Juarez M. Avelar

Ear Reconstruction

Second Edition

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Foreword I—Ear Reconstruction

Nature defies the plastic surgeon whenever we attempt to recreate the ear. The subtle architecture of the cartilaginous structure, covered with delicate skin and harmoniously balanced with the facial features, cannot be easily imitated. The diversity of congenital deformities and traumatic lesions of the ear has interested me throughout my career and has been the subject of past publications. We invariably encounter obstacles such as scar tissue, poor skin coverage, a remnant of cartilage, and a demanding patient. All of these factors point toward a less than favorable result, whether we are faced with a defect from birth or trauma. Nevertheless, once in a while, a brave soldier will step up to this challenge. Dr. Juarez Avelar is such a pioneer, both a studious scholar of the matter and a competent surgeon. In this book, he shows the reader the entire scope of auricular reconstructive surgery, from diagnosis to the myriad techniques and tactics to correct each segment of this complex appendage. The quality of the presentation of the book and the many solutions presented are to be commended. Finally, he is to be congratulated for a life dedicated to an arduous and ultimately fulfilling quest: perfecting the art of reconstruction of the ear.

Ivo Pitanguy

Foreword II—Second Edition

The success of the first edition of this book demonstrates the interest in ear reconstruction from the international plastic surgeon community and the vision that the author, Dr. Juarez Avelar, has in publishing this book. In the foreword of the first edition, I emphasized the importance of the surgeon's skill and continuous training to search for perfection and to achieve the optimal result for each patient. Also, the surgeon's patience in sculpting the best cartilage framework is important but not sufficient to achieve an excellent result; careful soft-tissue handling, followed by attentive daily postoperative care, with meticulous observation of the healing process, are also essential to obtain a superior final result. In our literature, we find surgeons who have reached this level of perfection because they have dedicated almost all of their lives just to this field. This book tells part of the story of Dr. Juarez Avelar, of whom I am very proud for the totality of his work. He worked in our service during a period of his life, and I had the opportunity to admire his tireless capacity for work, with the goal of reaching immortality by recording his name in the annals of medicine.

Jorge M. Psillakis

Preface

This second edition of my book *Ear Reconstruction* , first printed in 2013, is being published according to Springer's request due to the first edition's very good acceptance from plastic surgeons all around the world. In the first book, each chapter described the technical developments I introduced into this fascinated field during a long period of my professional activities. The chapters were written to immediately address technical points, emphasizing practical, tested, and successful procedures. At the same time, the book provided a solid platform on which surgeons could continue to expand their knowledge and skills, so that they may excel in this specific branch of plastic surgery. As each patient presents with their own particular deformities of the auricles, it is mandatory to solve their problems, which is a constant challenge. From the beginning of my practice, I was not looking for new techniques, but in each operation, it is necessary to find new surgical options in order to achieve adequate aesthetic results. Consequently, new approaches have been developed, which have been described in my articles and book chapters, as well as in my lectures all over Brazil and in several other countries.

In this second edition, new subjects are described in detail, which represent new fields in ear reconstruction, such as the specific anatomy of the auricle; reconstruction of the tragus; surgical planning before the operation; secondary reconstruction; repair and reconstruction after ear injuries caused by piercing, human bites, or animal bites; what to do about amputated segments of the ear; postoperative care of patients; analysis of surgical results on later follow-up; ear reconstruction for repair of the auricle secondary to prominent ear surgery, reconstruction of the auditory external canal, reduction otoplasty to improve facial contours, etc. Therefore, readers will find many new topics in this second edition of *Ear Reconstruction* , which will increase their knowledge in order to improve surgical results. According to this, I can say that this edition is a relevant complement to the previous one.

Utilization of well-known techniques, performed by well-qualified plastic surgeons, is not a guarantee of excellent results in ear reconstruction. Plastic surgeons must always be mindful to analyze the deformities of their patients meticulously, to care very much about surgical planning, and to follow up each patient peacefully after reconstruction of the ear. It is important to emphasize that scar tissue formation is an individual reaction of each patient, even it presents specific variations from one region to another. As cartilaginous tissue does not provide vascularization, it represent a constant challenge in performing ear reconstruction. Because of such considerations, the presence of scars secondary to previous surgeries must be well evaluated before planning for another operation, as is described in detail in several chapters of the book. In the meantime, they pose a difficult task for performing incisions, as well as for cutaneous undermining to create skin flaps, which is a fundamental and obligatory step during the operation.

Finally, it is useful to say to surgeons that to perform ear reconstruction is not a matter of how to employ a routinely updated procedure, since each patient is a new one, presenting with unknown deformities. Besides that, they complain of specific abnormalities with psychological repercussions, which must be well analyzed preoperatively. Despite those considerations, each plastic surgeon must be humidity concerning surgical outcomes and must be aware that to achieve a good aesthetic result does not mean that it is an ideal one for patients and their relatives. Such an observation is obtained by external judgment of the reconstructed ear with personal analysis of the surgical result. Because of this subjectivity, the final aspect of the new ear is much more a matter of spatial projection of the new organ than employment of well-known techniques.

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São Paulo, Brazil

The preface and forewords had been missed out in the original book and these have now been included. The original version of this book can be found under DOI 10.1007/978-3-319-50394-3 .

Contents

Juarez M. Avelar, Ear Reconstruction, https://doi.org/10.1007/978-3-319-50394-3_1

1. Surgical Anatomy with Regard to Ear Reconstruction

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Keywords Anatomy – Anatomy of the auricle – Surgical anatomy – External configuration of the ear

1.1 Introduction

The auricle has a sophisticated structure located on the central and on each side of the head, with an atypical architecture consisting of a blade of cartilage covered by delicate skin. Basically, they are two anatomical elements with abundant vascularization on each side, and with few vessels crossing from one side to the other. They are two appendages with an important esthetic purpose for the facial contour that give the organ a unique configuration, location, and position.

The organ is covered by thin skin on 95% of its surface, with special characteristics of texture, histology, elasticity, color, and thickness. The external shape of the auricle is oval, with the vertical length (5.8–6.3 cm) larger than the horizontal width (3.2–3.6 cm). There is a wide variety of shapes, sizes, positions, and external aspects that should be evaluated when examining an auricle (Fig. 1.1). A normal ear is at an angle of about 20–30° from the side of the head, as mentioned by Avelar and Bocchino (1989). The angle between the mastoid and the ear plane is about 20–30°, and the concho-mastoid angle is normally 90°.

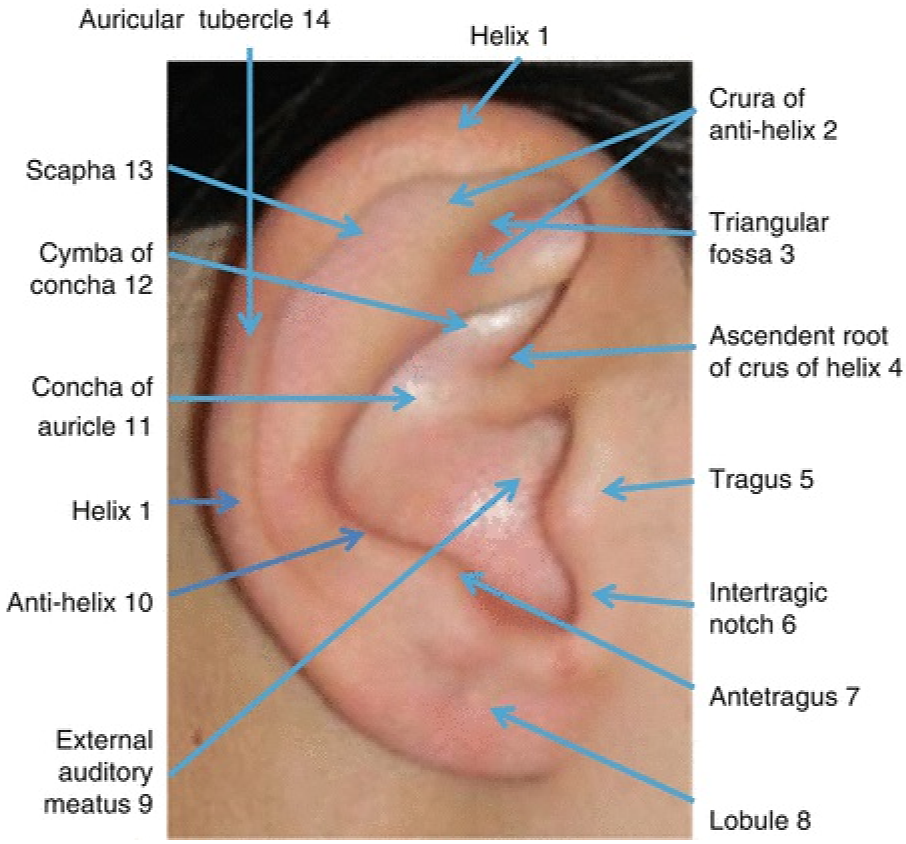

Fig. 1.1 The anatomy of the anterior side of an ordinary auricle with its esthetic and functional elements

Human auricles present some unknown characteristics and functions that are still a challenge when surgeons try to imitate nature, which is the unique capable of creating them with perfect configuration. Functional hearing may be damaged when a person is missing one ear, proving its importance to auditory function. On congenital anomalies of the ear, about 75% of my patients present with associated hearing disturbances due to a combination of internal anatomical alterations that may not be improved through reconstruction of the ear, even with the creation of the external auditory canal.

