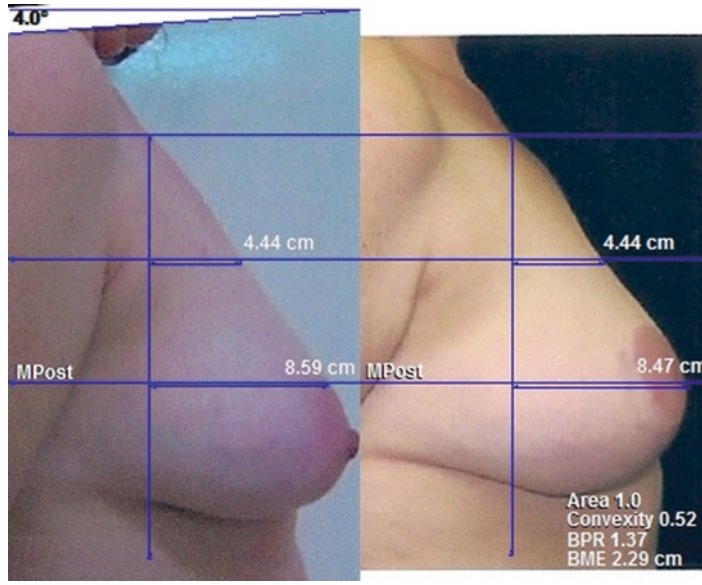

Fig. 5.2 This 46-year-old woman depicted by the authors in their Figure 3 is shown before (*left*) and 10 years after surgery (*right*) using the pectoralis muscle loop. A 21% magnification of the postoperative photograph and a 4° tilt have been corrected using the Canfield 7.4.1 Mirror Imaging software (Fairfield, NJ). There is no change in upper pole projection and a very slight decrease in breast projection. Her convexity (upper pole projection/breast projection) is 52%. The breast contour is slightly concave after surgery. Measurements were calibrated using a length of approximately 30 cm for the upper arm. *MPost* plane of maximum postoperative breast projection, *BPR* breast parenchymal ratio, *BME* breast mound elevation (Reprinted from Swanson [10]. With permission from Oxford University Press)

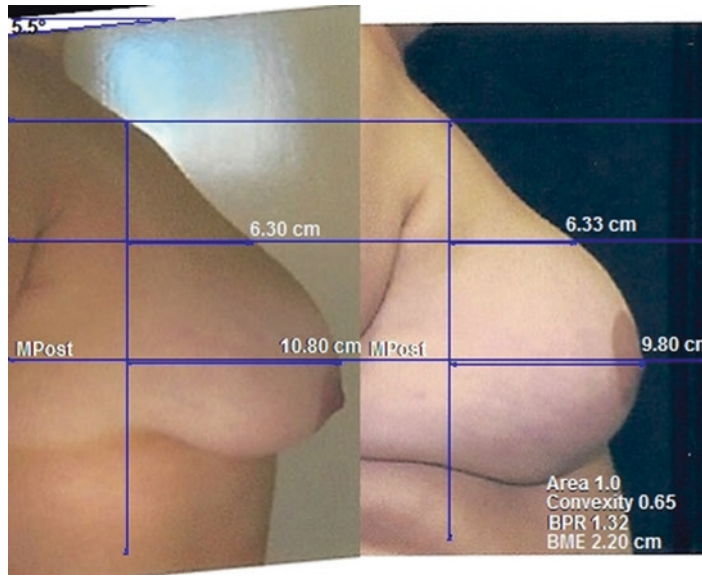

Fig. 5.3 This 42-year-old woman depicted by the authors in their Figure 4 is shown before (*left*) and 10 years after surgery (*right*) without using the pectoralis muscle loop. A 10% magnification of the postoperative photograph and a 5.5° tilt have been corrected using the Canfield 7.4.1 Mirror Imaging software (Fairfield, NJ). There is essentially no change in upper pole projection and a slight decrease in breast projection. Her convexity (upper pole projection/breast projection) is 65%. The breast contour is slightly convex after surgery. Measurements were calibrated using a length of approximately 30 cm for the upper arm. *MPost* plane of maximum postoperative breast projection, *BPR* breast parenchymal ratio, *BME* breast mound elevation (Reprinted from Swanson [10]. With permission from Oxford University Press)

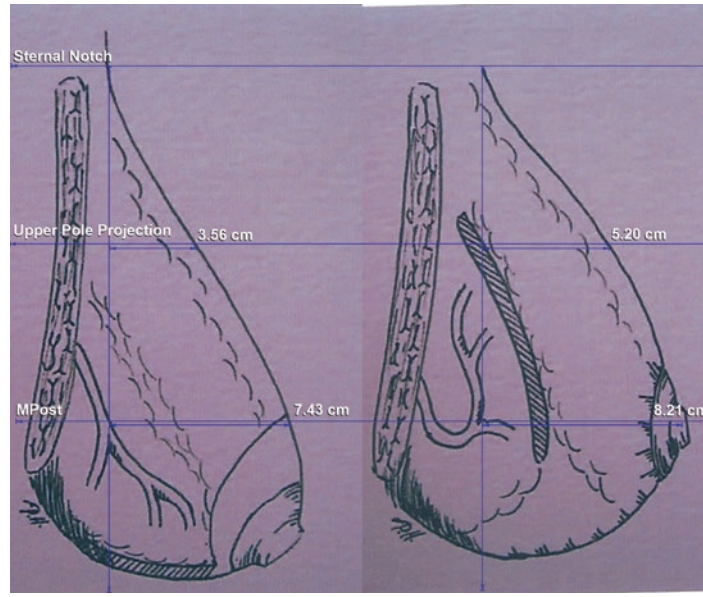

Fig. 5.4 The authors' illustration shows a boost in upper pole projection and breast projection (*right*). The increase in upper pole projection, approximately 1.6 cm, exceeds the change produced by the authors' method, but is matched by vertical augmentation/mastopexy (Swanson [12]). A 15-cm distance from the sternal notch plane to the plane of maximum postoperative breast projection (*MPost*) was used for standardization (Reprinted from Swanson [11]. With permission from Wolters Kluwer Health)

accurately depict the changes expected when a mastopexy is performed simultaneously with a breast implant [12].

Photographic Integrity

Despite long-standing recognition of the importance of photographic standardization [13, 14], investigators continue to present nonstandardized photographs in an effort to prove that their method effectively restores upper pole volume [15–21]. Common photographic inconsistencies include different focal distances [9, 15, 16, 18, 20, 21], tilt of the torso [9, 15, 16, 18–21], and arm positions [9, 15, 18–21]. In 2010, Riml et al. [22] documented a widespread disregard for photographic standards in articles published in the top plastic surgery journals.

Despite long-standing recognition of the importance of photographic standardization [13, 14], investigators continue to present nonstandardized photographs in an effort to prove that their method effectively restores upper pole volume

Fortunately, the Canfield Mirror imaging software (Canfield Scientific, Fairfield, NJ) makes it easy to correct many of these orientation and magnification differences. When analyzing published results, the photographs do not include a ruler. In the author's study of 82 published reports [1], the photographs were calibrated using a standard upper arm length of 32.5 cm. The average female upper arm length is 32.45 cm ± 2.06 (1 S.D.) [23]. The use of such a reference length is justified because it is the difference between pre- and postoperative values that is being studied. As long as the same calibration is used for both before and after images, the fact that an individual patient is slightly artificially enlarged or reduced does not affect the statistical significance of differences and ratios. Figures 5.5 and 5.6 compare published photographs [19] before and after image standardization [24].

Bonomi et al. [18] combine an inferiorly based parenchymal flap with a superiorly based pedicle to the nipple, claiming long-lasting upper pole fullness and increased projection of the nipple–areola complex. Measurements reveal that the postoperative lateral photographs of the two patients presented by the authors are enlarged 80% and 125% respectively. Both patients are tilted forward approximately 5° preoperatively. These factors contribute to the illusion of increased upper pole

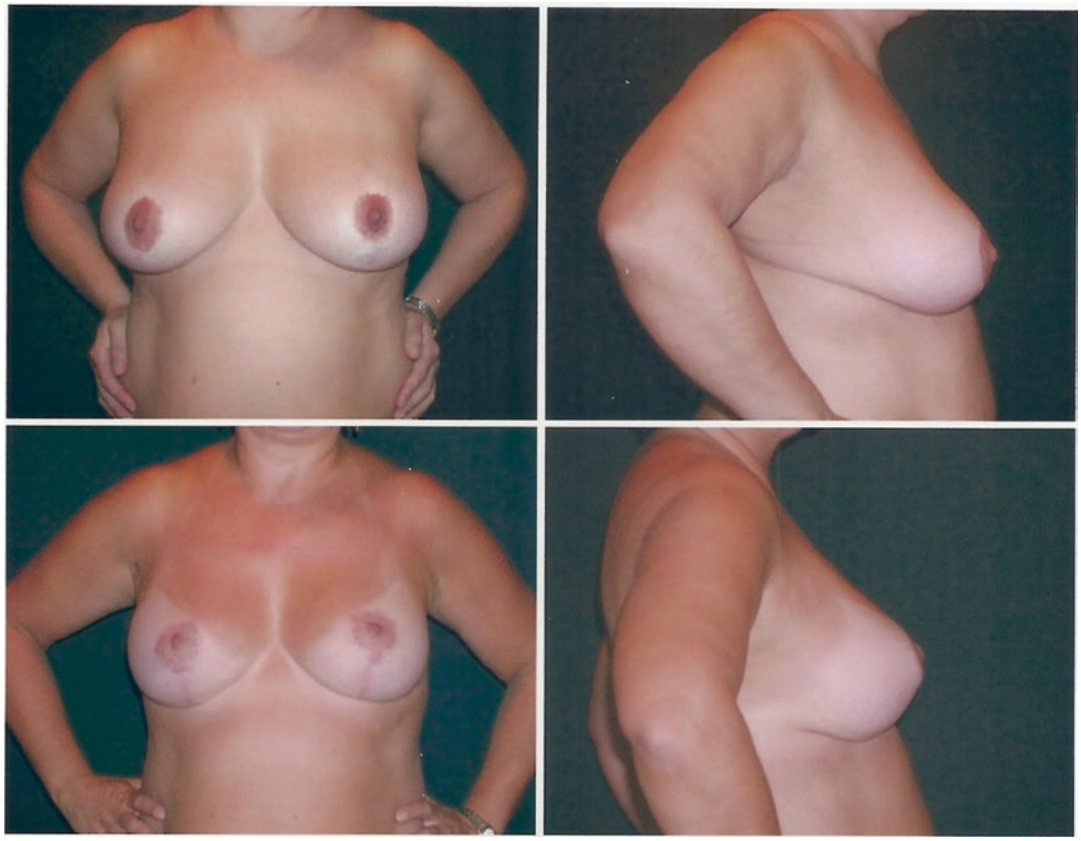

Fig. 5.5 These photographs depict a woman who has had a previous reduction mammaplasty before (*above*) and 6 months after (*below*) revision using the method popularized by Graf (*below*) (Reprinted from Neto et al. [19]. With permission from Wolters Kluwer Health)

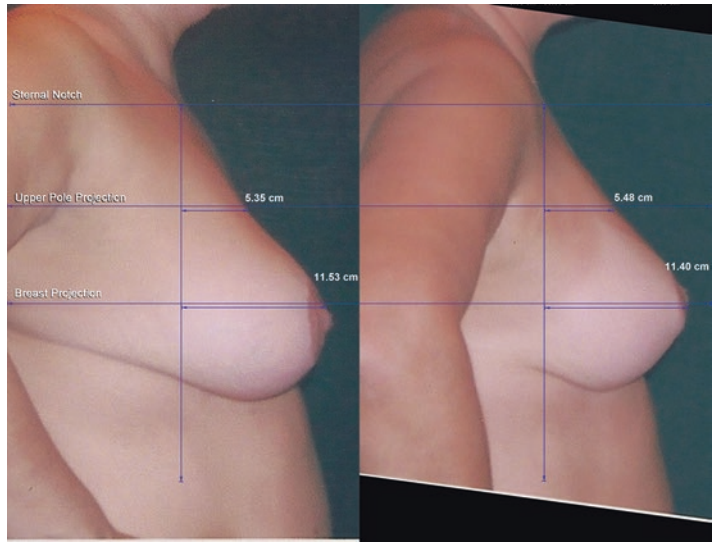

Fig. 5.6 Photographs of the patient in Fig. 5.5 have now been matched for orientation and size. An 8° tilt is corrected, as revealed by the black margins (*right*). There is essentially no change in breast projection or upper pole projection. The nipple is slightly overelevated (Reprinted from Swanson [24]. With permission from Wolters Kluwer Health)

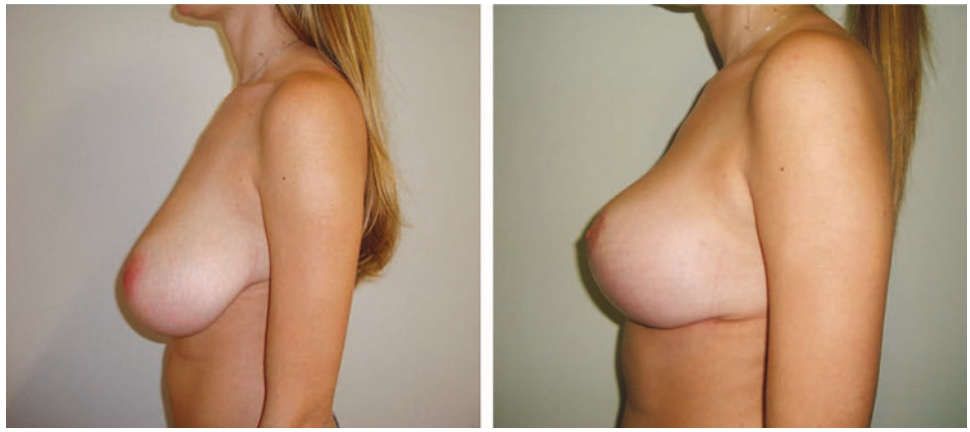

Fig. 5.7 This 24-year-old is shown before (*left*) and 1 year after (*right*) a breast reduction using an inferior dermoglandular flap and a superior pedicle. The after image is magnified 80% and tilted back 5° compared to the preoperative photograph (Reprinted from Bonomi et al. [18]. With permission from Wolters Kluwer Health)

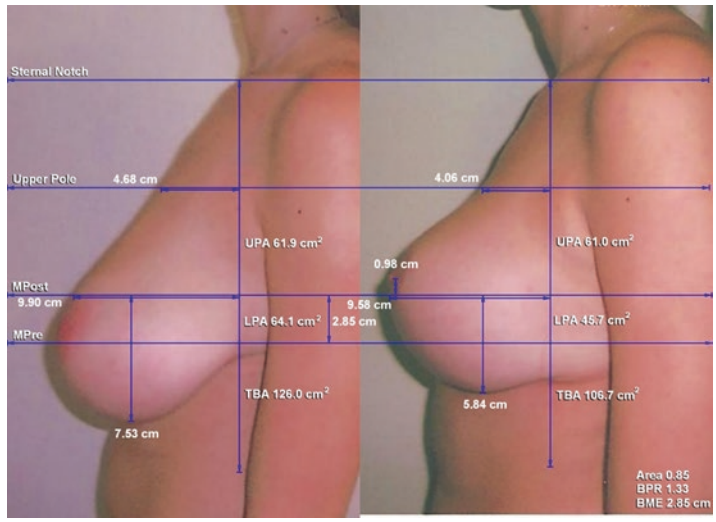

Fig. 5.8 Lateral photographs of the authors' patient, corrected for size and orientation. Measurements reveal a slight loss of upper pole projection and breast projection. For calibration, an arbitrary value of 30 cm was assigned to upper arm length. *MPost* maximum postoperative breast projection, *MPre* maximum preoperative breast projection, *UPA* upper pole area, *LPA* lower pole area, *TBA* total breast area, *BPR* breast parenchymal ratio, *BME* breast mound elevation (Reprinted from Swanson [25]. With permission from Wolters Kluwer Health)

fullness and breast projection after surgery (Fig. 5.7), an effect that disappears after correction for size and orientation (Fig. 5.8) [25].

Breast Projection and Upper Pole Projection

Breast projection was not increased significantly by published mastopexy/reduction methods evaluated in the author's study [1]. With the exception of the vertical procedure, all mastopexy/reduction procedures reduced breast projection, although this difference reached significance (p <0.01) only for the combined group, not individually. The mean change in breast projection for all procedures was a 0.65 cm decrease [1].

No mastopexy/reduction technique significantly increased upper pole projection. The mean change in upper pole projection for all techniques was a loss of 0.17 cm (not significant). The inverted-T, superior or medial pedicle, group

showed a significant loss of upper pole projection, 0.83 cm (p <0.01) [1].

Published photographs are likely to represent the authors' best-case results, so that the findings may be more favorable than the average results; this fact strengthens the findings of no significant change in several key breast shape parameters.

The author also studied his own patients treated with vertical mammaplasties [12]. The mean increase in breast projection after vertical mastopexy was 1.19 cm on the right side and 1.28 cm on the left side. Upper pole projection increased 0.48 cm on the right side and 0.60 cm on the left side. The increment in breast projection after vertical reduction was more modest – 0.63 cm on the right side and 0.61 cm on the left side (not significant). Upper pole projection increased 0.91 cm on the right side and 0.72 cm on the left side after vertical reduction. Not surprisingly, when an implant was added, the increases in breast projection and upper pole projection were greater.

In comparing a retrospective group of inverted-T inferior pedicle mastopexies and breast reductions with a prospective group of patients treated exclusively with the vertical method, the findings were favorable for the vertical group [26]. Vertical mastopexy, but not inverted-T mastopexy increased breast projection and upper pole projection. Vertical breast reduction better preserved breast projection than the inverted-T method. Vertical reduction significantly increased upper pole projection; the inverted-T reduction did not.

Fascial Sutures

The concept of using sutures [27, 28] or dermal strips [29] in an attempt to anchor the breast to the pectoral fascia and prevent descent is not new. Forty-two percent of the mastopexy/reduction publications studied used fascial sutures [1]. However, their efficacy has never been established and several surgeons have recommended that surgeons avoid using them [30–32]. McKissock, in 1980 [6], called suture suspension a "continuously recurring concept perpetuated by wishful thinking rather than unbiased observation." The author's study found no increase in breast projection or upper pole projection in patients treated with fascial sutures [1]. Neither patients treated with or without fascial sutures experienced a significant increase in breast projection or upper pole projection after surgery [1].

> The author's study found no increase in breast projection or upper pole projection in patients treated with fascial sutures.

"Laser Bra"

According to Stevens, the "Stevens laser bra" maintains breast shape and minimizes the possibility of "fallout" of the breast. According to the website [33], this method provides an "internal support structure for the breast tissue." An "internal brassiere protects the breast lift result." The laser bra creates a "perkier breast that retains its shape for a longer period of time." The website reassures its visitors that the laser bra is "not some sort of gimmick or marketing trick." It "holds the breast up and in place." The website references an article published in the *Aesthetic Surgery Journal* [34] finding no major complications in 367 patients who had the laser bra procedure, while saving 30–40 min of operating time.

The referenced article [34] describes deepithelialization of an inferior pedicle using a carbon dioxide laser and references previous reports by other surgeons using the laser in a similar fashion [35, 36]. A standard inferior pedicle Wise pattern breast reduction is performed [34]. The authors report no major complications, although there were 36 cases of wound breakdown, 6 infections (2 patients hospitalized), 3 hematomas, and 1 seroma. Scar deformities were not listed as separate complication. The average time for laser treatment of the inferior pedicles was 5½ min. It is not clear how 30–40 min of operating time are eliminated. No lateral photographs are available for analysis. The article [34] makes no claims regarding improved breast shape or durability of the result and does not include the term "laser bra." Nevertheless,

"laser bra" remains a popular Google search term and plastic surgeons are regularly asked by patients if they perform this type of breast reduction.

"Dermal Bra"

The "dermal bra" mammaplasty, described by Guo et al. [16] (Fig. 5.9), combines a periareolar incision and central mound dissection with plication of the dermis to the chest wall. Central mound dissections cut through the superficial blood vessels and nerves to the nipple on all sides, predictably causing nipple numbness and reduced vascularity [37]. Alarmingly, the authors reported four cases of nipple necrosis (1.2%) [16]. They believe that this complication rate is "lower than ever reported," despite the publication of a much larger series of patients treated with the vertical technique and no nipple necrosis [31].

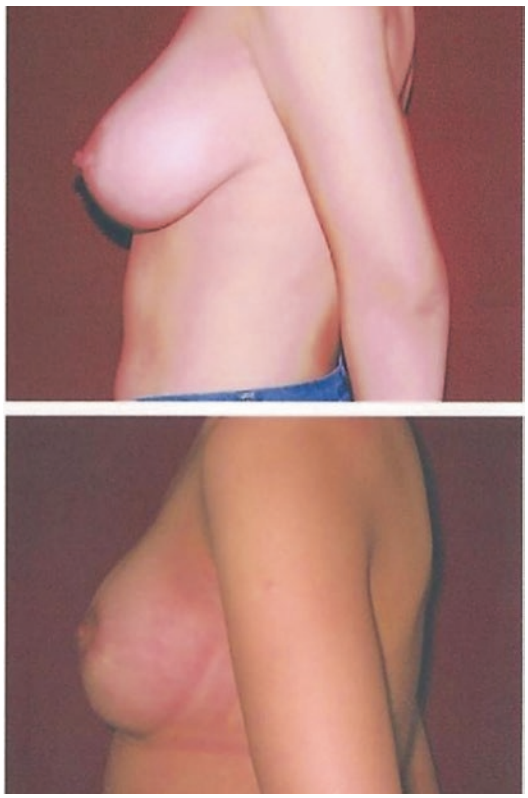

Fig. 5.9 Published photographs of a 38-year-old woman before (*above*) and 6 months after (*below*) a dermal bra mammaplasty. The after photograph is magnified 40% (Reprinted from Guo et al. [16]. With permission from Wolters Kluwer Health)

Fascial sutures may limit projection by compressing the breast tissue on the chest wall [10], as discussed with the pectoralis loop method. A large periareolar skin resection makes periareolar pleats inevitable. This approach is associated with persistent ptosis, flatness, and areolar deformity [37]. The authors claim that their method preserves breast projection and that 99% of patients are satisfied [16]. Orientation and size-matched photographs are provided in Fig. 5.10 [37].

"Internal Bra"

Góes, a Brazilian plastic surgeon has long advocated a "double skin technique" [38]. After deepithelializing a central mound, he applies a mesh consisting of 40% permanent polyester and 60% absorbable polyglactin (Fig. 5.11). The dissection is superficial, constructing a cone lined with dermis. The mesh is sutured to the anterior pectoralis fascia using nylon sutures or titanium clips. The author claims that this method improves anterior projection, resists early ptosis, maintains ideal breast shape, and counteracts gravity [38]. However, this claim is not substantiated by measurements of matched photographs (Fig. 5.12).

De Bruijn and Johannes [39] apply a preshaped, permanent mesh to the breast (Fig. 5.13), calling it an Internal Bra System, and claiming that this mesh results in a permanent desired shape. These investigators tried using polypropylene alone, polypropylene with absorbable Vicryl (polyglycolic acid), and polyester alone, settling on a preshaped polyester cone [39]. They use a Wise resection pattern in 42.5% of patients and a Lejour (vertical) resection in 57.5% of patients, with or without a horizontal component. A problem with polypropylene was its rigid structure and palpable margins, leading the authors to replace it with polyester. In three patients, the investigators inserted the mesh in one breast and no mesh in the other breast. The authors reported no recurrent ptosis and no scar hypertrophy. Unfortunately, the authors did not publish any preoperative and postoperative photographs of these three patients who

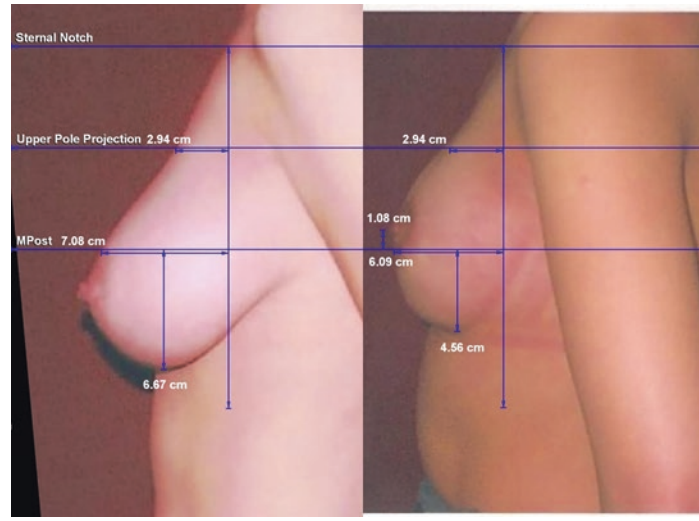

Fig. 5.10 Comparison of photographs after correction for size and a 5.5° tilt. Breast projection is decreased. The nipple is overelevated. *MPost* maximum postoperative breast projection (Reprinted from Swanson [37]. With permission from Wolters Kluwer Health)

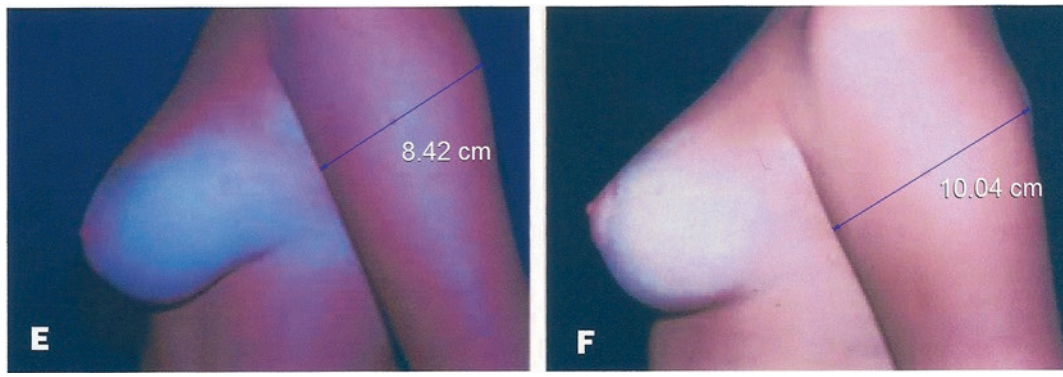

Fig. 5.11 Lateral photographs of a 25-year-old woman before (*left*) and 4 years after (*right*) undergoing a Góes double-skin 250 g reduction. Góes claims improved anterior projection of the mammary cone and areola (Reprinted from Góes [38]. With permission from Oxford University Press)

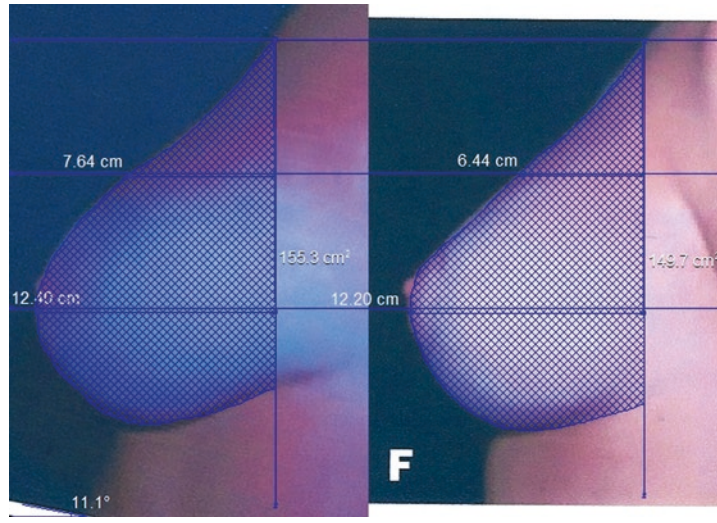

Fig. 5.12 The photographs in Fig. 5.11 are compared after correction of a 42% difference in magnification and 11° tilt. Measurements reveal no evidence of an increase in breast projection

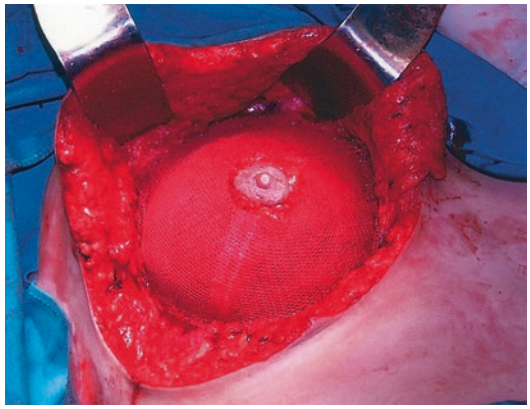

Fig. 5.13 The authors' "internal bra" (Reprinted from de Bruijn and Johannes [39]. With permission from Springer Verlag)

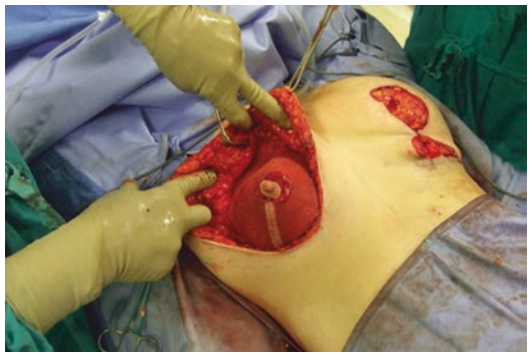

Fig. 5.14 Intraoperative photograph of preshaped polyester mesh (Reprinted from van Deventer et al. [40]. With permission from Springer Verlag)

functioned as their own controls. Despite treating 170 women, they were unable to provide any before and after photographs that included frontal and lateral views. The authors disclosed a financial interest in Breform Limited, a South African company, and indicated that this company developed the intellectual property. The authors reported no financial interest in any mesh manufacturer.

In 2011, van Deventer et al. [40] published an article describing an "internal breast-supporting system" using mesh (Fig. 5.14). The authors found that a disadvantage of the preshaped polyester used by de Bruijn and Johannes was the fixed shape of the mesh, which was available in only four sizes. Van Deventer et al. [40] believe that maintenance of breast shape relies on the skin envelope when a Wise pattern and inferior pedicle are used. Their goal was long-lasting optimal breast shape, nipple projection, upper pole fullness, and short scars. The mesh consisted of equal amounts of nonabsorbable polypropylene and absorbable polyglactin. The U-shaped mesh was overlapped to create a cone and was then sutured to the chest wall. Van Deventer et al. [40] believe that the mesh replaces a failed ligamentous suspension and releases the skin from the function of maintaining breast shape. The authors claim that their system "gives the illusion of an enlarged breast due to the more youthful shape and upper-breast fullness" and avoids the need for augmentation of the upper pole with an implant. Operating times were relatively long, averaging 3 h 20 min. The most common complication was loss of nipple sensation. Patient satisfaction scores were modest, and the authors found no benefit using the mesh in patients with large resection weights (> 700 g). Van Deventer et al. [40] started using a preshaped polyester mesh instead (Fig. 5.14). The authors caution that the learning curve is long. The only available lateral photographs are compared matching for size and orientation in Fig. 5.15. The lead author disclosed a financial interest in Breform Limited. This company also provided funding for the study. The disclosure also mentions that the authors had no commercial association with the manufacturer of the mesh used in their study.

Adopting the mesh method, Adams et al. [41] advocate the use of GalaFLEX (Galatea Surgical, Lexington, MA) as an internal bra or "scaffold." The authors believe that recent developments in long-term resorbable porous materials have provided surgeons the opportunity to "experiment" with tissue reinforcement with these products in their patients. This absorbable mesh is made from poly-4-hydroxybutyrate (P4HB), a material that loses mechanical strength more gradually than Vicryl (polyglycolic acid) [41]. Adams and Van Natta routinely use GalaFLEX in women with ptotic breasts to reinforce the skin envelope in mastopexy (Fig. 5.16) and to reinforce the breast capsule in revisional

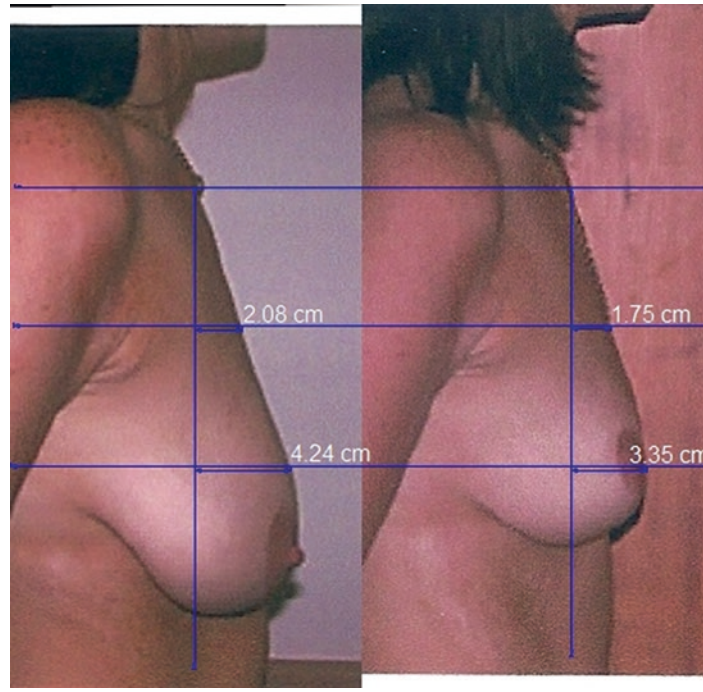

Fig. 5.15 This 39-year-old woman underwent a mastopexy and insertion of mesh. She is seen before surgery (*left*) and 6 months after surgery (*right*). These were the only lateral photographs available in the article by van Deventer et al. The authors mention that the patient lost weight after surgery (Reprinted from van Deventer et al. [40]. With permission from Springer Verlag)

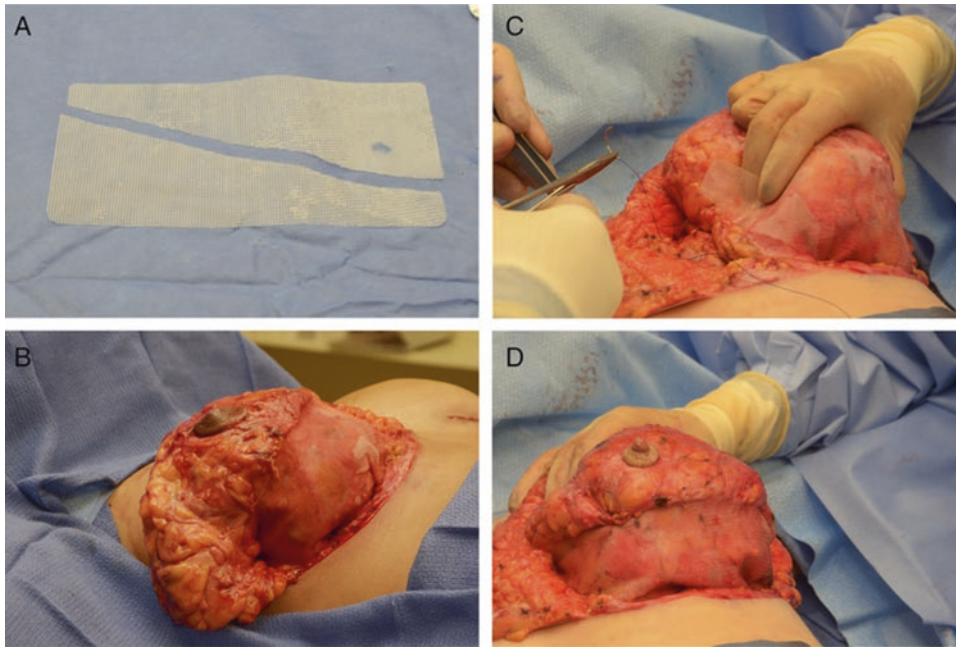

Fig. 5.16 Intraoperative photographs of a 33-year-old woman undergoing augmentation mastopexy using a breast implant. The authors applied GalaFLEX to the lower pole (Reprinted from Adams et al. [41]. With permission from Oxford University Press)

breast surgery [41]. The authors claim that this material increases mechanical strength and improves maintenance of the postoperative result, and even improves the appearance of skin scars by reducing tension. They claim that bottoming out will not occur.

The authors [41] state that P4HB scaffolds have been used in central mound, superior pedicle and inferior pedicle mastopexies. Van Natta [42] finds that patients do not mind paying $1200 extra for this product. Adams et al. [41] claim that GalaFLEX does not irreversibly stretch and a breast shaped with GalaFLEX will not relax over time. Therefore, they believe that bottoming out and pseudoptosis will not occur [41]. The study does not include control patients, so it is not possible to compare results with and without this material. Two of the three illustrated patients also received breast implants. According to the authors, the material can be felt under the skin for 6 – 9 months. Some patients had contour irregularities, which they treated with fat grafting. The disclosure paragraph indicates that Van Natta and Toriumi are paid consultants for Galatea Surgical, the manufacturer of GalaFLEX. Galatea also partially funded the supplement in which this article was published, along with another supportive article [43]. GalaFLEX received FDA clearance for reinforcement of fascial defects, where a bridging material is needed. It has not received clearance specifically for breast surgery [44]. Adams and Moses [45] recently published a series of 11 women treated with mesh. One patient's photographs are depicted in Fig. 5.17.

The Failed Promise of Autoaugmentation

The term "autoaugmentation" implies a net increase in size using autologous tissue. It is an overstatement of our capabilities [11]. A more modest claim might be breast "redistribution" or "remodeling" – no size increase, but a better shape (and even that goal may be difficult to achieve). Unfortunately, stuffing the upper pole with lower pole tissue works nicely on a diagram (Fig. 5.4),

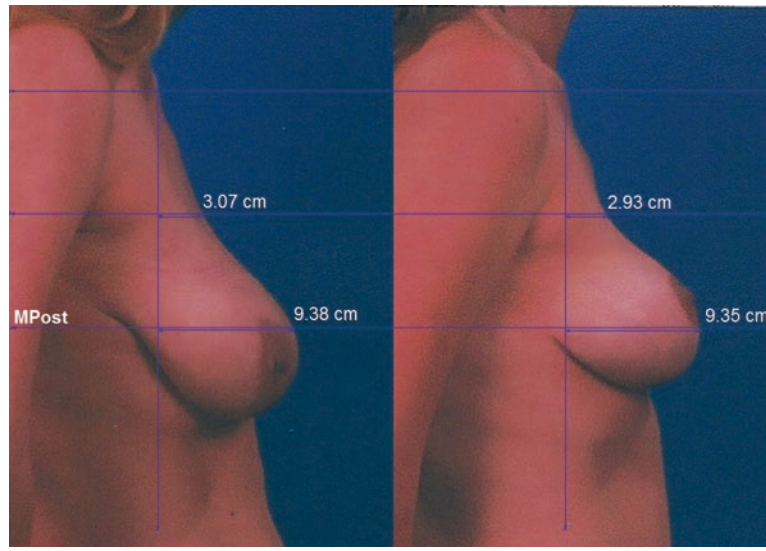

Fig. 5.17 Lateral photographs of a woman shown in the authors' Figure 4 before (*left*) and 12 months after (*right*) a mastopexy using the mesh technique. Breast projection and upper pole projection are essentially unchanged. The breast appears bottomed-out and the nipple is overelevated. There is a loss of breast volume. A 30-cm upper arm length was used for calibration (Reprinted from Adams WP Jr. and Moses AC. [45] With permission from Wolters Kluwer Health)

but not in practice [11]. Breast implants outperform natural breast tissue for holding shape [12].

It is abundantly clear that an implant is necessary to achieve a meaningful increase in breast projection and upper pole projection [1, 11, 12]. It is puzzling that plastic surgeons continue their efforts to augment the breast using local tissue or foreign materials, without results, in an age when breast implants are available as a safe and effective option with high levels of patient satisfaction [46].

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Mastopexy and Breast Reduction

6

Abstract

Vertical mastopexy and breast reduction are the same operation, differentiated only by the resection weight. The vertical technique converts an elliptical defect to a straight-line closure. The length dividend increases projection and produces conical lower poles. Breast shape is improved, with less scarring than the Wise pattern. Nonvertical mammaplasties have geometric limitations, including nipple overelevation, boxiness, and reduced breast projection.

A medially based pedicle and intraoperative nipple siting are recommended. A short, inverted-T modification is used when the vertical scar extends below the level of the new (elevated) inframammary fold. A mosque dome often creates an inverted teardrop deformity.

Surprisingly, in 60% of women with ptotic breasts, both nipples are located at or above the breast apex, suggesting that the nipple slides with the breast in most cases rather than on it.

Vertical breast reduction effectively inverts the breast parenchymal ratio. The mean increase in breast projection after vertical mastopexy is 1.2 cm. Upper pole projection increases 0.5 cm. The increment in breast projection is about half as much after breast reduction – 0.6 cm on both sides. These modest increases confirm the clinical impression that mastopexy and reduction cannot duplicate the effect of a breast implant.

Nipple transposition on long pedicles is unnecessary. Using the vertical method, 80% of the upward nipple movement derives from breast mound elevation; only 20% comes from nipple repositioning on the breast mound. Short pedicles reduce the incidence of nipple loss to almost none. Persistent ptosis is the most common indication for reoperation. Adequate lower pole parenchymal resection is needed to prevent persistent ptosis. Skin-only mastopexies are usually ineffective.

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Vertical mammaplasties facilitate combination ("mommy makeover") procedures. Operating times for vertical mammaplasties, typically 1–2 h, are about an hour shorter than for inverted-T procedures, with less blood loss. Outpatient surgery is the norm.

Breast augmentation, mastopexy, augmentation mastopexy, and reduction are all cosmetic procedures [1], notwithstanding the physical benefits of breast reduction and mastopexy [2]. Mastopexy and augmentation/mastopexy deserve close evaluation because these procedures have been a source of patient and physician dissatisfaction [3–5]. The author evaluated mastopexy and breast reduction as part of a comprehensive evaluation of cosmetic breast surgery that included a prospective outcome study [2], measurement studies [6–8], clinical study [9], and a study of published methods [10].

Failure to remove breast tissue from the lower pole – relying on tightening the skin envelope alone – is likely to provide no significant elevation of the lower pole, making the efficacy of a "skin-only" mastopexy questionable [6].

Today we recognize an overlap in indications for these procedures and even in physical benefits [2]. When a vertical technique is used, the mammaplasties are essentially the same, differentiated only by the resection weight [2, 6]. Recognizing that any cutoff is arbitrary, the author defines a breast reduction as a resection weight of 300 g or more from at least one breast [2, 6, 8, 9].

"Breast Lift"

Measurements confirm that the inframammary crease level moves up after a vertical mammaplasty [7]. Both vertical and inverted-T techniques can elevate the lower pole [10]. An underappreciated benefit of elevation of the lower breast pole is the appearance of a longer torso [9]. With the emphasis on fitness in our culture, and the frequent display of the midriff, this anatomic area takes on greater importance. However, upward mobilization of the *superior* border of the breast is more challenging [11]. "Autoaugmentation" has not lived up to its billing (see Chap. 5) [10]. Breast implants are needed to substantially boost breast projection and upper pole projection [6, 12–14], providing the appealing illusion of breast mound elevation.