The external configuration of the auricle is very similar to a question mark, as described by Gillies and Milard (1957); probably they wanted to stress the fact that this organ has many functions and attributes that still are not well known. I have already described how the shape of the human ear is very similar to the shape of an embryo and a fetus. This similarity is not only in its shape, since the vascularization of the auricle is also similar to that of the human being in intrauterine life (Avelar 1986, 1997, 2003, 2013). It is well known that arterial and venous circulation enter and exit from the embryo and fetus through the umbilical cord located on their concavity. In the auricles, the blood supply reaches the organ through the conchal wall on its concavity. This anatomical characteristic is the fundamental principle of my technique for ear reconstruction (Avelar 1979, 2011, 2013).

The human auricle has two surfaces: the anterolateral surface shows its peculiar organization with reliefs and folds (Fig. 1.1), and the posterior surface is quite hidden from view.

1.2 Method

Although there are several anatomical structures of the ear, it is important to emphasize the following elements: (1) the auricular skeleton; (2) the cutaneous covering; (3) the intrinsic muscles; (4) the arterial and venous blood supply; and (5) the sensitive innervations.

1.2.1 Auricular Skeleton

The auricular cartilage is an unusual anatomical structure, which is unique in that there is nothing similar to it in any other part of the human body. Its thickness is not uniform, and the surfaces present some typical irregularities that are particular to each person. For this reason, creating the folds is a constant challenge when one performs ear reconstruction (Fig. 1.2). The folds and curvatures create the characteristic elements of the ear, which must be created on rib cartilage during auricular reconstruction. The anatomical distribution is very important for the individual identification of each person (Avelar 2000a, b). Even with congenital malformations, there is a wide variety of shapes and sizes of the remnant auricular cartilages, which are the main characteristics of my classification (Fig. 1.2) (Avelar 1986, 2011, 2013).

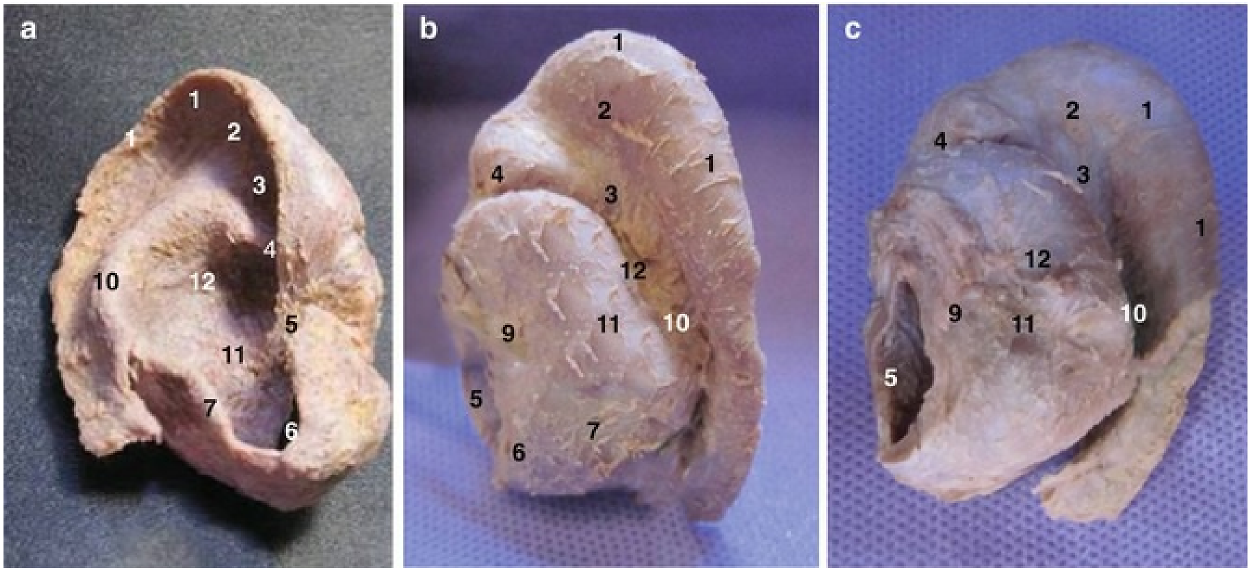

Fig. 1.2 The anatomy of the ear cartilage. (**a**) Anterior side of the ear with its anatomical structures: *1* helix, *2* crura of antihelix, *3* triangular fossa, *4* ascending root of crus of helix, *5* tragus, *6* intertragic notch; *7* antitragus, *8* lobule, *9* external auditory meatus, *10* antihelix, *11* concha of auricle, *12* cymba of concha, *13* scapha, *14* auricular tubercle. (**b**) Anatomical elements of the auricular cartilage. (**c**) (Pinna) Auricular framework excavated on rib cartilage with its anatomical elements for total ear reconstruction

The auricular cartilage is a blade with strong components for fixation on deep structures on temporal bone that creates an anatomical division between the anterior and posterior aspects of the auricles. However, it is more than a division − it is in fact a block that separates the vascularization of both aspects of the auricles (Fig. 1.2). Such a separation creates a rich vascular network on each side, providing a peculiar distribution, which is useful when performing surgery. This type of vascularization is especially important when a patient is first seen in the emergency room with partial traumatic laceration that leaves a pedicle. It is advisable to suture the lacerated segment of the ear to its normal position because a small pedicle can provide enough blood supply from its vascular network. Therefore, it is useful to mention Gillies's principle: "replace what is normal on normal position and retain it there" (Gillies and Millard 1957).

However, when a segment or total auricle is detached, I do not recommend suturing it during first aid at the emergency room because the possibility of its survival is minimal, and the matter is so important that I have dedicated an entire chapter of this book to it. There are only a few small vessels (part of a very important vascular network), never more than three, that cross from one side of the auricular skeleton to the other: the anterior and the posterior ones.

The auricular cartilage is covered on both sides with a thin, firm, regular, and adherent layer of perichondrium, which is quite easy to separate from the cartilage. Such a procedure is useful and should be done carefully at every operation on the auricles, using proper surgical instruments to preserve the perichondrium.

The perichondrium is firmly attached to the cartilage, but in certain areas it is even more adherent as on the border of the helix and on the folds. It can be seen in the adult human ear that the cartilage is responsible for its shape and size, except on its lower segment where the lobule is attached and hangs from the auricular framework. The cartilaginous skeleton lies firmly all around the osseous canal of the temporal bone, creating a tunnel that is the external canal of the ear. The auricular cartilage is supported by muscles and ligaments and is an excellent donor area for cartilaginous graft. To remove the auricular cartilage, the perichondrium must be preserved without any damage or resection. There are several circumstances in which auricular cartilage graft is very useful: rhinoplasty, secondary rhinoplasty, partial reconstruction of the nose, partial reconstruction of the ear, and reconstruction of the eyelids and orbital floor.

We have transplanted a very large composite graft (cartilage, perichondrium, subcutaneous tissue, and skin) for partial reconstruction of the nose and auricles. This sort of transplantation requires careful post-operative care for successful results (Avelar et al. 1984).

Since the cartilaginous tissue has no vascularization, a cartilage graft must be done on a new bed with adequate blood supply to develop a new perichondrium on both surfaces. Therefore, scar tissue formation is not an ideal area for cartilage graft because of the diminution of vascularization on the new bed. For this reason, a cartilage graft needs excellent vascular irrigation to provide the necessary nutrition to the cartilaginous tissue.

The auricular cartilage, besides creating the architecture of the ear, is also important for internal structures. The auricular cartilage is continuous from outside to inside through the mastoid bone, creating the external ear canal, which is covered by an unusual kind of skin up to the eardrum. Although ear reconstruction is an external procedure, it is useful to mention the relationship with internal structures of the middle and inner ears. Such information is important for most patients with acquired and congenital abnormalities (Fig. 1.3), and for this reason the presence of an otolaryngologist as well as a speech pathologist in the surgical team is very useful Baudet (1972, 1973), Baudet et al. (1972), Davis (1987), Destro and Speranzini (1994), Lewis and Fowler (1979), Mladick et al. (1971), Nahai et al. (1978), O'Toole et al. (2008)and Schonauer et al. (2004).