An underappreciated benefit of elevation of the lower breast pole is the appearance of a longer torso.

Mastopexy

The word *mastopexy* is derived from the Greek "mastos", for breast, and "pexy," for fixation. Commonly, mastopexy is understood to be synonymous with "breast lift." Among plastic surgeons, a mastopexy has been traditionally understood to mean a skin tightening procedure [15], certainly for a "skin-only mastopexy." However, the goal of a mastopexy is improvement in the shape of the breast, not simply tightening of its (elastic) envelope. In ptotic breasts, the lower pole needs to be reduced (i.e., parenchymal resection) to provide an aesthetic lower pole [6, 9, 16, 17] and avoid a "mastopexy wrecking bulge" [18].

No one denies that a breast reduction is also a mastopexy [10]. However, the reverse is true too. Measurements show that an effective mastopexy is also at least a small breast reduction [6]. Therefore, any distinction between mastopexy and breast reduction is arbitrary [10]. Indeed, mastopexy techniques evolved directly from reduction procedures [15]. We recognize the goals in optimizing breast shape are the same. Many authors acknowledge this false dichotomy and use the more inclusive term "mammaplasty." [10] These procedures treat the same problem – breast sagging – with the only variable being the resection weight [10]. Therefore, mastopexy and breast reduction may be considered together.

Any distinction between mastopexy and breast reduction is arbitrary.

Fascial Sutures

The concept of using sutures [19, 20] in an attempt to suspend the breast on the pectoralis fascia and prevent descent is not new. Maliniac [21] used dermal strips. Almost half (42%) of the publications on the topic of mammaplasty advocate fascial sutures [10]. However, their efficacy has never been established and several surgeons recommend against their use [10, 22–25]. McKissock, in 1980 [25], observed: *"The thought that suturing the inferior pedicle to the chest wall will suspend the breast for a prolonged period of time is naïve. It is a continuously recurring concept perpetuated by wishful thinking rather than unbiased observation."* Fascial sutures offer no advantage in breast projection or upper pole projection [10].

Mesh

One approach that has received renewed attention is the Góes procedure [26], a deepithelialized central mound dissection with an onlay of a mixed permanent/absorbable mesh. This technique does not produce an increase in breast projection or upper pole projection [10]. This method has been popularized recently with the introduction of longer-lasting absorbable mesh [27].

Periareolar Technique

The shortcomings of skin-only mastopexies are well-recognized [15, 28, 29]. Reports of "skin-only" periareolar mastopexies, including the "crescent mastopexy" [30], typically include patients treated simultaneously with implants [10]. Such patients are likely to benefit from the augmentation alone, making the benefit of the periareolar mastopexy questionable. The areola is often distorted [10]. A survey among board-certified plastic surgeons found periareolar techniques had the highest rate of surgeon dissatisfaction [5]. Furthermore, the periareolar operation has been disproportionately represented in malpractice lawsuits [31], accounting for 62% of mastopexy claims [32], despite being used as a single technique by only 6% of surgeons surveyed [5]. Measurements confirm that women treated with the periareolar technique have no significant benefit in breast projection, upper pole projection, lower pole elevation, breast convexity, or breast parenchymal ratio [10]. A conceptual problem with the periareolar technique is that it is usually a skin-only resection [33]. There is no glandular resection. Parenchymal resection is needed for lasting improvement in shape [10]. Not only is the wrong tissue being removed in a periareolar mastopexy, but it is also being removed from the wrong place – around the areola rather than from the lower pole.

Not only is the wrong tissue being removed in a periareolar mastopexy, but it is also being removed from the wrong place – around the areola rather than from the lower pole.

"No Vertical Scar" Method

The appeal of a periareolar or "donut" mastopexy is avoidance of a vertical scar. Generally, plastic surgeons prefer to avoid vertical scars on the face and body because vertical scars run against natural creases and are not concealed by them. The "no vertical scar" mammaplasty makes use of horizontal elliptical resection, similar to the Wise pattern, and a buttonhole for the new nipple/areola site [34, 35]. The Wise pattern produces a wide lower pole [10, 36]. This effect is exaggerated when no keyhole resection is used, producing a boxy breast shape (Fig. 6.1) [10, 36].

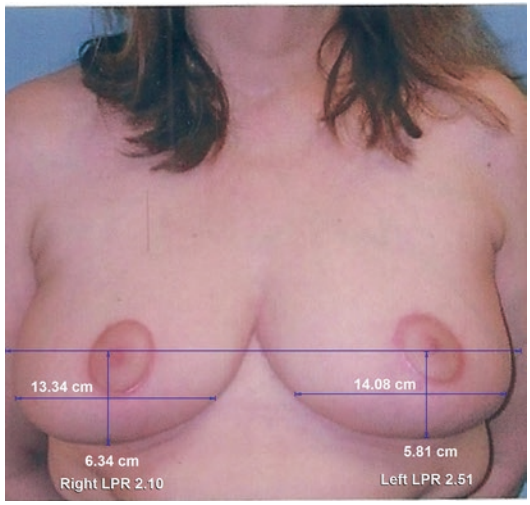

Fig. 6.1 Measurements of lower pole ratios in the example of a horizontal breast reduction provided by White et al. [36]. The patient is reportedly 50 years old and is shown 3 months after surgery. The mean lower pole ratio is 2.26, reflecting a boxy shape. *LPR*, lower pole ratio (Reprinted from Swanson [36]. With permission from Oxford University Press)

Regional Differences in Methods

It has been suggested that Brazilian and European surgeons, using "novel concepts," perform better mastopexies and reductions than their North American colleagues [37, 38]. Indeed, mastopexy is a subject of particular interest in Latin America, particularly Brazil, and notable advances have come from Brazilian plastic surgeons [39, 40]. Pioneering European surgeons, particularly from France, Belgium, and Germany, are responsible for many of the innovations still in use today [16, 41–48]. However, in comparing results in terms of the measured variables, there appears to be no geographical advantage [10].

Significant regional differences in technique include [10]:

1. Latin American and European surgeons prefer superior pedicles.
2. American surgeons use the inferior pedicle more frequently and Europeans use it less often.
3. North American surgeons use fascial sutures less often; Latin American and European surgeons use them more often.
4. North American procedures usually do not incorporate autoaugmentation; Latin American surgeons use the concept more.

Measurements of Published Studies

Despite the authors' claims, evaluation of 82 mastopexy and reduction articles reveals no significant increase in breast projection for any method (Fig. 6.2) [10]. On the contrary, nonvertical mammoplasties *reduce* breast projection. The mean change in breast projection for all procedures is a 0.7 cm decrease [10].

Similarly, no published mastopexy/reduction technique significantly increases upper pole projection (Fig. 6.3). The Wise pattern with a superior or medial pedicle decreases upper pole projection by 0.8 cm, on average.

Although the differences did not reach significance in the author's study of combined results from numerous surgeons, several individual studies did achieve a boost in breast projection and upper pole projection [17, 49–51]. All used the vertical technique.

The breast parenchymal ratio (upper pole area/lower pole area) increases significantly for Wise pattern, superior or medial pedicle mammaplasties, and for vertical mammaplasties. This ratio is not increased significantly by inverted-T, central pedicle, and periareolar mammaplasties (Fig. 6.4) [10].

All mammaplasty methods, with the exception of the periareolar and inverted-T, central mound dissections, significantly elevate the lower pole (the lowest point on the breast) and nipple (Figs. 6.5 and 6.6). Nipple overelevation was found in 42% of publications, with no significant difference between open and closed nipple siting techniques. None of the photographs showed a patient with a postoperative nipple level below the level of maximum postoperative breast projection [10].

Shape Advantages of the Vertical Technique

The vertical technique lengthens the lower pole distance (the length along the lateral curve from the plane of maximum postoperative breast pro-

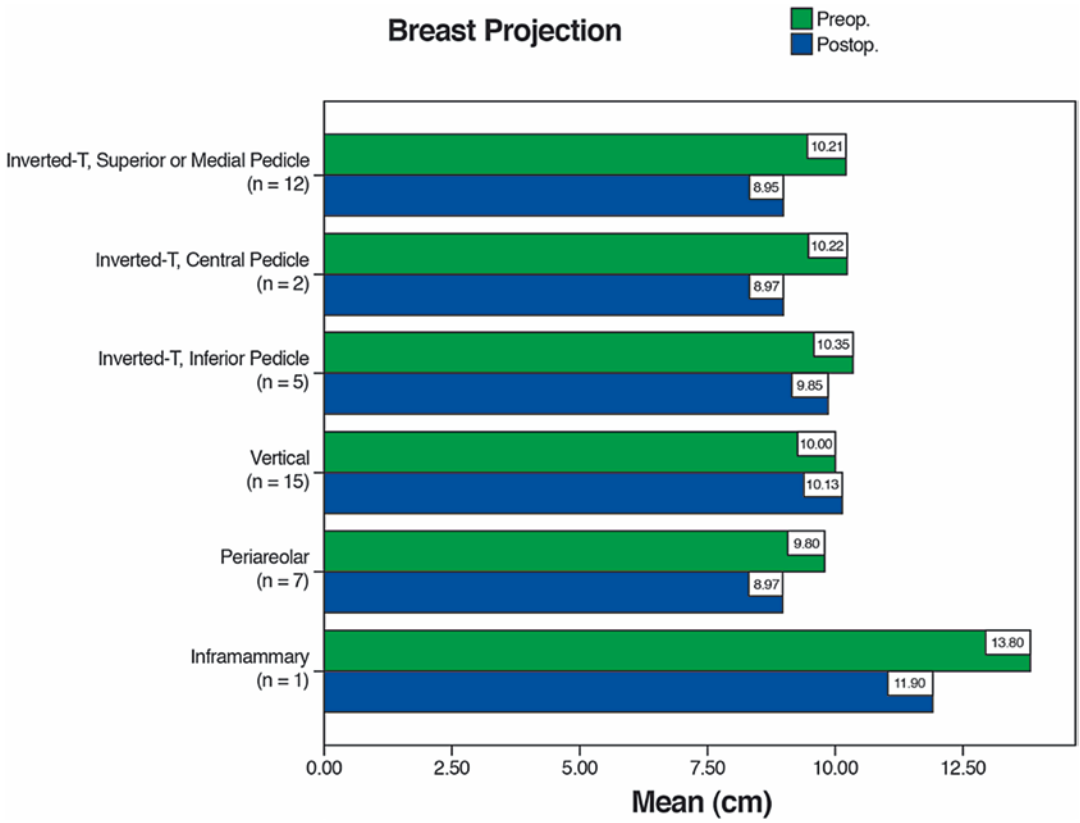

Fig. 6.2 Mean values for breast projection in 82 published studies. Preoperative (*green*) and postoperative (*blue*) (Reprinted from Swanson [10]. With permission from Wolters Kluwer Health)

jection to the posterior breast margin [52]), a measure of breast constriction [8], by converting an elliptical defect to a vertical straight-line closure (Fig. 6.7) [6, 9, 10, 22, 40, 53]. The lower pole is elevated and the length dividend increases projection [6, 8, 9]. By comparison, constriction of the lower pole, reduced breast projection, and increasing frontal boxiness, consequences of the inverted-T technique, are aesthetic problems that do not resolve [6, 8, 10].

The vertical technique lengthens the lower pole distance (the length along the lateral curve from the plane of maximum postoperative breast projection to the posterior breast margin), a measure of breast constriction, by converting an elliptical defect to a vertical straight-line closure.

Surgery

The surgical approach for a mastopexy or breast reduction is the same as for an augmentation mastopexy or breast reduction plus implants, without the implant insertion. A vertical mammaplasty is performed using a medially based pedicle [24] and intraoperative nipple siting [6, 8, 9]. A mosque-dome or keyhole preoperative pattern is not used. A vertical resection is performed. The nipple/areola site is determined after creation of the new breast mound. An inverted-T modification is used in patients in whom the vertical scar extends below the level of the new (elevated) inframammary crease. Videos demonstrating a vertical breast reduction in combination with implant insertion are available at the *Plastic and Reconstructive Surgery Global Open* website:

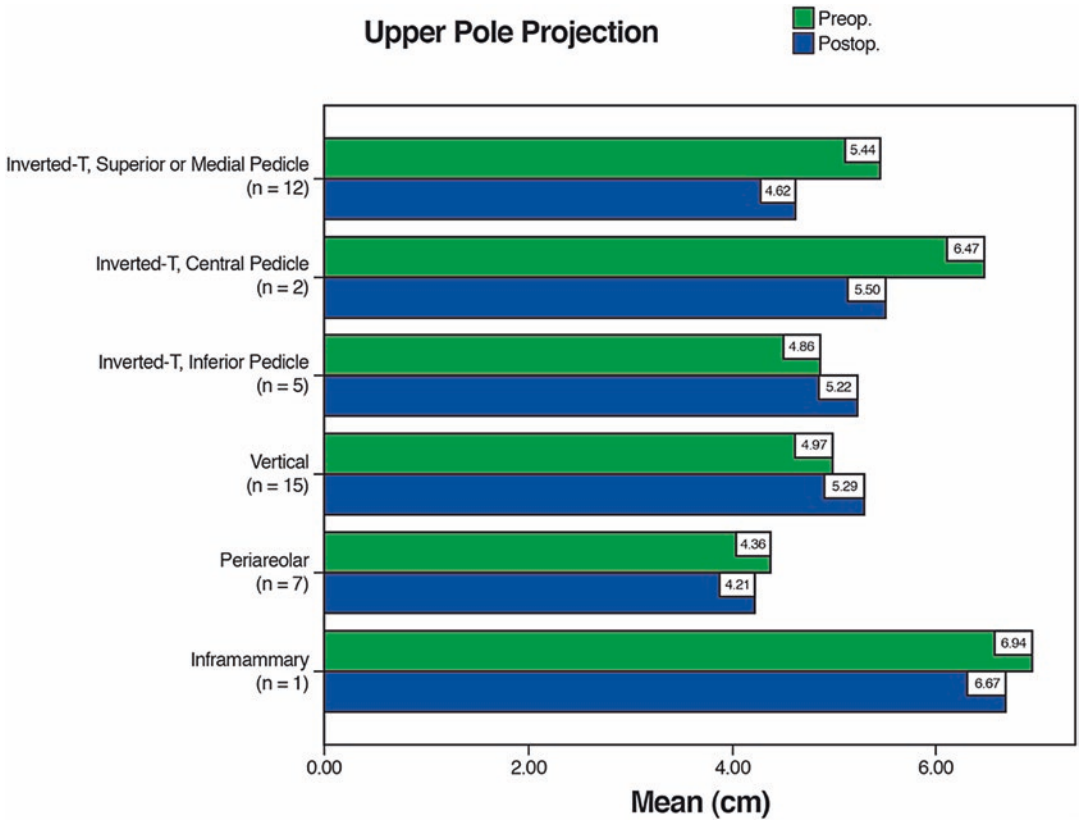

Fig. 6.3 Mean values for upper pole projection in 82 published studies. Preoperative (*green*) and postoperative (*blue*) (Reprinted from Swanson [10]. With permission from Wolters Kluwer Health)

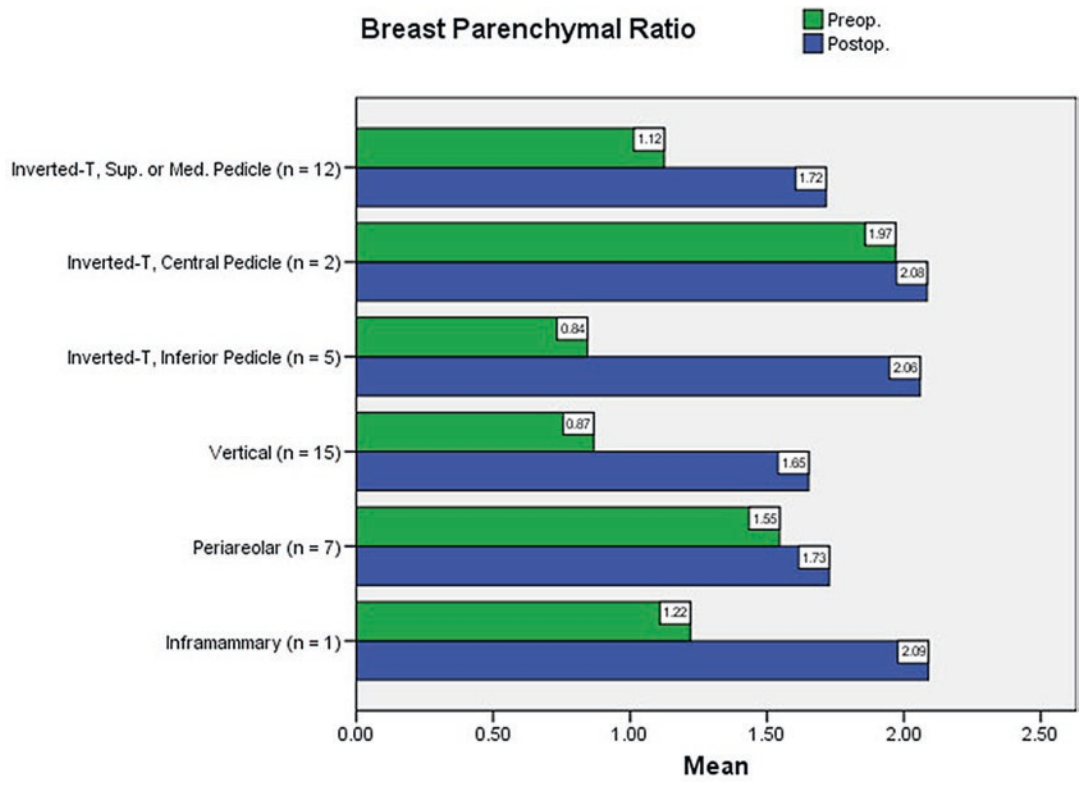

Fig. 6.4 Mean values for breast parenchymal ratio in 82 published studies. Preoperative (*green*) and postoperative (*blue*) (Reprinted from Swanson [10]. With permission from Wolters Kluwer Health)

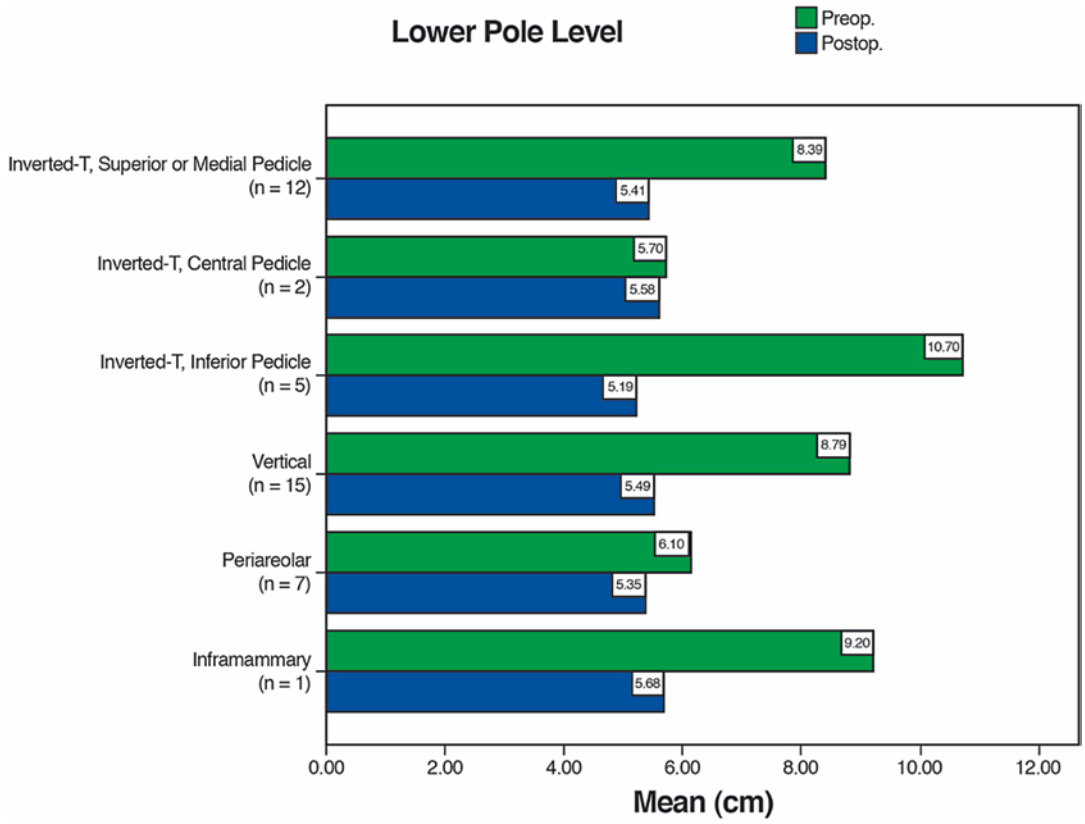

Fig. 6.5 Mean values for lower pole level (the lowest point on the breast) in 82 published studies. Preoperative (*green*) and postoperative (*blue*) (Reprinted from Swanson [10]. With permission from Wolters Kluwer Health)

http://journals.lww.com/prsgo/Pages/videogallery.aspx?videoId=23&autoPlay=true. The videos include preoperative marking, details of the surgery and anesthesia, and follow-up 24 h after surgery.

The author performs surgery on outpatients in a state-licensed ambulatory surgery center using total "SAFE" (*s*pontaneous breathing, *a*void gas, *f*ace up, *e*xtremities mobile) intravenous anesthesia [54]. No muscle relaxation is used so as to preserve the calf muscle pump [55]. Patients are also monitored for venous thromboembolism using ultrasound surveillance as part of a clinical trial in progress [56]. The mean operating time for a vertical mastopexy is 106 min, versus 121 min for a breast reduction [9]. The videos include preoperative marking, details of the surgery and anesthesia, and follow-up 24 h after surgery.

Measurements of Vertical Mastopexy and Reduction: Author's Patients

Measurements of results in published studies [10] have been discussed earlier in this chapter. The author sought to evaluate his own patients using the same measurement system [52].

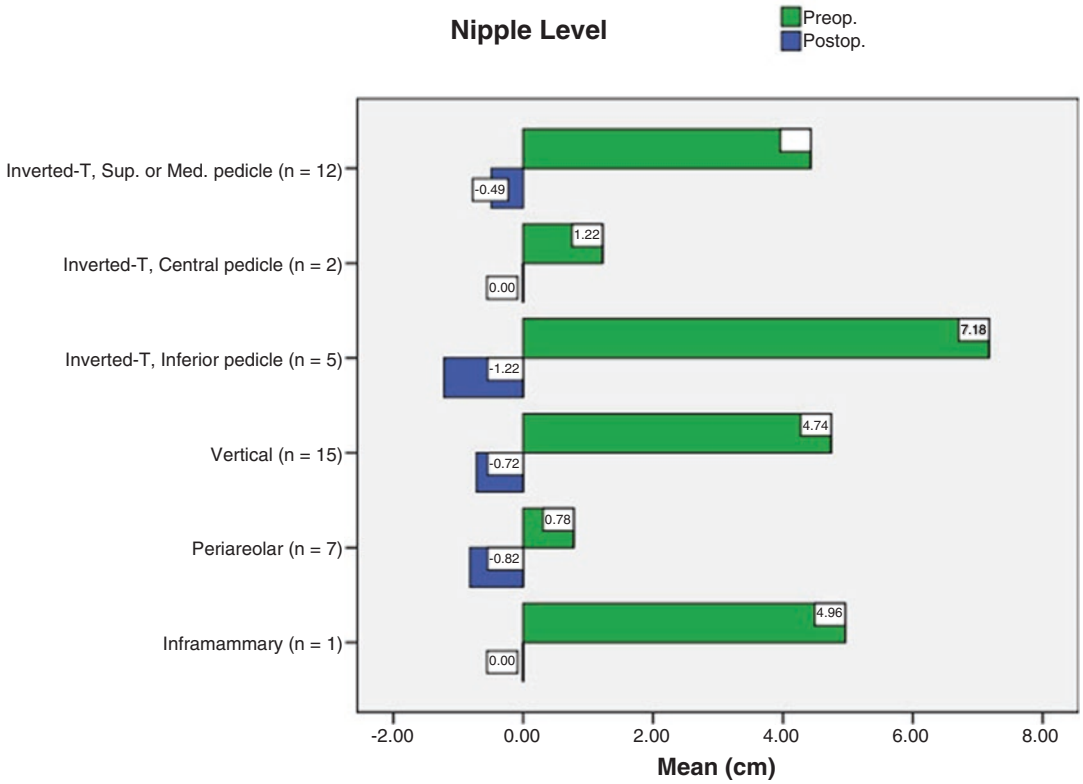

Fig. 6.6 Mean values for nipple level in 82 published studies. Preoperative (*green*) and postoperative (*blue*). Positive values indicate distances below the breast apex and negative values represent distances above the breast apex (Reprinted from Swanson [10]. With permission from Wolters Kluwer Health)

Preoperative Nipple Level

Surprisingly, in women with ptotic breasts who undergo mastopexy, augmentation mastopexy, or reduction procedures, the overall mean preoperative nipple displacement (the vertical distance between the nipple and the level of maximum breast projection [52]) is <1 cm on both sides [6]. In 75% of breasts the right nipple is positioned within 1 cm or above the level of maximum preoperative breast projection (Fig. 6.8), and in 60% of women with ptotic breasts both nipples are located at or above the breast apex before surgery [6]. These findings suggest that with breast hypertrophy and ptosis the nipple slides with the breast in most cases rather than on it. The nipple goes along for the ride, so to speak. It is, after all, an ectodermal appendage with the same embryonic origin as the rest of the breast [57]. The pathology is thought to be a weakening of the fascial ligamentous support system of the breast [51], with descent of the parenchyma in an elastic skin envelope, not a skin "brassiere" at all [6].

> With breast hypertrophy and ptosis the nipple slides with the breast in most cases rather than on it. The nipple goes along for the ride, so to speak.

Comparisons

Vertical mastopexy and reduction reduce breast areas approximately 12.5% and 25% respectively (Fig. 6.9). Vertical breast reduction increases the

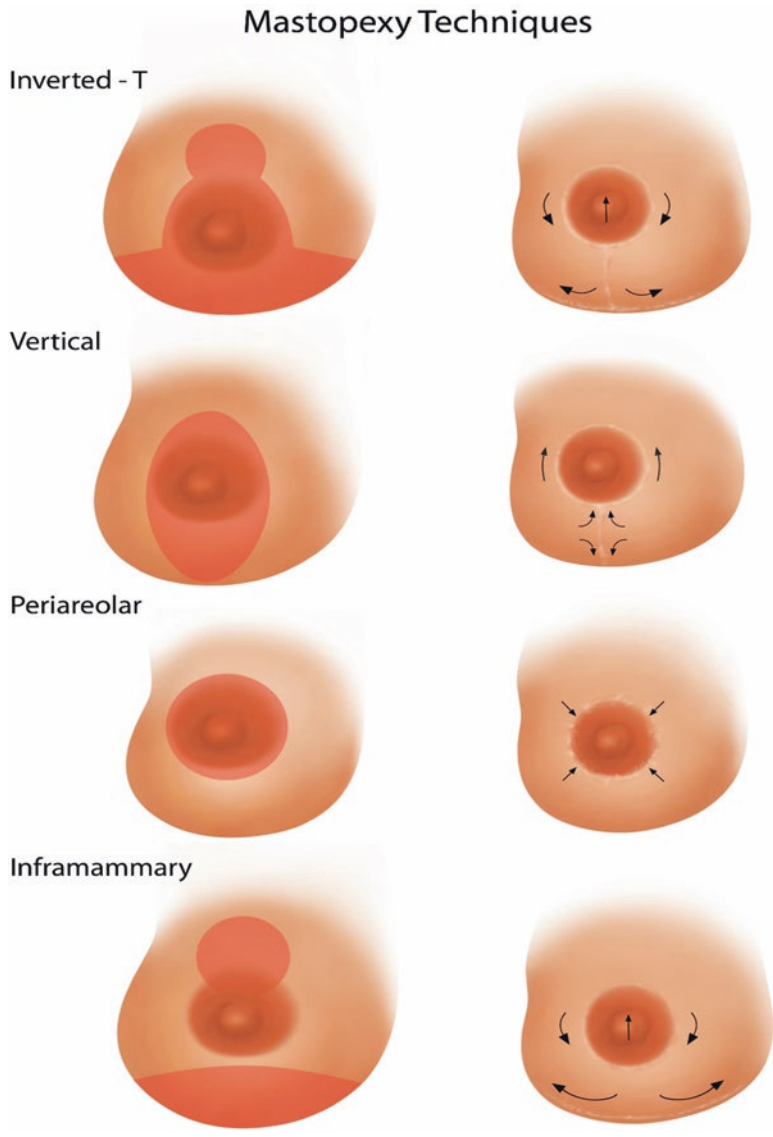

Fig. 6.7 Illustration of resection patterns for the inverted-T, vertical, periareolar, and inframammary techniques. The breast dimensions are drawn to the actual mean values determined from a study of 82 publications [10]. The *arrows* depict the movement of skin flaps and the nipple. (*Above*) In the inverted-T technique, the horizontal tissue resection causes lengthening in a horizontal direction at the expense of projection. Nipple transposition is used to counter the downward movement of the skin flaps. (*Second row*) In the vertical technique, the vertical limb length is increased, pushing the nipple up, with simultaneous reduction of width. (*Third row*) The periareolar technique does not significantly affect breast shape. (*Below*) Without a keyhole resection, the widening effect is more pronounced in techniques that avoid a vertical scar (Reprinted from Swanson [10]. With permission from Wolters Kluwer Health)

upper pole area 15% and decreases the lower pole area 50%, on average. Volume varies as the square of area. Therefore, breast reduction reduces volume 44% on average. Vertical breast reduction effectively inverts the breast parenchymal ratio (upper pole area/lower pole area). Most of the gain in breast parenchymal ratio derives from lower pole reduction as opposed to upper pole filling [6].

> Most of the gain in breast parenchymal ratio derives from lower pole reduction as opposed to upper pole filling.

The mean increase in breast projection after vertical mastopexy is about 1.2 cm (Fig. 6.10). Upper pole projection increases about 0.5 cm.

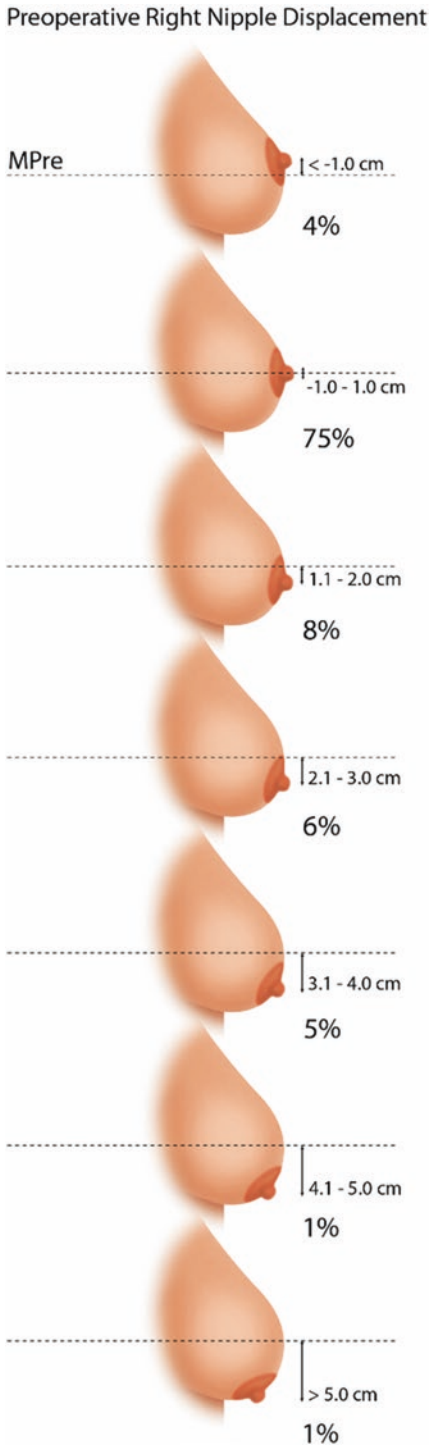

Fig. 6.8 Illustration of the distribution of right nipple levels relative to the level of maximum preoperative breast projection (nipple displacement) in 162 women with ptosis presenting for a mastopexy, augmentation mastopexy, or reduction. The right nipple was located within 1 cm of the level of maximum preoperative breast projection (*MPre*) in 75% of patients (Reprinted from Swanson [6]. With permission from Wolters Kluwer Health)

The increment in breast projection is about half as much after breast reduction – 0.6 cm on both sides, likely because of the greater reduction in volume (Fig. 6.11). Upper pole projection increases are similar to mastopexy (<1 cm). These modest increases confirm the clinical impression that mastopexy and reduction cannot duplicate the effect of an implant in creating upper pole fullness [12, 13].

These modest increases confirm the clinical impression that mastopexy and reduction cannot duplicate the effect of an implant in creating upper pole fullness.

The lower pole ratio (lower pole width divided by length) is a measure of the boxiness of the lower poles, with values much over 2.0 appearing boxy [52]. The mean postoperative lower pole ratio after vertical mammaplasty (combining mastopexy and reduction) is slightly under 2.0, measuring 1.97 on the right and 1.95 on the left [6].

Areola Diameter

Breast reduction patients tend to have large areolae, averaging 7.1 cm in diameter [6]. The areolar diameter decreases approximately 1.0 cm after mastopexy and 2.4 cm after breast reduction [6]. At least one nipple was overelevated in 30% of the author's patients. Patients do not favor wide areolae [6]. Despite using a 39 mm areola marking ring and an intraoperative positioning technique that theoretically reduces skin tension around the areola [10], areola diameters for the combined group of vertical mastopexies and reductions averaged approximately 5 cm after surgery, at the outside margin of the range deemed "okay" by patients [6]. For this reason, an areola marking device with a diameter ≤39 mm is recommended, allowing for a 1 cm stretch after surgery [6].

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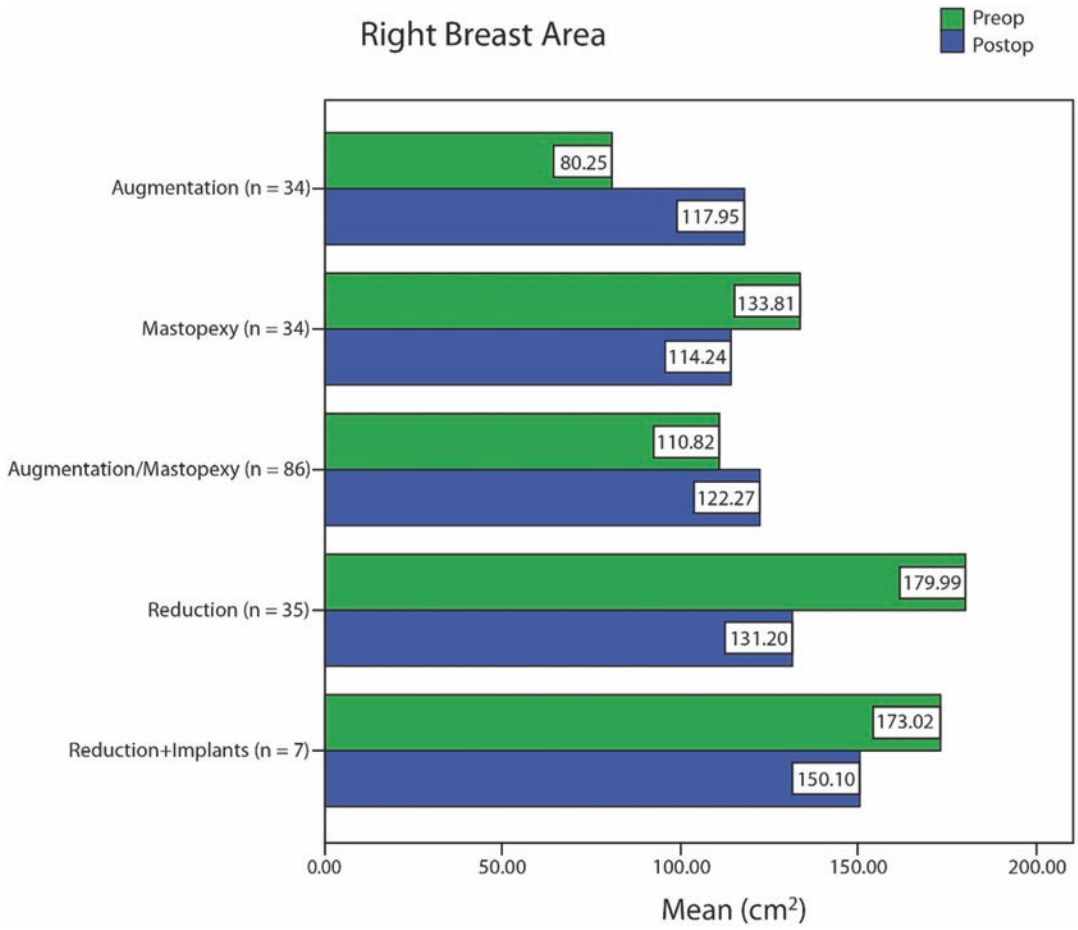


Fig. 6.9 Right breast area before (*green*) and after (*blue*) surgery. Volume changes vary as the square of area changes (Reprinted from Swanson [6]. With permission from Wolters Kluwer Health)

Both vertical mastopexy and reduction significantly elevate the lower pole level, about 3 cm after mastopexy and 5 cm after breast reduction [6]. Vertical mammaplasty effectively elevates the breast mound (level of maximum breast projection), about 4.7 cm after mastopexy and 5.6 cm after reduction [6]. The nipple moves up on average 5.8 cm after mastopexy and 7.5 cm after breast reduction. These measurements suggest that 80% of the upward nipple movement derives from breast mound elevation; 20% is from nipple repositioning on the breast mound (Fig. 6.12) [6]. This figure is calculated by dividing breast mound elevation by nipple elevation.

These measurements suggest that 80% of the upward nipple movement derives from breast mound elevation; 20% is from nipple repositioning on the breast mound.

Comparison of Inverted-T, Inferior Pedicle and Vertical Breast Reduction: Author's Patients

The author's study of published mammaplasties revealed shape deficiencies of the Wise pattern, regardless of pedicle orientation [10]. However,

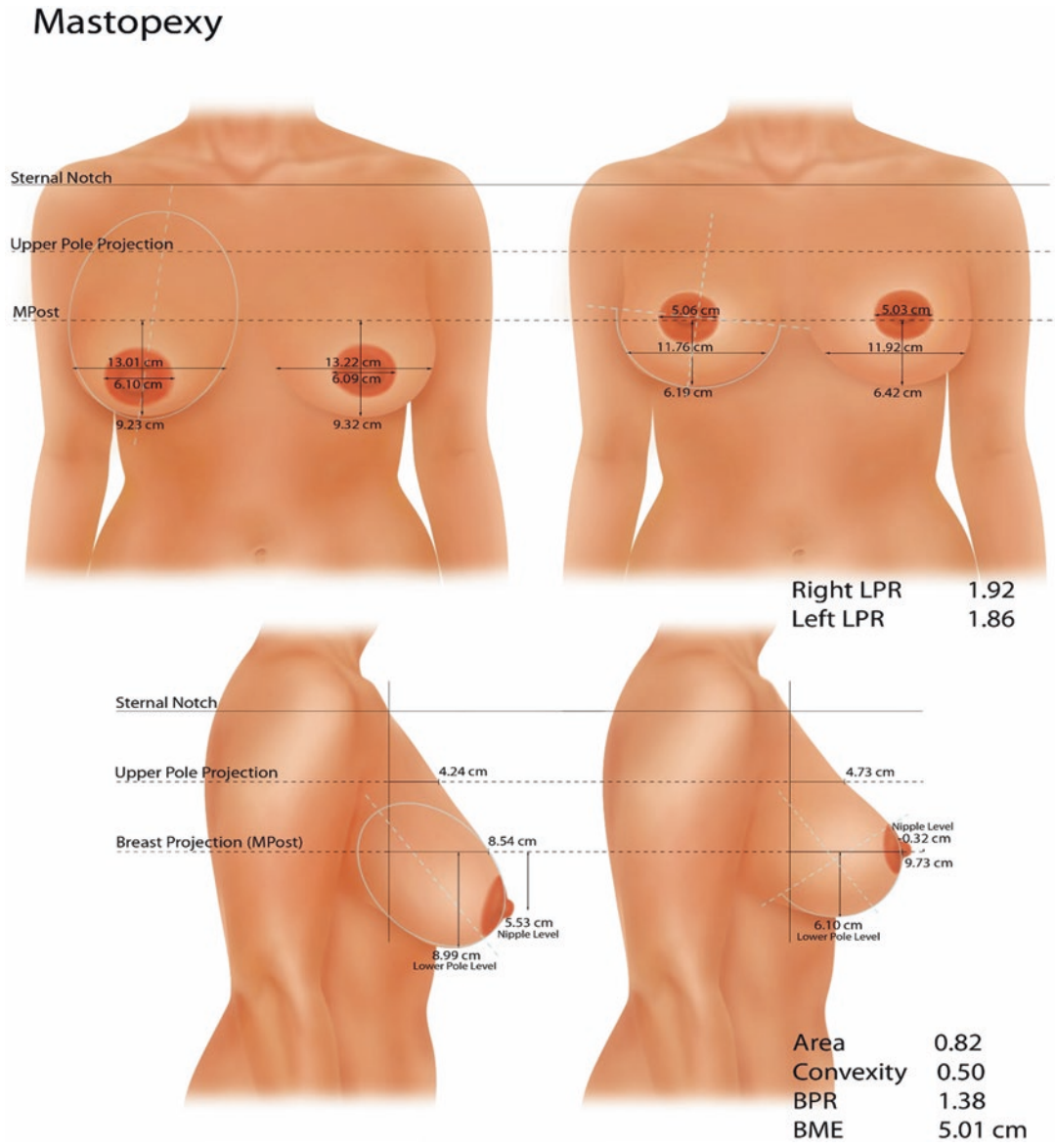


Fig. 6.10 Breast shape before (*left*) and after (*right*) vertical mastopexy with a medial pedicle. Breast projection and upper pole projection are modestly increased. The elliptical shape of the lower pole is tightened to a semicircle on both frontal and lateral views. The lower pole is elevated. The lower pole ratio (LPR) measures less than 2.0 on both sides. The upper pole contour remains linear after surgery. The areola diameter is reduced approximately 1 cm. These mammographs were created based on mean breast measurements among study patients. *MPost* maximum postoperative breast projection, *BPR* breast parenchymal ratio, *BME* breast mound elevation (Reprinted from Swanson [6]. with permission Wolters Kluwer Health)

this study combined results from many different surgeons. It also evaluated only published photographs, which are likely to represent favorable results.