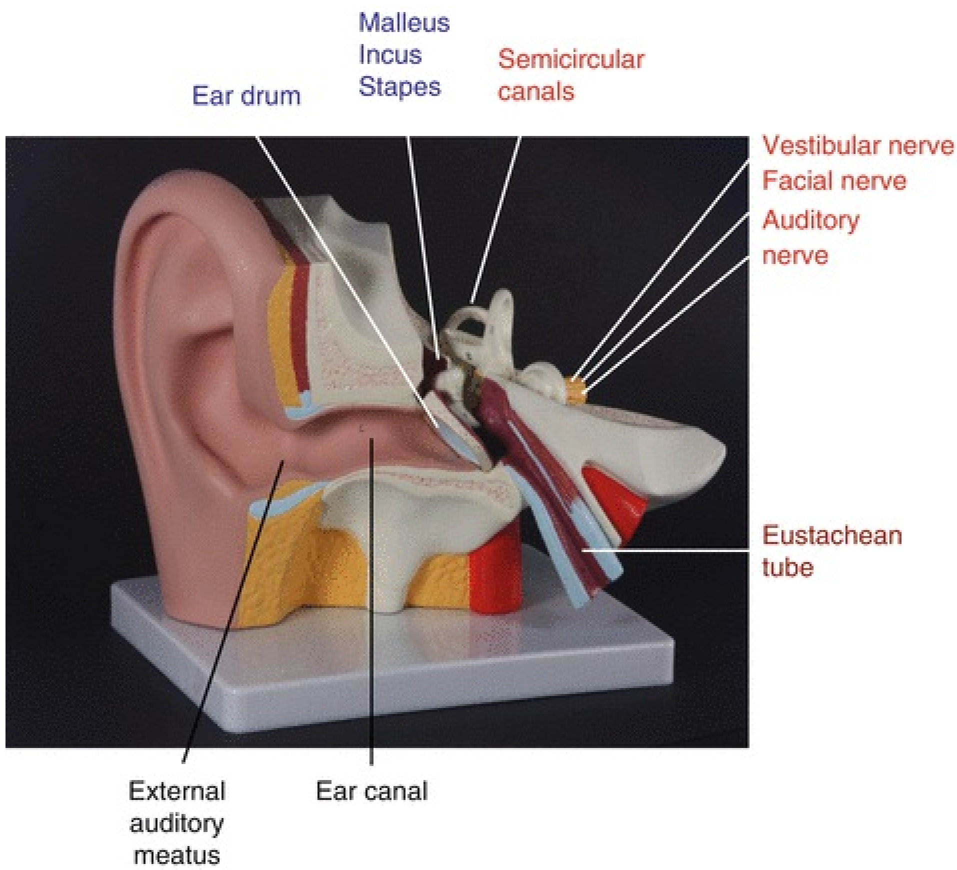

Fig. 1.3 Human ear model sample anatomy of the external, middle, and inner ear for didactic illustration to patients at the Brazilian Ear Institute

1.2.2 Cutaneous Covering

There are three types of skin that cover an auricle: the anterior surface, the posterior surface, and that which is on both sides of the lobule.

1.2.2.1 Anterior Surface

The anterior surface of the ear is covered by an unusual integument, formed by very thin skin that lies over the concha, scapha, and the architectural convolutions. It is the closest skin that adheres to cartilage anywhere in the entire human body (Fig. 1.1). Between the skin and the cartilage is just a very thin layer of perichondrium and an extremely fine subcutaneous layer of fat, wherein the vessels and nerves are distributed as a sophisticated network. Due to intensive blood supply, it is safe to create flaps to be rotated from one place to another, and in such circumstances the best level to undermine is below the perichondrium, which is bloodless.

The skin is hairless, highly sensitive, and is also an erogenous zone. However, with aging, some hair can appear close to the tragus and antitragus. Inside the auditory canal, abundant ceruminous glands and hair follicles cover the surface (Fig. 1.3).

1.2.2.2 Posterior Surface

The posterior part of the ear is covered by a different type of skin than the anterior one. It is soft and smooth, slides over the auricular cartilage skeleton on the sulcus, and is thicker than on the anterior part of the ear. The thickness of the integument shows an interesting composition. Underneath the skin are two fat layers with similar distribution, as on almost all surfaces of the human body, according to my description concerning the anatomy of the abdominal wall (Avelar 1986, 1989a, 2016). The superficial layer (areolar) is firm and has large fat cells with very small vessels perpendicular to the skin (which is also described later − Avelar 1989b, 2016). However, the deeper layer (lamellar) lies over the cartilage and is formed by several structures; because of the fat layer, the skin slides easily over the auricular skeleton. Between these two layers is the fascia, where a complex neurovascular network crosses.

1.2.2.3 Vascularization

The vascularization on the posterior parts of the auricles has two origins: (1) the superficial network coming from the posterior auricular artery, and (2) the depth blood supply, coming from branches of the external carotid artery.

1. Superficial network – the arteries derive from the posterior auricular artery to supply blood to the entire posterior portion of the auricle. These anatomical details must be thoroughly evaluated pre-operatively when planning cutaneous flaps.

2. Depth blood supply coming from branches of the external carotid. Due to this deep vascularization on the posterior side of the auricle, it is possible to create several types of cutaneous flaps that can be transposed through the cartilage to cover the anterior portion of the ear, as well as for repairing minor defects of the auricle (Fig. 1.4).

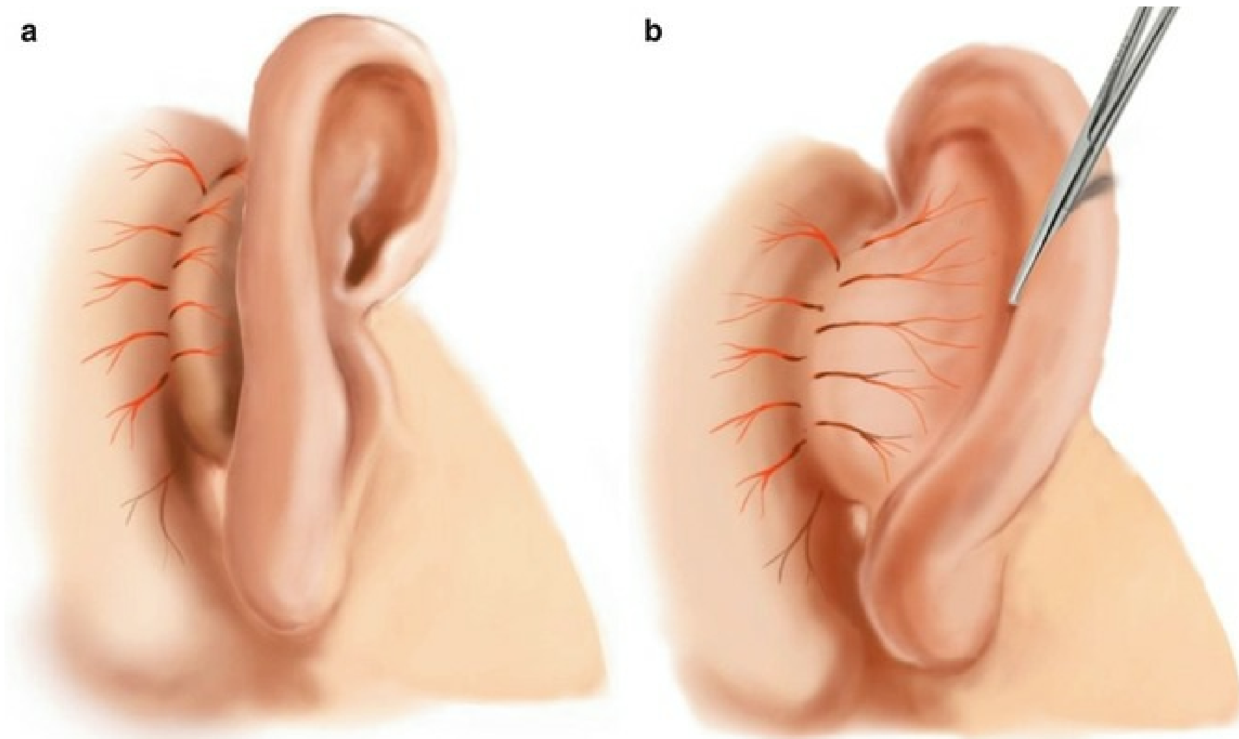

Fig. 1.4 Vascularization of the ear coming from depth. (**a**, **b**) Schematic representation shows small vessels coming from branches of the external carotid artery, those that irrigate the posterior aspect of the ear passing on the anterior border of the mastoid bone from deep to the superficial level. (**c**) Perioperative photo showing the cutaneous undermining creating a tunnel on right side of a patient with severe microtia. (**d**) The tunnel is already created with a "C-shaped" instrument introduced through it, ensuring that the future conchal area is not undermined

When creating these cutaneous flaps, the surgeon must take into account the deep blood supply that comes from branches of the external carotid artery that are independent of the vascularization from the posterior auricular artery. These vessels pass between the posterior part of the conchal cartilage and the anterior border of the mastoid bone.

The skin of the posterior aspect of the auricle is a wonderful donor area for full-thickness skin graft and is the softest skin for eyelid reconstruction, as well as for any other area of the face. It is possible to remove a very large portion for skin graft; as long as it is removed carefully, it will not damage the donor area, which is closed by running stitches – this is my preference as the donor area for skin graft during the second surgical stage of reconstruction of the ear. Besides the useful donor area for "island" flaps on a posterior part of the auricle, it is even possible to perform large composite grafts with skin and subcutaneous tissue removed from the retroauricular sulcus (Avelar et al. 1984).

1.2.2.4 Lobule

The auricular lobule is normally present on the lower segment of the ear, but with a different composition. It is soft, with a cover of thin skin on the anterior and posterior sides. There is a typical fat tissue with its own vascularization between the two layers of cutaneous surfaces, and it provides irrigation for the lower part of the auricle (Fig. 1.1).

Although there is no cartilage in the lobule, when it is reconstructed after total detachment of the ear as well as for anotia, we sculpt it out on the same block of cartilage framework. In those cases, reconstruction of the lobule using only cutaneous flaps may not bring about successful results because of postoperative skin retraction.

1.2.3 Muscles

There are two groups of muscles that may be used for treatment or repair of postoperative complications or during secondary reconstruction of the ear in ear surgery: (1) auricular muscles, and (2) muscles from neighboring regions.

1.2.3.1 Auricular Muscles

The auricular muscles in human beings have been considered to be vestiges and useless remnant structures of more primitive animals. In fact, these muscles are very strong and active in dogs, horses, cows, and many other animals. They are responsible for the orientation of the ears to improve hearing and attention. In humans, the muscles are very weak, and therefore movement of the ears is very rare.

It is useful to emphasize the comparative anatomy in order to understand the difference between the action of these muscles in humans and animals. The descriptions in this chapter are abbreviated to give information about ear surgery in human beings. Basically, the muscles of the auricles can be divided into two groups: intrinsic and extrinsic.

The *intrinsic muscles* are located within the ear. They work in combination with the ligaments, maintaining the position and shape of the auricle (Fig. 1.5).

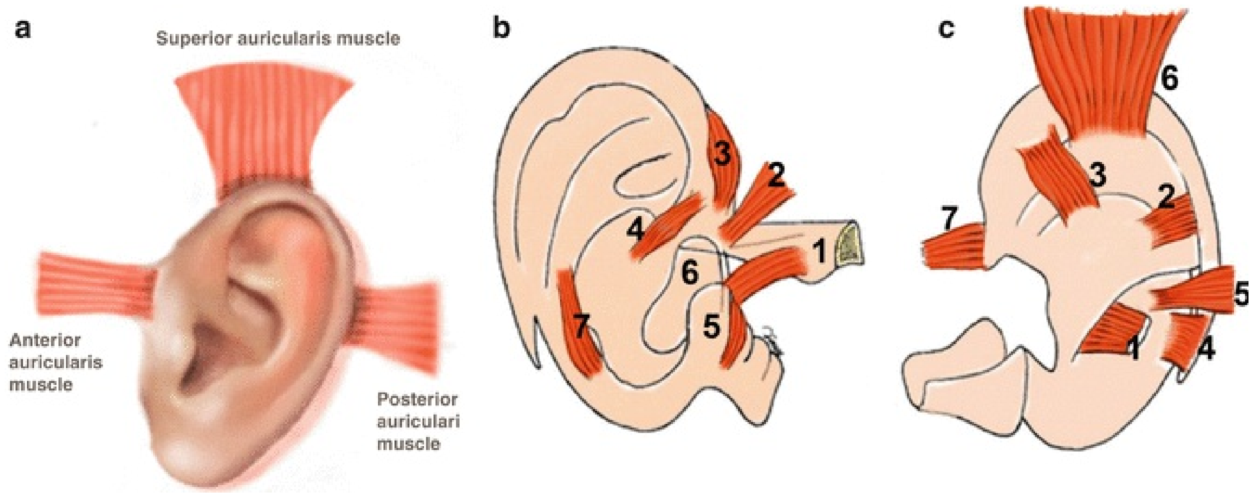

Fig. 1.5 Schematic representation of the intrinsic and extrinsic muscles and ligaments of the ear. (**a**) External muscles of the auricle: superior auricularis muscle, anterior muscularis muscle, and posterior auriculares muscle. (**b**) Anterior side of the auricular cartilage of the right ear: *1* anterior auricularis ligament, *2* extrinsic superior ligament, *3* helicis major muscle, *4* helicis minor muscle, *5* tragicus muscle, *6* pyramidal muscle, *7* antitragicus muscle. (**c**) Posterior side of the auricular cartilage: *1* posterior auricular ligament, *2* transverse muscle, *3* oblique muscle, *4* helicis incisura muscle, *5* posterior auricular muscle, *6* superior auricularis muscle, *7* anterior auricular muscle

There are other muscles located in the tragus and antitragus, working as dilators and constrictors of the sphincter to control sound entry. We have noticed that the intrinsic muscles are hypertrophic in prominent ears, which provide strong traction from one segment of the auricle to the other, with important alterations reducing the projection of the folds and becoming flatter.

When performing ear reconstruction on severe microtia without external canal, the intrinsic muscles are always present. These are on the deep structures of the remnant of the cartilaginous tissue, and they must be resected during the first stage of the operation. In fact, these muscles and the rudimentary ligaments are firmly inserted into the periosteum of the deep bone structures where the external canal would be located if the patient had a normal ear.

The *extrinsic muscles* of the ear are inserted at one end into the posterior side of the conchal cartilage, creating a strong tendon (Fig. 1.5). Thus, the junction of the insertion includes the ligaments, and the other extremities are attached to other structures of the skull and face. The location, position, and action serve to anchor and keep the ear in place. Although they are quite flat, short, and rudimentary, they give the ears significant reinforcement at the base. Because 90% of the external surface of the auricle is exposed, it requires strong fixation to its base. There are three extrinsic muscles: superior, posterior, and anterior; there is no inferior muscle, and they are all innervated by the facial nerve.

1.2.3.2 Superior Muscle

The superior muscle is the largest, with its vertical fibers lying upward on the posterior aspect of the concha. The inferior insertion is on the tendon, and the upper end of the muscle is attached to the deep layers of the temporal fascia (Fig. 1.5).

1.2.3.3 Posterior Muscle

The posterior muscle is smaller than the superior muscle. Its fibers progress horizontally from the tendon behind the conchal cartilage to its posterior end, which is attached to the mastoid (Fig. 1.5).

1.2.3.4 Anterior Muscle

The anterior muscle is even smaller than the other extrinsic muscles. Its posterior end is inserted in the tendon on the posterior part of the concha, and its anterior end is inserted in the zygomatic arch (Fig. 1.5).

1.2.4 Arterial Vascularization

There are two types of arterial vascularization to the auricles and neighboring regions: superficial, and deep.

1.2.4.1 Superficial

The superficial arterial vascularization is an important network that comes from three branches of the external carotid:

1. The superficial temporal artery (STA)

2. The posterior auricular artery (PAA)

3. The occipital artery (OA)

4. Branches from the external carotid artery (ECA)

The important vascularization of the ears and neighboring areas presents excellent conditions for performing several kinds of cutaneous flaps as well as for chondrocutaneous flaps. These arteries irrigate the cutaneous surface of the ear as well as the auricular area (Avelar 1977, 1989a, 1997, 2013). The STA is the most important one, irrigating the upper half of the ear, the surface of the temporal region, and the pre-auricular area. The PAA and OA come from the external carotid artery, providing vascularization to the posterior portion of the auricle, the retroauricular sulcus, and the mastoid region. These three main arteries break up into many branches to provide a rich vascular network for the auricle as well as for the mastoid, temporal, pre-auricular, and inferior auricular regions. According to Testut and Jacob (1975), the PAA and STA lead into a wide variety of branches. Performing anatomical dissections, we found that they are very useful for creating cutaneous flaps and fascial flaps for reconstruction of the auricle (Avelar 1977, 1978).

1.2.4.2 Deep Vascularization

More vascular irrigation comes from the deep structures of the auricle around the ligaments and the auricular cartilage. There are several branches that arrive from four main arteries: (1) STA, (2) PAA, (3) OA, and (4) the maxillary artery (deep auricular branch from the external carotid artery (ECA) (Fig. 1.4).

The vessels coming from those four arteries make a rich vascular superficial network, which is very important and independent of the superficial vascular network. The vessels come from deep tissue, running perpendicular to the surface of the cutaneous level and continuing around the auricular cartilage. Such anatomical information is useful during ear reconstruction on microtia as well as during the repair of a major or minor defect of an ear. The anterior border of the mastoid bone is the reference area where the blood supply changes from deep to superficial (Fig. 1.4). Taking this into account, during ear reconstruction on congenital anomalies, the anterior border of the mastoid should not be undermined in order to avoid any damage to the deep vascularization.

1.3 Vascularization in Microtic Patients

The anatomy of the remnant auricular structures in microtic patients is very different from other congenital anomalies. It is called "microtia" when there is some sort of rudimentary cartilaginous tissue in a congenital abnormality of the auricle. Therefore, the anatomy is not the same as on the normal ears. When studying the anatomy of the auricular region, one must consider not only the size of the organ, but also the profound alterations in its vascularization. Whenever there was an opportunity, we performed anatomical research on cadavers with microtia on the left side.

Based on our research, all operations have been performed with special care, studying the complex variation of the anatomical structures. With regard to vascularization, it is important to mention that both arterial branches coming from the external carotid are present but show a peculiar distribution. The STA branches irrigate the pre-auricular skin as well as the scalp of the temporal region. Sometimes the STA passes rather far from the auricular area. The PAA presents some variations that are difficult to describe. However, it is important to mention that the vascularization of the remnant auricular structures does not receive its blood supply from the posterior auricular artery. All vascularization of the remaining cartilage tissue comes from the deep bone surface cavity surrounding the auditory canal. When there is no auditory canal, there is a depression on the temporal bone where it would be located. Through this depression, the blood supply originates from deep tissue to irrigate the remnant cartilaginous tissue and the local skin as well. Therefore, the microtic structures have their own vascularization, which is independent of the temporal superficial artery and the posterior auricular artery. The vessels coming from deep structures reach the skin of the auricular region, creating a wide network with branches of the posterior auricular artery. The vessels show several arches that resemble an umbrella because they come from deep and run parallel to the border of the mastoid bone (Fig. 1.4).

Because of this vascular distribution, the center of the future ear should not be undermined during reconstruction because it will be the pedicle of the future ear. From one artery, several branches stem around to irrigate the skin, and all vessels pass parallel to the local skin. As a result, it is possible to dissect the cutaneous flap, keeping the good vascularization that comes from the deep structures (Fig. 1.4).