In order to compare these methods in the absence of confounders, the author undertook a comparative study of his own breast reduction patients [8]. The author performed all mammaplasties using the

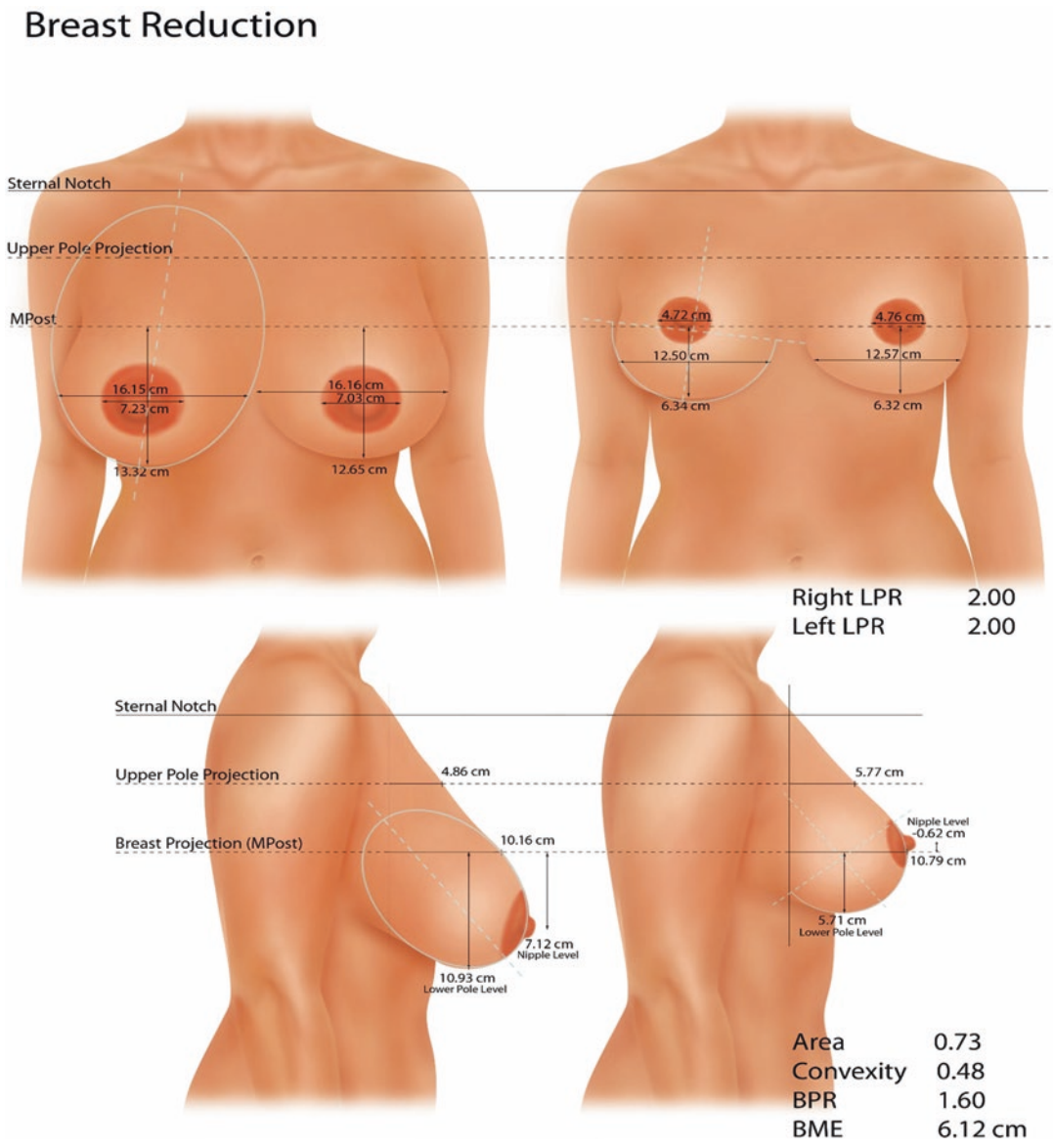


Fig. 6.11 Breast shape before (*left*) and after (*right*) vertical breast reduction. Breast projection and upper pole projection are modestly increased (<1 cm). The lower pole level is elevated 5 cm. The breast parenchymal ratio is effectively inverted, from 0.65 to 1.60. On average, the nipples are slightly (and not ideally) overelevated. The areola diameters are reduced over 2 cm, to a diameter <5 cm deemed desirable by patients. The upper pole contour describes a mild ogee curve before surgery and is linear after surgery. These mammographs were created based on mean breast measurements among study patients. *MPost* maximum postoperative breast projection, *LPR* lower pole ratio, *BPR* breast parenchymal ratio, *BME* breast mound elevation (Reprinted from Swanson [6]. With permission from Wolters Kluwer Health)

inverted-T, inferior pedicle method before 2002, and all subsequent mammaplasties with the vertical method, making possible a Level 3 study comparing a historical cohort with a prospective cohort. This study design avoided selection bias based on breast size or other considerations. An inclusion criterion was at least 3 months' follow-up. Longer follow-up times are preferred. However, they come at the cost

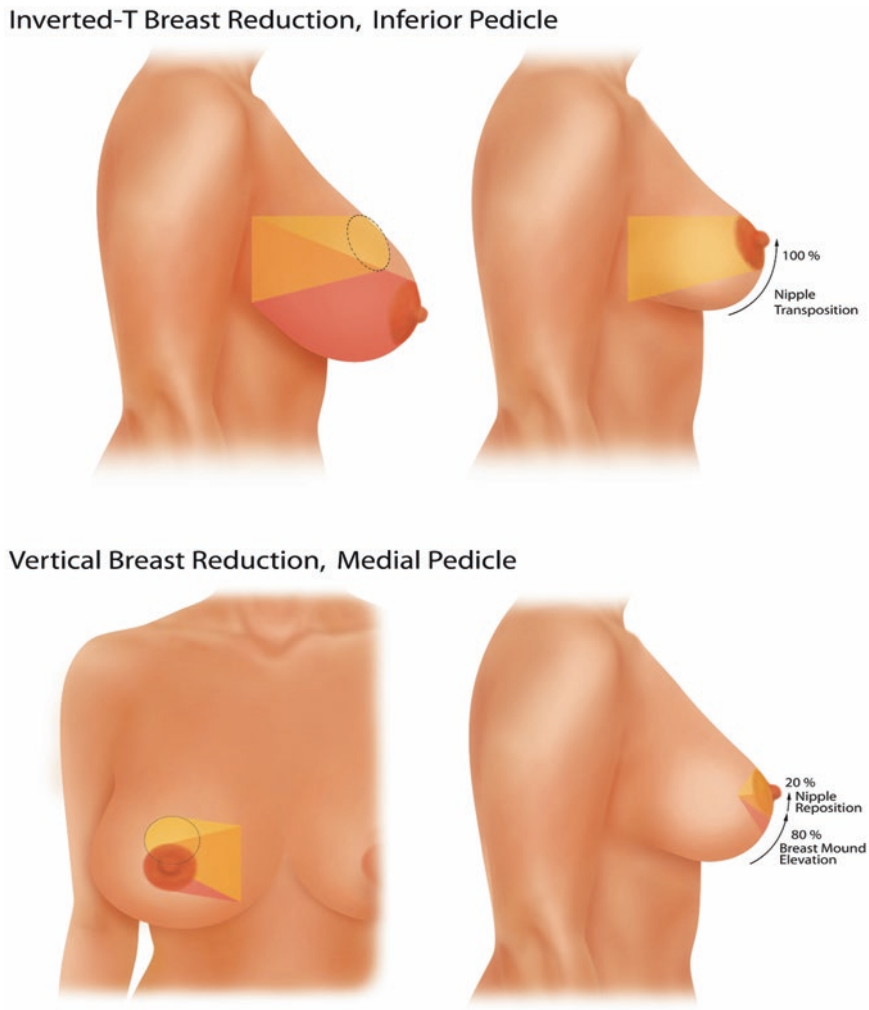


Fig. 6.12 Comparison of inverted-T, inferior pedicle reduction (*above*) and vertical, medial pedicle reduction (*below*) techniques. The inverted-T, inferior pedicle technique relies completely on transposition of the nipple with respect to the surrounding breast tissue, with no assist from breast mound elevation because the pedicle remains attached at the level of the inframammary crease. The nipple is overelevated despite limiting the vertical limb length to 5 cm. The vertical, medial pedicle technique benefits from breast mound elevation caused by closure of the vertical ellipse, which raises the pedicle, including its base. On average, breast mound elevation provides 80% of the superior nipple movement in vertical breast reduction. Pedicle length is minimized. Diagrams are drawn to actual mean measurements for these procedures (Reprinted from Swanson [6]. With permission from Wolters Kluwer Health)

of lower inclusion rates [8]. At 3 months, swelling has sufficiently resolved so as not to represent an important confounding factor [6]. Subsequent shape changes are usually minimal [58].

In order to select most representative patients, those patients from each group with the lowest *z*-scores were chosen for publication (Figs. 6.13 and 6.14). These patients had, overall, the most average measurements among the patients in each study group. Figures 6.15 and 6.16 compare mean shape values depicted in mammographs for the two methods [8].

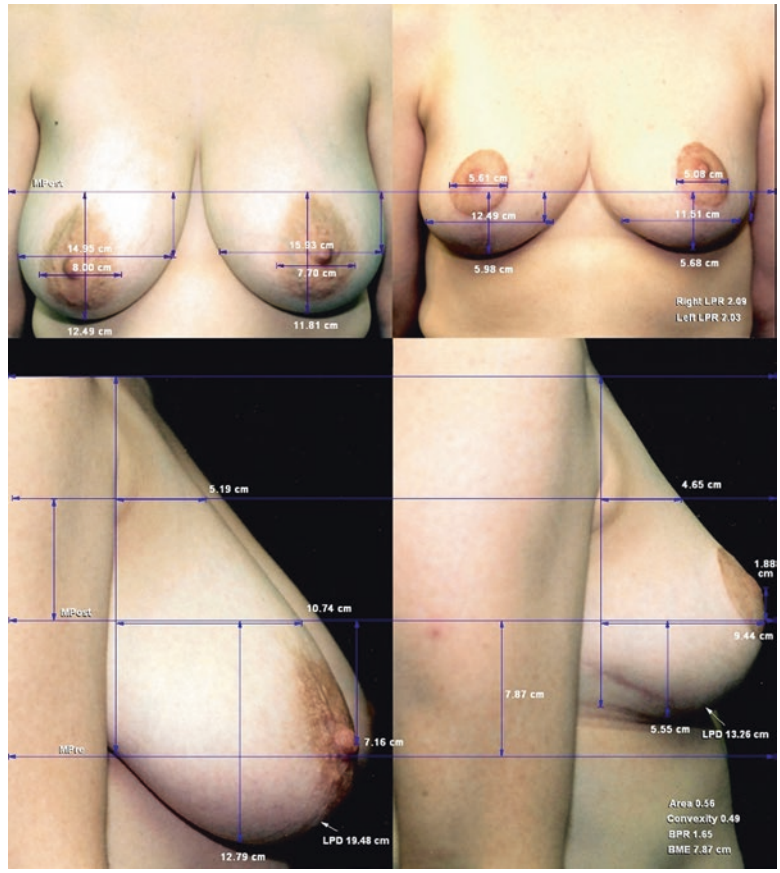


Fig. 6.13 Orientation-matched views of the inverted-T reduction patient with the most average (lowest *z*-score) breast measurements, a 37-year-old woman before (*left*) and 22 months after (*right*) an inverted-T, inferior pedicle breast reduction. Resection weights: right breast, 440 g; left breast, 510 g. Breast projection and upper pole projection are decreased. The lower pole distance is 6.2 cm shorter after surgery. The upper pole contour is linear before surgery and slightly concave after surgery, with an upturned nipple. *MPost* maximum postoperative breast projection, *MPre* maximum preoperative breast projection, *LPD* lower pole distance, *LPR* lower pole ratio, *BPR* breast parenchymal ratio, *BME* breast mount elevation (Reprinted from Swanson [8]. With permission from Wolters Kluwer Health)

Clinical Examples of Mastopexy (<300 g per Breast)

Examples are provided in Figs. 6.17, 6.18, 6.19, 6.20, 6.21, 6.22, 6.23, and 6.24.

Clinical Examples of Breast Reduction (≥300 g per Breast)

Figures 6.25, 6.26, 6.27, 6.28, 6.29, and 6.30 provide examples of breast reduction.

Areola Circularity

Areola shape is affected by the size and shape of the recipient site [59]. The recipient site needs to be circular with no distorting tension. This goal is difficult to achieve in practice. It has been suggested that closure of the mosque-dome shape of an open technique produces a circle [13]. Although a circular shape may be achieved in diagrams, it is unlikely to happen in surgery. An inverted teardrop is the norm rather than the exception, present in 84% of the studies using a preoperative keyhole (Wise

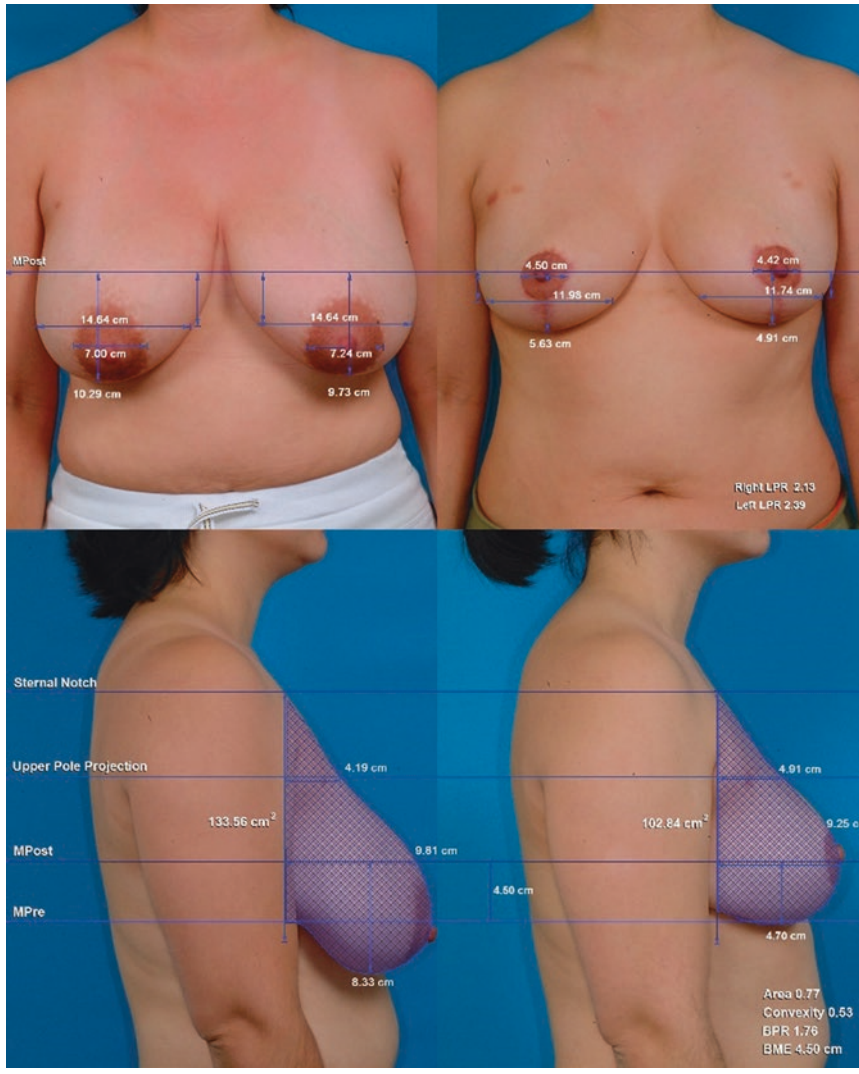


Fig. 6.14 Orientation-matched views of the vertical reduction patient with the most average (lowest *z*-score) breast measurements, a 28-year-old woman before (*left*) and 6.0 months after (*right*) a vertical breast reduction using a medial pedicle. Resection weights: right breast, 367 g; left breast, 464 g. Breast area is reduced 23% (*shaded*). Breast projection is slightly decreased in this patient and upper pole projection is slightly increased. The lower pole level and breast mound are elevated. Nipple position is appropriate. *MPost* maximum postoperative breast projection, *LPR* lower pole ratio, *BPR* breast parenchymal ratio, *BME* breast mount elevation (Reprinted from Swanson [8]. With permission from Wolters Kluwer Health)

pattern) or mosque-dome shaped (Lejour) marking pattern [10]. It is so common that it is generally overlooked as a complication. This suboptimal shape is frequently apparent even on intraoperative photographs [10]. Unfortunately, an inverted teardrop shape (Fig. 6.31) can mar an otherwise excellent result, to the extent that it is impossible to have an optimal result with this operative stigma.

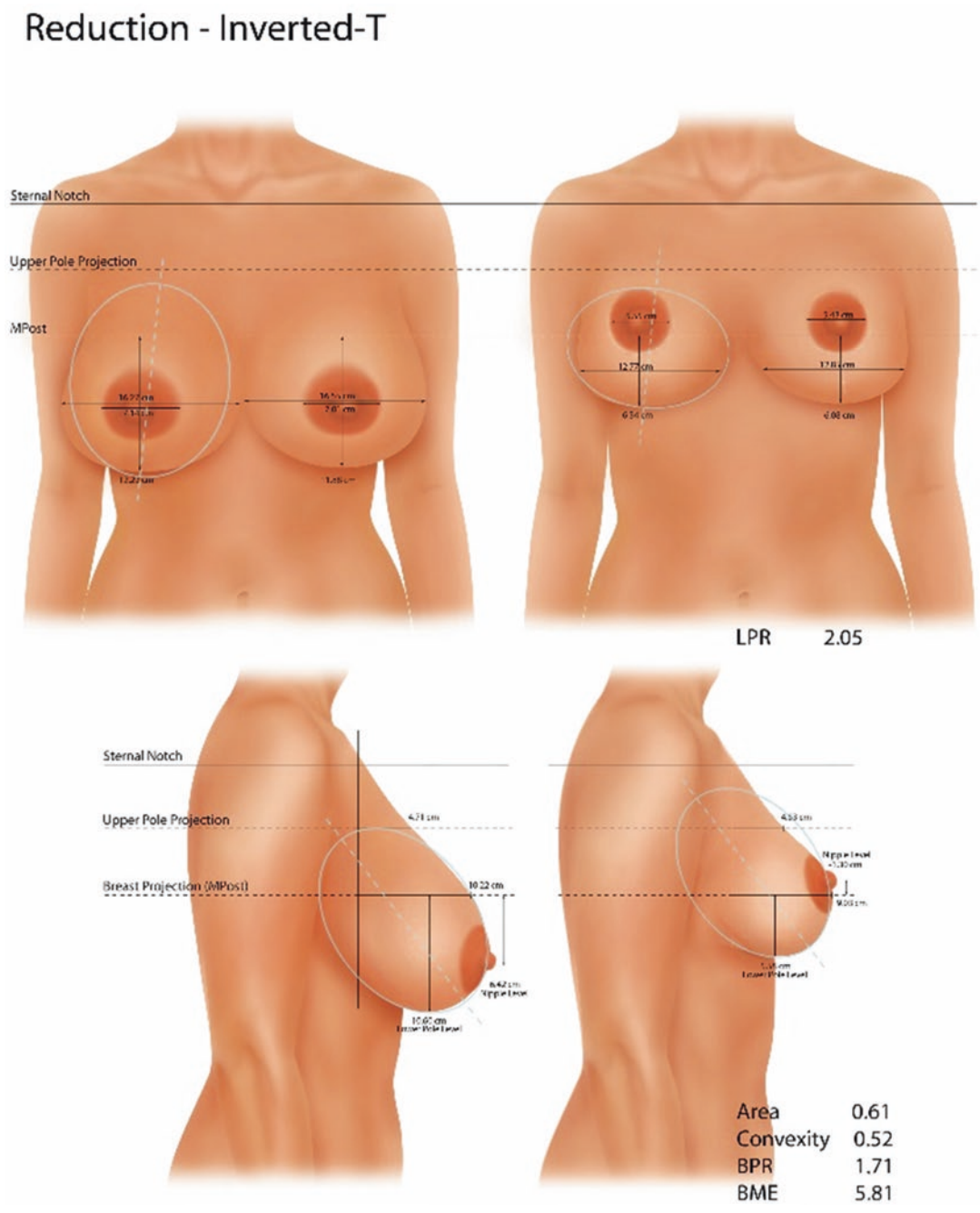


Fig. 6.15 (*Left*) Breast shape before and (*right*) after inverted-T breast reduction. Breast projection is reduced. Despite the use of the 5 cm rule for the vertical limb of the inverted-T, the nipple is overelevated. The mean lower pole ratio, 2.05, is slightly boxy. Illustrations are based on actual mean breast measurements. *MPost* maximum postoperative breast projection, *LPR* lower pole ratio, *BPR* breast parenchymal ratio, *BME* breast mount elevation (Reprinted from Swanson [8]. With permission from Wolters Kluwer Health)

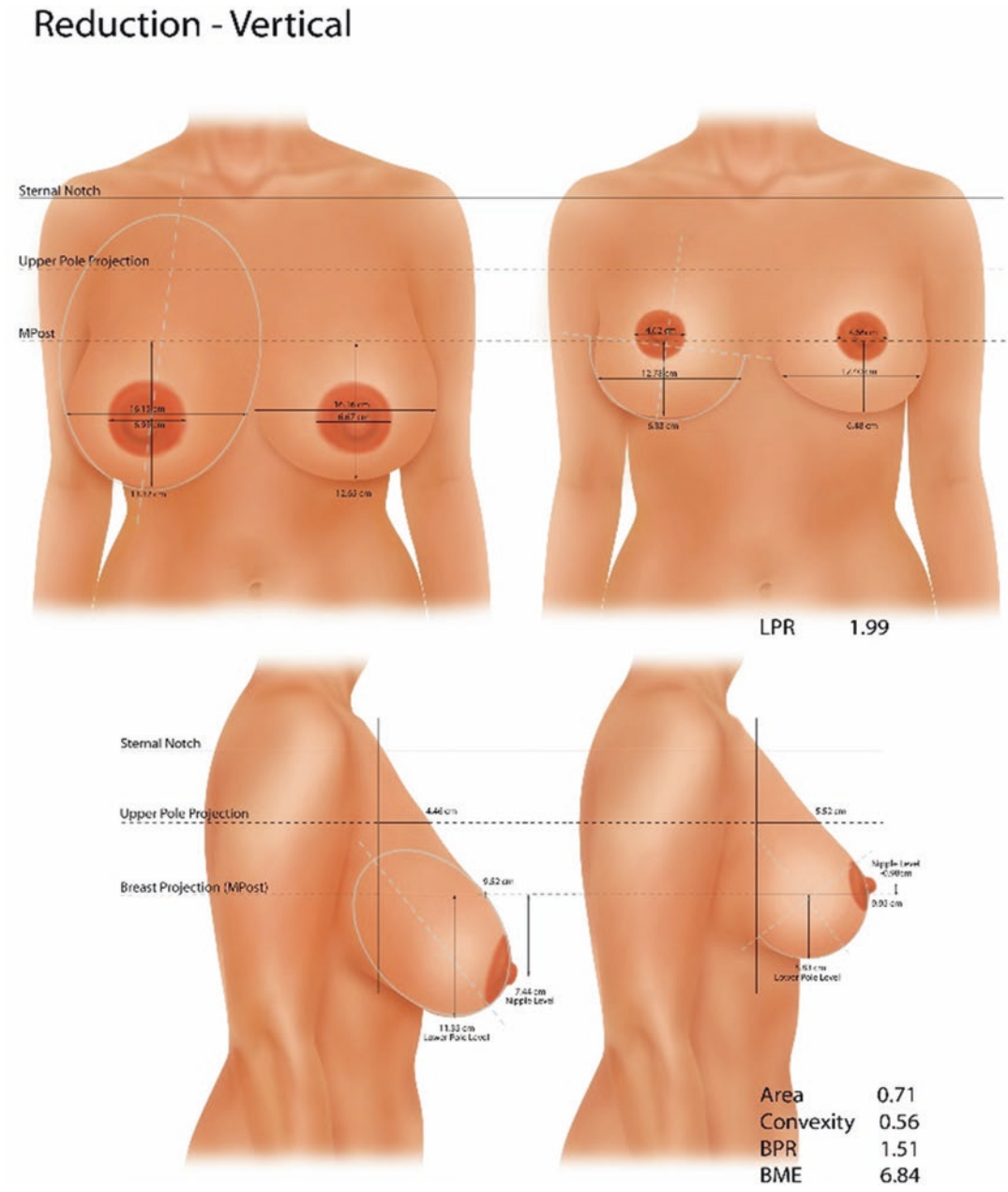


Fig. 6.16 (*Left*) Breast shape before and (*right*) after vertical breast reduction. Breast projection is maintained and upper pole projection is increased. The nipple is slightly (and not ideally) overelevated. The upper pole contour describes a mild ogee curve before surgery and is slightly convex (upper pole projection/breast projection) after surgery. An elliptical shape of the lower pole is reduced to a semicircle. The mean lower pole ratio is just under 2.0. Illustrations are based on actual mean breast measurements. *MPost* maximum postoperative breast projection, *LPR* lower pole ratio, *BPR* breast parenchymal ratio, *BME* breast mount elevation (Reprinted from Swanson [8]. With permission from Wolters Kluwer Health)

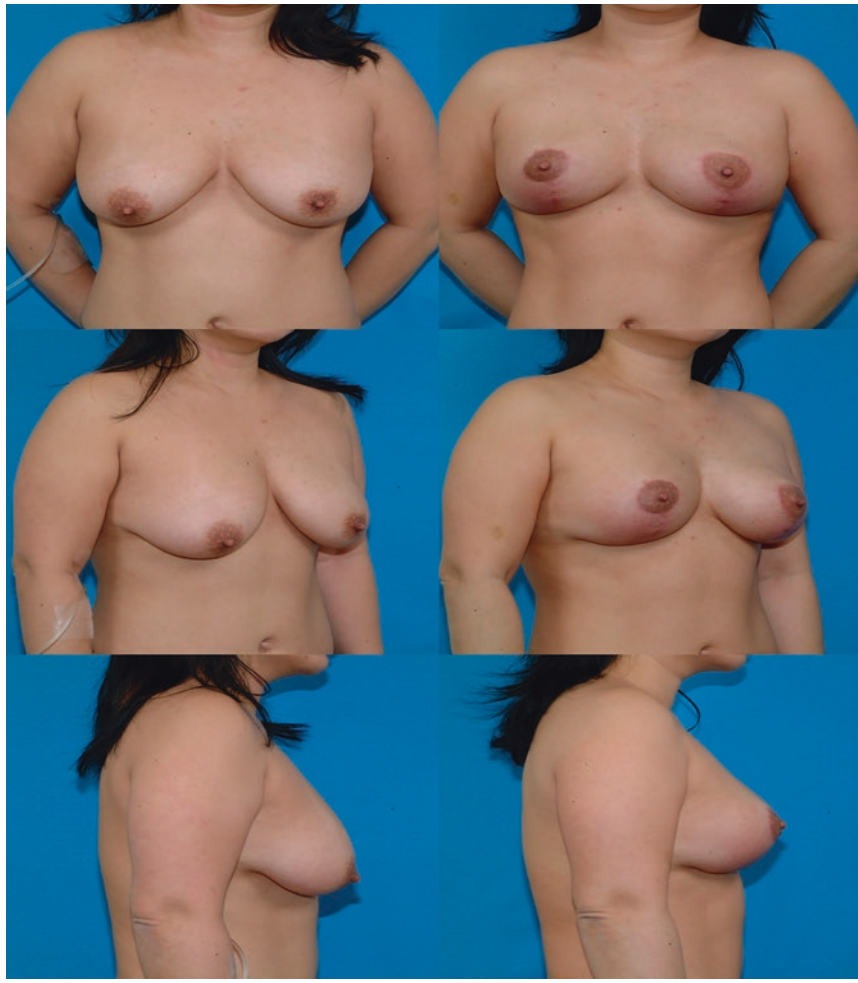


Fig. 6.17 This 36-year-old Asian woman is seen before (*left*) and 4 months after (*right*) a vertical mastopexy. Resection weights: right, 78 g; left, 18 g

An inverted teardrop is the norm rather than the exception, present in 84% of the studies using a preoperative keyhole (Wise pattern) or mosque-dome shaped (Lejour) marking pattern.

Fortunately, an inverted teardrop areola deformity is usually avoidable. As the vertical ellipse of a vertical mastopexy is closed, a dog ear is produced superiorly. The topography of this local skin excess is variable, depending on the width of the vertical ellipse, skin laxity, and the possible simultaneous use of an implant, making the amount and pattern of skin resection variable and difficult to predict. The shape of redundant skin to be excised is unlikely to exactly match a preoperative marking. However, when this local skin redundancy is oversewn in the closed technique and then resected as a circle, there is better assurance of equal and balanced tension and circularity of the recipient site [6, 10].

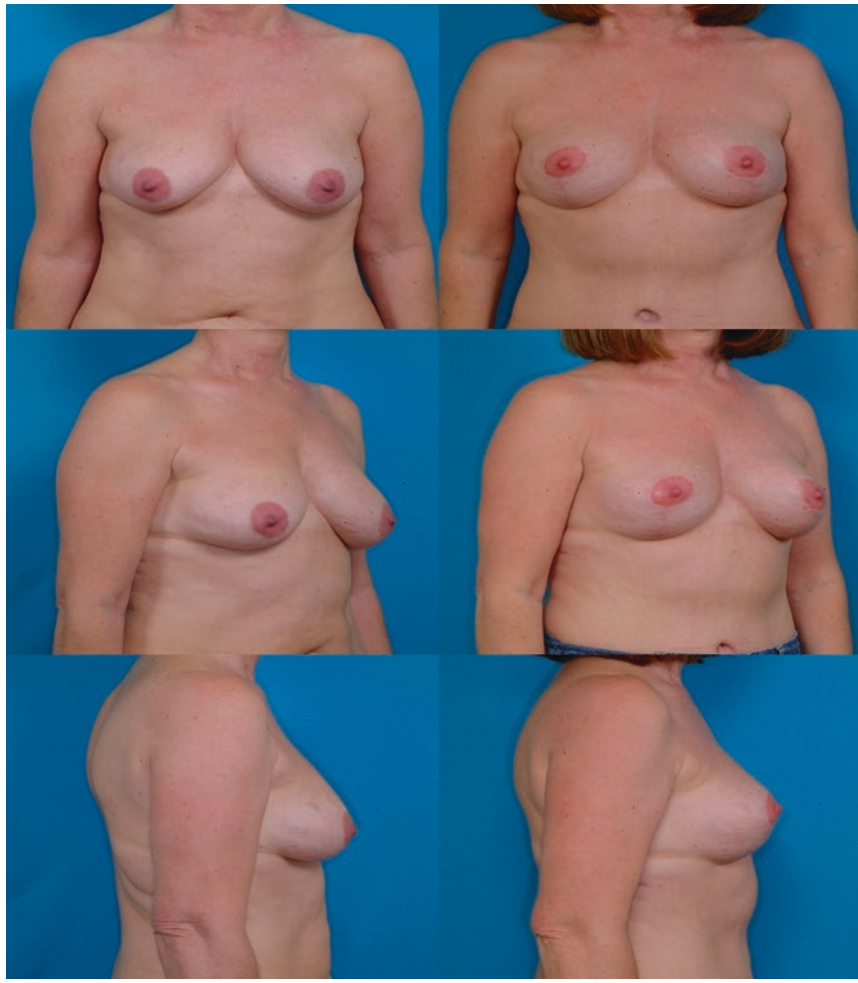


Fig. 6.18 This 50-year-old woman had a vertical mastopexy in combination with an abdominoplasty and liposuction. She is seen before (*left*) and 1 year after surgery (*right*)

Although the closed technique [43] was known to American pioneers, including Aufricht and Maliniac [20, 28], this concept was largely lost in favor of preoperative markings using the Wise pattern [60]. Many of the advocates of the vertical technique use the Lejour mosque-dome shape open approach [13, 16, 23, 61]. The Brazilians, however, have used intraoperative determination of nipple/areola placement for decades [39, 41] and this technique has not gone unnoticed by American surgeons [22, 51, 62–68].

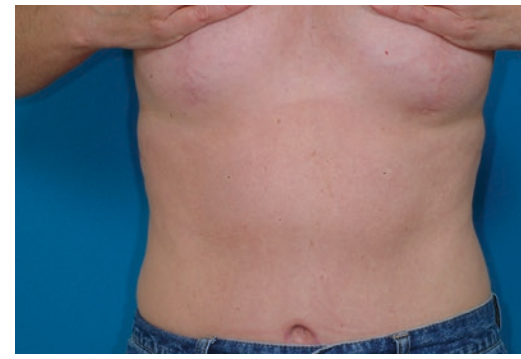


Fig. 6.19 Photograph of the vertical scars of the patient in Fig. 6.18 at the same 1-year postoperative visit

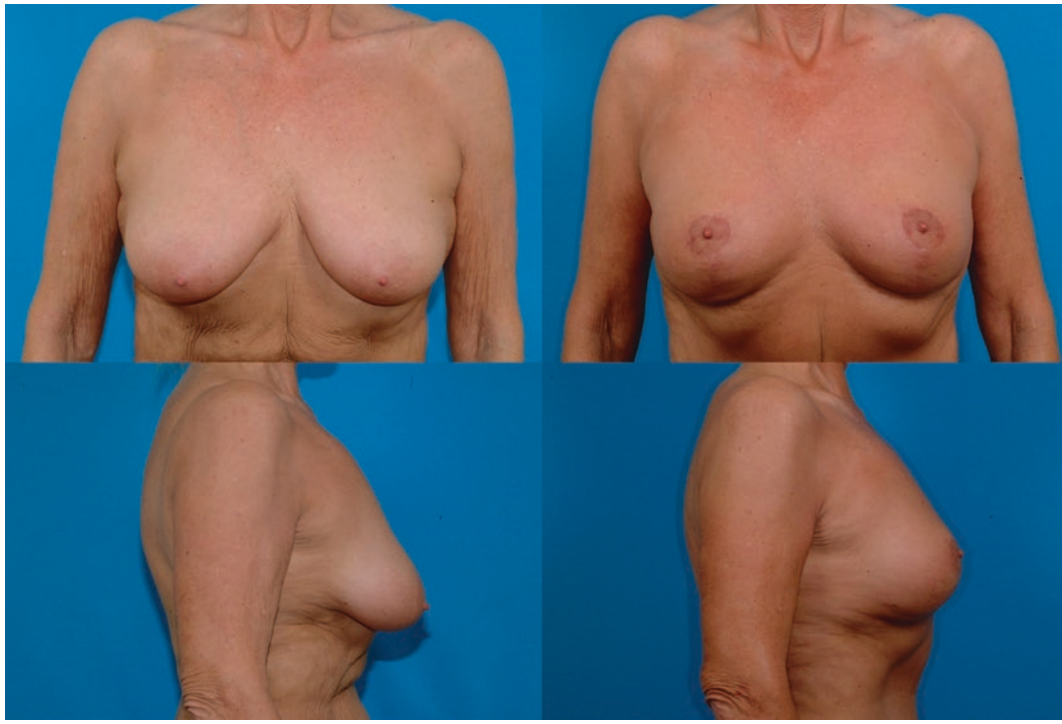


Fig. 6.20 This 65-year-old woman is seen before (*left*) and 9 months after (*right*) a vertical mastopexy, abdominoplasty, and brachioplasties

Nipple Level

Nipple overelevation is likely to appear worse with time as the lower pole descends [64, 69]. The 5-centimeter "rule" [69] limiting the vertical limb length does not prevent nipple overelevation or boxiness of the lower poles [10] and does not prevent pseudoptosis [70]. The lower pole is constricted [8]. This problem is an unavoidable consequence of the geometry of the inverted-T design [8, 10]. The nipple is rarely underelevated with respect to the breast mound; the problem is overelevation [6, 10]. Nipple overelevation may be avoided by (1) the use of the vertical technique and (2) intraoperative positioning of the nipple at, or slightly below, the level of maximum breast projection [6].

> The 5-centimeter rule limiting the vertical limb length does not prevent nipple overelevation or boxiness of the lower poles and does not prevent pseudoptosis.

Nipple position is measured relative to the level of the breast apex, which is the only important anatomic landmark for nipple position [52]. There is no consideration of its relationship to the sternal notch or inframammary crease level, a level that is hidden in photographs and known to be dynamic, making it an unreliable landmark [7]. The author's system [52] evaluates changes in breast glandular position (e.g., breast mound

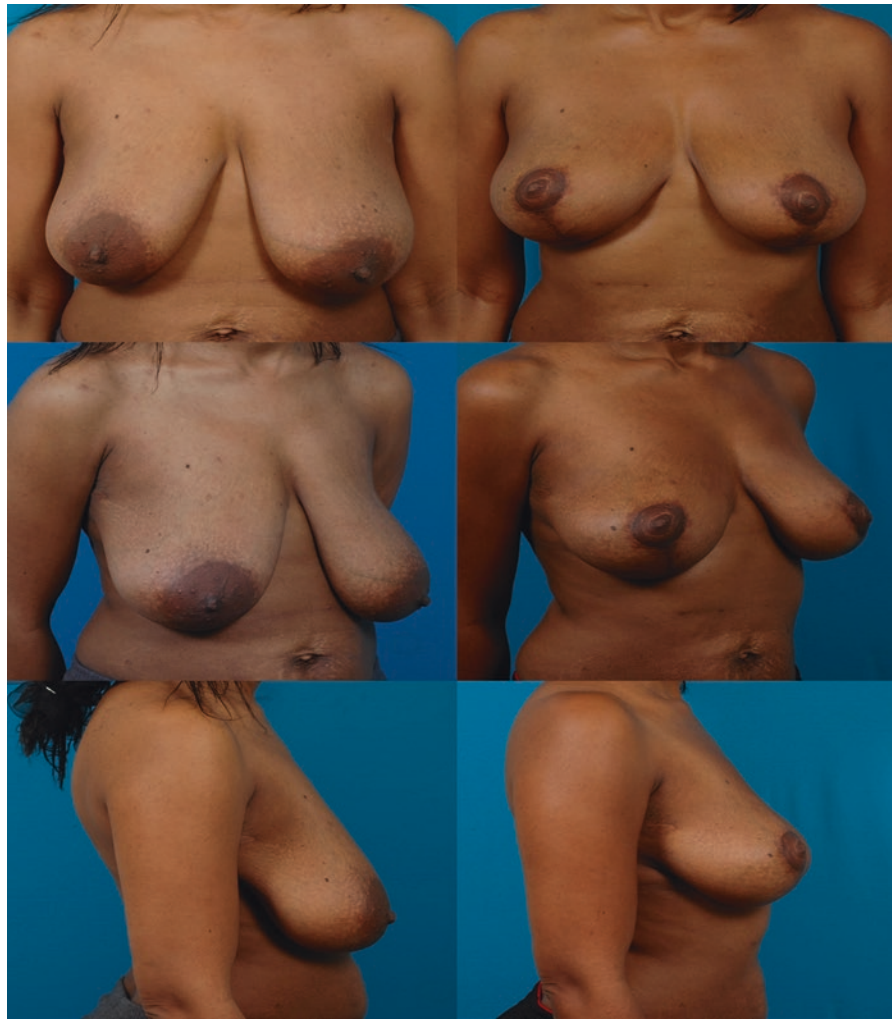


Fig. 6.21 A 36-year-old woman before (*left*) and 6 months after (*right*) a vertical mastopexy (resection weights: right, 122 g; left, 212 g)

elevation, lower pole level, and breast parenchymal ratio) separately from nipple position (nipple displacement), discarding with the notion of pseudoptosis [70], which mixes these parameters [6, 52].

Nipple Repositioning

Because the nipple is moved upward by the creation of the new breast mound, in most patients minimal nipple movement is needed.