This information is very useful when performing skin undermining to reconstruct the auricle. Consequently, any surgical scar on the auricular region is a difficult problem to deal with because the vascularization of the skin is damaged, making it difficult to create cutaneous flaps; however, this does not mean that it is not possible to perform surgery. The planning of the operation should be done in such a way that the scars will not lie in the middle of the skin flap. Because the surgical scar tissue stops the vascularization, the blood supply to the extremity of the flap may be seriously damaged. Therefore, the creation of cutaneous flaps must be done carefully.

1.3.1 Venous Circulation

The veins follow the same distribution as the arteries, providing the return blood flow from the ear as well as from the surrounding areas. There are more veins than arteries, with a ratio of two veins to every artery. However, sometimes there is only one vein or three veins to each artery. All venous blood goes to the external jugular.

1.3.2 Innervation

The auricles and neighboring areas receive innervation to develop the necessary motor and sensitivity functions. There are basically three main groups of branches that innervate the muscles of the ears: great auricular, facial, and auriculotemporal (Fig. 1.6). As soon as the facial nerve penetrates the parotid gland, it presents a wide area of fibers that may be divided into five groups. The posterosuperior group of fibers originates from the temporofacial nerve. It becomes more superficial after it emerges from the parotid gland, passing 5 mm from the anterior border of the tragus cartilage, moving in an upward direction to supply the anterior auricular muscle and some intrinsic muscles. The upper fibers of this nerve continue vertically to innervate the superior and posterior auricular muscles.

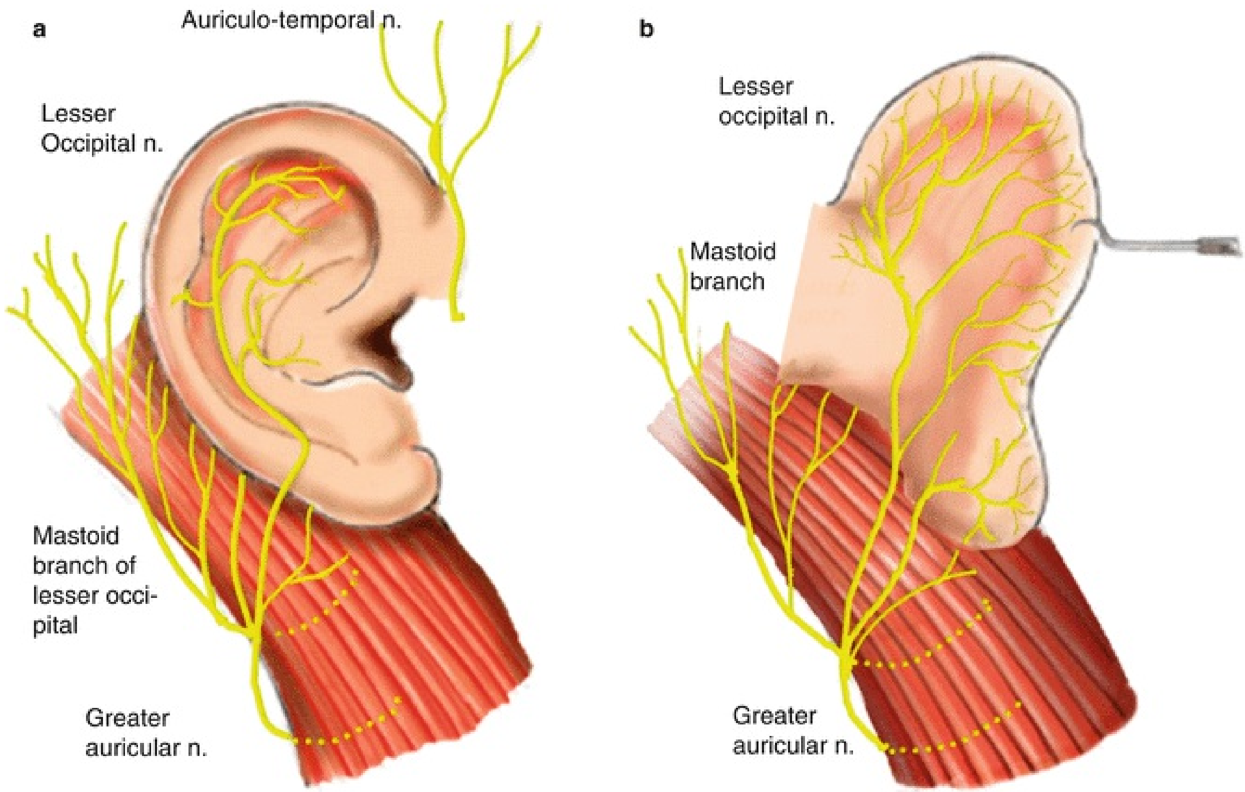

Fig. 1.6 (**a**, **b**) Innervation of the anterior and posterior sides of the ear

The action of the facial nerve on the auricle and neighboring regions has been well documented. The sympathetic vasomotor and secretory functions of the artery and veins of the region seem to be developed by fibers coming from the trigeminal nerve. However, the sensitivity function is also very important and needs to be studied in order to perform any kind of surgery on the auricle. The principal nerve is the great auricular; it receives fibers from the second and third roots (C2 and C3) of the cervical plexus (Fig. 1.6). This nerve may be seen during skin dissection of the lateral wall of the neck, when face lifts are performed. It becomes more superficial on the posterior border of the sternocleidomastoid muscle, following its upward course, lying between the aponeurosis and the platysma muscle or the superficial cervical fascia, which is the prolongation of the aponeurosis of the platysma. The great auricular nerve comes up and forward, crossing the jugular vein to divide it into two groups of fibers, as anterior and posterior branches. The anterior branches go straight to the lobule, subdividing into several smaller ones to supply the sensation of the lower half of the lateral aspect of the auricle (Fig. 1.6). The posterior branch reaches the mastoid surface; therefore, any trauma to the great auricular nerve can damage sensation in the lower half of the ear.

The sensation of the anterior and lateral surfaces of the auricle is provided by the auriculotemporalis nerve. This nerve also supplies sensitivity to the anterolateral auricular aspect as well as the anterior helix (Fig. 1.7). The auditory canal is innervated by the great auricular on the anterior and superior walls, whereas the posterior wall is innervated by the auriculotemporalis.

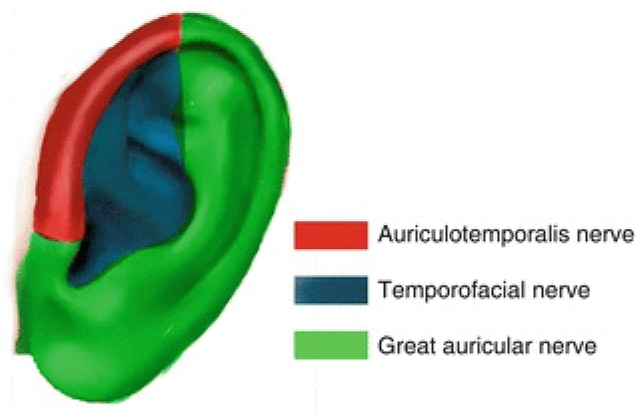

Fig. 1.7 Schematic representation of the sensitive innervation of the anterior side of the ear

1.3.3 Discussion

The knowledge of the anatomy of the ear is very important for repairing or reconstructing the auricle. The descriptions of the surgical anatomy of the auricle specifically cover the elements of the auricular cartilaginous architecture as well as the cutaneous covering of the auricle with its vascularization. The cartilage is a peculiar and unique structure that gives an individual configuration to the organ. Because the cartilage is a tissue without vascularization, performing the repair of a minor defect, as well as total reconstruction of the auricle, is very challenging, and following these procedures is mandatory when replacing the missing segment of the ear, as was first reported by Gillies (1920).

Due to the wide variety of congenital anomalies and acquired deformities, a specific approach is required to achieve satisfactory results. The vascularization of the auricle is a fundamental step during surgery. Three main arteries provide blood supply to the organ and to all tissues: the superficial temporal artery, the posterior auricular artery, and the occipital artery are responsible for the important superficial vascular network (Avelar

1977, 1978, 1989b). In addition, another deep vascular network comes to the auricle, passing on the anterior border of the mastoid bone, which is useful in performing ear reconstruction. To create a skin cover, the cutaneous undermining must be done carefully in order to preserve the central area of the future organ, which will be its pedicle.

Conclusions

The purpose of presenting the anatomy of the ear is to provide basic information regarding the possibility of creating cutaneous and chondrocutaneous flaps in order to repair congenital and acquired deformities of the ear. The temporal superficial artery, posterior auricular artery, and occipital artery provide a superficial vascular network that is very important for supplying the cutaneous flaps. Additionally, the blood supply coming from deep tissues passing on the anterior border of the mastoid bone provides important vascular support to create the pedicle of the future auricle. When ear reconstruction is done on acquired deformities, the pedicle of the future auricle is created near the auditory canal without subcutaneous undermining of the posterior border of the external auditory meatus. For reconstruction of the ear due to congenital anomalies, the future pedicle of the auricle is located in the center of the projection of the future ear.

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2. Classification of Congenital Anomalies of the Ear

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2.1 Introduction

Deformities of the auricle may be classified into two major groups: congenital anomalies, and acquired defects. (Acquired defects are described in Chap. 11). Congenital abnormalities have a complex association with other regions and segments of the human body, so they are an important field in ear reconstruction. Before performing surgery, it is useful to classify the deformity because the wide variety of clinical forms requires specific procedures. Quite often, congenital anomalies are associated with other deformities of the body, which occur during the critical period of embryogenesis referred to by Nishimura and Tanimura (1976) as being between the 3rd and 12th week post-conception in humans. In about the 6th week of embryonic life, the six hillocks that originated on ectodermal thickening begin to grow following the development of the ears (Rogers 1974). Such a period may be more precisely placed between the 8th and 12th week of gestation (Avelar and Bocchino 1989). Patients with auricular dysmorphogenesis involving the absence or diminution of the size of the ear cartilage present with one, two, three, or more associated lesions because of combined embryologic disturbances.

Before performing surgery, an adequate physical examination must be done to identify all deformities. Surgical planning of ear reconstruction may be done according to the correct diagnosis as well as the identification of correlated dimorphisms of other organs (Converse 1968). It is useful to consider congenital malformation of the ear along with several combined anomalies of other organs and segments of the body.

2.2 Heredity

Among 576 patients treated at the Brazilian Ear Institute for reconstruction of the auricle caused by congenital deformities with the reduction or absence of the ear cartilage, there were only two patients − brothers − with microtia. Therefore, only two patients (0.34%) presenting with such a family anomaly, seem to be strong indicators of the existence of hereditary transmission. In fact, there is relatively little evidence for a familial aggregation of affected individuals, as also described by Melnick and Myrianthopoulos (1979). On the other hand, more than 400 patients with congenital anomalies who underwent ear reconstruction at our institute were married before or after the operation. None of them has a child with microtia or any other auricular malformation. Therefore I have sufficient reason to conclude that congenital anomalies of the ear are not of hereditary transmission.

Very often, parents come for consultation regarding their newborn child with congenital defects of the auricle a few weeks after birth, looking for a solution to the problem. Their anxiety is great because they had not seen such a deformity among their relatives. In addition to being worried about the physical abnormalities of the child, they are always very concerned about hereditary transmission. We feel confident in telling them about the incidence of auricular anomalies among relatives of our patients so that they have sufficient information to make a decision about future pregnancies (Converse 1968; Derlacki 1969).

2.3 Classification of Congenital Anomalies of the Ear

In Fig. 2.1, one can see a comparison between classifications from six different authors in which it is possible to compare the clinical characteristics of each group in different time periods. Congenital anomalies of the auricle present in many different clinical forms that should be identified before planning and performing reconstruction. I have always been concerned about classifying the congenital anomalies of the ear, trying to identify each one before the operation. Avelar's classification is a result of 43 years of practice and research, which were very useful for planning as well as performing ear reconstruction. During the last 10 years, other groups of deformities have been identified and included in previous classifications. During this period, a correlation was made between each group of deformities in comparison with others. The Avelar classification is the result of studying and analyzing the remaining cartilaginous tissue removed from each patient. It is a product of embryological, anatomical, functional, clinical, and surgical fundamentals, which are useful correlations between the auricles and other organs of the body.

		CONVERSE (1963)	PITANGUY (1967)	ROGERS (1968)	TANZER (1975)	MELNICK (1979)	AVELAR (2011)
Absence of ear cartilage	No EAC					Anotia	Anotia
	with EAC and tragus						Agenesis of the Auricle
Reduced size of the ear cartilage		Microtia	" Typical "	Microtia	Microtia	Microtia	Severa Microtia
			Conchal helix Appendix es fistulas	Cup ear Lop ear	Constricted ear	Lop, cup ear cryptotia	Moderate Microtia A- Eutopic B- Ectopic
Ear cartilage is larger than normal						Macrotia	Macrotia
Normal size		Prominent ear	Prominent ear	Prominent ear	Prominent ear	Prominent ear	Prominent ear

Fig. 2.1 Comparison between six classifications regarding congenital ear deformities

Congenital anomalies of the auricle are classified into five groups: anotia

(Fig. 2.2), agenesis of the auricle (Fig. 2.3), severe microtia (Fig. 2.4), moderate eutopic microtia (Fig. 2.5), and moderate ectopic microtia (Fig. 2.6). Besides the vast variation of the deformities, it is well known that there are numerous associated dimorphisms because the embryological development occurs simultaneously with all organs and regions of the human body.

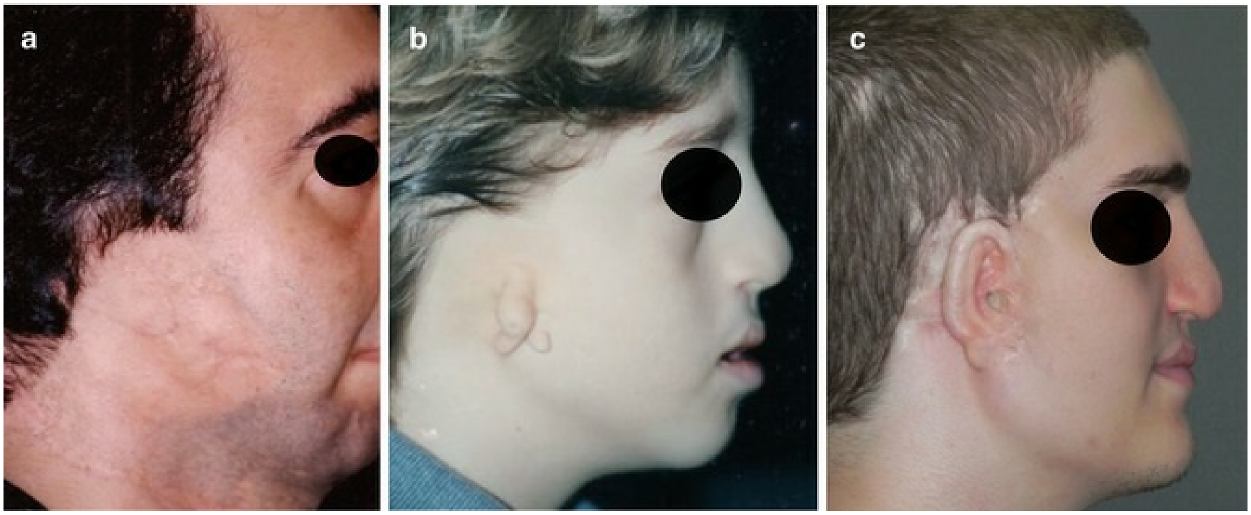


Fig. 2.2 Anotia. Photos (**a**, **b**) of two patients classified as anotia. It is so named because there is no vestige of auricular cartilage and therefore no external auditory canal. Patient in photo (**a**) there is no auricular lobule; (**b**) in this case, there is a remaining auricular lobule on upward rotation; (**c**) same patient 2 years after total reconstruction of the auricle, external canal, and tragus

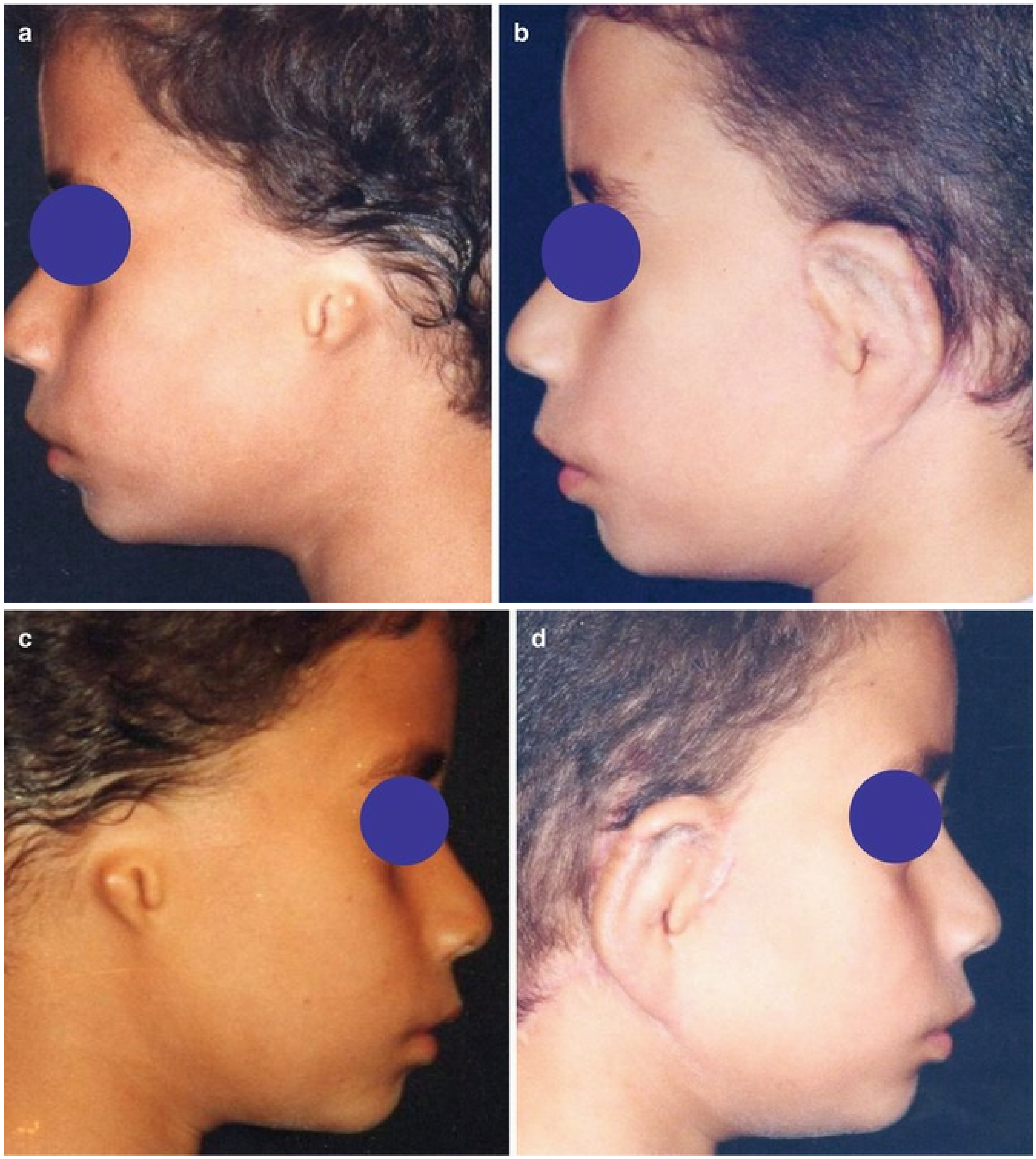


Fig. 2.3 Auricular agenesis. It is a bilateral deformity presenting with external auditory meatus and a rudimentary auditory canal with hearing deficiency. (**a**, **c**) Pre-operative photos: (**b**, **d**) same patient after two-stage ear reconstruction