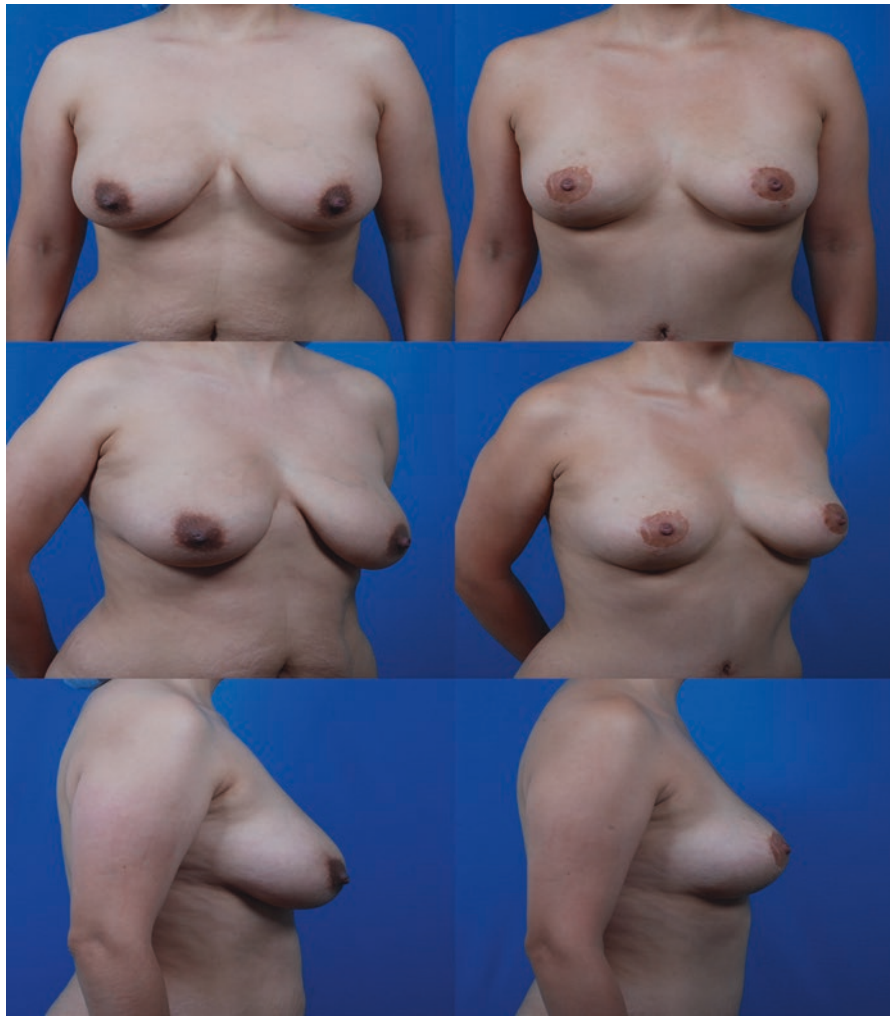


Fig. 6.22 A 30-year-old Hispanic woman before (*left*) and 1 year after (*right*) vertical mastopexies (resection weights: right, 175 g; left, 196 g), abdominoplasty, and liposuction of lower body, arms, and axillae

Because the nipple is moved upward by the creation of the new breast mound [6], in most patients minimal nipple movement is needed. Nipple transposition [43] was originally added to the inverted-T design [44, 46] in an attempt to preserve nipple level as the skin flaps were paradoxically displaced downward, leading to predictable nipple overelevation with respect to the breast mound. The new paradigm is to correct the parenchymal disproportion and to reposition the nipple when this is done (Fig. 6.12). The nipple is temporarily oversewn and then pulled through and replaced atop the breast mound – *nipple reposition, not transposition.* Using the vertical technique, which pushes the nipple and its pedicle up, the challenge for the surgeon is usually in keeping the nipple from being located too high on the breast mound, while still removing the excess skin (dog ear) that accumulates at the superior end of the elliptical resection [6]. Even in mastopexy/reduction patients who present with nipples located well below the level of

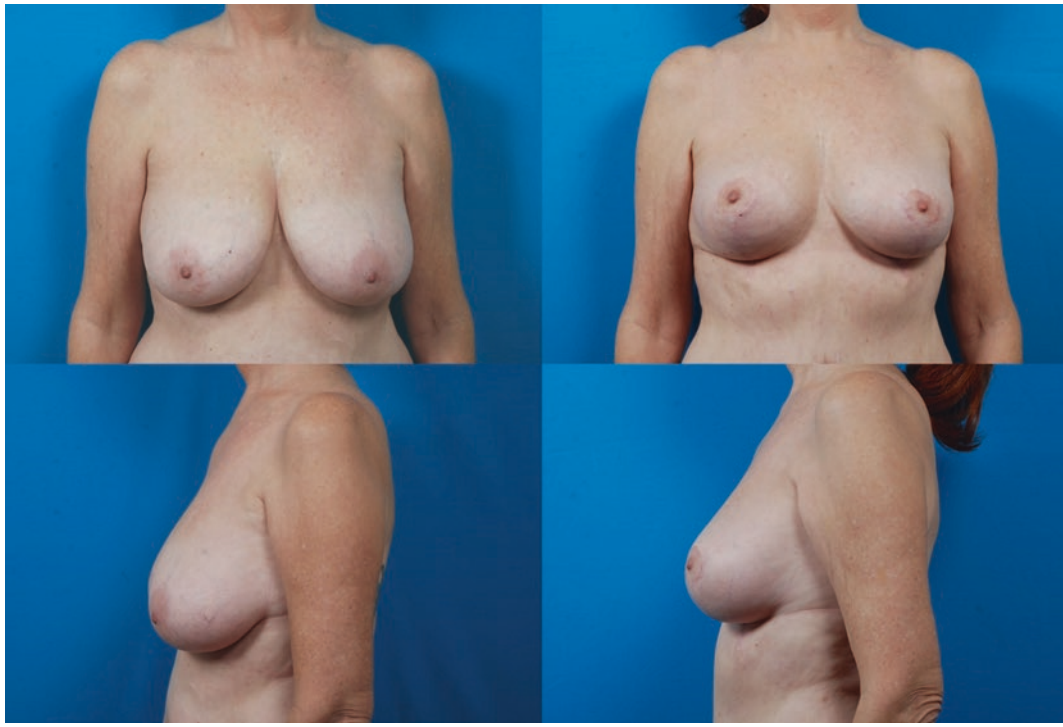


Fig. 6.23 A 56-year-old woman before (*left*) and 1 year after (*right*) vertical mastopexy (resection weights: right, 179 g; left, 203 g), abdominoplasty, and liposuction of lower body

maximum preoperative breast projection, the needed nipple elevation with respect to the breast mound is usually minimal (Fig. 6.30). The greatest discrepancy between nipple level and maximum breast projection in the author's series was one reduction patient whose down-pointing nipples were both located 6.5 cm below the plane of maximum preoperative breast projection [6]. Therefore, the maximum distance a nipple needed to move on its pedicle relative to the surrounding breast tissue in this study was 6.5 cm. Short pedicles greatly improve the reliability of nipple/areola perfusion, avoid the need for nipple grafting, and reduce the incidence of nipple loss to almost none [23].

Short pedicles greatly improve the reliability of nipple/areola perfusion, avoid the need for nipple grafting, and reduce the incidence of nipple loss to almost none.

Complications

In the author's clinical study [9] there were no major systemic complications, no deep venous thromboses, and no pulmonary emboli. No patient required a blood transfusion or hospital admission. The incidence of complications was 33% for mastopexy and 52% for breast reduction. Persistent ptosis was observed in 9.5% of patients treated with a vertical mammaplasty. Partial areola necrosis occurred in one reduction patient (Fig. 6.32), healing spontaneously. There were no cases of nipple loss.

In evaluating mastopexies and breast reductions, there were no significant correlations between the incidence of complications and body mass index, resection weights, or combination procedures.

Published complication rates for vertical mastopexy and breast reduction vary widely, from 11%

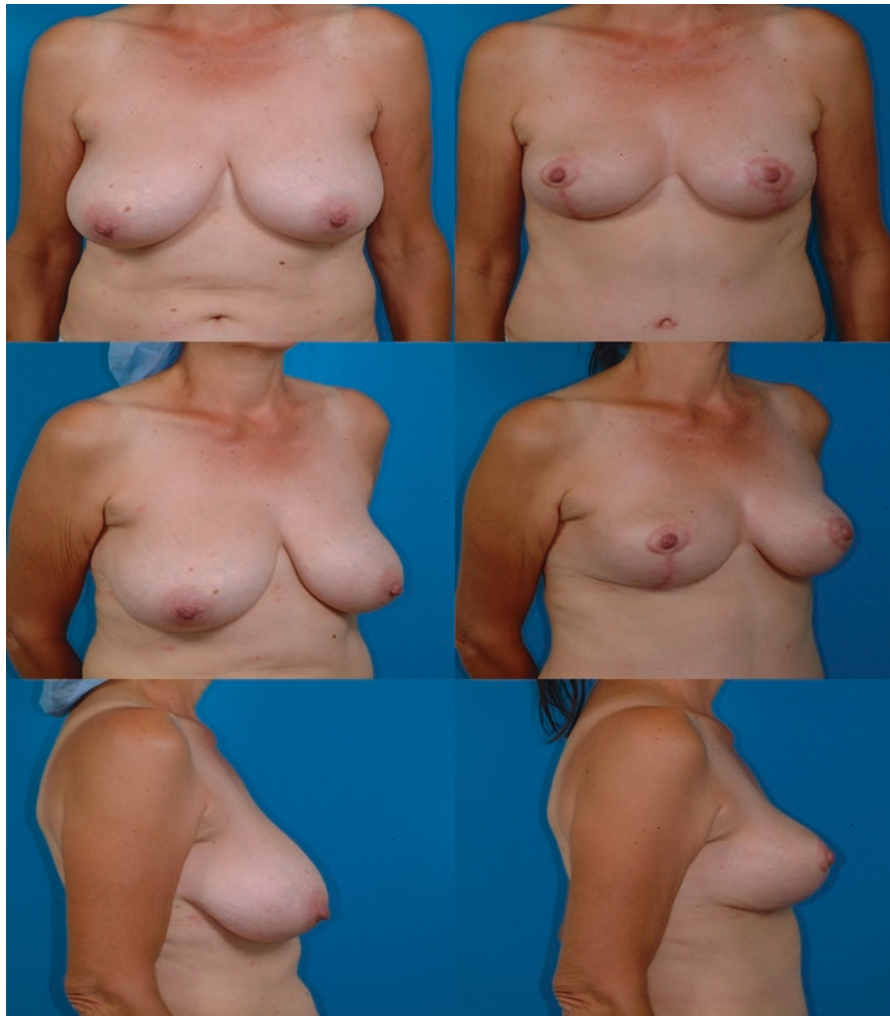


Fig. 6.24 A 52-year-old woman before (*left*) and 3 months after (*right*) a vertical mastopexy (resection weights: right, 251 g; left, 197 g), abdominoplasty, and liposuction of lower body, arms, and axillae

to 45% [49, 61, 66, 71–78], and depend largely on the surgeon's definition of a complication [79]. If persistent ptosis, suboptimal scars, areola noncircularity, and minor delays in wound healing (Fig. 6.33) are counted, the "complication rate" approaches 100%. Fortunately, patients tend not to count these common problems as complications [2]. With appropriate preoperative counseling, they accept that fine-tuning is to be expected [11] and report complication rates about half as high as their surgeon [2].

Similar to the findings of other studies [4, 80], persistent ptosis was a frequent complication encountered by mastopexy and reduction patients (9.5%), and the most common indication for reoperation. Adequate lower pole parenchymal resection is needed to prevent persistent ptosis [13, 16–18, 66, 73]. Notably, there were fewer seromas (0.8%) encountered among mammaplasty patients in this study than in some other series [71, 73]. This favorable experience may be related to the use of a wedge-shaped parenchymal

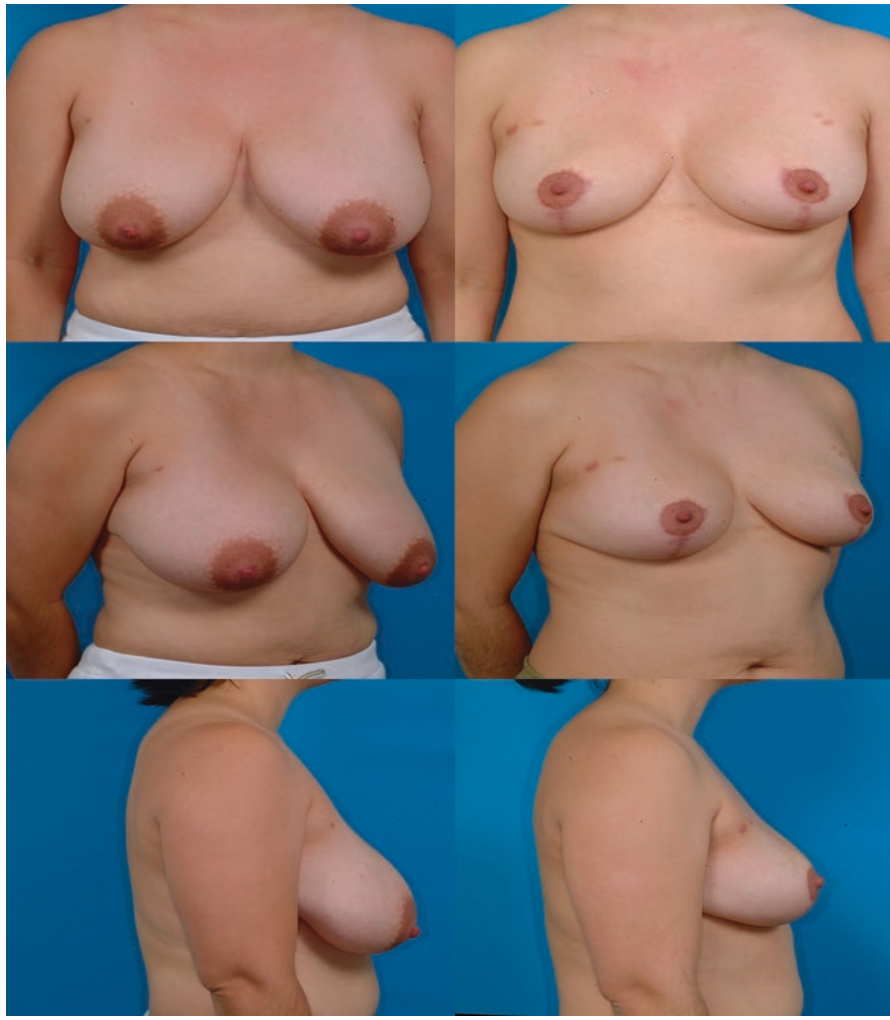


Fig. 6.25 A 28-year-old woman before (*left*) and 6 months after (*right*) vertical breast reduction (resection weights: right, 367 g; left, 464 g)

excision without skin undermining, no liposuction, and the use of scalpel dissection rather than cutting electrocautery [71, 81].

Older breast reduction patients fare no worse than younger patients [9], consistent with the findings of several studies [78, 82, 83]. A correlation between complication rates and resection weights has been reported in some studies [77, 83–87] and not in others [23, 66, 78, 82, 88–90]. A greater body mass index has also been reported to increase the risk of complications in some series [23, 82, 87, 91, 92] and not in others [77, 83, 89, 90, 93]. There was no evidence of increased risk from obesity or large resection weights in the author's study [9].

The effect of smoking is controversial, with some reports suggesting an increased risk [83, 94–96] and others reporting no increased risk related to breast reduction [75, 77, 82, 86, 89]. The author [9] found no increased smoking

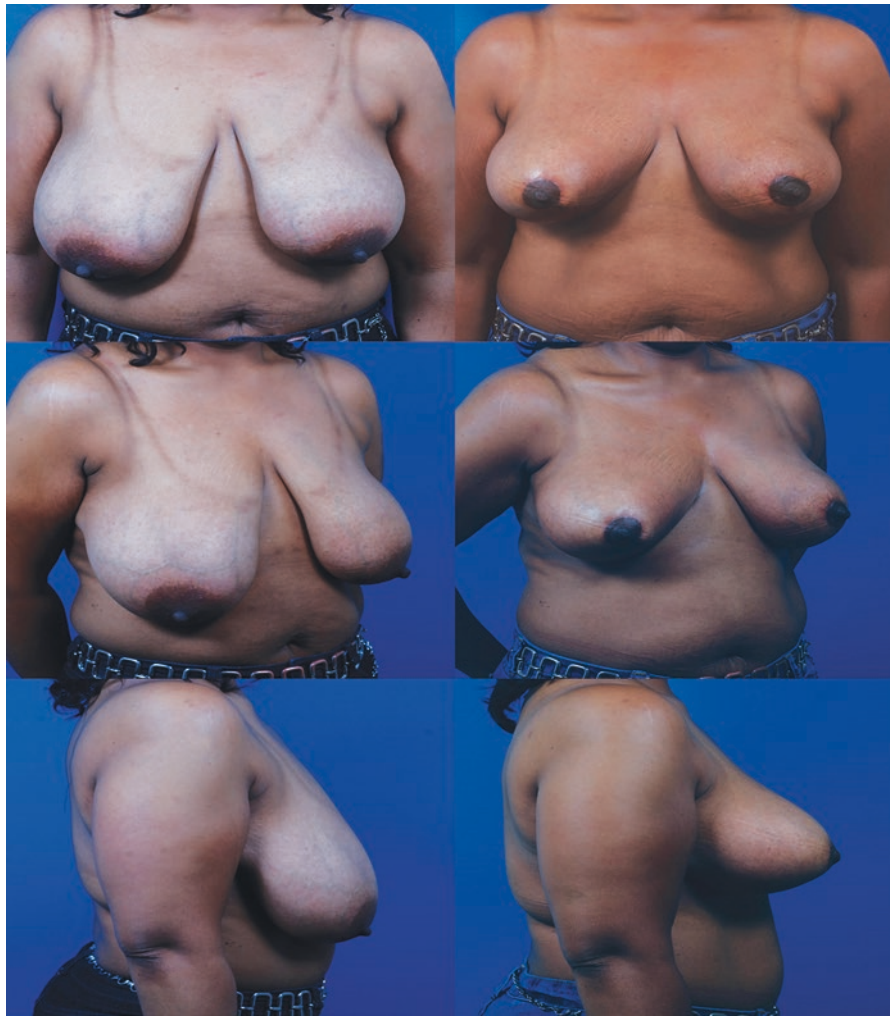


Fig. 6.26 A 38-year-old woman before (left) and 3 months after (*right*) a vertical breast reduction (resection weights: right, 314 g; left, 181 g). The hyperpigmentation related to her bra is much improved

risk for breast augmentation and mastopexy, but a small positive correlation ($r = 0.25$) for augmentation/mastopexy and breast reduction. Recommendations that patients cease smoking during the perioperative period seem to be justified [94].

Notably, there was no increased risk for secondary mastopexies or reductions. In the author's study [9], all previous mastopexies had been performed using the inverted-T technique and all were revised using the vertical technique. Although it might seem logical to reuse the same resection pattern in secondary cases [97], out of concern for blood supply across periareolar scars, in practice this precaution seems unnecessary [98, 99].

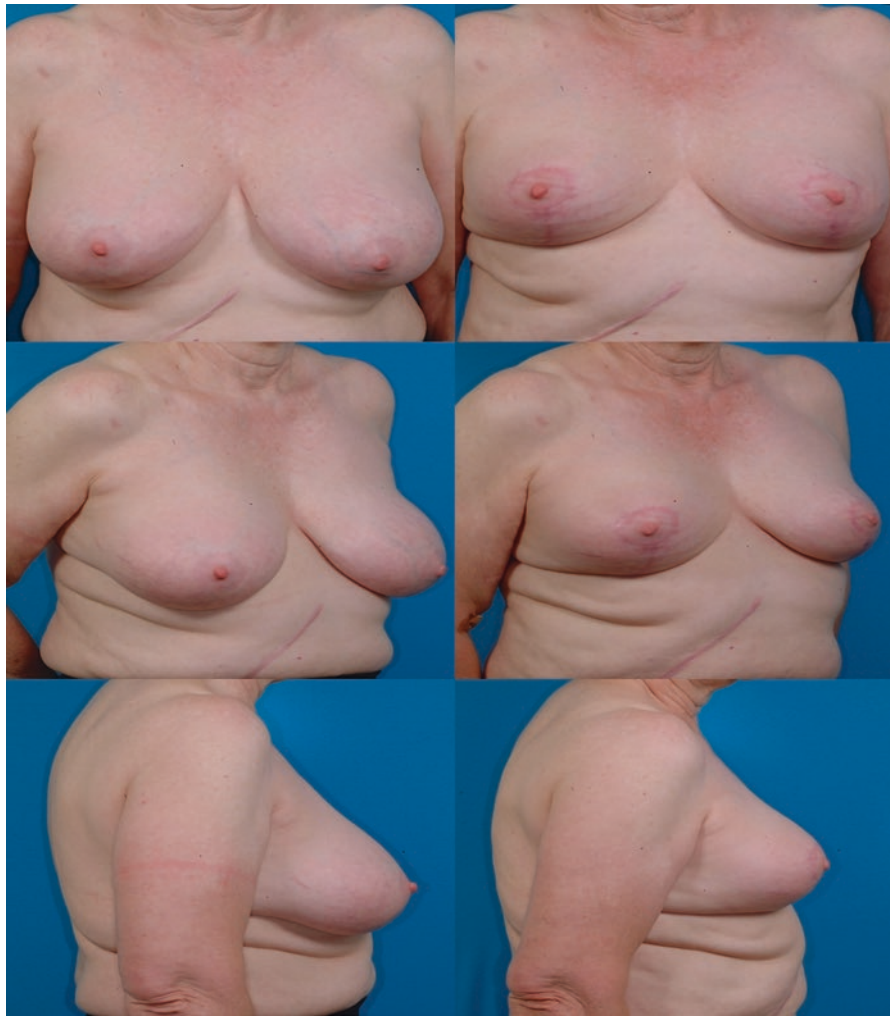


Fig. 6.27 A 63-year-old woman before (*left*) and 6 months after (*right*) vertical breast reduction (resection weights: right, 278 g; left, 352 g) and liposuction of the arms and axillae

Revisions

The high rate of revisions after vertical mastopexies and reductions (7–24%) [49, 61, 72, 73] is a well-known and frequently cited disadvantage of the vertical technique [5, 61, 73]. However, this frequency of revisions is at least partly related to the fact that such revisions are possible. Problems associated with an inverted-T technique do not lend themselves easily to surgical revision [53]. If shape considerations are given the importance they deserve, then the inverted-T technique has a consistently high level of such "complications" as flattening of the upper poles, loss of breast projection, squaring of the lower poles, and nipple overelevation [10]. In fact, most inverted-T results resemble preoperative

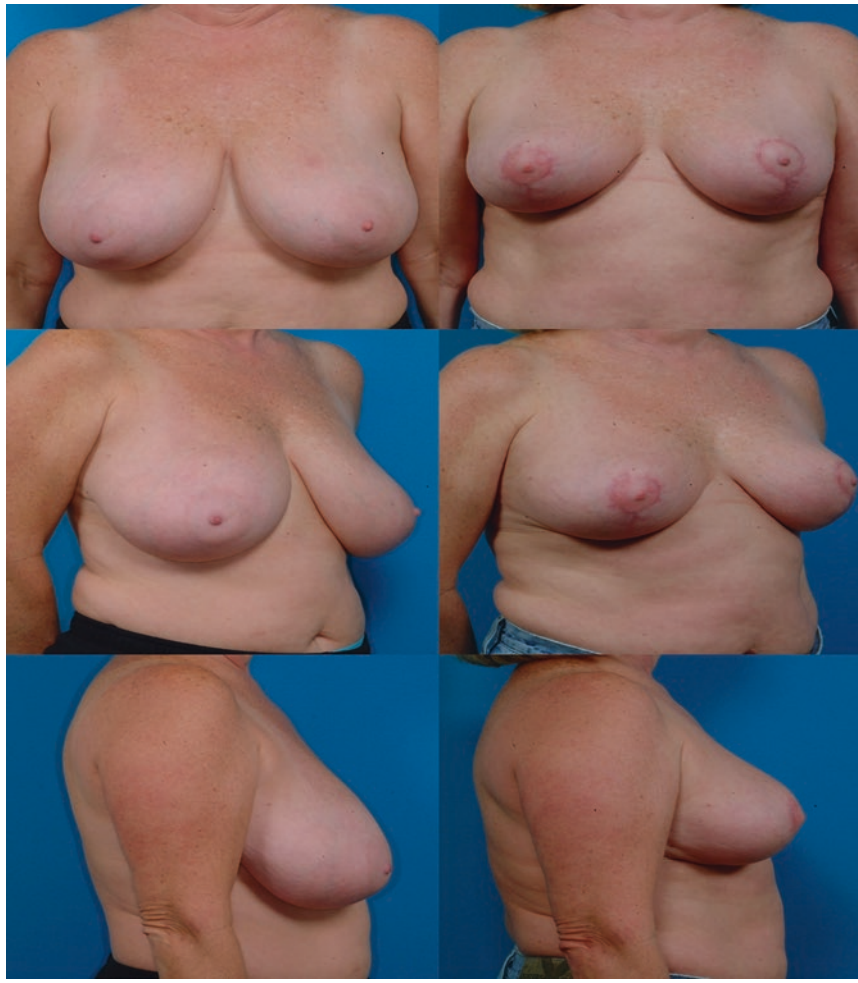


Fig. 6.28 A 50-year-old woman before (*left*) and 3 months after (*right*) breast reduction (resection weights: right, 547 g; left, 480 g)

candidates for augmentation/mastopexy and look better after revision using a vertical technique with implants [9].

Many cosmetic procedures have a high revision rate (liposuction, for example), and this is not necessarily an indictment of the procedure [11, 100]. Revision rates may reflect the surgeon's level of perfectionism as much as the patient's, and a favorable pricing policy. Patient satisfaction remains high despite the frequency of revisions [2, 72].

Combined Procedures

A practical benefit of the vertical technique is a greater capability for combination ("mommy makeover") procedures. Operating times for vertical mammaplasties, typically 60–130 min [9, 23, 61, 75, 101], are about an hour shorter than for inverted-T procedures [101]. By shortening operating times and reducing blood loss [23, 59], combinations with other cosmetic pro-

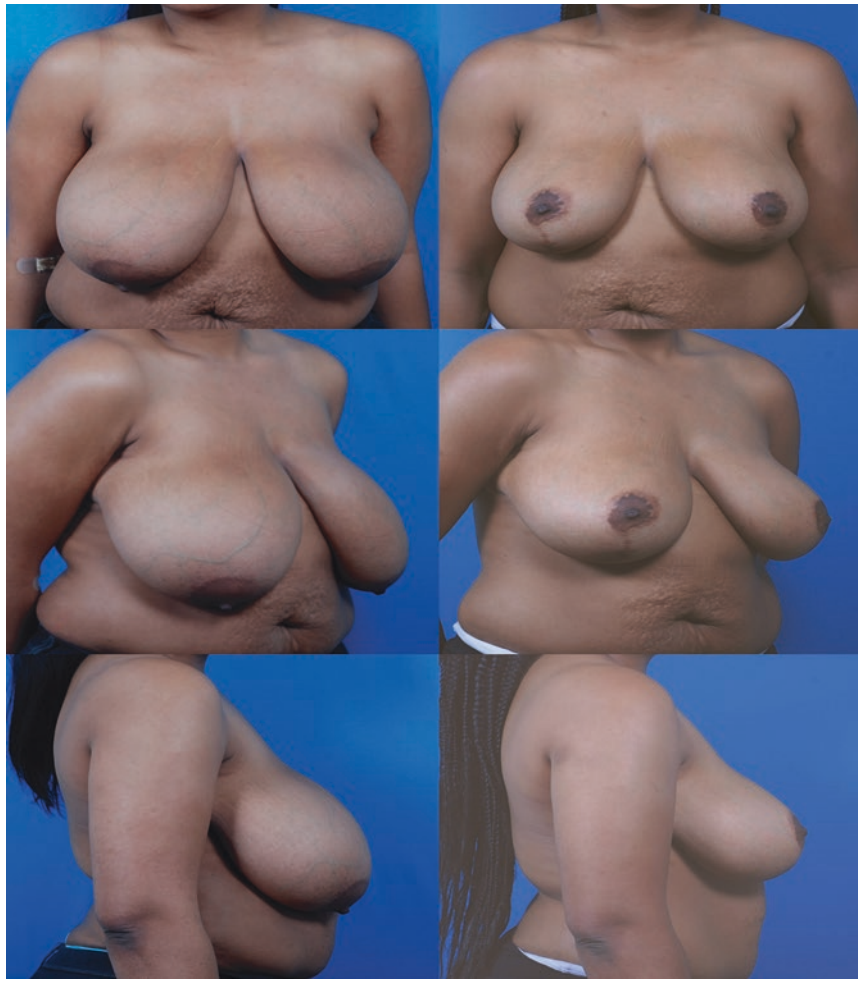


Fig. 6.29 A 25-year-old woman before (*left*) and 2 years after (*right*) a vertical breast reduction (resection weights: right, 602 g; left, 609 g)

cedures, such as liposuction and abdominoplasty, may be undertaken safely [82], with appropriate attention to anesthetic considerations and blood loss [102].

Nipple Reduction

Although it is not considered a mastopexy, protruding nipples can be a nuisance for women, who may need to wear pads so that they are not

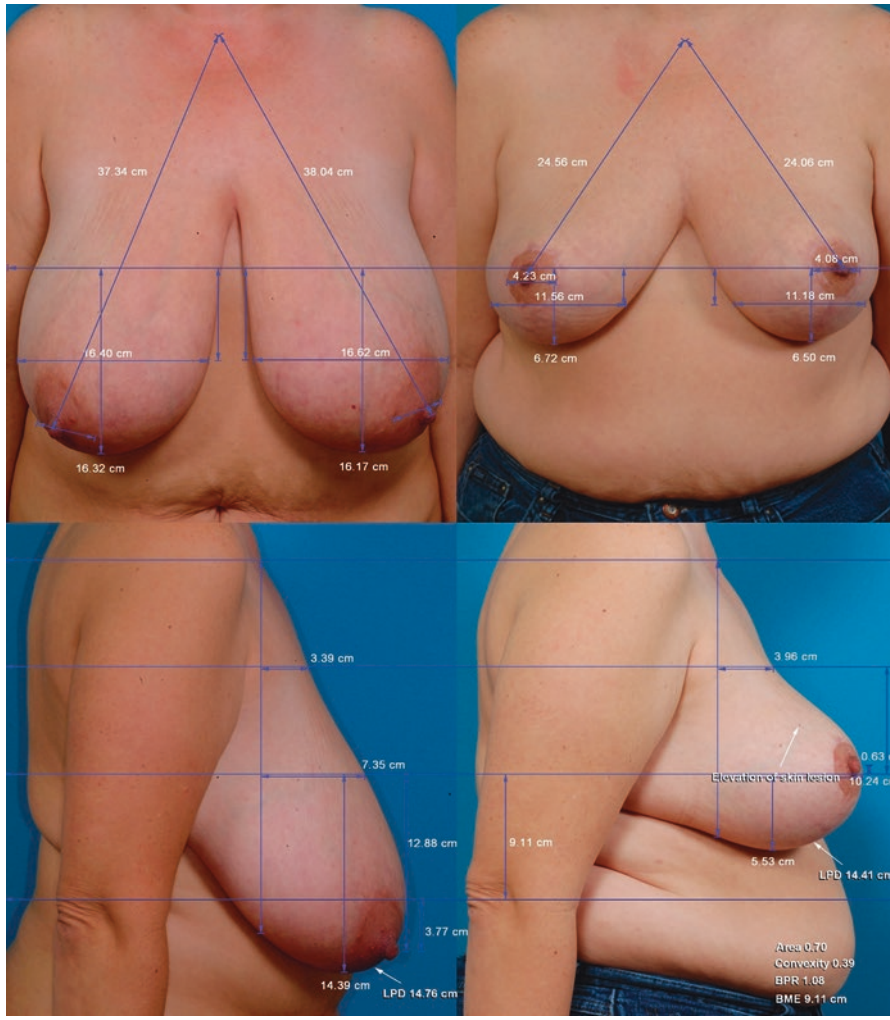


Fig. 6.30 (*Left*) Orientation-matched views of a 43-year-old woman before and (*right*) 6 months after a vertical breast reduction, using a medial pedicle. Resection weights: right breast, 953 g; left breast, 1040 g. The suprasternal notch-to-nipple distances were 37 cm on the right and 38 cm on the left (these measurements are not used by the author, but have been used by some surgeons in determining procedure selection). Despite the severe ptosis, the preoperative right nipple displacement is only 3.8 cm. The skin lesions on the right lateral breast reveal the upward mobilization of breast skin. *BPR* breast parenchymal ratio, *LPD* lower pole distance, *BME* breast mound elevation (Reprinted from Swanson [9]. With permission from Wolters Kluwer Health)

so obvious in clothing. Nipple reduction may be performed easily by removing a donut of skin from the base of the nipple using the technique described by Regnault (Fig. 6.34) [103]. The stalk is preserved, along with its ducts and sensory nerve endings. This procedure may be done simultaneously with breast implants using a trans-areolar incision (see Chap. 3).

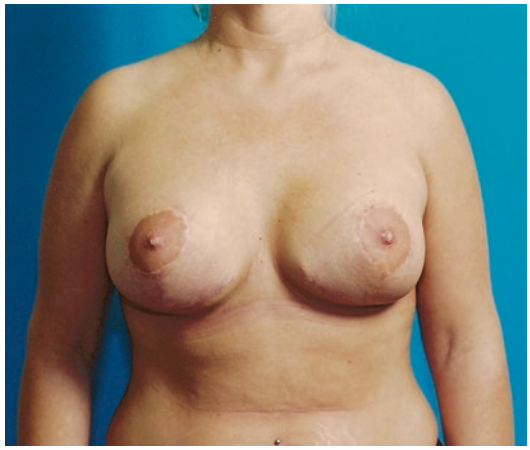


Fig. 6.31 This 36-year-old woman demonstrates an inverted teardrop deformity of her left areola after a previous inverted-T mastopexy with implants. The areolae measured 6 cm in diameter, slightly greater than the desired 4–5 cm. She has a mild dog ear of the medial end of the left inframammary scar

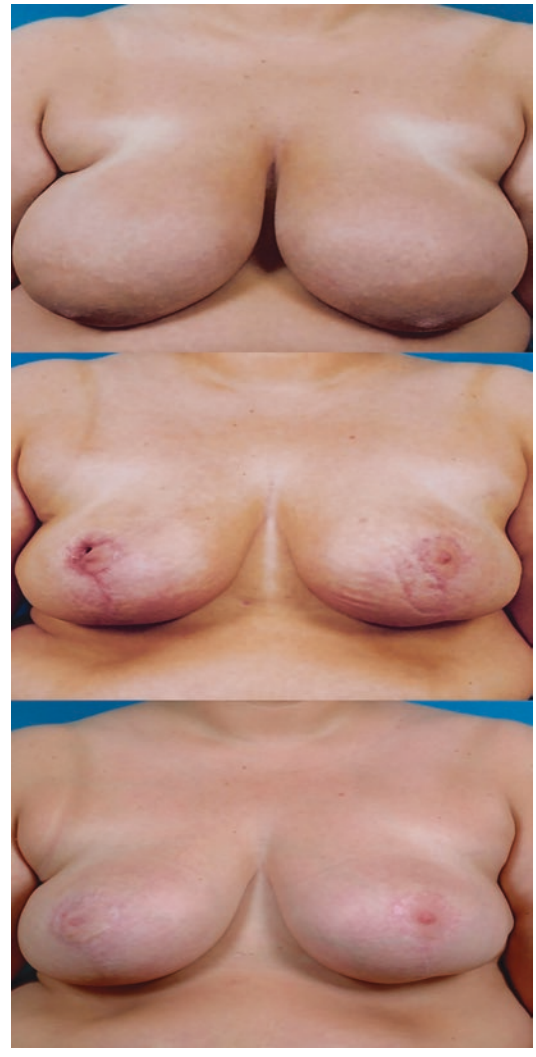
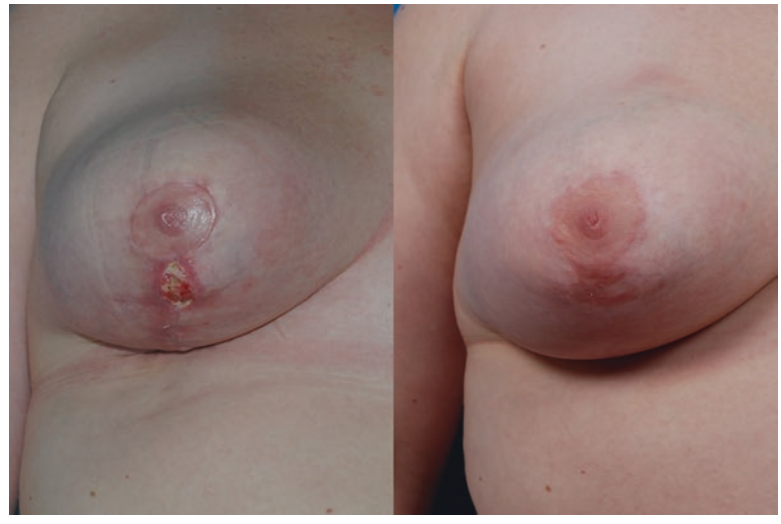


Fig. 6.32 This 29-year-old woman developed partial necrosis of the right areola. The wound was allowed to heal spontaneously. She is seen before surgery (*above*), 2 months after surgery (*center*), and 7 months after surgery (*below*). Resection weights: right, 738 g; left, 744 g

Fig. 6.33 Delayed wound healing 1 month after breast reduction in a 26-year-old woman (*left*). This wound was allowed to heal spontaneously. No revision was needed. The healed wound is seen 4 months after surgery (*right*)



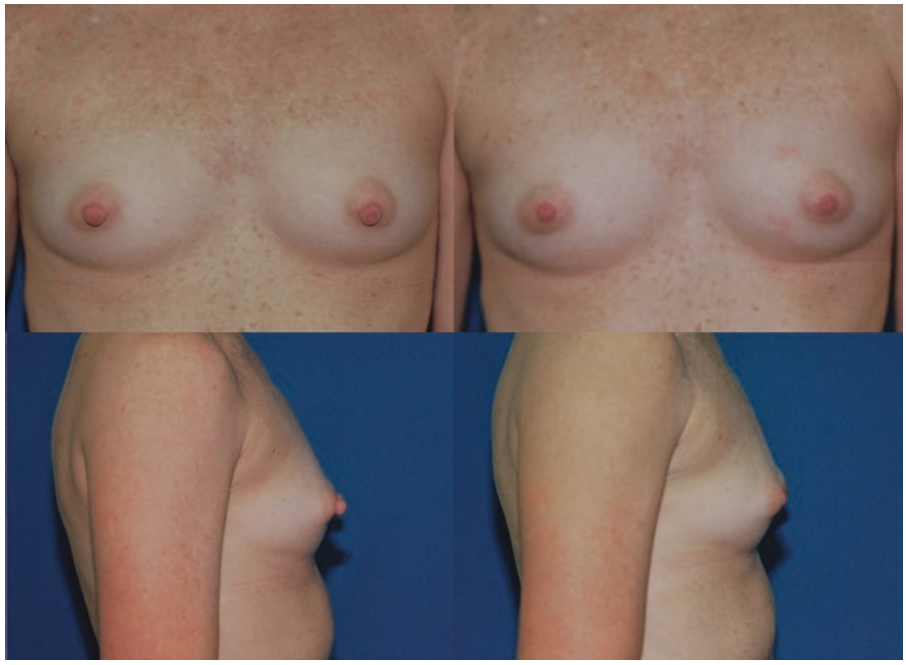


Fig. 6.34 A 37-year-old woman before (*left*) and 1 month after (*right*) nipple reduction. This procedure was performed under local anesthesia in the office

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All-Seasons Vertical Augmentation Mastopexy

7

Abstract

Augmentation mastopexy is still regarded with trepidation by some surgeons. The conventional view is that the operations are at cross-purposes: the implant stretches the skin envelope while the mastopexy tightens it. The limitations of nonvertical methods are exposed when an implant is introduced, such as added pressure on a long inferiorly based pedicle.

Clinical experience and laser perfusion data demonstrate that, when a vertical technique with a medial pedicle is used, the combined procedure is safe. A medial pedicle is well-perfused and preserves superficial nipple innervation from the 3rd, 4th, and 5th anterior cutaneous branches. A deep parenchymal attachment maintains deep innervation. The medial pedicle is preferred over a superior pedicle, which sacrifices deep nipple innervation.

The combined operation offers many synergies. Breast asymmetry, for example, is much easier to treat. Almost all cosmetic breast patients may be treated with either a breast augmentation or a vertical mammaplasty performed individually or in combination. Staging is unnecessary. A woman who lifts her breasts up with the cups of her hands to demonstrate what she wants is best served with an augmentation mastopexy.

Complications include persistent ptosis (8.7%), scar deformities (7.9%), delayed wound healing (7.1%), and asymmetry (6.0%). In secondary cases, the nipple/areola may require little or no elevation. The original surgical pattern does not need to be followed.

Patients report being "back to normal" 1 month after surgery. The mean pain rating is 5.3 on a scale of 1 (least pain) to 10 (worst pain). According to patient surveys, 84% of women are satisfied with their result, 94% would repeat the surgery, and 96% would recommend it to others. Almost all women (97%) are pleased with their decision to have implants. Self-esteem is improved in 86% of patients and 70% of women report an improved quality of life.

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Introduction

Conventional wisdom holds that plastic surgeons need to be familiar with a number of different surgical techniques to treat different degrees of breast ptosis and breast volume [1]. The traditional recommendation is to use a periareolar resection for cases of minor ptosis, vertical mammaplasty for more moderate degrees of breast ptosis, and an inverted-T technique for major ptosis [1, 2]. In 1979, Georgiade et al. [3] dismissed the concept of an "all seasons mammaplasty." At that time, almost all plastic surgeons in North America were using a Wise pattern and inferior pedicle. In 1999, Hall-Findlay [4] published her seminal article describing a vertical mammaplasty with a medial pedicle. The vertical mammaplasty with a medial, superior, or superomedial pedicle is now used exclusively by a growing number of plastic surgeons [5–11], including the author, who abandoned the Wise pattern in 2002.

A periareolar resection removes extra tissue from around the areola, but provides minimal breast mound elevation (Fig. 7.1) [12]. By omitting a lower pole tissue resection, the effectiveness of this mastopexy technique is compromised [12, 13]. Periareolar mastopexy, popularized by Benelli [14], has fallen into disfavor as plastic surgeons recognize its limitations [13, 15] and the frequent areolar distortion that accompanies this technique (Fig. 7.1) [13]. The author reserves periareolar mastopexies for areola reduction or small adjustments in the position of the nipple/areola (Fig. 7.2). In this application, the label "mastopexy" might be an overstatement, in that breast shape is minimally affected.

Measurements confirm a long-held belief among surgeons that a Wise pattern and inferior pedicle produce a boxy shape with a flat upper pole [12, 16]. Upper and lateral portions of the breast are resected, with (illogical) preservation of the lower pole tissue. Closure of a horizontal ellipse reduces projection and constricts the lower pole while increasing width [12]. Unfortunately, patients after a Wise pattern mammaplasty often resemble preoperative candidates for a vertical augmentation mastopexy [5]. The vertical technique provides greater upper pole projection, breast projection, and more conical lower poles [16]. Not surprisingly, patients prefer the aesthetic result of the vertical method [17].

> Patients after a Wise pattern mammaplasty often resemble preoperative candidates for a vertical augmentation mastopexy.