Fig. 2.4 Severe microtia. Photos (**a**, **b**) of a 7-year-old female patient classified as severe microtia because the very small remnant of auricular cartilage is not used for reconstruction. The new auricular framework is created by excavation from the rib cartilage. It is the most frequent (80%) among all anomalies involving the absence and diminution of the size of the ear cartilage. It is an embryological development disorder of the ectoderm

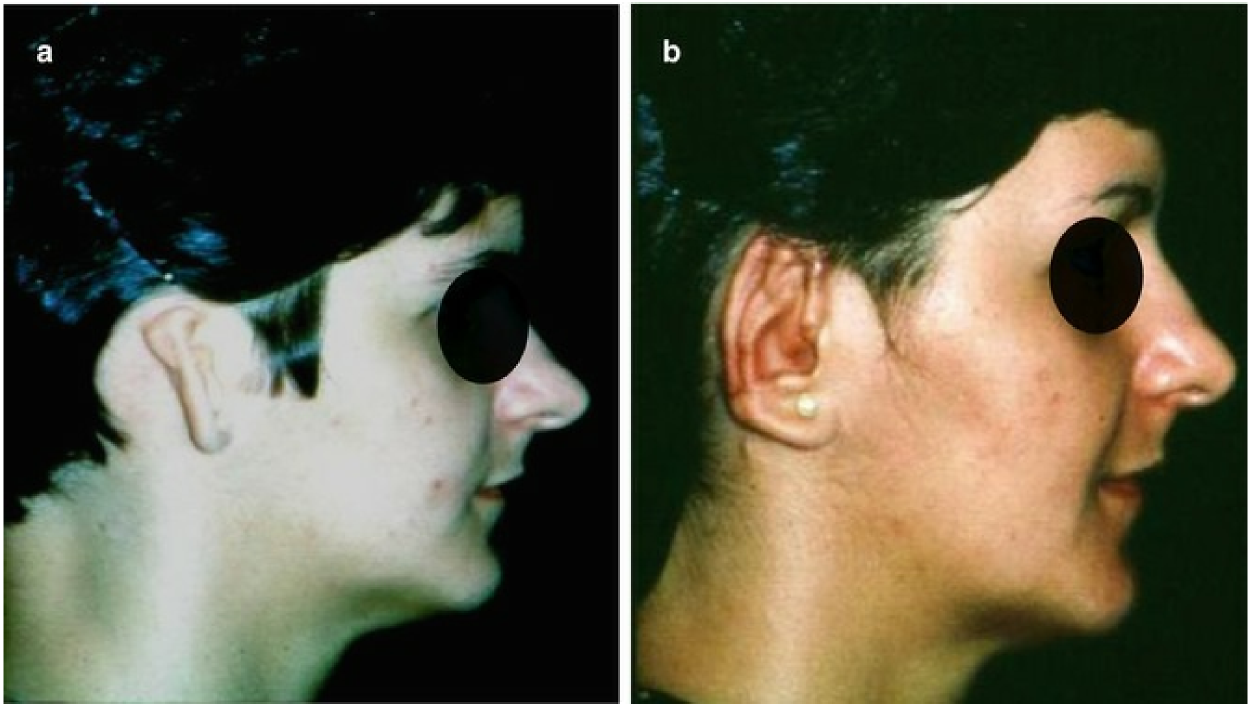
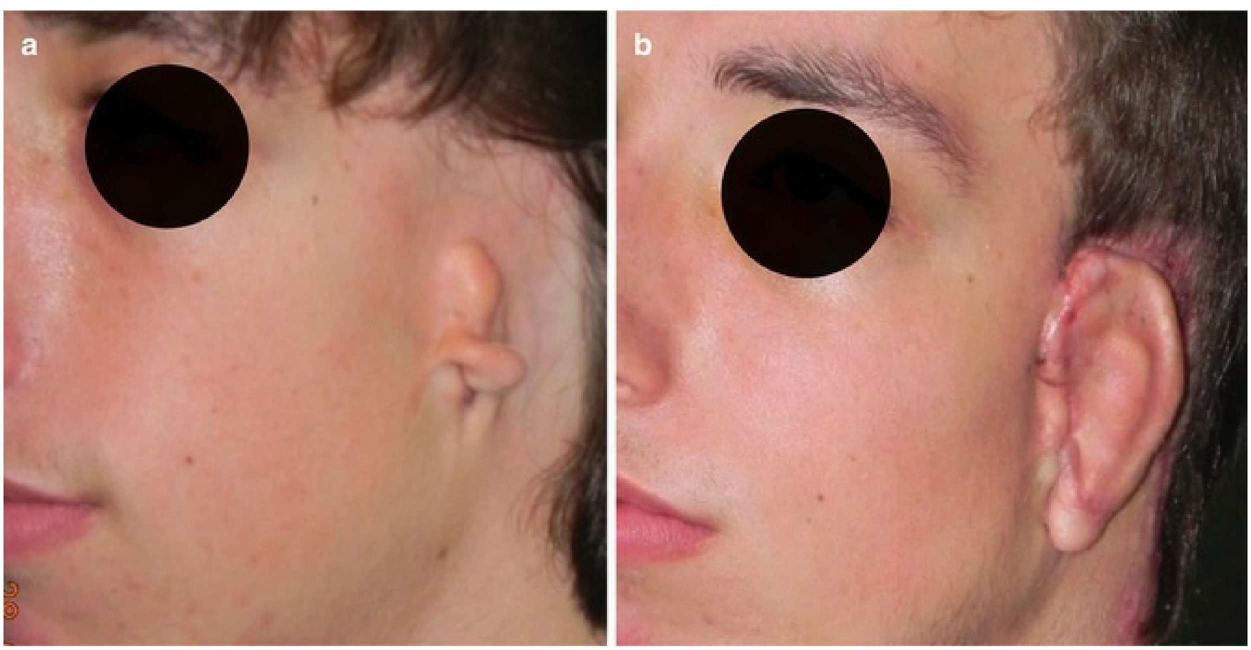


Fig. 2.5 Moderate eutopic microtia. Photos (**a**, **b**) always present a great amount of auricular cartilage with cutaneous covering that is used during the reconstruction. The remaining auricular tissue is located in the normal position



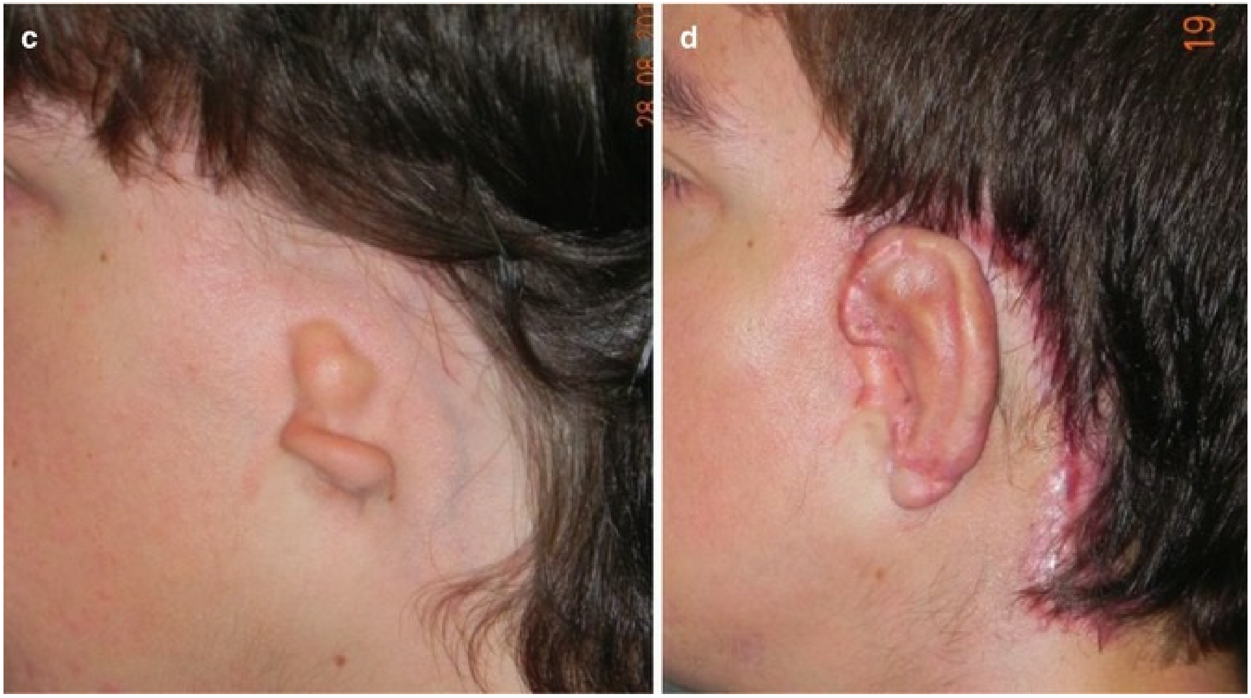


Fig. 2.6 Moderate ectopic microtia. A 19-year-old male with moderate ectopic microtia on left side. Photo (**a**, **c**) in oblique view before surgery; (**b**, **d**) same patient 2 years after two-stage ear reconstruction with transposition of the external ear canal to its normal location

The success of the operation depends on correct diagnosis in order to use the relevant technique, since repairing any ear defect is not as simple as a routine procedure. This concept is the key to the surgical treatment of ear imperfections, because each defect requires adequate analysis to evaluate the remnant tissues and finally to plan the reconstruction (Avelar 1977, 1979, 2013).