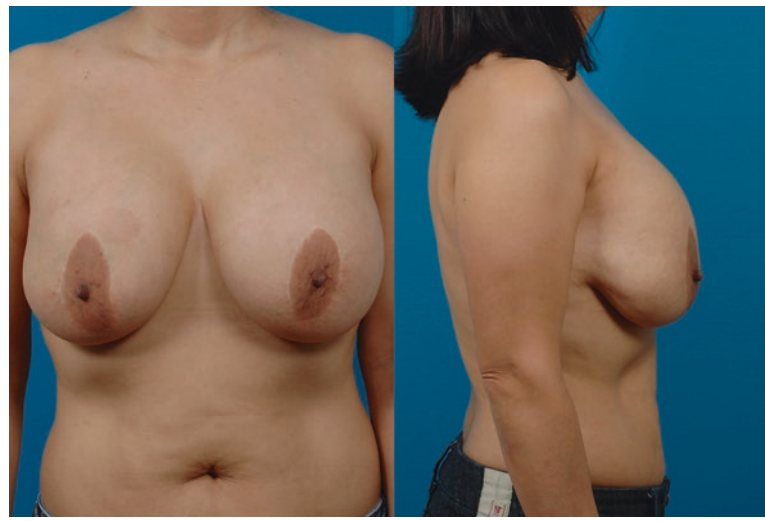

Fig. 7.1 This 41-year-old woman underwent an augmentation mastopexy 8 years previously performed by another surgeon who promised a "scarless" breast lift. A periareolar approach was used with simultaneous implants. Her areolae are vertically elongated and she has persistent tissue excess of the lower poles. She also has capsular contractures. I recommended a vertical mastopexy, replacement of implants, and capsulotomies. However, the patient did not return for this surgery

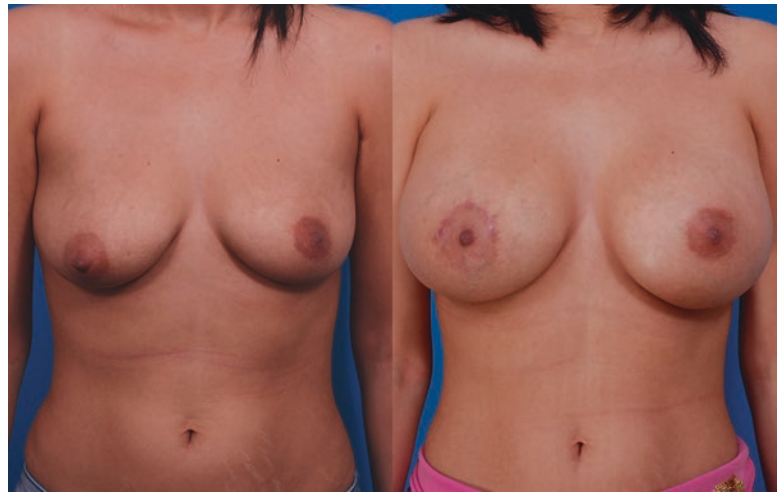

Fig. 7.2 This 27-year-old woman desired a DD cup size. She is seen before (*left*) and 1 month after (*right*) a breast augmentation using smooth, round saline-filled implants (Natrelle style 68, Allergan Inc., Irvine, Calif.) inflated to 500 cc. The right nipple was elevated simultaneously using a crescent mastopexy

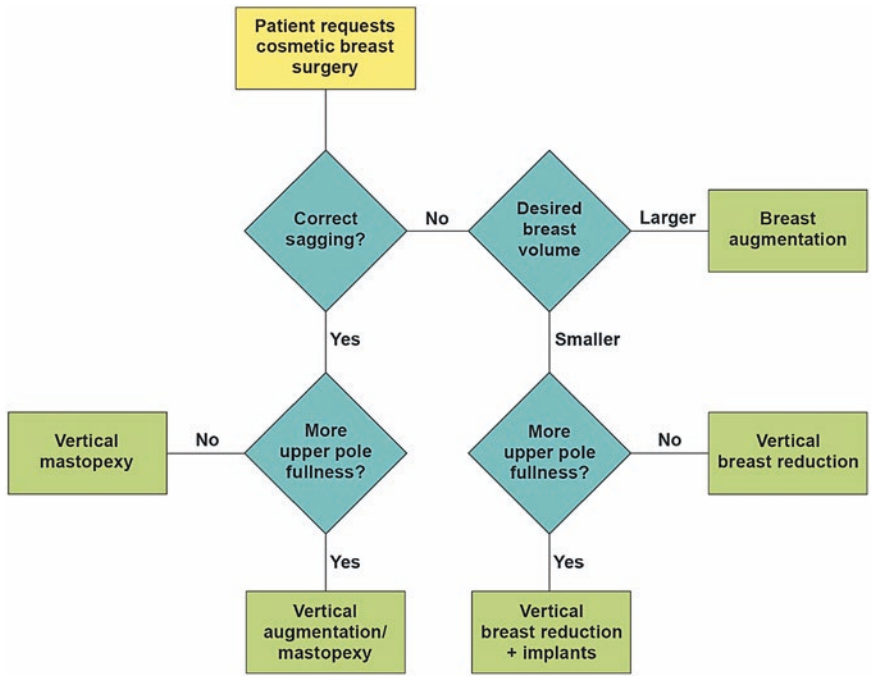

Fig. 7.3 Simplified algorithm for cosmetic breast surgery. Only two procedures are needed, breast augmentation and vertical mammaplasty (labeled a breast reduction for patients with ≥300 g tissue removal from at least one breast). The procedures are performed either individually or in combination (Reprinted from Swanson [20]. With permission from Wolters Kluwer Health)

A Simple Algorithm

With over 100 published methods [12], mammaplasty continues to be a subject of confusion for plastic surgeons. Numerous skin patterns and pedicles are used [2, 18]. Algorithms can be complicated [19]. Since 2002, the author has used a simple algorithm in selecting cosmetic breast procedures (Fig. 7.3) [20]. This algorithm differs from others in its simplicity. Almost all cosmetic cases may be treated with either a breast augmentation or a vertical mammaplasty individually or in combination.

This algorithm does not include revisions of course, or occasional procedures such as a nipple reduction or areola reduction or lift (Fig. 7.1) that are also cosmetic in nature.

Almost all cosmetic cases may be treated with either a breast augmentation or a vertical mammaplasty performed individually or in combination.

Augmentation Mastopexy: Is It a Risky Combination?

Augmentation mastopexy is still regarded as a particularly difficult and risky procedure by many plastic surgeons [22]. Spear and others caution that this procedure not only combines complication rates but multiplies them [21–23]. The conventional view is that the operations are at cross-purposes: the implant stretches the skin envelope while the mastopexy tightens it [15, 22–27]. Many surgeons advocate staging the procedures in patients deemed to be at higher risk, such as women with greater degrees of ptosis [25–27].

In discussions of risk, the mastopexy method is often overlooked [20]. The surgical technique is important because different dissections are likely to differ in their degree of safety. Almost all published series include patients treated with different methods [23, 25–32]. In two recent large series, the vertical method was used in 40% of patients in one study [26] and in 10% of patients in the other study [32]. When different methods are being used, it is difficult to sort out the risk of the combination from the risk of the individual procedures. The author [20] studied augmentation mastopexy using the vertical technique exclusively and the most pertinent findings are included in this chapter.

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Clinical [5] and intraoperative breast perfusion data [33] obtained in patients treated with vertical augmentation mastopexy suggest that the dangers attributed to the combined surgery do not derive from combining techniques after all. The increased risk to nipple/areola perfusion is related to the mastopexy technique [5, 12]. The limitations of non-vertical techniques are exposed when an implant is introduced [5]. For example, adding an implant may create pressure on a long, inferiorly based pedicle, further reducing nipple/areola perfusion and possibly tipping the balance to necrosis (Fig. 7.4) [5]. In a periareolar mastopexy, the breast area being stretched has already undergone skin resection, increasing tissue tension [5]. When using the vertical method, staging is unnecessary. Any patient who is a candidate for breast augmentation and vertical mastopexy performed individually is a candidate for the combined procedure [5].

Any patient who is a candidate for breast augmentation and vertical mastopexy performed individually is a candidate for the combined procedure.

Synergy

When the vertical technique is used, the methods are no longer at cross-purposes, but synergistic. These advantages of combinations are summarized below [5].

Augmentation Assists Mastopexy

1. Implant increases breast projection, upper pole fullness, and convexity.
2. Autoaugmentation is unnecessary. Additional breast tissue dissection, which may increase the risk of complications, is avoided.
3. Greater capability to improve symmetry. Implants make it unnecessary for the surgeon to reduce the larger side to obtain symmetry, leaving the patient with breasts that are too small on both sides. It is easier to match an augmented breast.

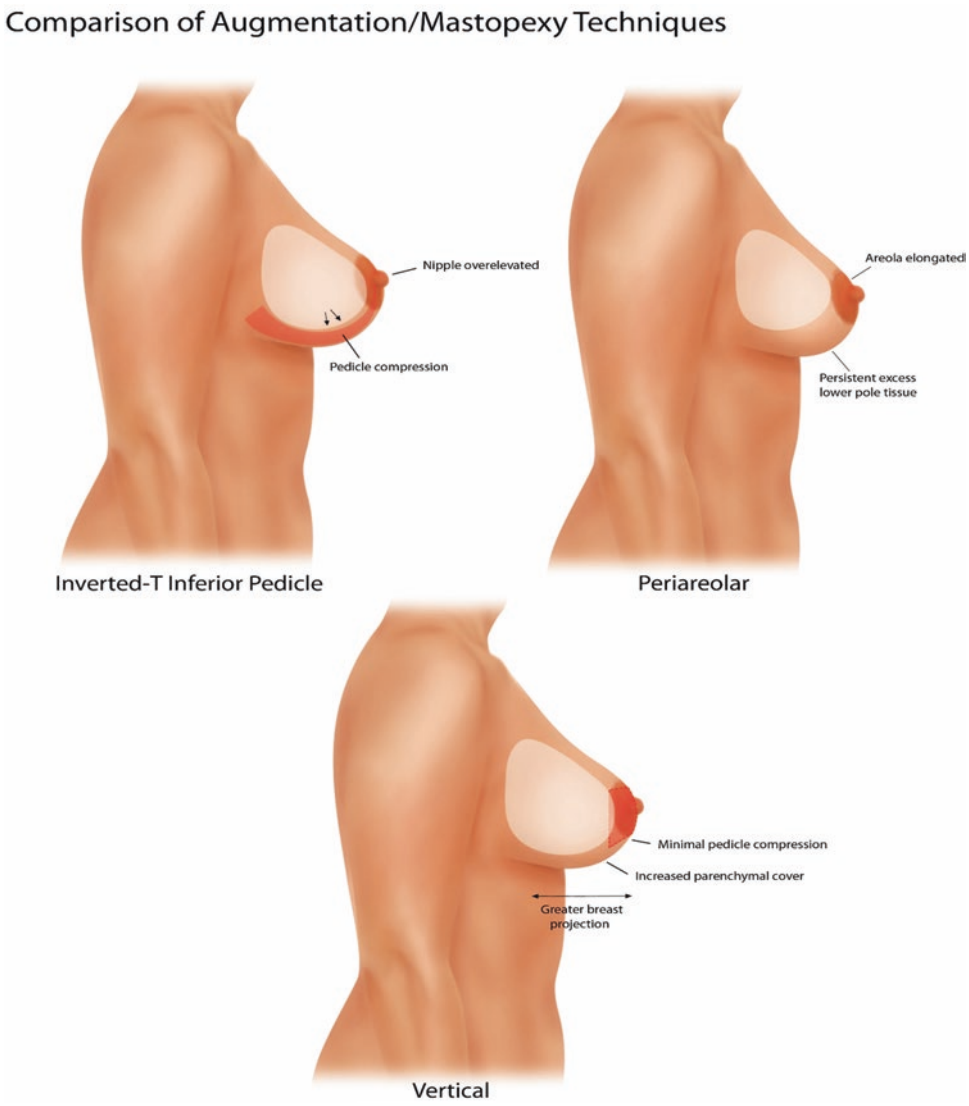

Fig. 7.4 This illustration compares augmentation/vertical mastopexy to augmentation using inverted-T, inferior pedicle and periareolar techniques. The inferior pedicle of an inverted-T procedure is prone to pedicle compression by the implant. The nipple is overelevated. The periareolar procedure removes skin in the periareolar area that will be subject to expansion by the implant, with greater tension on the periareolar scar. Vertical mammaplasty avoids pressure on the pedicle (periareolar skin resection is limited), eliminates excess lower pole tissue, and provides secure lower pole parenchymal closure, allowing the implant to fill out the upper pole (Reprinted from Swanson [5]. With permission from Wolters Kluwer Health)

4. By increasing breast projection, the implant makes closure of the vertical wound easier, with less gathering of tissue. The vertical scar smoothes out more quickly.
5. It is easier to keep the vertical scar from extending below the inframammary crease where it may be visible. An inverted-T closure at the bottom is usually unnecessary.
6. Nipple/areola transposition is minimized. The base of a medially based pedicle moves up with the implant.
7. Intraoperative determination of nipple position is made easy with a firm, projecting breast mound.
8. The tendency for nipple/areolar collapse (falling in) is reduced.

Mastopexy Assists Augmentation

1. The incision can be several centimeters long, up to the width of the skin resection pattern.
2. Improved exposure makes the pocket dissection easier, with less trauma to the implant.
3. Existing asymmetry of nipple position may be corrected.
4. Mastopexy provides lower pole elevation, breast mound elevation, and nipple elevation.
5. Greater tissue cover over the implant.
6. A tuberous breast deformity may be corrected simultaneously.
7. Excessive areolar diameter may be reduced.

Today, women are often confronted with a choice between procedures – augmentation with implants (and more recently fat injection), mastopexy, and augmentation mastopexy. Measurement data helps us avoid recommending a mastopexy to a woman who wants to keep her volume, but just have her breasts lifted, a very common scenario. A woman who lifts her breasts up with the cups of her hands and says "This is what I want" is usually best served with an augmentation mastopexy [5]. If a woman wants to remain about the same breast size, she needs upper pole addition and lower pole subtraction. Women understand that stuffing the upper pole with tissue from the lower pole works well on the drawing board but not in reality because of the malleable nature of breast tissue.

A woman who lifts her breasts up with the cups of her hands and says "This is what I want" is usually best served with an augmentation mastopexy.

Anesthesia and Venous Thromboembolism Prophylaxis

All procedures are performed on an outpatient basis in a state-licensed ambulatory surgery center using total intravenous anesthesia and a laryngeal mask airway. This type of anesthesia avoids intraoperative hypotension and preserves the calf muscle pump, reducing the risk of venous thromboembolism [34, 35]. Doppler ultrasound screening is performed preoperatively, the day after surgery, and approximately 1 week after surgery [36, 37]. Chemoprophylaxis is not used. Patients typically receive cefazolin 1 g IV preoperatively, followed by three doses of cephalexin 500 mg p.o. q12h.

Surgery

A vertical elliptical resection pattern is marked preoperatively (Figs. 7.5 and 7.6). A medially based pedicle [4] and intraoperative nipple siting are used. A mosque-dome or keyhole preoperative pattern is not used. The lower end of the ellipse is marked preoperatively just above the existing inframammary fold (Fig. 7.5).

Before performing the mastopexy, the breast implant is placed submuscularly, with partial release of the inferior sternal origin of the pectoralis muscle. As in breast augmentation, the degree of muscle release is critical. If the muscle is inadequately released, the intermammary space may be too wide. Over-release can cause the dreaded symmastia, with continuity from one breast to the other – the breasts may resemble buttocks. In patients with existing breast implants, the pocket is usually expanded superiorly to accommodate the new implant at a higher level on the chest wall. Implants have typically settled since the original surgery, or the patient may desire a larger size. Subpectoral placement of the breast implant adds a layer of tissue cover and is preferred by most surgeons [5, 23, 24, 26–32]. However, prepectoral placement is a valid alternative, particularly in women with adequate breast tissue, and avoids an animation deformity [20].

Breast Implant Selection and Size

There is a general preference for silicone gel implants [18], although some surgeons more commonly insert saline implants [5, 23]. Silicone gel implants have traditionally been favored for a more

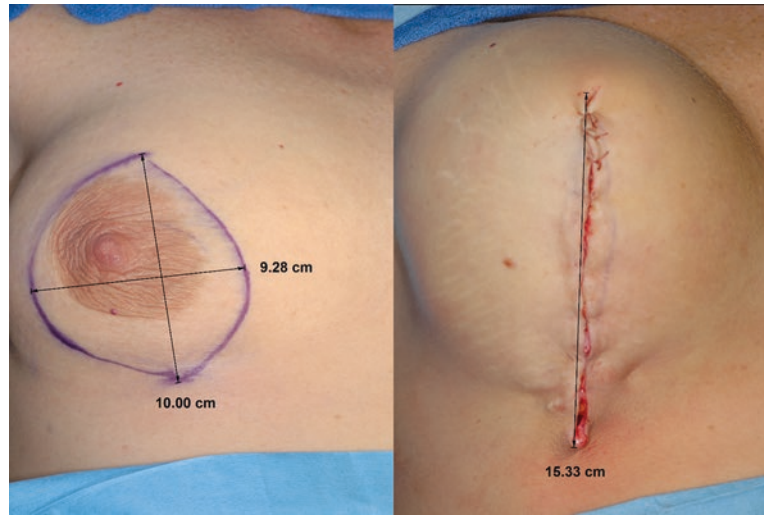

Fig. 7.5 Intraoperative photographs of vertical augmentation mastopexy. (*Left*) Before and (*right*) after elliptical skin resection. With side-to-side tissue approximation, the vertical length increases from 10.00 to 15.33 cm. If the vertical and horizontal dimensions of the resection are the same (i.e., roughly a circle), an increase in vertical length of $\pi/2$ (57%) is expected. Additional photographs of this patient are provided in Figs. 7.6 and 7.7 (Reprinted from Swanson [5]. With permission from Wolters Kluwer Health)

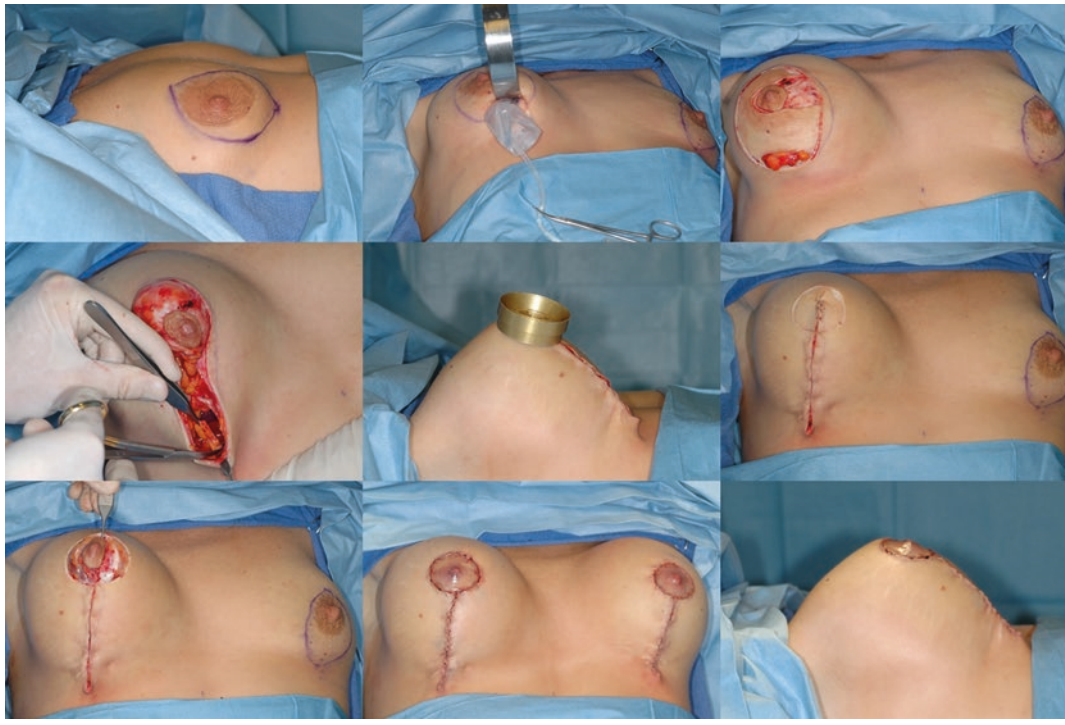

Fig. 7.6 Operative sequence in a 34-year-old woman undergoing vertical augmentation mastopexy. (*Above, left*) Preoperative marking of vertical ellipse. (*Above, center*) Subpectoral placement of smooth, round saline implant inflated to 390 cc (moderate plus profile, Mentor Corp., Santa Barbara, Calif.). (*Above, right*) Deepithelialization of medial pedicle. (*Center, left*) Resection of breast tissue from inferior pole. (*Center*) Nipple siting just below apex with slight lateral inclination. (*Center, right*) Incision of new nipple/areola site. (*Below, left*) Nipple repositioning. (*Below, center*) Skin closure. (*Below, right*) Lateral photograph after completion of surgery. Before-and-after photographs are provided in Fig. 7.7

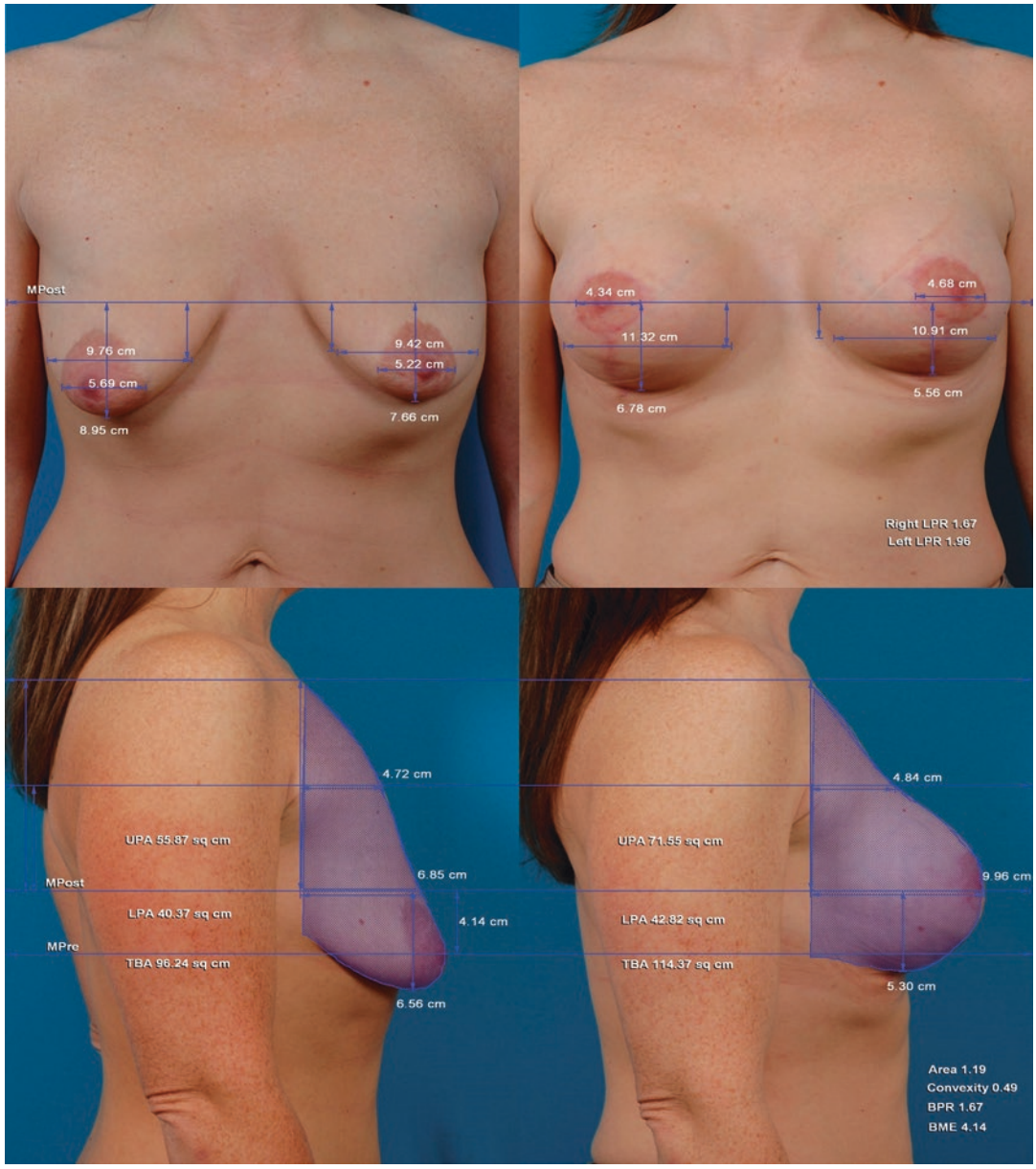

Fig. 7.7 This woman is seen before (*left*) and 3 months after (*right*) a vertical augmentation mastopexy. Subpectoral smooth, round subpectoral saline implants (moderate plus profile, Mentor Corp.) were inflated to 390 cc on each side. Resection weights were 40 g on the right side and 43 g on the left side. Her intraoperative photographs are provided in Figs. 7.5 and 7.6

natural feel characteristic and possibly less rippling [38]. However, in a woman who has a moderate breast volume, this difference may be negligible, particularly in a subpectoral pocket. Form-stable implants are not used by the author because they have not been shown to produce a superior outcome [39–41], and have disadvantages, including firmness, rotation, expense, and texturing, which

is linked to late seromas, double capsules, and anaplastic large cell lymphoma (ALCL) [42, 43]. Mean implant volumes in other studies vary from 306 cc to 450 cc [23, 26, 27, 31, 32, 44]. In this study, the average implant volume was 372 cc, 20 cc less than the average for breast augmentations without mastopexy [45], and similar to the mean volume in the study by Calobrace et al. (392 cc) [26]. It is best to insert the implant before committing to the mastopexy incisions so as to avoid an overly tight repair. The same caution needs to be exercised in choosing an implant size for an augmentation mastopexy as in a breast augmentation [33]. It has been suggested that, logically, larger implants should have a higher complication rate [27]. However, neither this study nor the study by Calobrace et al. [26] substantiates this claim. Larger implants correlate with greater patient satisfaction [45, 46].

Some investigators promote tissue-based measurements as a means to determine implant size [47–49], and this subject is discussed in more detail in Chap. 3. Tissue-based measurements do not include patient input in size selection, and tend to produce low recommended implant sizes (e.g., mean volume, 289 cc) [48] that are likely to disappoint at least 20% of patients [48]. There are no patient-reported outcome studies that support this method, which supplants the patient's desires with the surgeon's. Another method used to predict implant size is having the patient stuff her bra with implants. However, about 16% of women still report an inadequate size [50], possibly because an implant placed on top of the breast does not accurately simulate an implant within the breast. My own method is to have patients show me photographs on their handheld devices and look at photographs of other patients. This gives me a qualitative idea of an appropriate implant size, but is admittedly not scientific. I am an advocate of measurements, but these measurements are for comparison of preoperative and postoperative breast shape and size; they are not used for size determination. Any system that does not include patient choice is unlikely to achieve patient satisfaction with the result, which is the goal of cosmetic surgery [45, 51]. Computer simulations do not yet have this capability because the software is not based on actual tissue measurements derived from patients [52, 53]. A zero reoperation rate is impractical because women may change their minds about implant size after having the surgery [45].

Lower Pole Resection

The lower pole resection width is difficult to predict in a mastopexy, particularly when an implant is inserted simultaneously. Intraoperative adjustments are needed to avoid under- or over-resection. The final lower pole resection margins are determined after insertion of the breast implant and creation of the new breast mound, not necessarily aligning with the preoperative markings (Fig. 7.5). The deepithelialized right medial pedicle extends from approximately 1 o'clock to 4 o'clock (8 o'clock to 11 o'clock on the left breast) along the areola margin, to include the third and fourth anterior cutaneous sensory branches (Fig. 7.8) [54]. The deep branch of the lateral branch of the fourth intercostal nerve provides consistent nipple innervation [54]. A parenchymal attachment deep to the nipple/areola complex is maintained in an effort to preserve this deep innervation.

> The author prefers to maintain a parenchymal attachment deep to the nipple/areola complex in an effort to preserve deep innervation, and a medial pedicle to capture the dominant medially based superficial innervation

The lower pole resection raises the inframammary fold [55] and the implant lowers the inframammary fold [55]. Therefore, the lower end of the incision relative to the new inframammary fold is unknown until after implant insertion and creation of the new breast mound. A vertical mastopexy elevates the inframammary fold [55] because a lower pole tissue wedge is removed and the medial

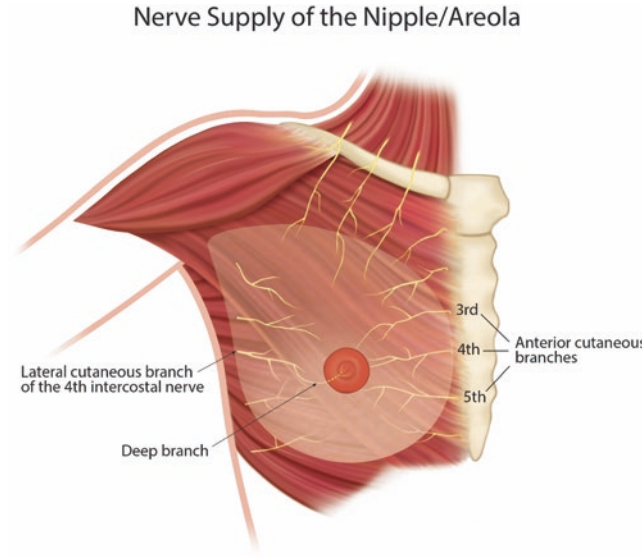

Fig. 7.8 The predominant superficial nipple innervation is provided by the medially based 3rd, 4th, and 5th anterior cutaneous branches. A deep branch of the lateral cutaneous branch of the 4th intercostal nerve consistently provides deep innervation to the nipple

and lateral pillars are brought together, tightening the breast circumference. The length of the vertical scar is longer than for a Wise pattern, typically 10–12 cm (Fig. 7.5) [4, 5]. The vertical method does not constrict the lower pole, unlike the Wise pattern mammaplasty [16]. Direct excision is used rather than liposuction so as to adequately remove denser breast tissue along with fat from the lower pole and to limit tissue trauma.

Intraoperative Nipple Siting

The new nipple/areola site is determined after insertion of the breast implant and creation of the new breast mound (Fig. 7.6). The nipple is positioned in reference to the breast mound, not to a predetermined level or distance to the sternal notch [56]. A 39-mm areola marking ring is preferred because the areola tends to stretch about 1 cm postoperatively [56], and women prefer areola diameters that do not exceed 5 cm [46]. Although many surgeons prefer to sit the patient up during surgery, I do not find this position necessary to correctly site the nipple. A short inverted-T modification is used when the vertical scar extends below the level of the new (elevated) inframammary fold. The length of this horizontal scar is shorter than the inframammary component of the Wise pattern**,** just long enough to remove the inferior dog ear. No drains are used. Videos demonstrating this procedure are available at the *Plastic and Reconstructive Surgery Global Open* website: http://journals.lww.com/prsgo/pages/default.aspx [57].

> The new nipple/areola site is determined after insertion of the breast implant and creation of the new breast mound.

Breast Perfusion

The intercostal perforating arteries from the internal mammary artery provide the dominant superficial circulation to the nipple and areola in 70% of women (Fig. 7.9) [58, 59].

Measurements of nipple/areola perfusion [33] reveal that implant sizes up to 575 cc may be safely inserted using a vertical method and medial pedicle (Figs. 7.10, 7.11, and 7.12).

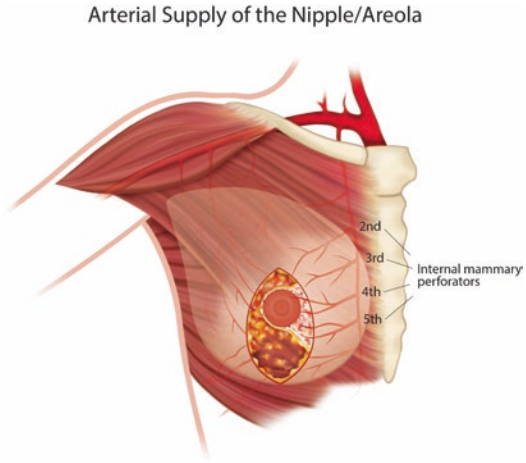

Fig. 7.9 Arterial blood supply of the nipple and areola. The intercostal perforation arteries from the internal mammary artery supply the dominant superficial circulation to the nipple and areola in 70% of women. A medially based pedicle is designed to include these vessels

Measurements

As expected in patients treated with implants, augmentation mastopexy increases breast projection (2.3 cm) and upper pole projection (1.6 cm) more than mastopexy alone (1.2 cm and 0.5 cm respectively). Not surprisingly, in view of the lower-pole lowering effect of implants, there is less lower pole elevation when implants were combined with mastopexy. The areola stretching effect of the augmentation appeared to be balanced by the areola reduction provided by the mastopexy so that there is no significant change in the mean areola diameter (Fig. 7.13) [56].

Clinical Examples

The versatility of vertical augmentation mastopexy is demonstrated in Figs. 7.14, 7.15, 7.16, 7.17, 7.18, 7.19, 7.20, 7.21, 7.22, and 7.23.

Breast Asymmetry

Treating asymmetry by varying the mastopexy technique from one side to the other can be challenging. Matching a nonaugmented breast is notoriously difficult. This problem may be more easily remedied by placing similar implants on each side and then simply resecting more lower pole tissue on the larger side (Figs. 7.15, 7.16, 7.17, 7.18, and 7.19) [56].

Torso Lengthening

The appearance of a longer torso is an underappreciated benefit of vertical augmentation mastopexy (Fig. 7.20).

Large Breast Size

(See Figs. 7.21 and 7.22)

Tuberous Breasts

Even small, ptotic breasts and tuberous breasts, traditionally considered the domain of the periareolar technique [28], respond well to vertical mastopexy (Fig. 7.23).

Changes in Breast Shape Over Time

Figures 7.24 and 7.25 illustrate changes in breast shape over time.

Augmentation Mastopexy After Massive Weight Loss

Patients after massive weight loss usually benefit from implants to replace lost upper pole volume (Fig. 7.26).

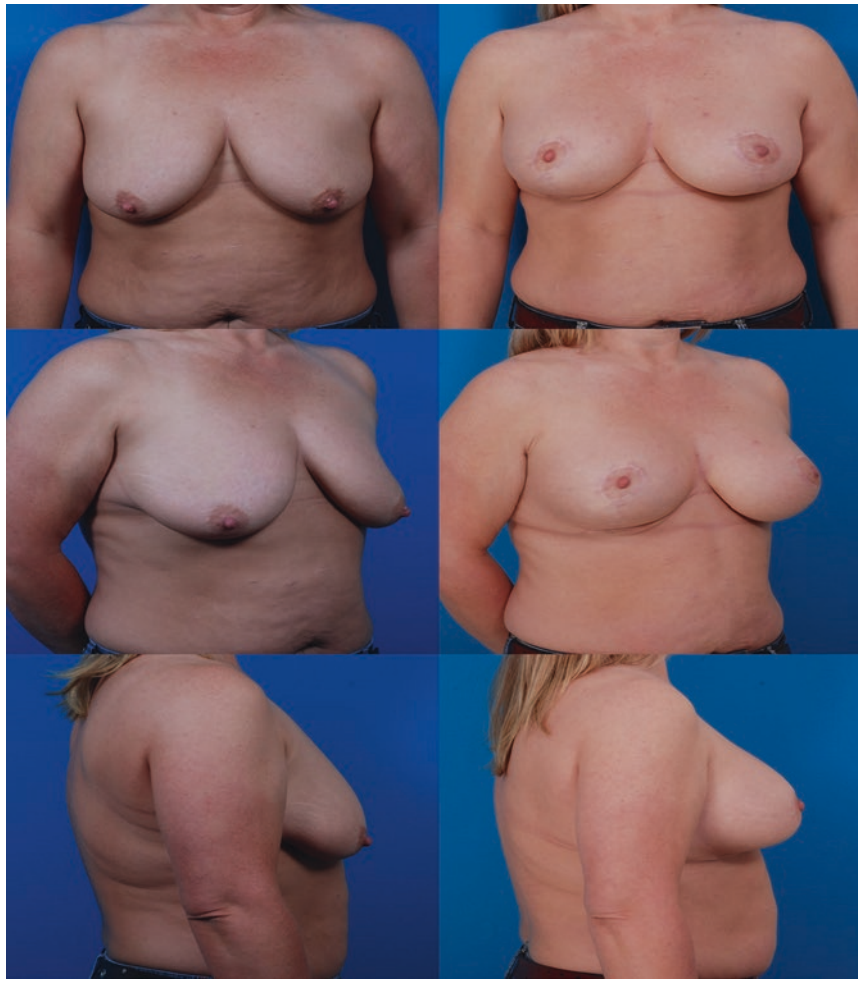

Fig. 7.10 This 43-year-old woman wished to have her ptosis corrected and her breasts enlarged to a DD cup size. Smooth, round moderate-profile saline-filled implants (Natrelle style 68, Allergan Inc.) were inserted submuscularly and filled to 540 cc. Resection weights: right breast, 145 g; left breast, 142 g. She is seen before (*left*) and 2 years after (*right*) a vertical augmentation mastopexy. The frontal photographs (*above*) demonstrate correction of ptosis. The lateral images (*below*) demonstrate gains in breast projection and upper pole projection, and elevation of the lower pole level. This patient's intraoperative photographs and perfusion studies are provided in Figs. 7.11 and 7.12

Secondary Augmentation Mastopexy

A vertical mastopexy is used for all secondary augmentation mastopexies, irrespective of the original surgical method, which is usually a Wise pattern with an inferior pedicle in North America. In secondary cases, the nipple position rarely requires elevation, facilitating a wider base that always includes a medial pedicle and is frequently extended to include the superior areola hemicircumference (Fig. 7.27) [5, 20]. In secondary cases requiring no change in nipple position and only tightening of the lower pole (i.e., a revision), a periareolar incision may be unnecessary (Fig. 7.28) [5].

In secondary cases, the nipple/areola typically does not need to be transposed because it is almost never too low. It is preserved both on a deep glandular pedicle and by a 270-degree superior/lateral/medial deepithelialized pedicle.

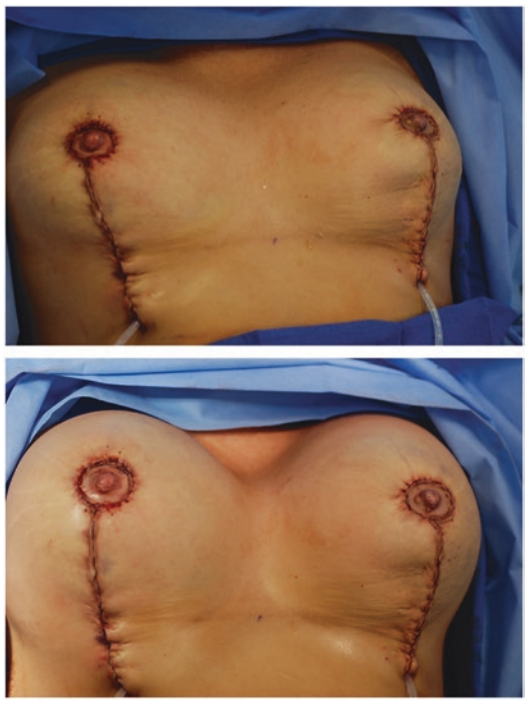

Fig. 7.11 Intraoperative photographs after vertical mastopexies and after insertion of submuscular implants (*above*), and after inflation of the implants to their maximum 540 cc fill volume (*below*). Before-and-after photographs are provided in Fig. 7.10, and perfusion studies are presented in Fig. 7.12. Note that the tubes in the photographs are filling tubes that are removed in surgery after the final laser perfusion image is obtained; they are not drains (Reprinted from Swanson [33]. With permission from Oxford University Press)

Complications

The complication rate in the author's series of cases from 2002 to 2016 was 32.9%, including persistent ptosis (8.7%), scar deformities (7.9%), delayed wound healing (7.1%), and size asymmetry (6.0%) [20]. Less frequent complications included capsular contracture (4.8%) and cellulitis (4.0%). Two deep venous thromboses (0.8%) were detected. One hematoma and one seroma were encountered, and there were no implant deflations. There were no hospital admissions and no blood transfusions. There were no cases of nipple loss.

The revision rate was 15.5% [20]. No significant correlations were detected between the incidence of complications and age, body mass index, resection weights, implant volumes, or operating time. A significant ($p < 0.01$) correlation was detected for patients with a smoking history, but not for combined procedures, secondary breast augmentations, or secondary mastopexies. Delayed wound healing was not significantly associated with secondary mastopexy [20]. It is unnecessary to determine the original dissection pattern and repeat it out of concern for blood supply. Women who have had previous Wise pattern mammaplasties may be safely treated using the vertical technique [5, 60–62], provided a wide areola attachment is preserved.

Comparing complication and revision rates between surgeons is difficult. Surgeons differ in how they define a complication [5]. Some investigators do not consider cosmetic issues such as asymmetry, persistent ptosis (Fig. 7.29), or scar deformities as complications [63]. Others do not recognize implant size change as a complication [26]. The vertical repair does not appear as neat as a Wise pattern on the operating table, with pleats along the incision line [2]. A higher revision rate has been reported using the vertical method [17]. However, an implant takes up volume and minimizes skin gathering, reducing the need for an inverted-T component [5]. My revision rate (15.5%) is slightly lower than the rate reported for predominantly Wise pattern augmentation mastopexies (19.3%) [23], despite a larger mean implant volume (372 cc versus 247 cc). The hematoma rate (0.4%) compares favorably with breast augmentation alone (2.7%) [45], possibly because of improved exposure. The capsular contracture rate (4.8%) is very similar

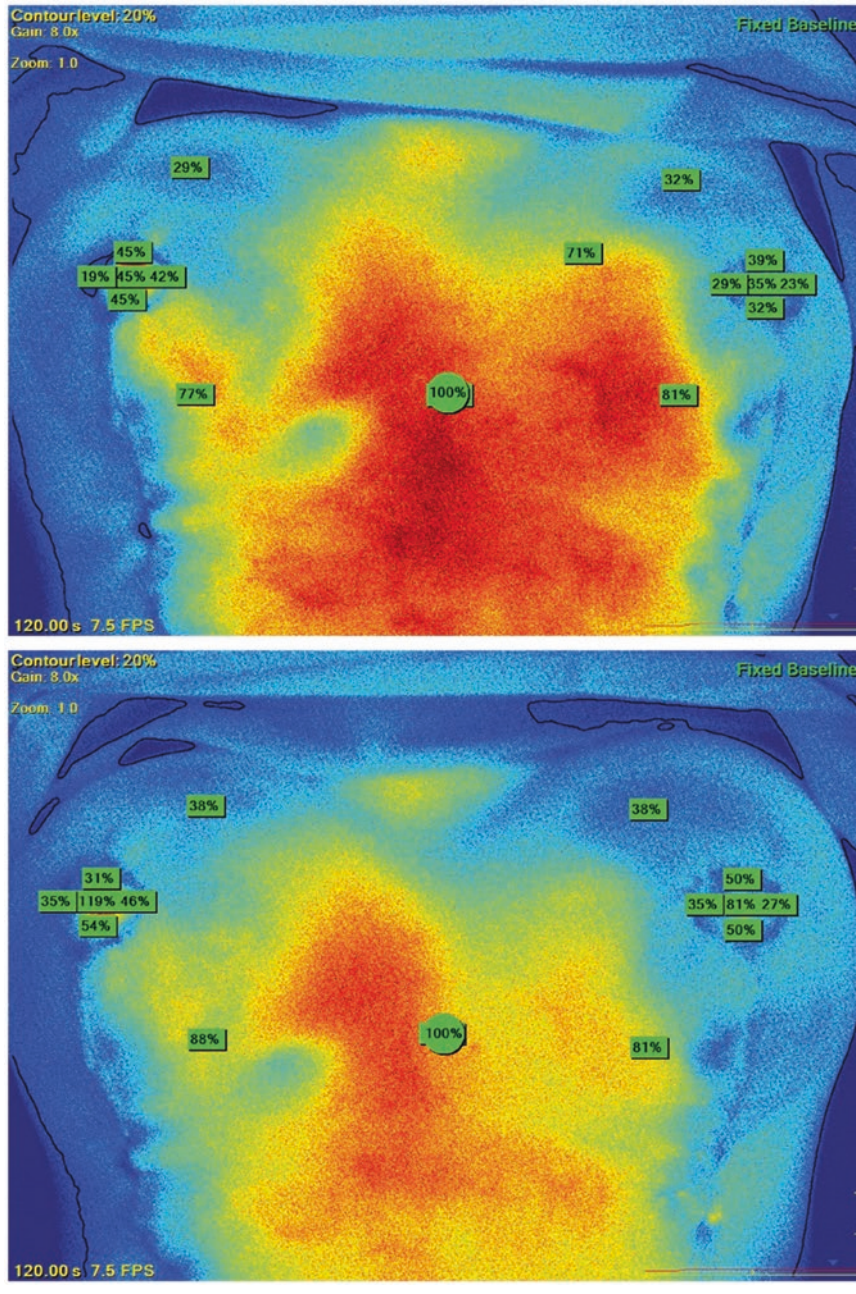

Fig. 7.12 Perfusion study after completion of mastopexies and insertion of unfilled breast implants (*above*), and after inflation of breast implants to the maximum fill volume of 540 cc (*below*). Measurements are made 120 s after the contrast agent was injected and flushed with 10 cc of normal saline. Relative perfusion values at each site are provided, using the xiphoid site as a reference. The nipples and areolae remain adequately perfused despite the large fill volume (Reprinted from Swanson [33]. With permission from Oxford University Press)

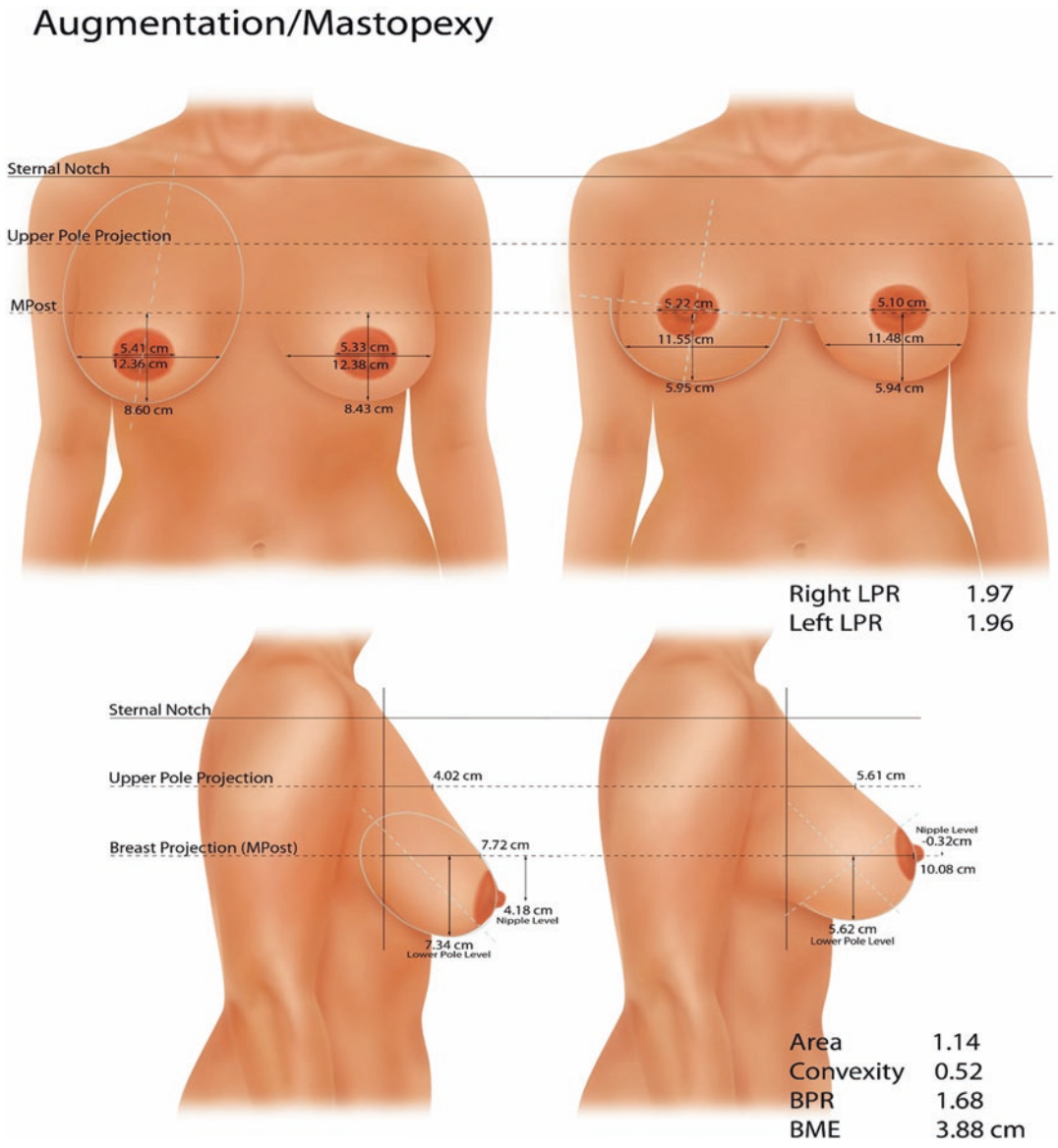

Fig. 7.13 Breast shape before (*left*) and after (*right*) vertical augmentation mastopexy with a medial pedicle. Similar to the vertical mastopexy, the elliptical shape of the lower pole is tightened to a semicircle on both frontal and lateral views. Breast projection and upper pole projection are substantially increased with implants. The upper pole contour is slightly convex after surgery. The areola diameter stays approximately the same. These mammographs were created based on mean breast measurements among study patients. *MPost* maximum postoperative breast projection, *LPR* lower pole ratio, *BPR* breast parenchymal ratio, *BME* breast mound elevation (Reprinted from Swanson [56]. With permission from Wolters Kluwer Health)

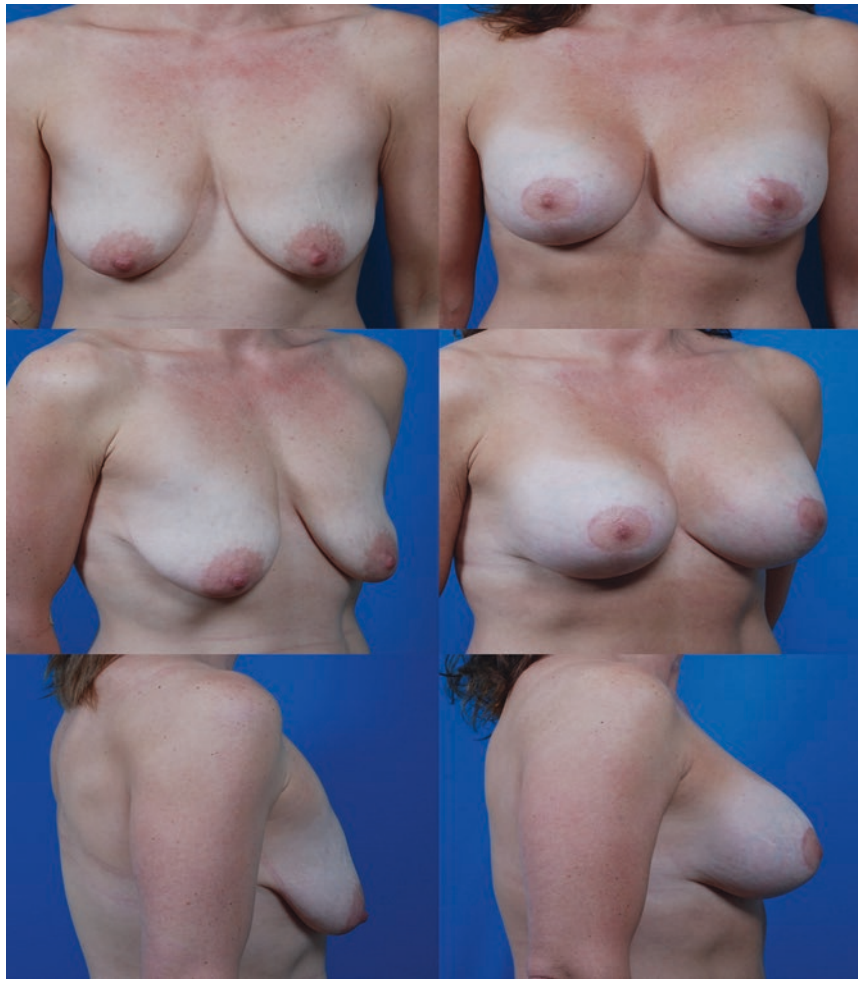

Fig. 7.14 This 41-year-old woman had marked deflation and breast ptosis. She wished to be restored to a C cup size. She is seen before (*left*) and 13 months after (*right*) a vertical augmentation mastopexy. She chose saline-filled implants (smooth, round subpectoral Allergan Natrelle style 68MP) inflated to 330 cc. Resection weights: right, 52 g; left, 47 g. An abdominoplasty and liposuction of the abdomen and flanks were performed simultaneously (Reprinted from Swanson [20]. With permission from Wolters Kluwer Health)

to that found in another large study of augmentation mastopexy [26].

There were no known cases of implant deflation, a finding that will no doubt change with longer follow-up. Importantly, no double bubbles were encountered. A double bubble describes inferior implant displacement causing a bulge below the original breast contour [64]. Secure approximation of the medial and lateral pillars helps prevent inferior implant displacement. For implant insertion, the author prefers a horizontal incision within the lower pole, just above the existing inframammary fold (see Chap. 3) [65].

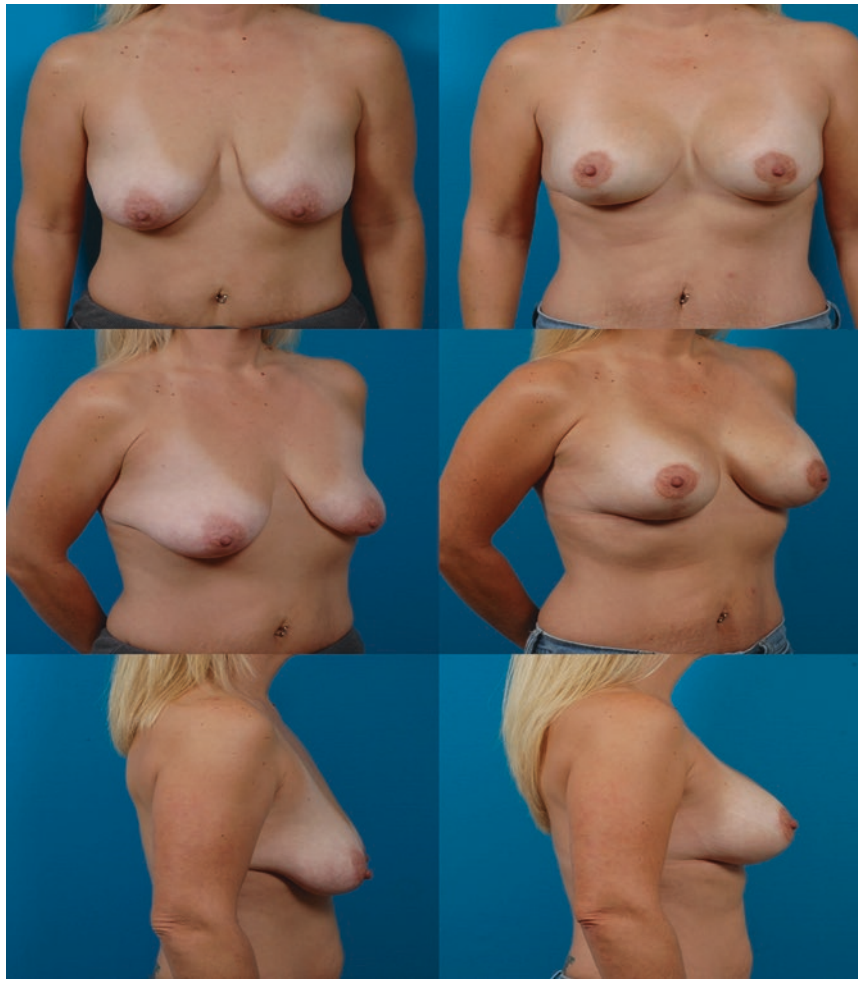

Fig. 7.15 This 41-year-old woman had asymmetrical breasts. She is seen before (*left*) and 1.5 years after (*right*) a vertical augmentation mastopexy. She chose saline-filled implants (smooth, round subpectoral moderate plus profile, Mentor Corp.), which were inflated to 280 cc on the right side and 300 cc on the left side. Resection weights: right, 81 g; left, 58 g (Reprinted from Swanson [20]. With permission from Wolters Kluwer Health)

Persistent Ptosis

(See Fig. 7.29)

Nipple Overelevation

A high-riding nipple (Fig. 7.30) is very common, present in at least one breast in 41.9% of published mammaplasties [12]. Nipple overelevation is usually caused by (1) the inverted-T technique (a design that overelevates the nipple [12, 56]) and (2) preoperative marking of the planned nipple position [56]. Preoperative marking commits the surgeon to a nipple level before the new breast mound is formed. Nipple overelevation may be avoided by (1) using the vertical technique and (2) determining nipple level after breast mound creation and locating the new nipple site at or just below the apex [56].

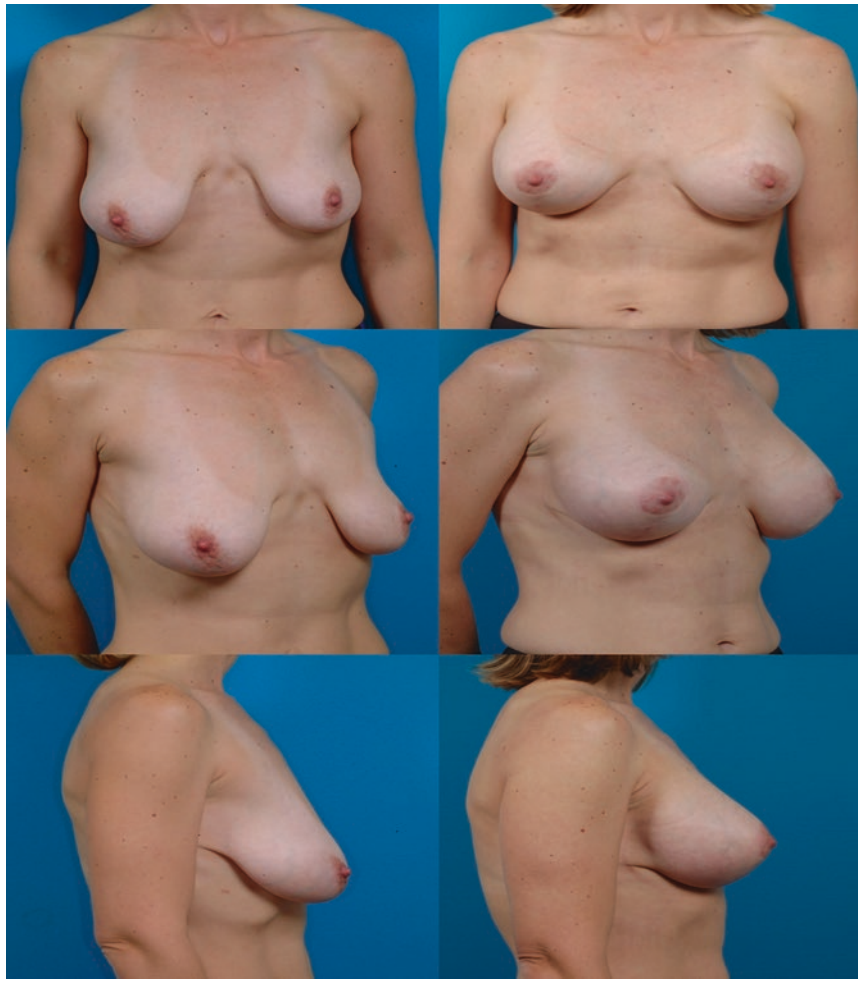

Fig. 7.16 This 36-year-old woman with two children complained of breast asymmetry and sagging. She required a D-cup bra to accommodate her right breast, even though this cup size was too big for her left breast. She is seen before (*left*) and 1 year after (*right*) vertical augmentation mastopexy using submuscular, saline-filled implants, inflated to 240 cc on the right side and 290 cc on the left side. The resection weights were as follows: right breast, 112 g; left breast, 8 g (Reprinted from Swanson [5]. With permission from Wolters Kluwer Health)

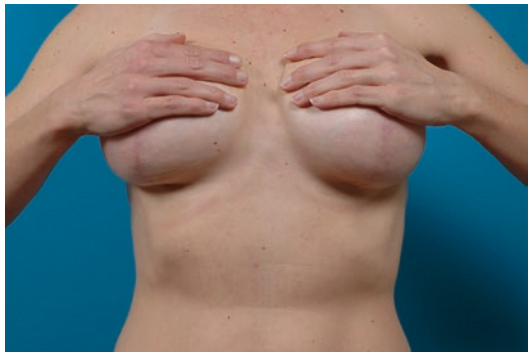

Fig. 7.17 Close-up view of mastopexy scars 1 year after surgery for the patient in Fig. 7.16

Both areola grafting and transposition on local flaps leave unacceptable scars on the upper pole of the breast [66, 67]. Millard et al. [68] described skin excisions within the inframammary crease to pull the nipple down in mammaplasty patients with superiorly displaced nipples. Breast implants can assist by providing a fulcrum [69]. The procedure may be repeated, keeping the scar tucked within the inframammary crease where there is often an existing scar. Inframammary skin resection is safe from a vascular and sensory standpoint because there is no periareolar dissection.

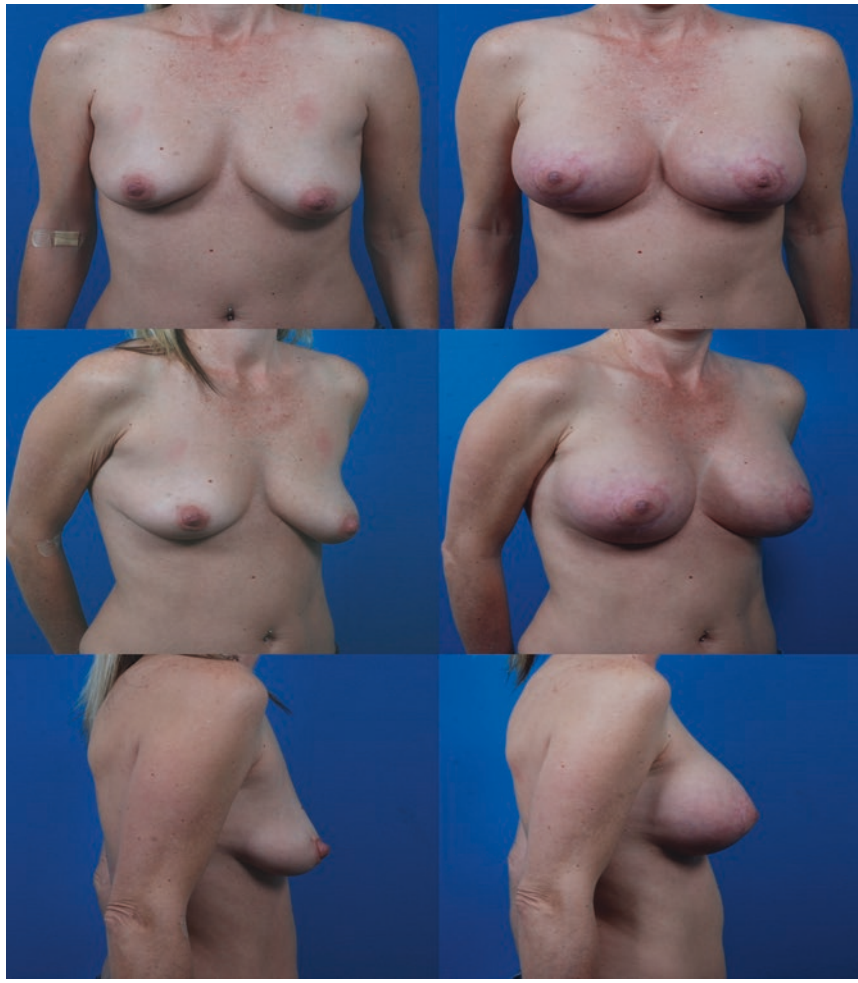

Fig. 7.18 This 43-year-old woman is seen before (*left*) and 3 months after (*right*) vertical augmentation mastopexy using smooth, round subpectoral Natrelle style 68 implants inflated to 420 cc on the right side and 390 cc on the left. Resection weights: right, 12 g; left, 65 g

Infection

A superficial wound infection, or cellulitis (Fig. 7.31), occurs in about 4% of patients [20]. A deep infection involving the implant is rare.

Nipple Sensation

Eighty percent of women undergoing reduction mammaplasty report that nipple sensation is important sexually [70]. Regardless, sensate body parts are always to be preferred. An inverted-T pedicle sacrifices all superficial innervation to the nipple. The deep innervation is precarious and depends on the extent of the deep dissection. Courtiss and Goldwyn [71] reported that 35% of women experience persistent nipple numbness 2 years after an inverted-T, inferior pedicle breast reduction – much higher than the 13.3% rate of persistent nipple numbness in the author's study [20]. Although many surgeons favor a superior or superomedial pedicle, Schlenz et al. [72] found that a superior pedicle

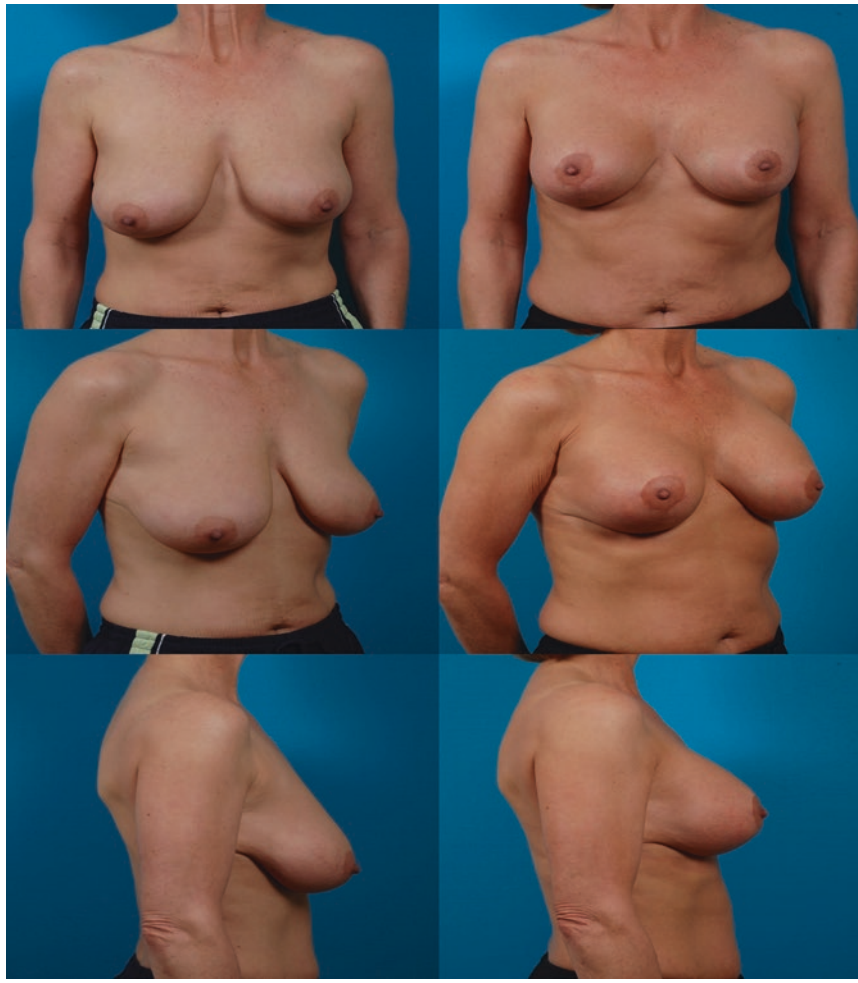

Fig. 7.19 This 47-year-old woman is seen before (*left*) and 1 year after (*right*) an augmentation mastopexy using smooth, round subpectoral moderate plus saline implants (Mentor Corp.) inflated to 200 cc. Her resection weights were 150 g on the right side and 74 g on the left side

compromises nipple sensation by sacrificing the deep innervation. The author prefers to maintain a parenchymal attachment deep to the nipple/areola complex in an effort to preserve deep innervation, and a medial pedicle to capture the dominant medially based superficial innervation (Fig. 7.8) [54].

Patient-Reported Outcomes

Patients report being "back to normal" approximately 1 month after surgery. The mean pain rating is 5.3 on a scale of 1 (least pain) to 10 (worst pain). One-sixth of patients (16.7%) report dissatisfaction

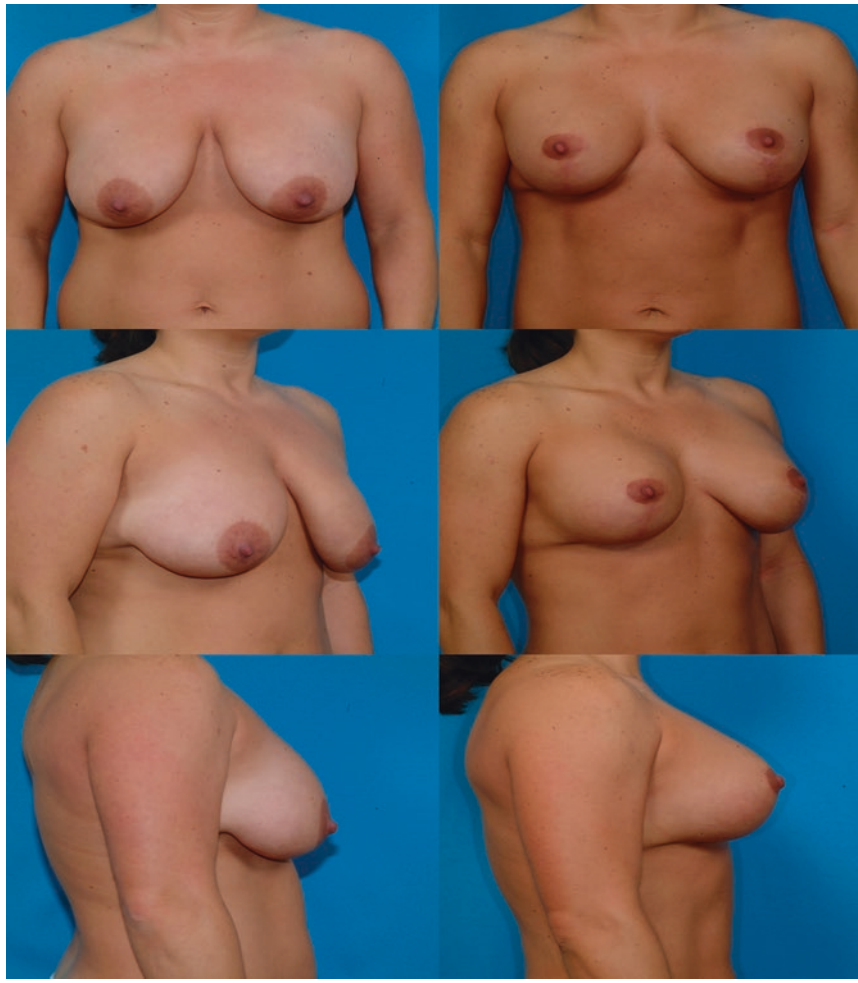

Fig. 7.20 This 32-year-old with three children underwent a vertical mammaplasty, breast implants using smooth, round moderate-profile subpectoral saline implants (Mentor Corp.) inflated to 380 cc on the right and 350 cc on the left, and liposuction of her abdomen, flanks, inner thighs, and arms in two operations. Her resection weights were 115 g on the right side and 48 g on the left side. She is seen before (*left*) and 8 months postoperatively (*right*). Her torso appears longer after surgery. She looks taller and leaner

with their scars. Approximately half the women (48.9%) report at least temporary nipple numbness, which is persistent in at least one nipple in 13.3%. Eighty percent of women are self-conscious about their breast appearance before surgery; 22% are self-conscious about their breasts after surgery. According to patient surveys, 84.4% of women are satisfied with their result, 94.4% would repeat the surgery, and 95.6% would recommend it to others. Almost all women (96.7%) are pleased with their decision to have implants. Self-esteem is improved in 85.6% of patients, and 70.0% of women report an improved quality of life [20].

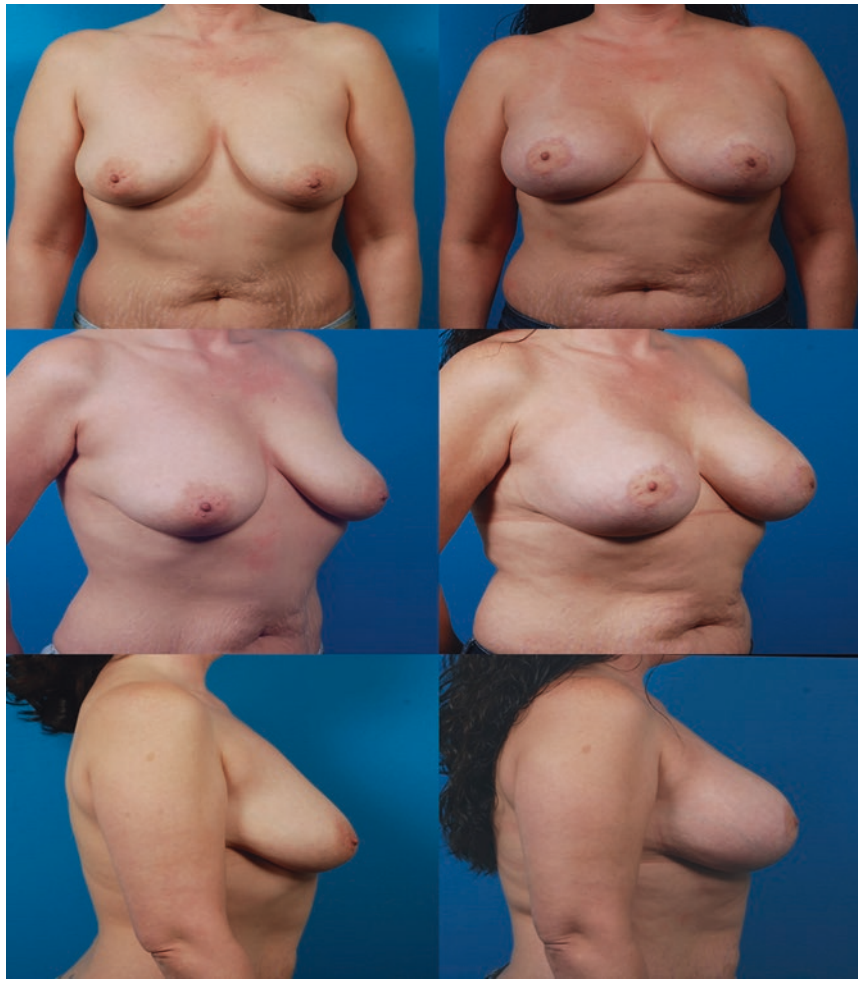

Fig. 7.21 This 35-year-old woman requested a full D cup size. A video of this patient's surgery is available at: [57] She is seen before (*left*) and 9 months after (*right*) a vertical augmentation mastopexy. She chose saline-filled implants (smooth, round subpectoral Allergan Natrelle style 68 MP), which were inflated to 360 cc on the right side and 375 cc on the left side. Resection weights: right breast, 116 g; left breast, 128 g. *MPost* plane of maximum postoperative breast projection (Reprinted from Swanson [20]. With permission from Wolters Kluwer Health)

Vertical (Not "Vertical Scar") Mammaplasty

Many publications refer to a "vertical scar" mastopexy or reduction [7, 9, 62, 64], or "short scar" mammaplasty. These labels miss an important point. The most important consideration in a vertical mammaplasty is not the resulting scar, but the parenchymal dissection [73, 74]. An ellipse of lower pole parenchyma and skin is resected from the lower pole. The resulting scar consists of a periareolar scar plus a vertical scar, commonly known as the "lollipop" scar by patients.

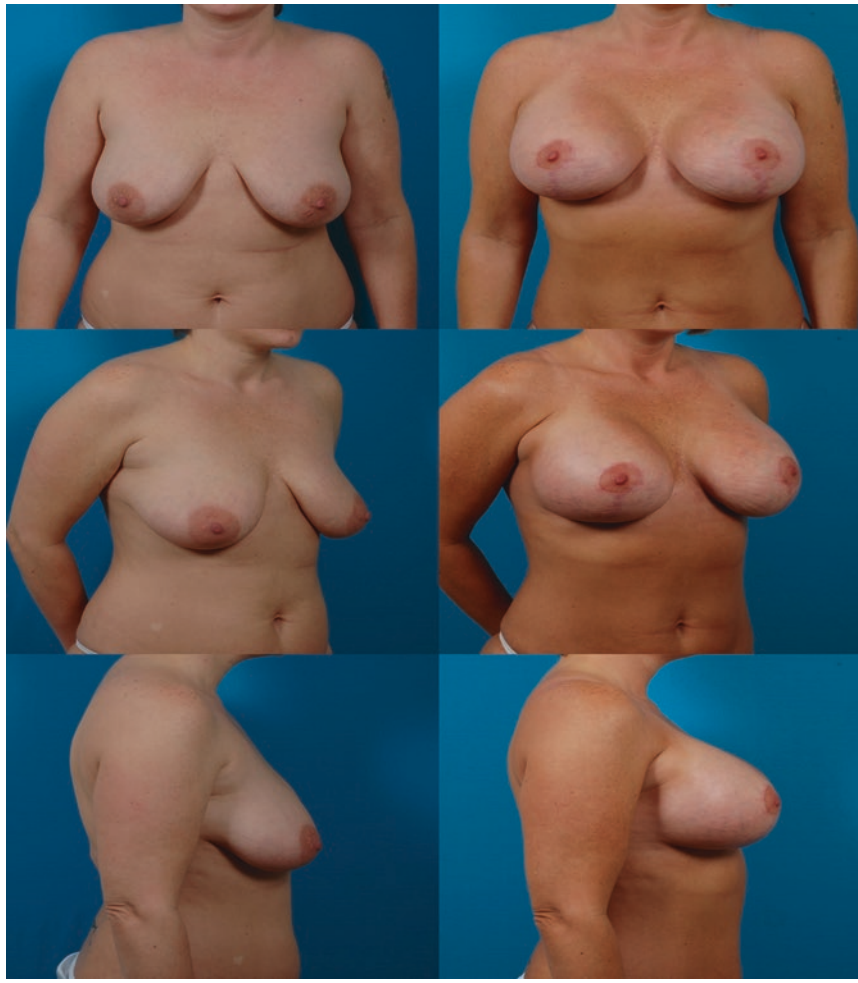

Fig. 7.22 This 39-year-old woman requested a full D cup size. She is seen before (*left*) and 5.5 months after (*right*) an augmentation mastopexy using 510 cc smooth, round subpectoral (moderate plus profile, Mentor Corp.). Her resection weights were 90 g on the right and 68 g on the left

A Wise pattern is often used in cases of major ptosis [1, 2], such as after massive weight loss. However, the vertical parenchymal dissection may be combined with an inverted-T modification of the lower pole incision to maximize skin removal (often cited as an advantage for the Wise pattern) while preserving the advantages of a vertical parenchymal dissection. A short, safe medial pedicle is preferable to a long inferior pedicle, which jeopardizes nipple/areola perfusion. The scar resembles that from a Wise pattern mammaplasty, in that there is an inframammary component. However, the parenchymal dissection is completely different and the horizontal scar is

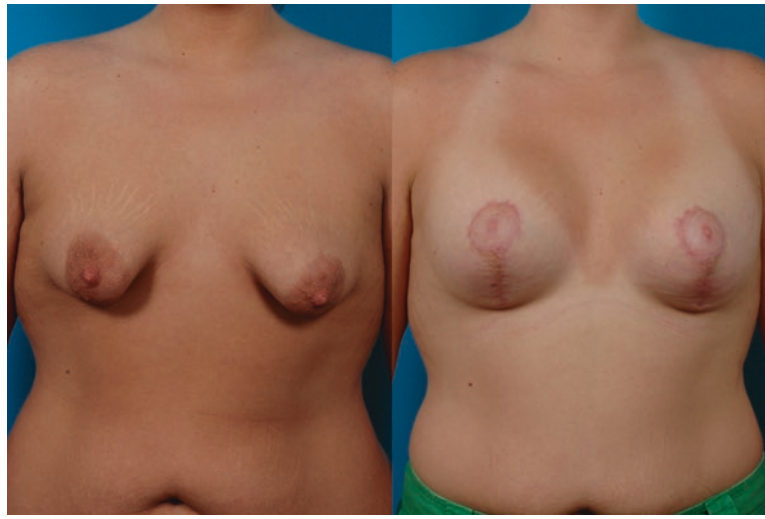

Fig. 7.23 (*Left*) This 24-year-old woman presented with a tuberous breast deformity and asymmetry. (*Right*) She is seen 4 months after vertical augmentation mastopexy using submuscular, saline-filled implants, inflated to 450 cc on each side. Resection weights were as follows: right breast, 62 g; left breast, 44 g. She had simultaneous liposuction of the lower body. The vertical resection removes the herniated periareolar parenchyma, converting a tuberous breast to a nontuberous breast, which may otherwise be left behind in a periareolar skin resection; the implant fills out the constricted base without a need for scoring (Reprinted from Swanson [5]. With permission from Wolters Kluwer Health)

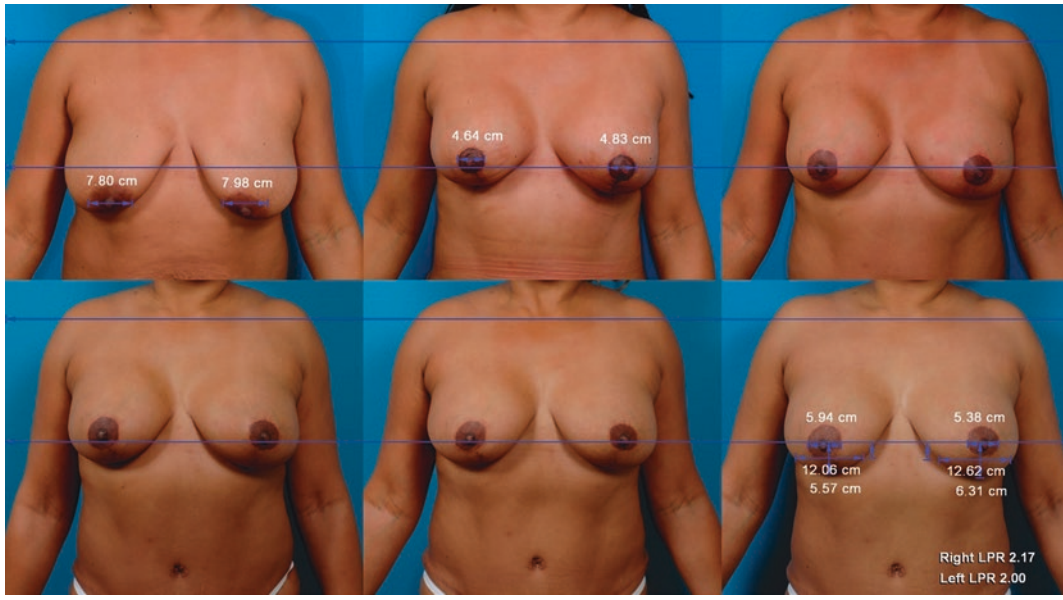

Fig. 7.24 Frontal photographs of a 39-year-old woman who underwent an augmentation mastopexy, abdominoplasty, and liposuction of the abdomen, flanks, inner thighs, and arms. She is seen before surgery (*above, left*), 1 month (*above, center*), 3 months (*above, right*), 6 months (*below, left*), 13 months (*below, center*), and 20 months after surgery (*below, right*). Smooth, round moderate plus profile subpectoral saline implants filled to 275 cc (Mentor Corp.) were used. Resection weights were 110 g on the right side and 148 g on the left side. One month after surgery, the nipple appears slightly too low on the breast mound. Three months after surgery, the exaggerated upper pole fullness has settled and the nipple appears correctly positioned at the level of maximum breast projection. The upper pole contour remains convex 20 months after surgery

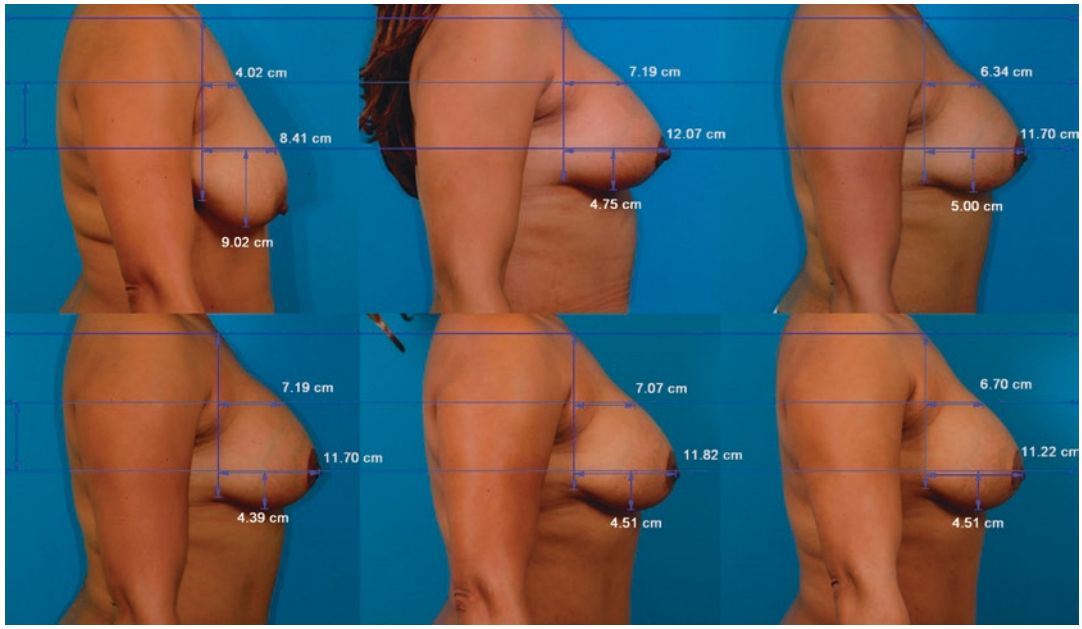

Fig. 7.25 Lateral photographs of the same 39-year-old woman (from Fig. 7.24) who underwent an augmentation mastopexy, abdominoplasty, and liposuction of the abdomen, flanks, inner thighs, and arms at the same time intervals after surgery

much shorter. It is possible to gather skin (with short-term pleating) to keep the scar short and concealed within the inframammary crease, without extending medially or laterally where it might be visible. The term "vertical mammaplasty" is preferred to "vertical scar mammaplasty" because the scar after a vertical mammaplasty is not always just vertical [5]. Vertical mammaplasties are not really "short scar" techniques (the anchor scar might be considered a "long scar") and should not be considered in the same category as periareolar resections. Mammaplasties are better categorized as vertical and nonvertical [20].

Technical Points Learned

This series of patients spanning the years 2002 to 2016 contains my learning curve experience, including my first 100 cases using the vertical method. Technical points learned include [20]:

1. A willingness to "T" off the lower end of the mammaplasty when needed
2. Adequate resection of excessive lower pole parenchyma

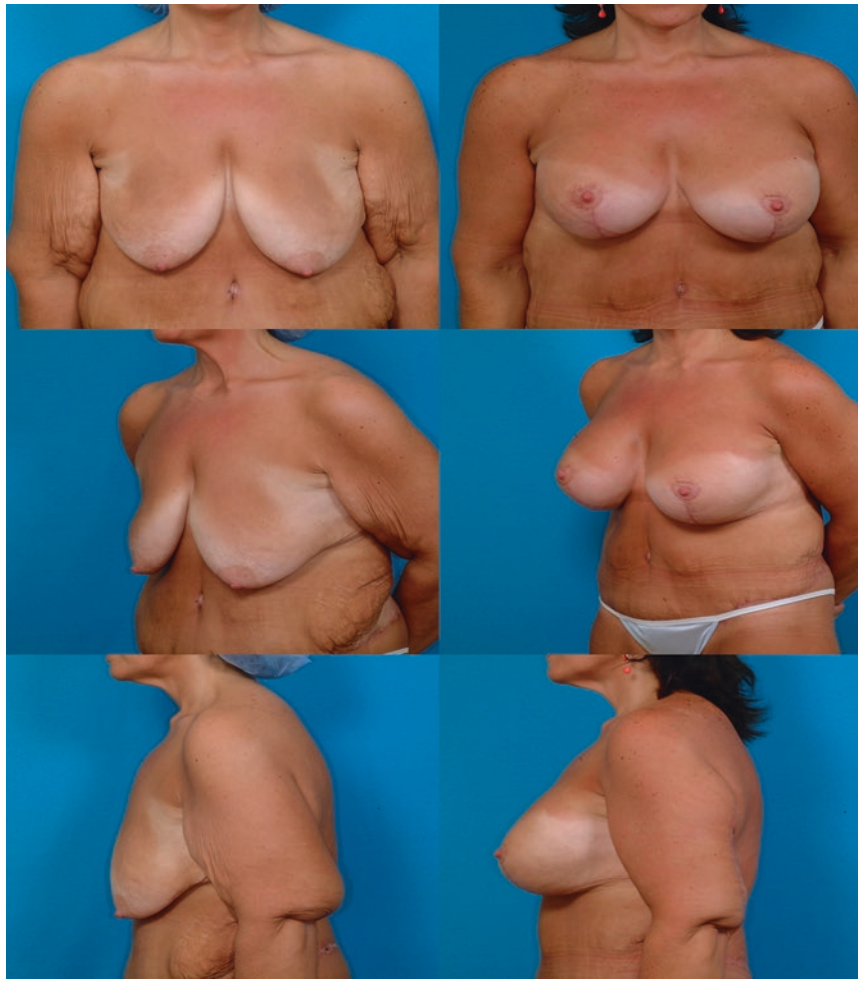

Fig. 7.26 This 42-year-old woman lost 150 pounds after a gastric bypass. She is seen before (*left*) and 7 weeks after (*right*) her second staged reconstruction, which consisted of a vertical augmentation mastopexy, inner thigh lifts, liposuction of the arms, and brachioplasties. At her first stage (3 weeks previously) she had a lower body lift. Smooth, round moderate-profile subpectoral saline implants (Mentor Corp.) were inflated to 550 cc on the right side and 515 cc on the left side

3. Greater tightening of the lower pole and coning of the breast
4. Intraoperative nipple positioning just below the apex of the breast to avoid nipple overelevation

With these adjustments, the need for revisions for persistent ptosis has dropped in half, from 10.3% to 5% for the most recent 100 cases [20]. Adequate parenchymal resection of the lower pole avoids a "mastopexy wrecking

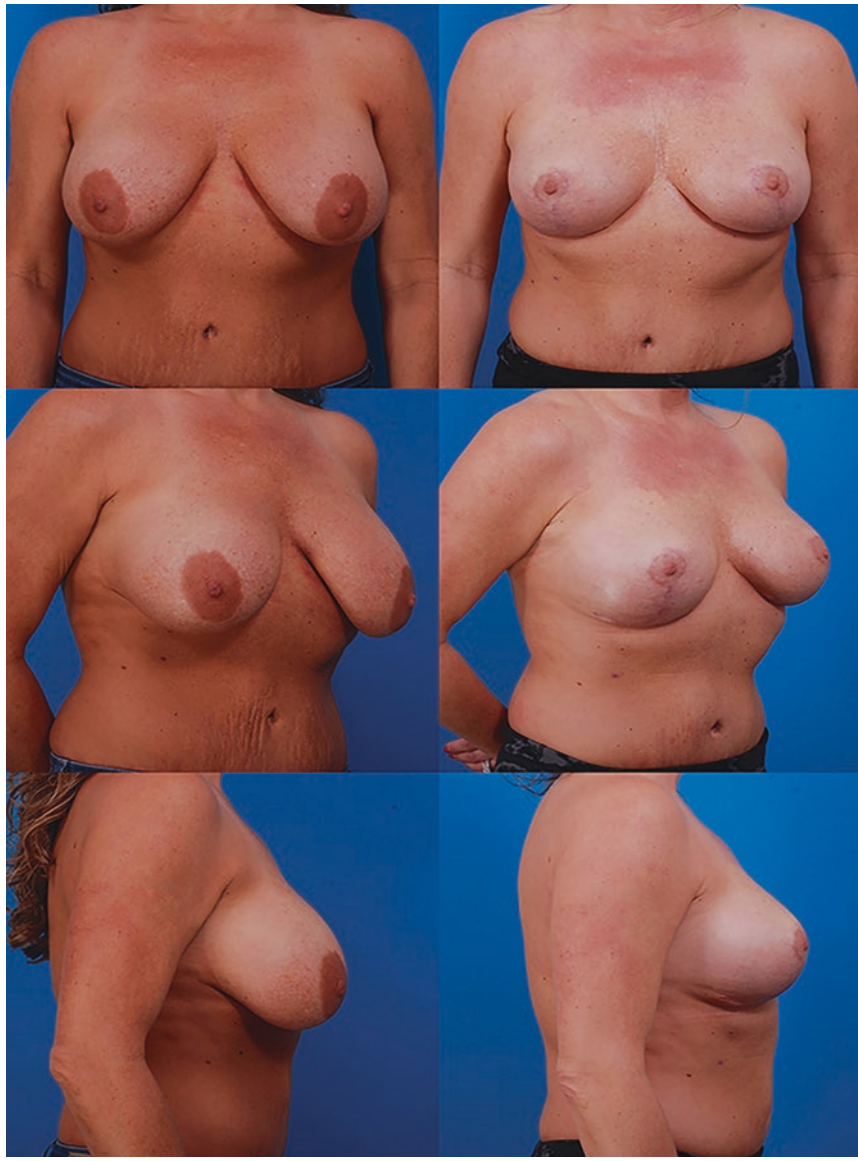

Fig. 7.27 This 43-year-old woman wished to have her existing implants, inserted 10 years previously, replaced with smaller ones. She also wanted her areolae reduced. She is seen before (*left*) and 9 months after (*right*) secondary augmentation mastopexy. Her existing subpectoral 280 cc saline-filled implants were replaced with smooth, round saline implants inflated to 210 cc (Natrelle style 68 midrange profile, Allergan Inc.). Her resection weights were 109 g on each side

bulge" [75] (Fig. 7.29) or a snoopy deformity, characterized by breast tissue that appears to slide off the breast [64].

Importantly, this potent combination is capable of treating a wide variety of presentations, truly an all-seasons operation.

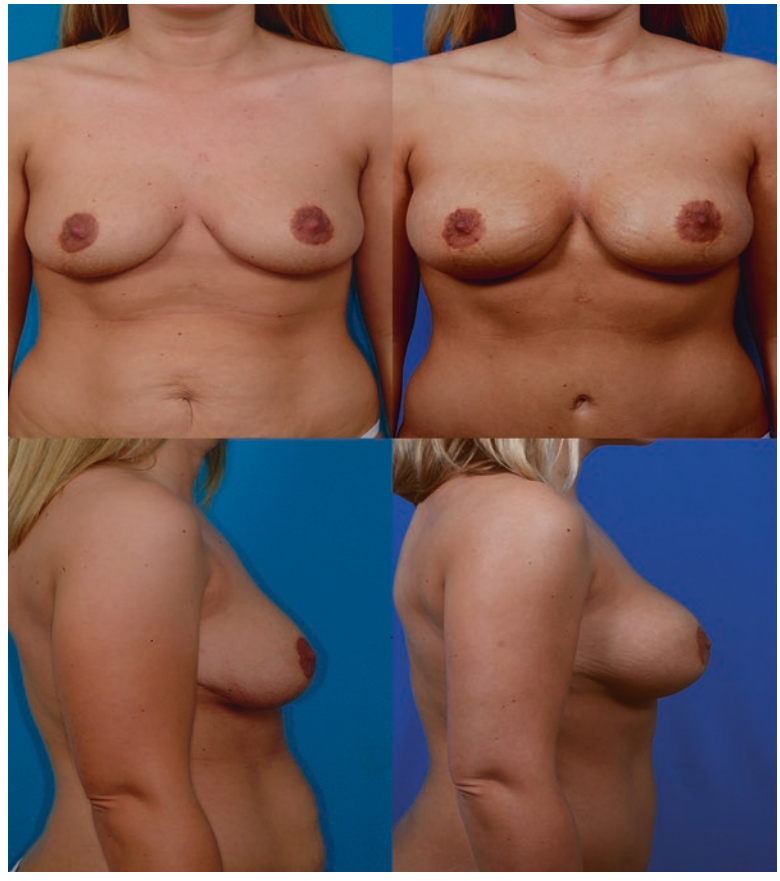

Fig. 7.28 Secondary mastopexy (lower pole only, no periareolar incision) and primary augmentation, combined with liposuction of the lower body and abdominoplasty, in a 28-year-old woman who presented with flat upper poles 4 years after an inverted-T, inferior pedicle reduction. (*Left*) Before and (*right*) 1 year after vertical augmentation mastopexy using subpectoral Mentor moderate plus profile saline-filled implants inflated to 240 cc, resecting 10 g from each lower pole, with no periareolar incision. The existing horizontal scar is shortened, concealing it better within the inframammary crease (Reprinted from Swanson [5]. With permission from Wolters Kluwer Health)

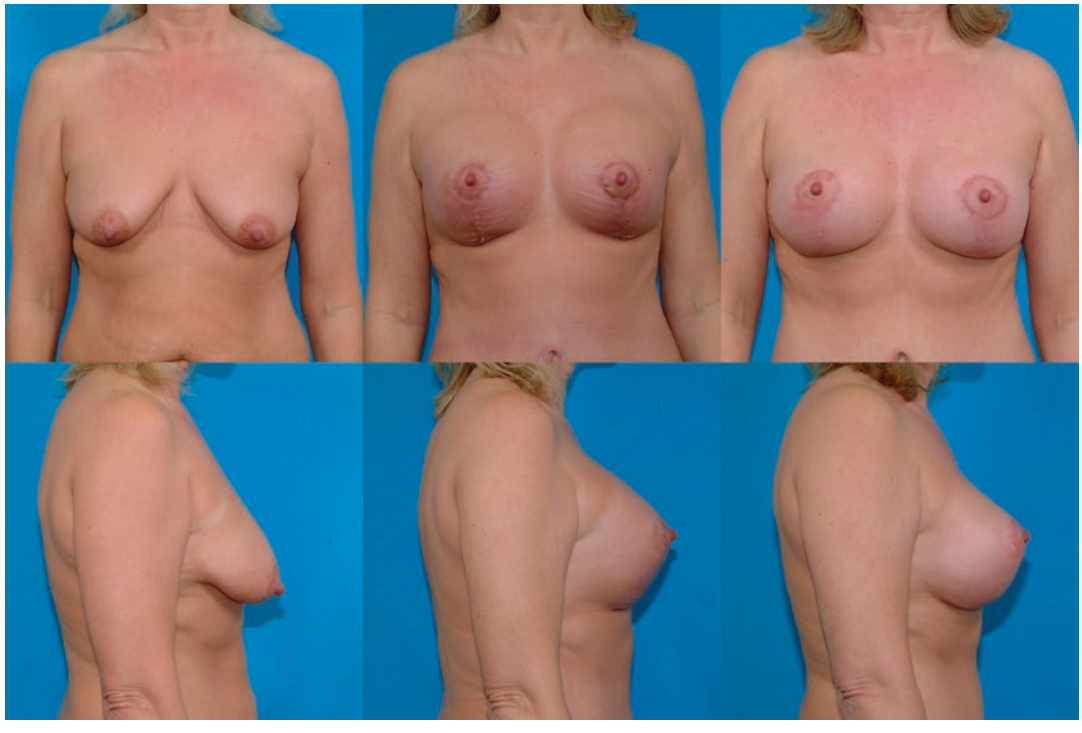

Fig. 7.29 This 46-year-old woman is seen before (*left*), 1 month after (*center*), and 3.5 months after (*right*) an augmentation mastopexy using subpectoral smooth, round saline-filled implants (moderate profile, Mentor Corp.) inflated to 330 cc and no parenchymal resection. She also had an abdominoplasty and liposuction. One month after surgery, she demonstrates the expected and desired upper pole convexity and lower pole flattening. By 3.5 months, the lower pole has dropped (bottomed-out). This deformity is caused by inadequate lower pole parenchymal resection. Persistent ptosis is more likely when a "skin-only" mastopexy is performed

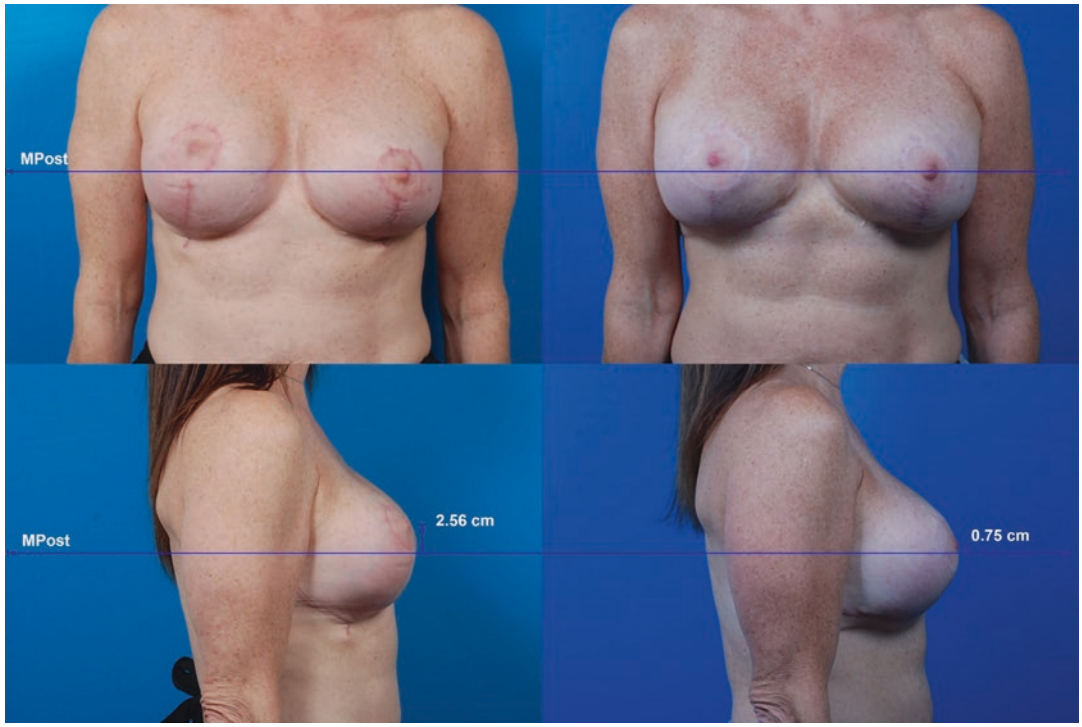

Fig. 7.30 This 51-year-old woman presented with an overelevated right nipple/areola after a secondary vertical mastopexy and implant replacement. She was unhappy with the conspicuous nipple asymmetry, and she also requested greater breast volume and cleavage. She underwent another operation to replace her implants with larger ones, combined with a superior capsulotomy and inferior capsulorrhaphy, and a horizontal inframammary skin resection to pull the right nipple/areola complex down and into better alignment with the breast mound. She is seen before this secondary surgery (*left*) and 8 months after surgery (*right*). The right nipple/areola remains slightly higher than the left, but the patient is satisfied and can now wear her bikini and low-cut tops without feeling self-conscious. Photographs are matched for size and orientation. *MPost* maximum postoperative breast projection (Reprinted from Swanson [69]. With permission from Wolters Kluwer Health)

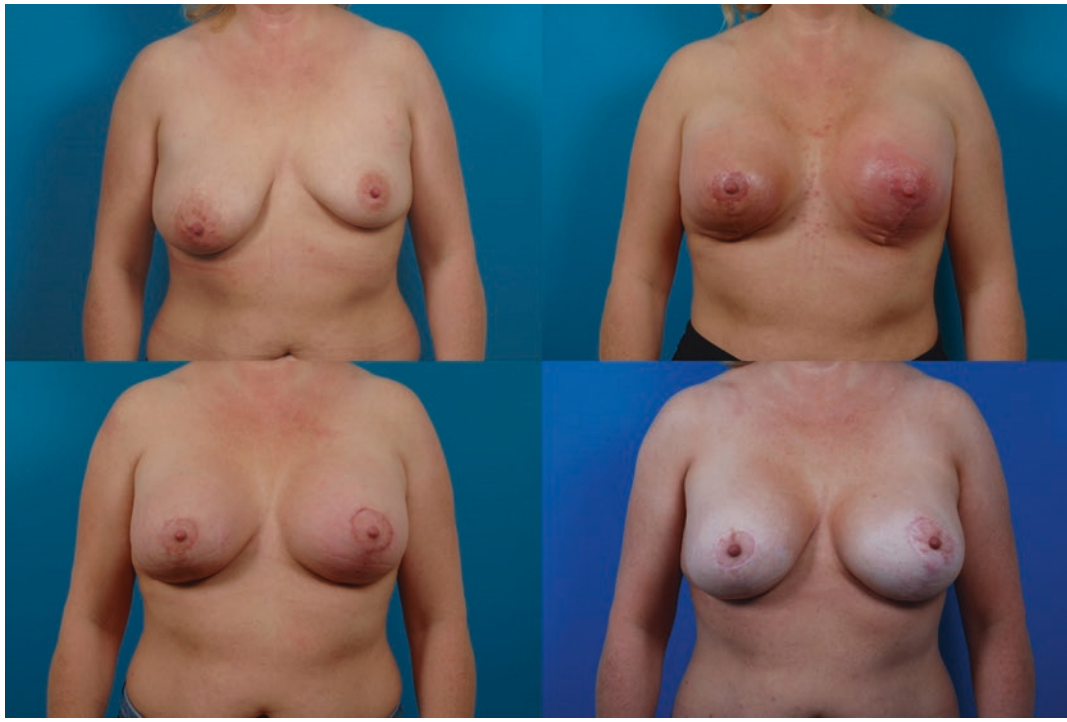

Fig. 7.31 This 46-year-old woman presented with severe asymmetry. Smooth, round moderate plus profile, saline implants (Mentor Corp.) were inserted subpectorally and inflated to 420 cc on the right side and 570 cc on the left side. The resection weights were 434 g from the right breast and 165 g from the left breast. She is seen before surgery (*above, left*), 3 weeks after surgery (*above, right*), 2 months after surgery (*below, left*), and 14 months after surgery (*below, right*). She developed soreness, redness, and a mild fever (99.1 ° F, orally) 3 weeks after surgery. The infection cleared with oral antibiotics. She was left with a small area of scar hypertrophy along her left areola that did not require revision

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Breast Reduction Plus Implants

8

Abstract

Unfortunately, many women after a breast reduction resemble candidates for an augmentation mastopexy because the Wise pattern can leave breasts looking deflated and boxy. A vertical reduction provides a modest boost in breast projection and upper pole projection, and tighter, more circular lower poles than a Wise pattern. Patients prefer the aesthetic result and scars of the vertical technique. In patients who wish to restore upper pole volume, breast implants are most effective.

Originally, a breast reduction was considered a purely functional procedure. Today, expectations are higher and include aesthetic considerations. Numerous studies document the physical benefits of a breast reduction. Fewer publications evaluate the patient's perception of the aesthetic result. Patients readily understand that the goal is still to make their breasts smaller and relieve symptoms. Breast implants can help to restore a more ideal shape to a breast that has been distorted by hypertrophy and gravity.

The surgical approach for a breast reduction plus implants is the same as for an augmentation mastopexy. The procedures are arbitrarily differentiated only by the weight of breast tissue removed (≥300 g from 1 breast). A vertical mammaplasty is performed using a medially based pedicle and intraoperative nipple siting. Breast implants are inserted subpectorally. An inverted-T modification is used when the vertical scar extends below the level of the new inframammary fold.

Upper pole projection is increased approximately 2 cm when implants are used, compared with <1 cm for women who do not have implants. The most common complication is delayed wound healing (25%). After surgery, symptoms of back, shoulder, or neck pain are reported by only 21% of women undergoing breast reduction alone versus 19% of women who also receive implants (difference nonsignificant). The data suggest that implants do not undermine the functional benefit of reduction mammaplasty.

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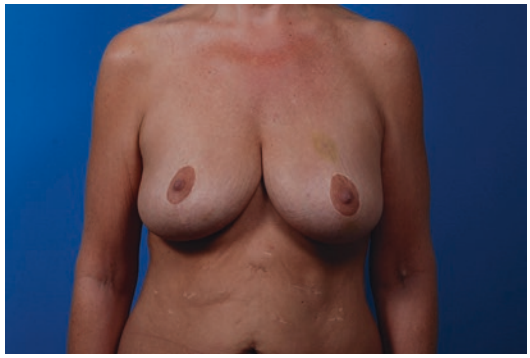

Fig. 8.1 This 52-year-old woman had undergone a previous Wise pattern breast reduction elsewhere. Her breasts appear boxy, with deflated upper poles

Plastic surgeons have observed that many women after a breast reduction resemble candidates for augmentation mastopexy (Fig. 8.1) [1]. This observation is especially true after a Wise pattern inferior pedicle reduction, which typically leaves the breasts looking deflated and boxy [11]. Measurements confirm that an inverted-T (Wise pattern), inferior pedicle mammaplasty does not improve breast projection or upper pole projection [2]. A vertical reduction mammaplasty provides a modest boost in breast projection and upper pole projection (<1 cm), and tighter, more circular lower poles than a Wise pattern [2]. In patients who wish to restore upper pole volume, breast implants are most effective [3]. The author uses the term "breast reduction plus implants" [1, 3] to label this combination, avoiding the possibly confusing term "augmentation reduction."

Combining breast reduction and implants might strike some surgeons as contradictory and even unethical [4]. A growing number of plastic surgeons, however, believe that this combination has a proper place in the plastic surgeon's armamentarium [5]. To learn more about this procedural combination, the author undertook a study to determine its efficacy and safety, and to compare breast measurements and patient-reported outcomes in breast reduction patients treated with and without implants [6]. A breast reduction was defined as removal of ≥300 g of breast tissue from at least one breast [3].

All patients were treated by the same surgeon, at the same facility, using the same operation, and imaged using standardized methods. These factors avoid confounding influences and increase the reliability of the conclusions. For example, if different surgeons treat patients with different operations (a common practice is to use the vertical technique for moderate reductions and a Wise pattern for large ones) [7], it is impossible to exclude the influence of the surgeon and technique. Only by holding these variables constant is it possible to isolate the effect of implants on the surgical result.

It might seem that resecting approximately 369 g of breast tissue and adding approximately 334 cc of volume in the form of an implant (these are the average values from the study) [6] would produce a result similar to a small (i.e., 35 g) mastopexy. However, this is not the case because such a calculation does not take into account the profound changes in proportions of the upper and lower poles, which tend to cancel out when added together. Figure 8.2 depicts such a patient. The morphological changes after a small-volume mastopexy are much less pronounced [3].

Function and Appearance

Originally, a breast reduction was considered a functional procedure, meant to reduce breast mass and elevate the nipple position. These goals were achieved by the 1920s [8–10]. Today, expectations are higher and include aesthetic considerations [11]. Patients having breast reduction are concerned about their symptoms, but the majority quite understandably wish to improve their breast appearance as well [11]. Numerous studies document the physical benefits of a breast reduction [11]. Fewer publications evaluate the patient's perception of the aesthetic result [11]. Patients consistently prefer the aesthetic result and scars of the vertical technique [12–15]. Surgeons [16–18] are aware of the flattening, boxiness, and bottoming-out that can be apparent after breast reduction. These observations have been confirmed with measurements [2, 19].

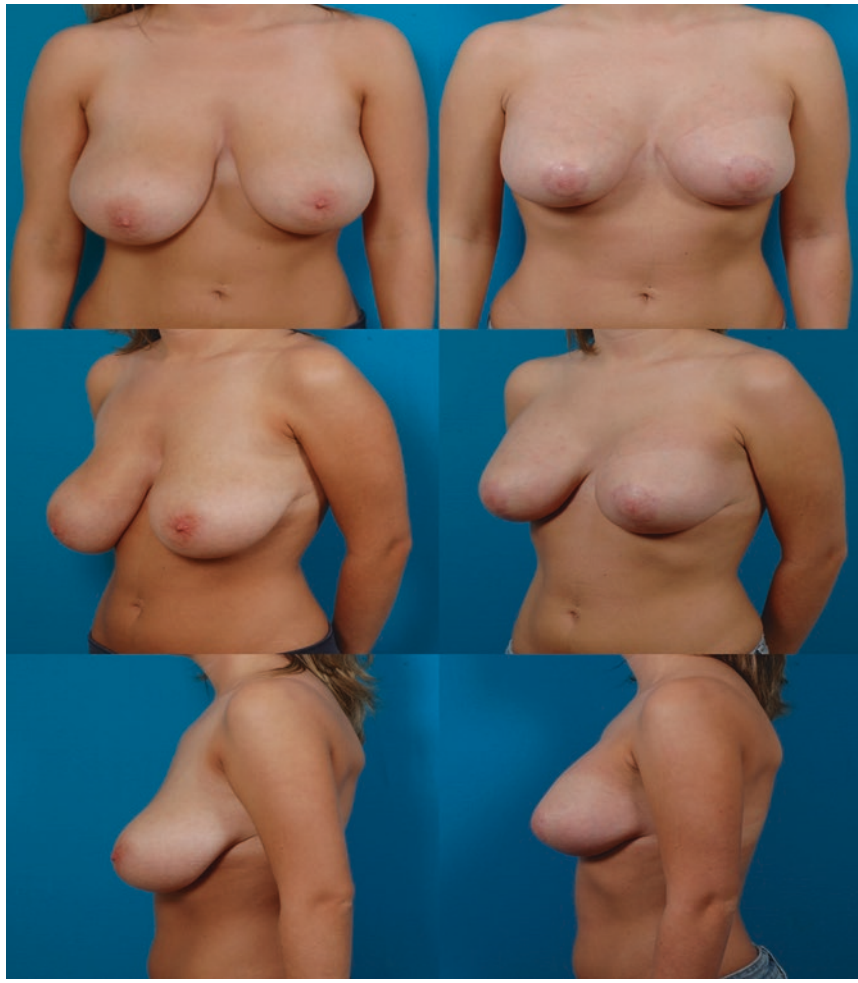

Fig. 8.2 This 23-year-old was aware of her asymmetry. She wanted to feel comfortable wearing a bikini. She is seen before (*left*) and 3 months after (*right*) a breast reduction plus implants. The same implant size was used for both breasts, a smooth, round moderate plus profile 240 cc saline implant (Mentor Corp.). The resection weights were 466 g on the right side and 314 g on the left side

Surgery

The surgical approach for a breast reduction plus implants is the same as for an augmentation mastopexy. The procedures are arbitrarily differentiated only by the weight of breast tissue removed. A vertical mammaplasty is performed using a medially based pedicle [16] and intraoperative nipple siting [1–3]. A mosque-dome or keyhole preoperative pattern is not used. Breast implants are inserted subpectorally, although some surgeons may prefer a prepectoral plane. A vertical resection is performed (Fig. 8.3). The nipple/areola site is determined after creation of the new breast mound. An inverted-T modification is used in patients in whom the vertical scar extends below the level of the new inframammary fold (Fig. 8.3).

Surgery is performed on outpatients in a state-licensed ambulatory surgery center using total "SAFE" (*s*pontaneous breathing, *a*void gas, *f*ace

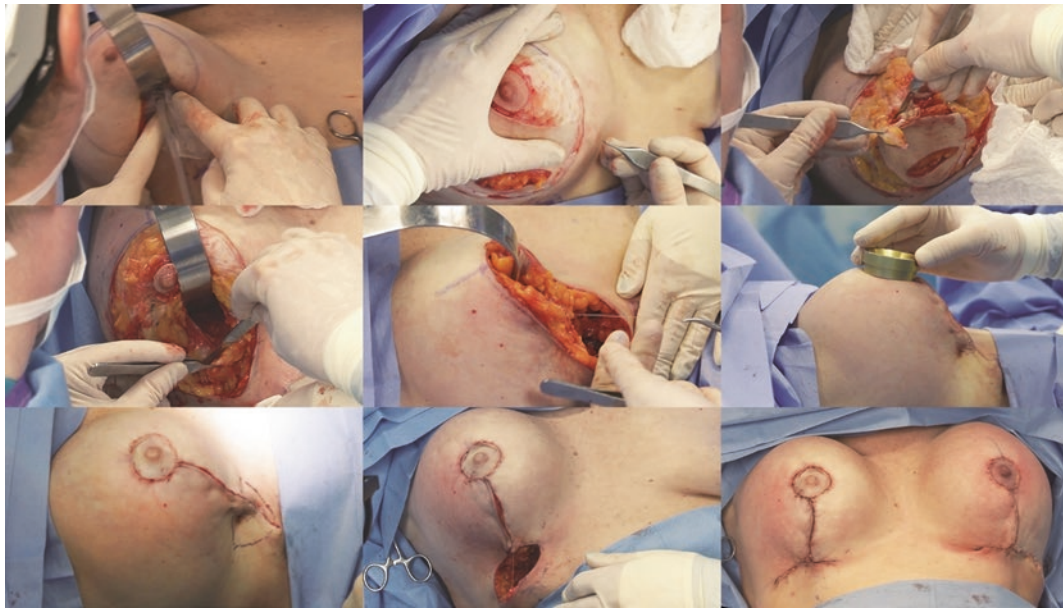

Fig. 8.3 Intraoperative photographs in a 52-year-old woman showing subpectoral insertion of a saline implant, inflated to 270 cc (*above, left*), medial pedicle dissection (*above, center*), lower pole resection (*above, right*), inferior pole resection (*center, left*) pillar approximation (*center*), and lateral view of nipple siting (*center, right*). This patient's inframammary fold was raised approximately 2.5 cm by the vertical mammaplasty, leaving the inferior portion of the wound below the level of the new inframammary fold (*below, left*). Accordingly, the inferior dog ear is revised using a short inverted-T modification so as not to be visible below the crease (*below, center*). She is seen after skin closure (*below, right*)

up, *e*xtremities mobile) intravenous anesthesia [20]. No muscle relaxation is used so as to preserve the calf muscle pump [21]. Patients are also monitored for venous thromboembolism using ultrasound surveillance as part of a clinical trial in progress [22]. The mean operating time for a vertical breast reduction is 2 h [6]. Simultaneous implant insertion adds only 18 min of operating time, on average [6]. The same synergistic advantages for augmentation mastopexy (compared with either operation performed individually) are available for this combination [1]. Videos demonstrating this combined procedure are available at the *Plastic and Reconstructive Surgery Global Open* website: http://journals.lww.com/prsgo/Pages/videogallery.aspx?videoId=23&autoPlay=true. The videos include preoperative marking, details of the surgery and anesthesia, and follow-up 24 h after surgery.

Measurements

Breast area, measured on lateral photographs (a surrogate for volume), decreases despite the use of implants [6]. Not surprisingly, the upper pole area is increased to a greater extent than in women who do not receive implants. A vertical breast reduction increases breast projection and upper pole projection even without implants. However, upper pole projection is increased approximately 2 cm when implants are used, compared with <1 cm for women who do not have implants [6].

Upper pole projection is increased approximately 2 cm when implants are used, compared with <1 cm for women who do not have implants.

A vertical reduction, with or without implants, reduces the lower pole area and elevates the lower pole level, reflecting the fact that the lower pole resection is the same regardless of whether implants are used [6]. The lower pole ratio is defined as the lower pole width divided by lower pole length (height) and is an indicator of the boxiness of the lower poles [23]. Values exceeding 2.0 start to appear boxy; values <2.0 appear conical. The overall mean lower pole ratio after a vertical breast reduction is 2.0 cm, with or without implants [6].

Other breast parameters changes are similar in vertical reduction patients treated with or without implants. The breast parenchymal ratio is defined as the upper pole area divided by the lower pole area, and is a measure of the "perkiness" of the breast [23]. The breast parenchymal ratio increases mostly because of the substantial reduction of lower pole area. Breast mound elevation represents the vertical change in position of the most projecting point on the breast [23]. The breast mound is effectively elevated. Before surgery, areola diameters average about 7.0 cm in diameter in women with hypertrophic breasts. These diameters are reduced to 4.7 cm after surgery. Nipple displacement is defined as the vertical distance between the nipple position and the level of the apex of the breast [23]. The nipple is (nonideally) overelevated approximately 0.6 cm after surgery (Fig. 8.4) [6].

Clinical Example

Before-and-after photographs and measurements for a typical patient are provided in Fig. 8.5.

Complications

The overall complication rate is approximately 50%, with no significant difference between patients undergoing breast reduction alone and breast reduction plus implants [6]. A complication rate of 50% ordinarily might be considered excessive. However, this complication rate includes appearance considerations, such as asymmetry, persistent ptosis, and suboptimal scars. These problems are common after reduction mammaplasty [1]. If such aesthetic issues are not included, the complication rate drops in half, to 25%. Other series reporting lower complication rates may not include such aesthetic concerns [24, 25].

In the author's study, the most common complication was delayed wound healing in 6 patients (25%). One woman (4.2%) who underwent a breast reduction plus implants underwent secondary surgery for persistent ptosis. There were no seromas or hematomas in women having a breast reduction plus implants. No patient returned to have her breast implants removed. One patient with asymmetry returned to have one breast implant replaced with a larger size. There were no breast implant-related complications, although the follow-up time was short (mean, 5.6 months).

Survey Responses

Pain ratings are slightly greater for patients who have implants (5.6 versus 4.8 for women without implants, on a scale of 1–10), but the difference is nonsignificant. There is no significant difference in reported nipple numbness. Almost all women (93.8%) are self-conscious of their breast appearance before surgery; 31.2% are self-conscious after surgery – values almost identical for breast reduction alone. All patients would repeat the surgery or recommend it to someone else. The mean result rating is 8.6 on a scale of 1–10 (range, 6–10). All surveyed patients who elected to have implants reported that they were pleased with their decision to have implants. An improvement in self-esteem was reported by 87.5% of women. An improved quality of life was reported by 80% of patients.

Improving Breast Shape

Historically, the surgeon's focus has been on nipple position [26]. Less importance has been given to the relative contributions and contours

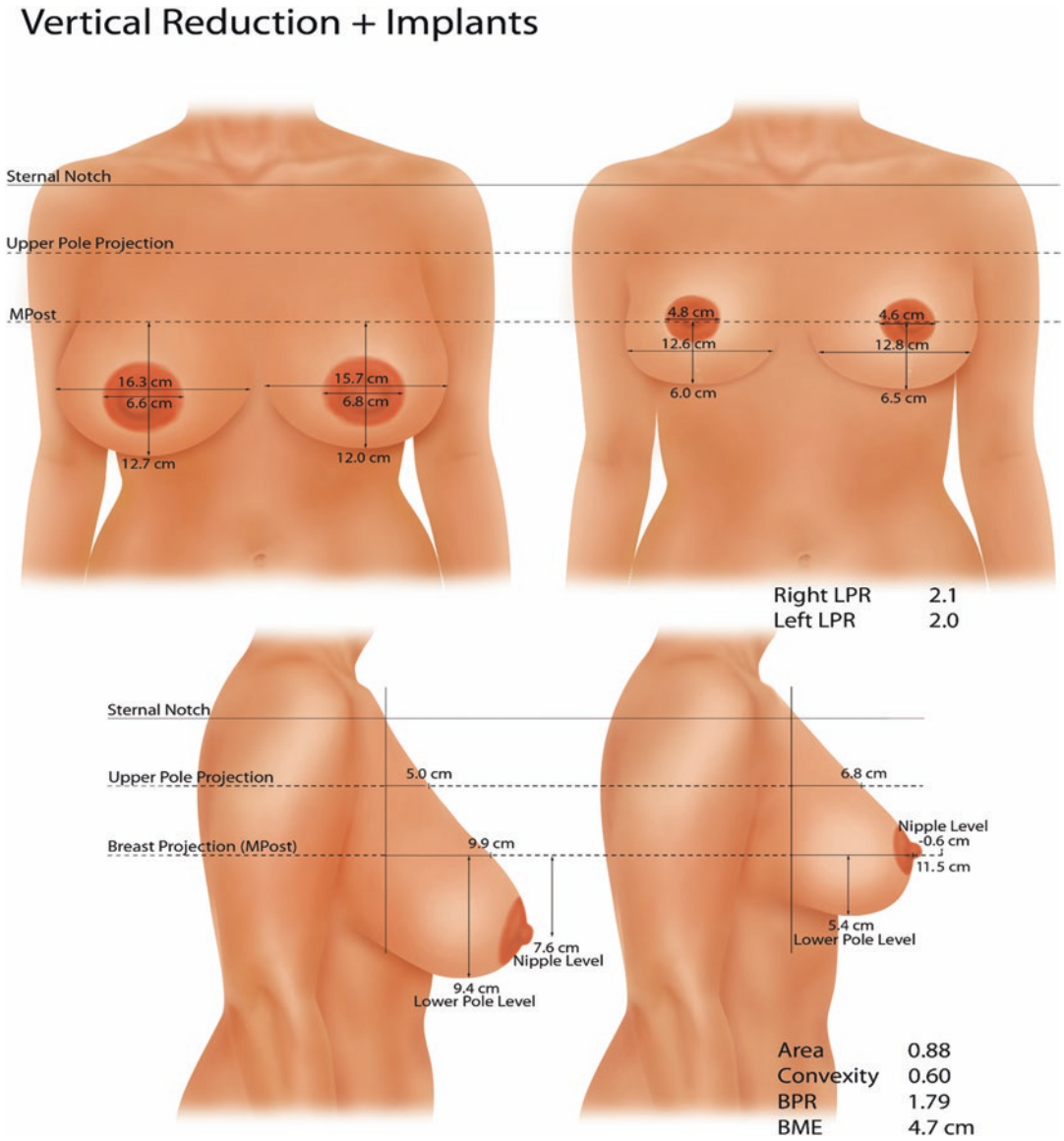

Fig. 8.4 This mammograph provides a two-dimensional rendering of the mean breast measurements for all patients undergoing a breast reduction plus implants. The frontal views (*above*) demonstrate nonboxy lower poles. The areolae are reduced in size. The lateral views (*below*) show a 12% reduction in total breast area. There is a greater increase in breast projection (1.6 cm) and upper pole projection (1.8 cm) compared with breast reduction alone. The breast parenchymal ratio is favorable (i.e., >1.5). The nipple is slightly overelevated (0.6 cm above the apex). *MPost* maximum postoperative breast projection, *LPR* lower pole ratio, *BPR* breast parenchymal ratio, *BME* breast mound elevation (Reprinted from Swanson [6]. With permission from Wolters Kluwer Health)

of the upper and lower poles. Lateral photographs reveal that a breast reduction typically produces a linear or even concave upper pole contour [2, 19]. Most women prefer convexity of the upper pole [27], which is the appearance produced by bras. Only breast implants are capable of providing a substantial boost in upper pole projection [3]. To provide the illusion of a breast lift (i.e., vertical movement of the breast on the chest wall), a lower pole reduction and upper pole

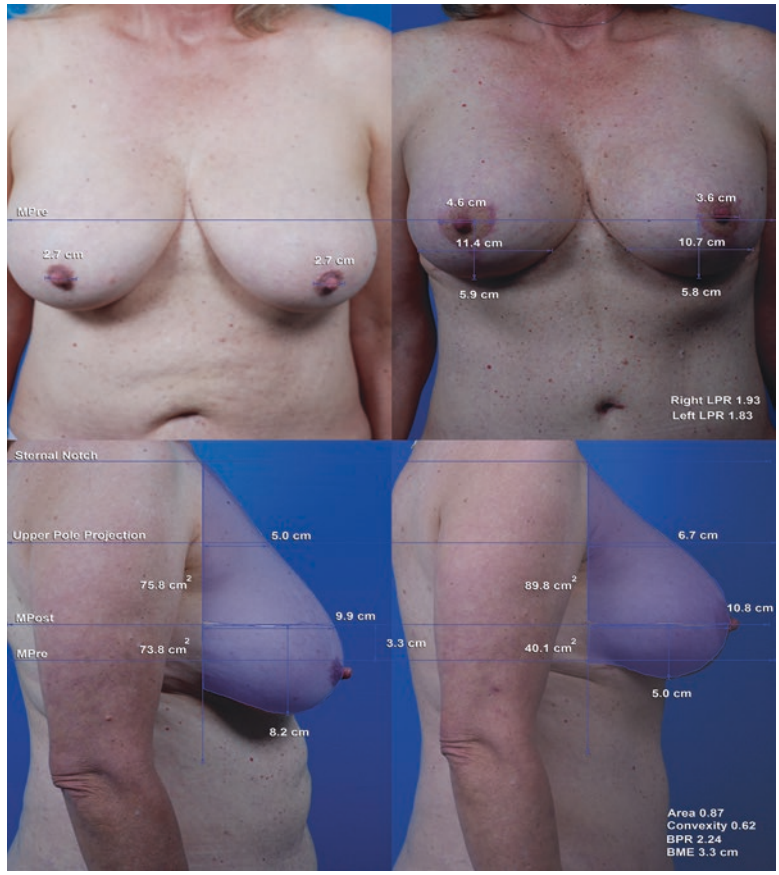

Fig. 8.5 This 59-year-old woman is seen before (*left*) and 9 months after (*right*) a breast reduction plus implants. The resection weights were 293 g from the right breast and 309 g from the left breast. Smooth, round saline-filled breast implants (Natrelle 68MP, Allergan Corp. Irvine, Calif.) were inserted submuscularly on both sides and inflated to 270 cc. The frontal views (*above*) demonstrate nonboxy lower pole ratios (LPRs), measuring <2.0 on both sides. The lateral views (*below*) reveal a boost in breast projection (0.9 cm) and upper pole projection (1.7 cm). The lower pole level and breast mound are elevated. The upper pole contour has changed from linear to convex. The patient had a simultaneous abdominoplasty and liposuction of the abdomen and flanks. The photographs have been matched for size and orientation using the Canfield Mirror 7.1.1 software (Canfield Scientific, Fairfield, NJ) *MPost* maximum postoperative breast projection, *MPre* maximum preoperative breast projection, *BPR* breast parenchymal ratio, *BME* breast mound elevation (Reprinted from Swanson [6]. With permission from Wolters Kluwer Health)

augmentation are needed [1, 3]. This concept was first described as "minus-plus" in reference to augmentation mastopexy by Regnault et al. [28]. If a patient takes her breasts in the cups of her hands and lifts up, she is interested in such breast remodeling [3].

Prospective patients need to know that a breast reduction will effectively reduce breast size and eliminate the lower pole excess, but this procedure alone will not fill out the upper pole or create convexity [3]. For many women (70% in the author's study [6]), such an outcome is acceptable. These patients may be satisfied that this shape can be produced by bras, or they simply wish to avoid implants or additional cost. However, there are also women (30%) who want more perkiness and it is best that they are informed of their options. Patients readily understand that the

goal is still to make their breasts smaller and that this "icing on the cake" option is available to restore a more ideal shape to a breast that has been distorted by hypertrophy and gravity.

Patients readily understand that the goal is still to make their breasts smaller and that this "icing on the cake" option is available to restore a more ideal shape to a breast that has been distorted by hypertrophy and gravity.

Functional Benefit

It is reasonable to ask whether the use of implants compromises the functional benefit of a breast reduction. On a first-principles basis, one might assume that a resection of 500 g and insertion of a 300 cc implant is functionally equivalent to a 200 g mammaplasty [4]. This intuitive argument assumes that only total breast mass, and not its distribution, is relevant to symptoms. Surprisingly, Thoma et al. [29] reported that relatively small breast reductions (<400 g per breast) often alleviate symptoms and the resection weight is not significantly related to quality-of-life improvement. These authors concluded that not just size but an unfavorable tissue distribution (i.e., glandular ptosis) may contribute to symptoms [29]. Subsequent outcome studies reveal that patients with resection weights <375 g per breast [30] and even <300 g per breast [11] often experience physical symptoms that are relieved by surgery. Most patients (56.3%) who elect to have implants at the time of breast reduction also experience physical symptoms [6]. After surgery, symptoms of back, shoulder, or neck pain are reported by only 21.1% of women undergoing breast reduction alone and 18.8% of women who also received implants (difference nonsignificant) [6]. Among women having breast reduction plus implants, 81.3% report difficulty exercising before surgery; none report difficulty exercising after surgery. The data suggest that implants do not undermine the functional benefit of reduction mammaplasty [6].

Safety

Pressure on an inferior pedicle might tip the balance to nipple ischemia [1]. A vertical mammaplasty that incorporates a medially based pedicle avoids additional tension or pressure on the pedicle caused by an implant [1]. The base of a medial pedicle is mobile and rides up with the breast mound as the vertical ellipse is approximated [1–3]. By contrast, the base of an inferior pedicle remains fixed at the inframammary fold [1–3]. A medially based pedicle is much shorter and has a more reliable blood supply than an inferior pedicle [2], making it safer when an implant is used [1]. The "minus-plus" [28] combination of a vertical mammaplasty and implants is synergistic [1]. The often-repeated concern [1, 31] that a mammaplasty and implant work at cross-purposes relates to the deficiencies of the Wise pattern technique [1]. Breast reduction plus implants deserves a place in the plastic surgeon's armamentarium.

The often-repeated concern [1, 31] that a mammaplasty and implant work at cross-purposes relates to the deficiencies of the Wise pattern technique.

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Gynecomastia Surgery

9

Abstract

Adolescent gynecomastia can severely affect self-esteem. The cause is usually idiopathic. Anabolic steroids or dietary supplements are commonly implicated in bodybuilders. Gynecomastia can start with puberty, resolving on its own in most cases, or develop in older men as the balance of circulating testosterone and estrogens shifts toward estrogens.

Ultrasound or power-assisted liposuction is advantageous in removing fatty tissue from the breast. Many men having liposuction of the abdomen and flanks will also have the chest treated simultaneously. These patients may be satisfied with an improvement, if not correction, of their gynecomastia.

A combination of liposuction and direct excision is widely applicable. The traditional approach is periareolar because the scar is usually inconspicuous. A pad of breast tissue is preserved directly under the nipple/areola to prevent a depression deformity. Young men who have dense breast tissue or adolescent obesity, patients who present specifically for treatment of gynecomastia rather than an adjunct procedure done at the time of liposuction of the trunk, and bodybuilders are best served with a one-stage combination of liposuction and direct excision.

In cases of severe skin laxity (e.g., after massive weight loss), skin resection may be unavoidable. Nipple grafts are debilitating to this unique body part, and correct nipple siting can be a challenge. Just as in female breast reduction, nipples are best maintained on well-vascularized pedicles. This procedure is done no differently from a vertical breast reduction in a woman except that maximum breast tissue is removed.

Hematomas do occur. Over-resection is a common error, and can leave an unnatural saucer-like contour deformity. Fat injection may be used to treat contour depressions.

E. Swanson, *Evidence-Based Cosmetic Breast Surgery*, DOI 10.1007/978-3-319-53958-4_9

Gynecomastia, the enlargement of male breasts, is a common condition, affecting about one-third of males overall, and an even larger percentage of adolescent boys and men older than 65 years [1]. Men feel self-conscious without a shirt and, in severe cases, even with a shirt on. Adolescent gynecomastia can severely affect self-esteem and even sexual identity [2].

Adolescent gynecomastia can severely affect self-esteem and even sexual identity.

Etiology

The cause is usually idiopathic [1]. Gynecomastia can start with puberty, resolving on its own in most cases [1], or develop in older men as the balance of circulating testosterone and estrogens shifts toward the latter [1, 3].

Pathologic gynecomastia may be caused by medications such as antiandrogens, exogenous hormones, cardiovascular medications such as digoxin and spironolactone, and antiulcer medications such as cimetidine and ranitidine [3]. Chronic alcoholics and men who use anabolic steroids as part of a bodybuilding program are more likely to develop this condition. Certain hormonal abnormalities, inherited or acquired, usually involving either a deficiency of testosterone or an excess of estrogen, can cause breast enlargement. Other causes include thyroid abnormalities, renal failure, liver disorders such as alcoholic cirrhosis. In rare cases gynecomastia may be cause by an estrogen-producing tumor [1].

Surgical treatment addresses excess volume and, when needed, excess skin [4]. Ideally, surgical correction should allow a man to expose his chest without feeling self-conscious. Scars need to be kept to a minimum so as not to exchange one cosmetic flaw for another. Even if the skin is not optimally tight, this is a normal consequence of aging, and preferable to an operated-on appearance.

Scars need to be kept to a minimum so as not to exchange one cosmetic flaw for another.

Liposuction

Ultrasound-assisted or power-assisted liposuction is advantageous in removing dense adipose tissue from within the fibrous parenchymal framework of the breast [4, 5]. Many men having liposuction of the abdomen and flanks will also have the chest treated simultaneously if it is offered to them and the price increment is not prohibitive. These patients may be satisfied with an improvement, if not correction of their gynecomastia. Because gynecomastia is not their presenting concern, an improvement without necessarily a correction is welcome (Fig. 9.1). I tell patients to expect about a 30–40% reduction from liposuction alone. If they desire a "flat" chest, liposuction alone may not suffice.

Liposuction is performed under total intravenous anesthesia, laryngeal mask, airway, and no paralysis. The chest is first infiltrated with a wetting solution of normal saline with 0.05% lidocaine and 1:500,000 epinephrine. Typically, 200–300 cc of solution is infused per side through inframammary incisions. Both sides are infused along with the abdomen and flanks if treated simultaneously. After infusion of all areas to be treated, ultrasonic liposuction (Lysonix 3000, Mentor Corp.) is performed using the same incisions in the same sequence to allow time for the local anesthesia and epinephrine to take effect. In many cases the patient is turned onto each side during surgery and the axilla and lateral breast are treated from the same axillary incision (simultaneously with the flanks in many men). Patients are never turned prone.

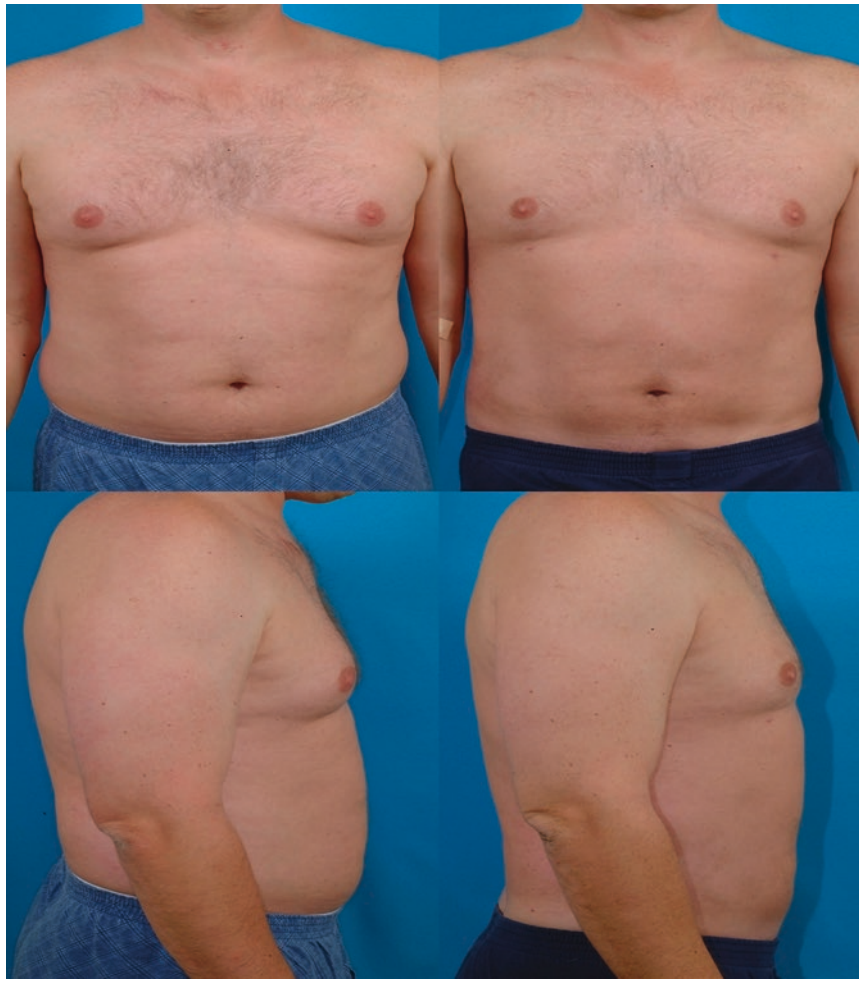

Fig. 9.1 This 41-year-old man elected to have his chest treated along with his midsection. He is seen before (*left*) and 3 months after (*right*) ultrasonic liposuction of the abdomen, flanks, breasts, and axillae. The right breast liposuction volume was 200 cc and the left breast aspirate volume was 250 cc. The inframammary incisions are small and inconspicuous. He also has an incision in each axilla

Liposuction and Direct Excision

A combination of liposuction and direct excision is widely applicable (Fig. 9.2). The traditional approach for direct excision is periareolar because the scar is usually inconspicuous [4]. A pad of breast tissue is preserved directly under the nipple/areola to prevent a depression deformity [4]. Additional local anesthesia may be injected (0.5% lidocaine, 1:200,000 epinephrine) to supplement the wetting solution.

The pull-through method [4–6] is a popular alternative because only one inframammary incision is needed. Liposuction with ultrasonic or power assistance is performed first [5]. Next, breast tissue deep to the nipple/areola and from other areas of the breast is pulled through the opening and blindly excised using tendon tunnel forceps or scissors introduced through the wound [5]. Lista and Ahmad [5] recommend that patients wear a compression garment for 6 weeks [5]. A drawback is that the incision needs to be a little longer than a standard liposuction incision. In some cases a periareolar incision is still needed to remove resistant fibroglandular tissue deep to the areola [5].

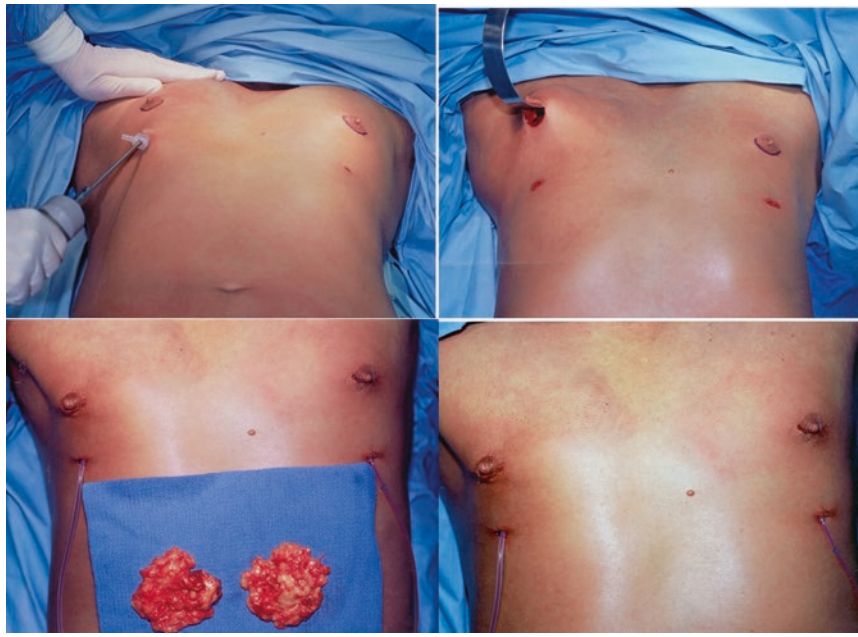

Fig. 9.2 Ultrasonic liposuction is used first (Lysonix 3000, Mentor Corp.) to remove fatty tissue (*above, left*). Breast tissue is removed by direct excision through a periareolar incision (*above, right*). The resected breast tissue is composed of firm glandular tissue and fat (*below, left*). Drains exit the inframammary liposuction access incisions (*below, right*) and are left in place for 3–4 days

Young men who have dense breast tissue (Figs. 9.3 and 9.4), adolescent obesity (Fig. 9.5), patients who present specifically for treatment of gynecomastia (Figs. 9.6 and 9.7) rather than an adjunct procedure done at the time of liposuction of the trunk, and bodybuilders (Fig. 9.8) are best served with a one-stage combination of liposuction (done first), followed by direct excision. Care is taken to make the incision exactly along the inferior areola border [4] and not to traumatize the wound during surgery so as to optimize scar quality (Fig. 9.9).

Obesity

Obesity can produce fatty gynecomastia in adolescents, and is not necessarily a contraindication to surgery in view of the psychological effects of the condition [4].

Fitness Enthusiast/Bodybuilder

Competitive bodybuilders have a higher bar to achieve in physical appearance, so even degrees of gynecomastia can be distressing (Fig. 9.7) [7]. Gynecomastia in bodybuilders is generally related to anabolic steroid use or over-the-counter hormones [7]. In very lean patients with breast buds, direct periareolar excision alone, without liposuction, may suffice [4, 7]. Liposuction alone is unlikely to fragment the firm breast bud [4].

Secondary Surgery

Persistent breast tissue is common and usually managed using the same principles (Fig. 9.10), although skin resections may be indicated [4].

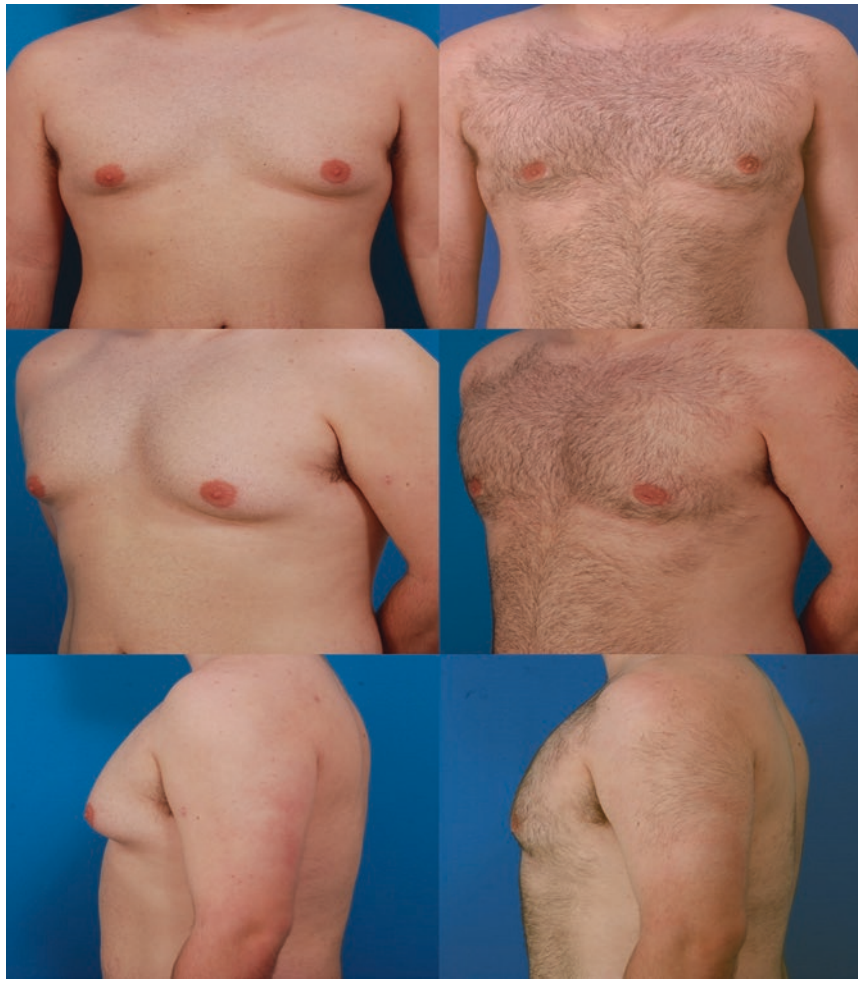

Fig. 9.3 This 18-year-old man is seen before (*left*) and 6 months after (*right*) liposuction of the breasts and axillae (175 cc per side) and direct breast tissue excision (right, 95 g; left, 102 g)

Breast Reduction with Skin Resection

In cases of severe skin laxity (Fig. 9.11), skin resection may be unavoidable [4]. Although some operators use nipple grafts [8], this procedure is debilitating to this unique body part. Nipple grafts leave the nipples insensate and may be complicated by partial necrosis, flatness, and depigmentation. Correct nipple siting can be a challenge [8]. Just as in female breast reduction, nipples are preferably maintained on well-vascularized pedicles. This procedure is done no differently than a vertical breast reduction in a woman except that maximum breast tissue removal is performed. A disadvantage is the vertical scar, although the scar usually becomes inconspicuous over time and the trade-off remains a very positive one for this distressing condition.

Nipple grafts leave the nipples insensate and may be complicated by partial necrosis, flatness, and depigmentation. Correct nipple siting can be a challenge.

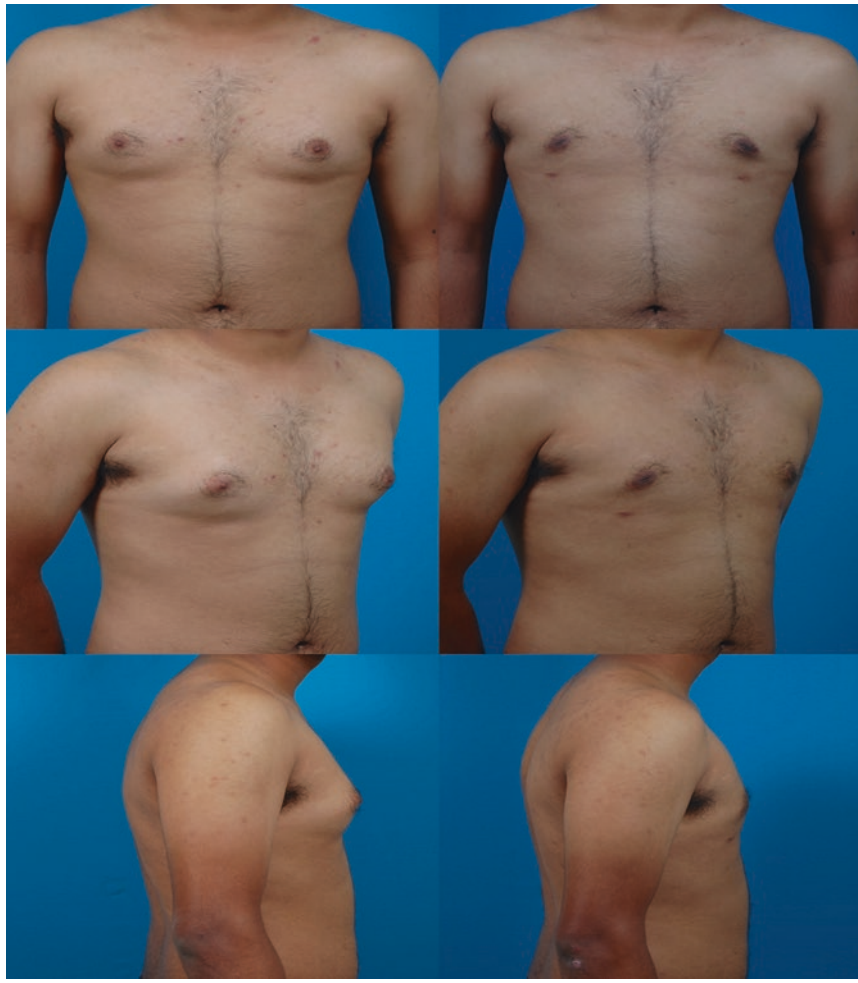

Fig. 9.4 This 18-year-old Indian-American man is seen before (*left*) and 2 months after (*right*) liposuction of the breasts (150 cc per side) and direct breast tissue excision (right, 47 g; left, 53 g)

Hammond [4] combines circumvertical and a horizontal axillary extension in cases of severe skin laxity. Hurwitz [9] uses a "boomerang" technique to remove both extra breast skin and loose axillary skin, called a lateral torsoplasty, in massive weight loss patients, usually in combination with lower body lifts (i.e., a "total body lift"). Greater skin tightening is achieved but at the expense of greater scarring.

Breast Reduction in the Transgender Patient

In young patients, skin contraction can be quite impressive (Fig. 9.12). In older patients with pendulous breasts a vertical reduction may be needed.

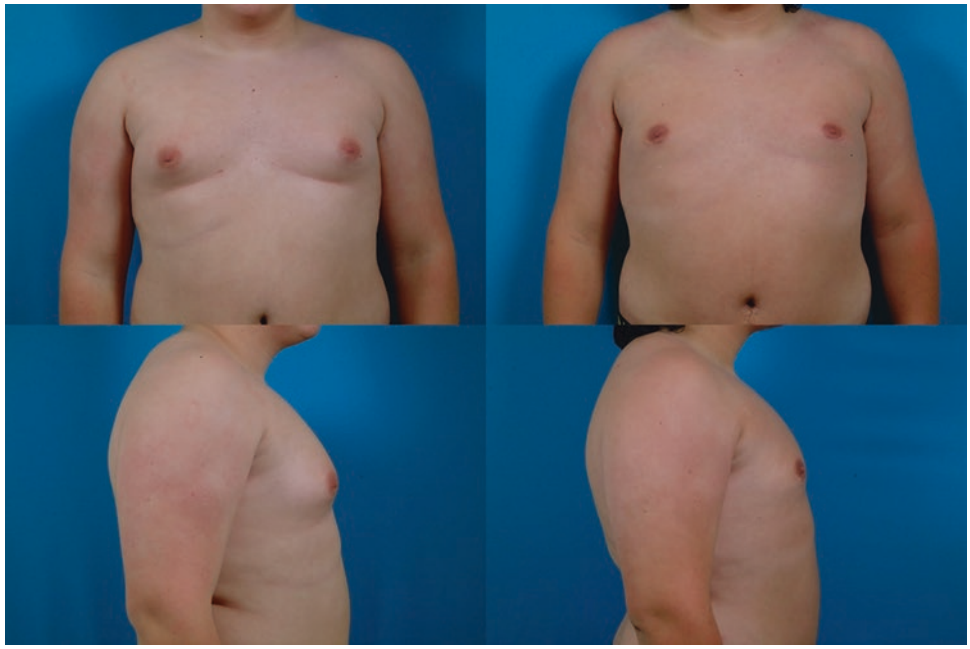

Fig. 9.5 This 15-year-old's self-confidence improved dramatically after treatment. He is seen before (*left*) and after (*right*) liposuction (right breast, 175 cc; left breast, 225 cc) and direct excision of breast tissue (right breast, 87 g; left breast, 90 g)

Complications

Hematoma

Because subcutaneous mastectomies involve sharp dissection of breast tissues and creation of a dead space where fluid can collect, hematomas occur. The incidence is in the range of 6.0–13% [7]. Although many surgeons use drains, the efficacy is questionable [5], as is evident in Fig. 9.13.

Seromas

Seromas are simply treated with 1–3 aspirations in the office [7].

Over-resection

Over-resection is a common error [10] and can leave an unnatural saucer-like contour deformity. Fat injection may be used to treat contour depressions.

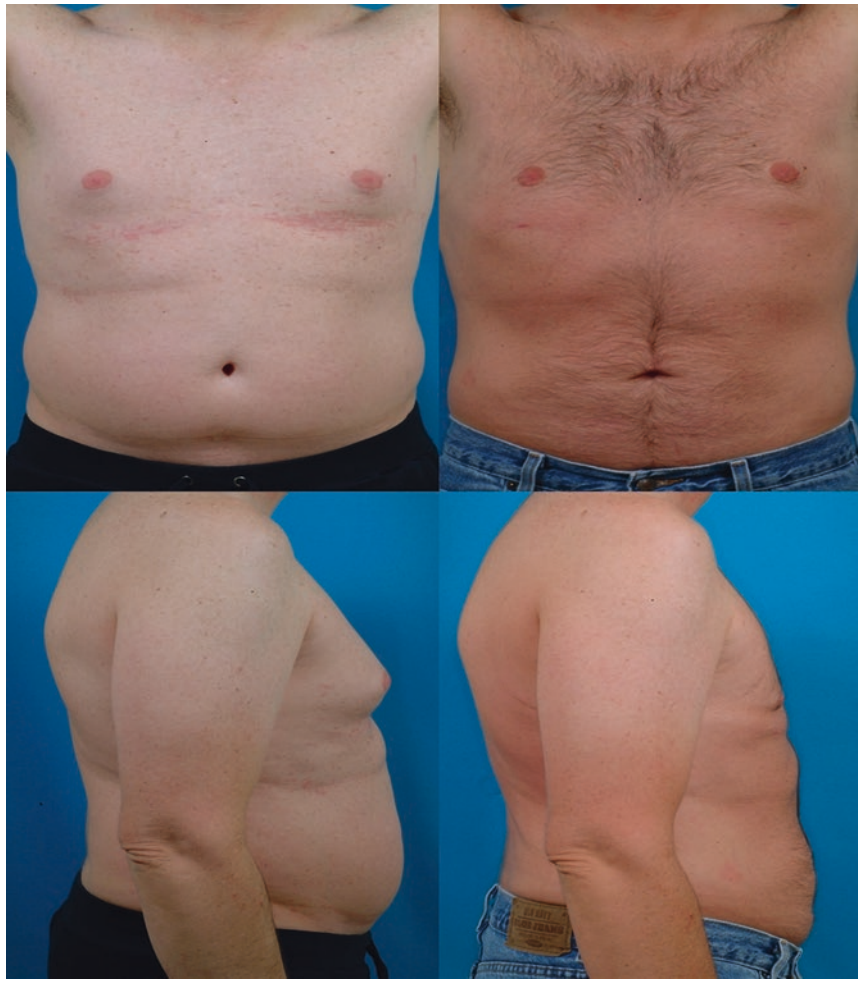

Fig. 9.6 This 40-year-old man underwent liposuction of his breasts (right, 200 cc; left, 200 cc), abdomen, and flanks. The weight of breast tissue removed by direct excision was 52 g on the right side and 63 g on the left side

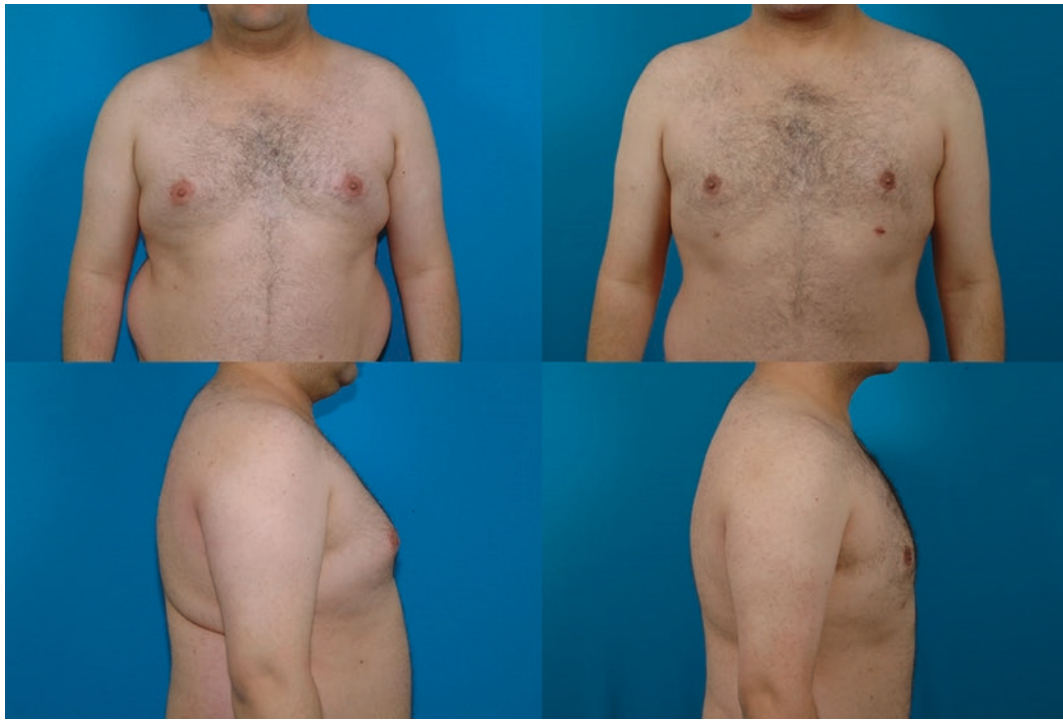

Fig. 9.7 This 28-year-old Pakistani-American man underwent liposuction of the breasts (200 cc per side), abdomen, flanks, and axillae, and a submental lipectomy. Simultaneous direct excision of breast tissue yielded 75 g on the right side and 92 g on the left side. He is seen before (*left*) and 15 months after surgery (*right*). A hypertrophic left inframammary scar was later revised

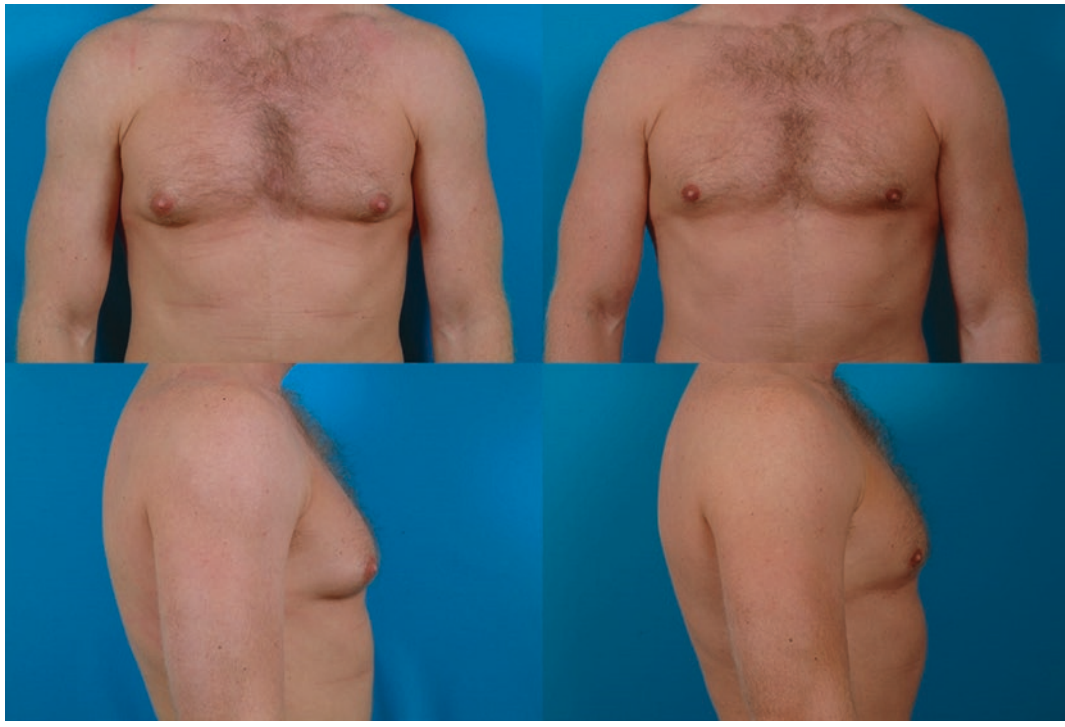

Fig. 9.8 This 39-year-old triathlete was in excellent physical condition and very lean. He is seen before (*left*) and 2.5 years after (*right*) liposuction of the breasts (150 cc per side) in combination with direct excision of breast tissue (resection weights: right, 25 g; left, 15 g)

Other Complications

Occasionally, a hypertrophic scar may form (Fig. 9.7). A revision under local anesthetic in the office may make it less noticeable. Bleaching creams are an option for hyperpigmentation. Infection is very unusual, similar to liposuction of other areas of the body.

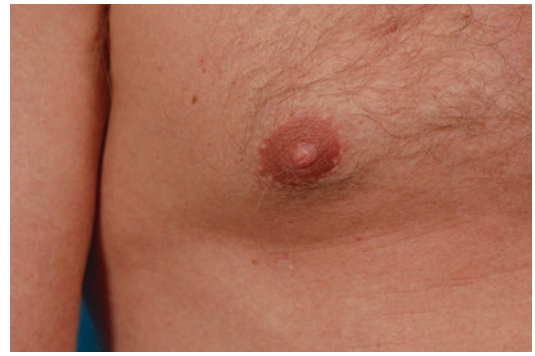

Fig. 9.9 Close-up view of periareolar scar 2.5 years after surgery

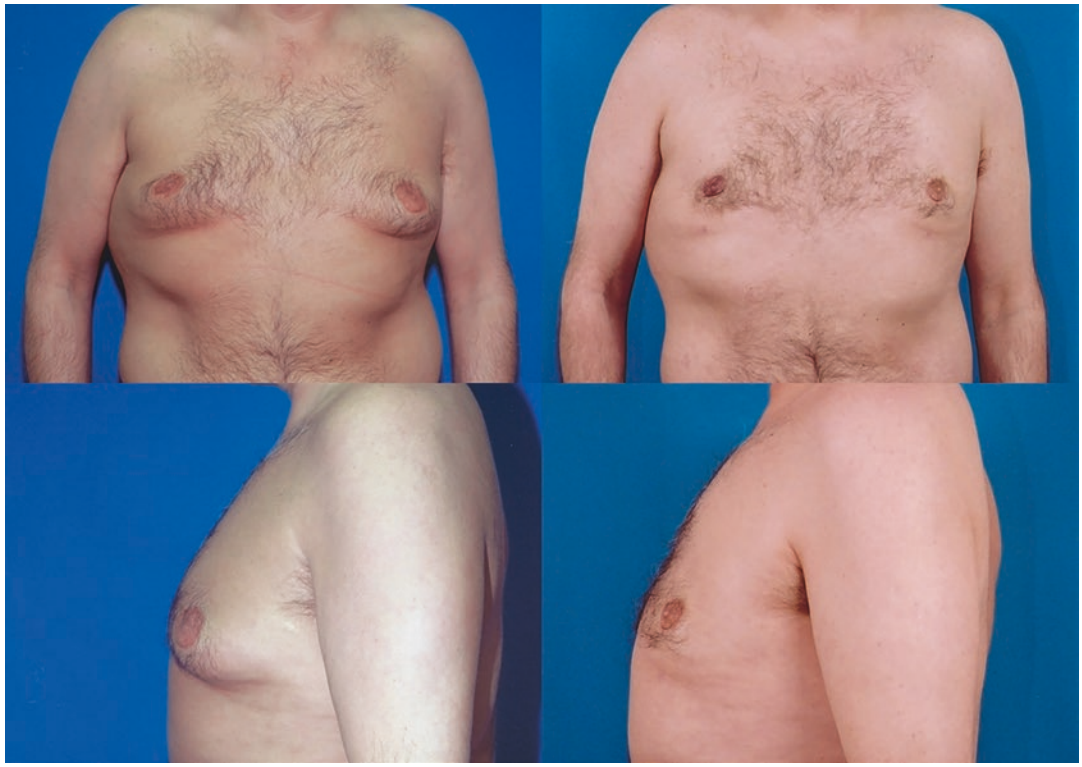

Fig. 9.10 This 37-year-old man had undergone previous gynecomastia surgery elsewhere. He was treated with liposuction (225 cc per breast) in combination with direct excision using periareolar incisions. He has scoliosis, accounting for the elevated position of the right shoulder. His skin contraction was excellent, so he did not require subsequent skin-excisional surgery

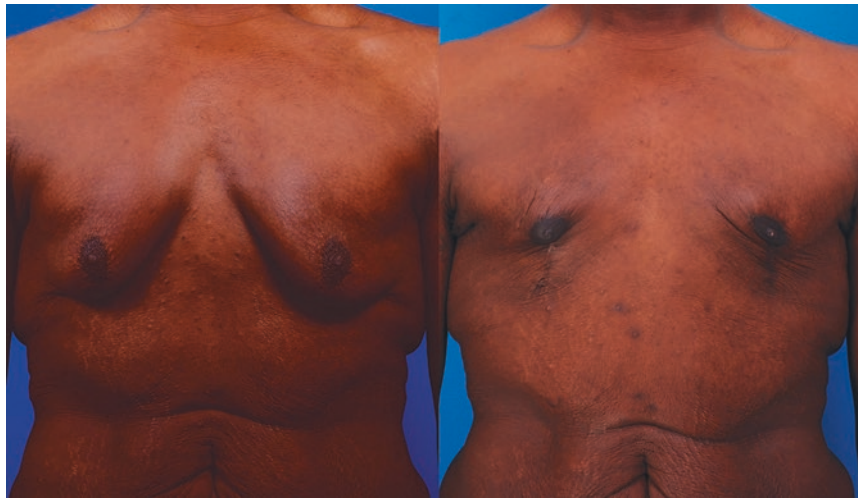

Fig. 9.11 This 24-year-old African-American man lost 130 lb by dieting and exercising. His skin was judged to be too lax to contract adequately without an excisional procedure. A one-stage procedure was recommended. Ultrasonic liposuction was used to remove 100 cc from each breast. Next, a vertical breast reduction was performed with a medial pedicle (right resection weight, 69 g; left resection weight 84 g). He is seen before (*left*) and 3 months after surgery (*right*). He plans to return for an abdominoplasty

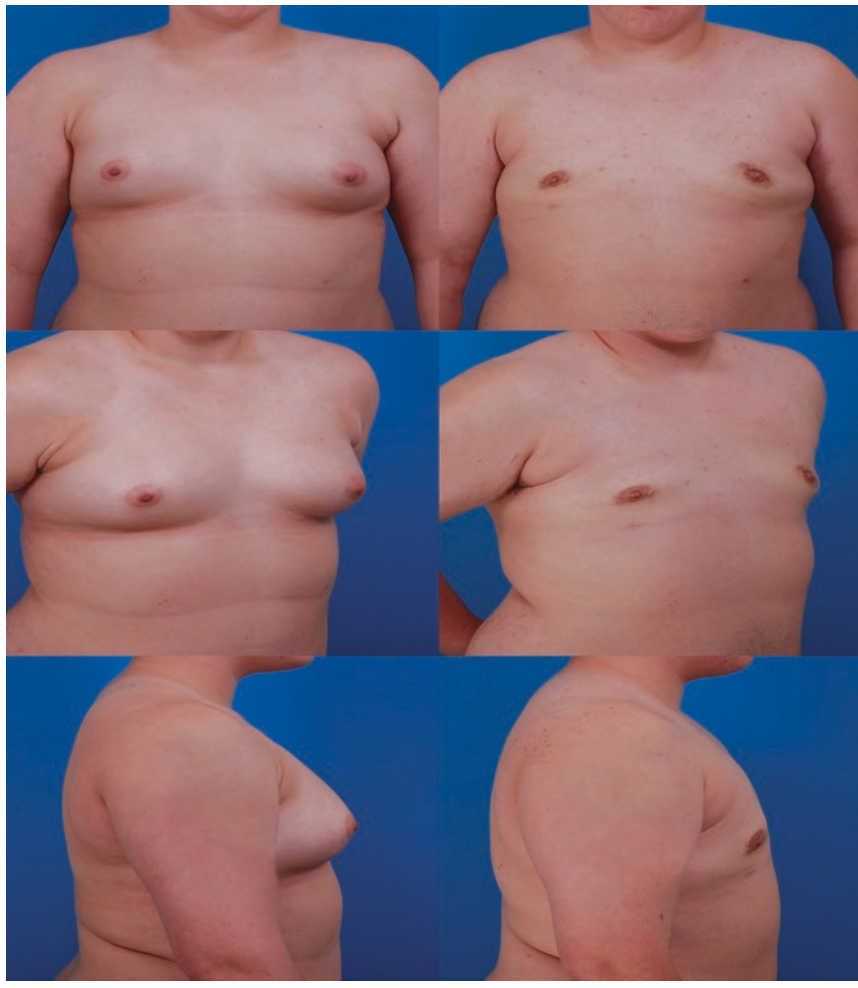

Fig. 9.12 This 18-year-old female transgender patient was treated in two stages with a combination of ultrasonic liposuction (225 cc per side) and direct breast tissue excision (right, 230 g; left, 266 g) using a periareolar incision. The patient is seen before (*left*) and 3 months after the second operation (*right*)

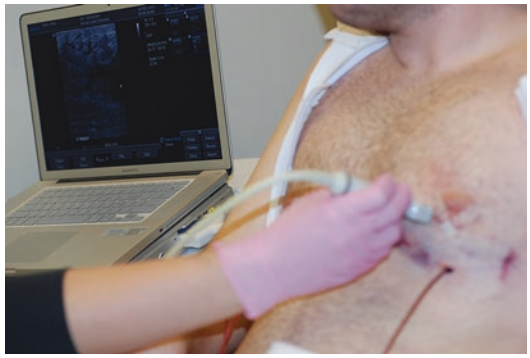

Fig. 9.13 This 18-year-old patient's before and after photographs are provided in Fig. 9.3. At the time of his follow-up appointment the day after surgery, he had more swelling and bruising of the left breast. An ultrasound examination confirmed the presence of a fluid collection, which developed despite the use of a compression garment and a drain. A hematoma was drained in the office

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