According to Rogers (1974), in 1929 Marx proposed a classification into three groups: Grades I, II, and III, depending on the severity and degree of malformation without reference to associated anomalies. Following Avelar's classification (Avelar 1986, 1989), it is useful to identify the anomalies of the ear and associated deformities as well. Further information was added to the previous classification (Avelar 2011, 2013) as a result of meticulous clinical evaluation. Currently, the classification is based on embryological, anatomical, functional, clinical, and surgical fundamentals in order to identify the deformities of the ear as well as the other segments of the body to optimize the relevant technique.

Embryological characteristics are used because some anomalies are related to other segments or organs of the body. Anatomical, functional, and clinical characteristics are used because each group of deformities presents correlated alterations on the remnant auricular tissues with repercussions for hearing function. Surgical characteristics are used because each group of deformities requires the most fitting approach to properly treat the anomaly.

The embryological development of the external auricles originates at the ectoderm, and the middle and internal ears at the mesoderm. Therefore, according to the classification, anotia (Fig. 2.3), moderate ectopic microtia, (Fig. 2.6), and agenesis of the ear (Fig. 2.3) are dysgeneses originating from an association of ectoderm and mesoderm disturbances. For this reason, most patients with such deformities present with congenital abnormalities in several organs and segments of their bodies. On the other hand, patients with severe microtia (Fig. 2.4) or moderate eutopic microtia (Fig. 2.5) do not present with complex associated congenital deformities of other organs because the anomalies are derived specifically from disturbances of ectoderm development.

Regarding the anatomical, functional, and clinical alterations, each group of patients presents with similar alterations of the anatomy, hearing, and clinical form as well. Therefore, by analyzing each patient and studying his or her congenital anomalies, the following classification was proposed (Table 2.1):

Table 2.1 Congenital anomalies of the ear. Total: 576 patients

Congenital anomaly	Number of patients (percentage according to all anomalies)	Number of ears
Anotia	56 patients (9.72%)	61
Agenesis of the auricle	10 patients (1.73%)	14
Microtias	510 patients (88.54%)	599
Severe microtia	331 patients (57.46%)	367
Moderate eutopic microtia	128 patients (22.22%)	161
Moderate ectopic microtia	51 patients (8.85%)	71
Total	**576 patients**	**674**

The classification of congenital deformities is the result of a study of 576 patients with the absence or reduced size of the ear cartilage. Among those patients, 674 ears have been already been reconstructed using rib cartilage to replace the lack of auricular framework. As described in Table 2.1, congenital anomalies of the auricles are anotia, agenesis of the auricle, severe microtia, moderate eutopic microtia, and moderate ectopic microtia.

2.3.1 Anotia

The term anotia comes from the Greek and means “complete absence of the auricle.” I recommend this term only for congenital dysgenesis of the ear in which there is no remnant auricular cartilage. Because there is no cartilage, the external ear canal does not exist (Fig. 2.2a, b). For this reason, the term anotia really represents the complete absence of the whole auditory system (external auricle, middle, and inner ear). Authors such as Melnick and Myrinthopoulos (1979) described anotia as complete absence of the external ear without any correlation with other congenital anomalies. In Avelar’s classification, patients with anotia always present with agenesis of all auricular cartilaginous internal structures because they do not have an external auditory canal. In addition to the absence of the auricle, all our patients with anotia present with complex associated malformations of either the face, torso, lower and upper extremities, as well as the internal organs of the chest and abdominal cavities (Fig. 2.2a, b).

Among the 576 patients with congenital anomalies of the auricle who underwent ear reconstruction at the Brazilian Ear Institute, there were 56 cases of anotia (9.72%), in which the absence of the cartilaginous tissue was the essential characteristic (Table 2.2).

Table 2.2 Anotia: 56 patients (9.7%) incidence among 576 patients with congenital anomalies of the ear

Side of the deformity	Number of patients (percentage withinanotia group)	Number of ears
Right side	26 (46.42%)	26
Left side	25 (44.64%)	25
Bilateral	5 (×2) (8.92%)	10
Total	**56 patients (9.72%)**	**61**
	Male = 57%	**Female = 43%**

2.3.2 Agenesis of the Auricle

There were 10 patients (1.73%) classified with agenesis of the auricle among the 576 patients presenting with anomalies of the ear. Within this group of deformities, 8 presented with congenital bilateral facial palsy associated with a peculiar dysgenesis of the auricle presenting with external auditory canal and tragus caused by the presence of a rudimentary cartilage (Fig. 2.3). This anomaly is very different from microtia and anotia (Table 2.3).

Table 2.3 Agenesis of the auricle: 10 patients (1.73%) – incidence among 576 patients with congenital anomalies of the ear

Side of the deformity	**Number of patients (percentage within agenesis of the auricle group)**	**Number of ears**
Right side	5 (50%)	5
Left side	1 (10%)	1
Bilateral	4 (×2) (40%)	8
Total	**10 patients (1.73%)**	**14**
	Male = 80%	**Female = 20%**

2.3.3 Microtia

The term microtia also comes from Greek and means "small ear."

Converse and Wood-Smith (1963) considered microtia to be all deformities of the ear. Because of its constant use, it has symbolized all congenital auricular deformities for many decades, as described by Spina et al. (1971). We are not included in this group of surgeons because our concepts in this field give us a different view of the anomalies.

After thorough studies and analyses of 40 different groups, Rogers (1968) classified these malformations into four groups: microtia, lop ear, cup ear, and prominent ear. On the other hand, Tanzer (1975) called "constricted ear" those deformities classified by Rogers as cup ear and lop ear. Therefore, there is no common terminology among surgeons who perform ear reconstruction. The term anotia has not been mentioned by the authors. Later, Melnick and Myrianthopoulos (1979) proposed another classification including the terms anotia, microear, cryptotia, and macrotia, without any relationship to anomalies of other organs and regions. Avelar's classifications (Avelar 1986, 2011, 2013) were useful in practice to identify the deformities in order to use an appropriate surgical technique (Fig. 2.4).

Our preference is to apply the term microtia only to congenital deformities where there is a diminution of the size of the auricular cartilage (Table 2.4), which occurred in 510 (88.54%) patients (Fig. 2.4a, b). In Avelar's classification, there are three groups of deformities in microtia:

severe microtia (Fig. 2.4), moderate eutopic microtia (Fig. 2.5), and moderate ectopic microtia (Fig. 2.6).

Table 2.4 Microtias: 510 patients (88.54%) – incidence among 576 patients with congenital anomalies of the ear

Side of the deformity	Number of patients (percentagewithin microtia group)	Number of ears
Right	289 (56.07%)	289
Left	132 (25.88%)	132
Bilateral	89 (×2) (17.45%)	178
Total	**510 patients (88.54%)**	**599**
	Male = 55.5%	**Female = 44.5%**

2.3.4 Severe Microtia

The term “severe microtia” is applied to congenital anomalies when the remnant cartilaginous tissue is too small to be used during reconstruction. It should be totally removed during the first stage of surgery. Among the 576 patients, there were 331 (57.46%) presenting with a wide variety of clinical forms in which the external shape was similar to a very large comma.

The comma shape presents two segments: The upper segment is created by the presence of a rudimentary portion of the undeveloped auricular cartilage underneath the cutaneous covering. The lower segment is an anatomical structure similar to an auricular lobule − but in the wrong position − which represents the lower tail of the comma. There are also intermediate cases where the tragus, auditory canal, and lobule are present. Therefore, in Avelar’s classification, this is included in the severe microtia group (Table 2.5).

Table 2.5 Severe microtia – incidence among all microtia

	Number of patients (percentage according to microtia)	Number of ears
Right side	212 patients (64.04%	212
Left side	83 patients (25.07%)	83
Bilateral	36 (×2) (10.87%)	72
Total	**331 patients (57.46%)**	**367**
	Male = 56.5%	**Female = 40.5%**

All patients with severe microtia have associated deformities only on neighboring regions of the face and skull, which is denoted as hemicraniofacial microsomia. Therefore Avelar's classification is based on correlated anomalies of the ear with malformation on other segments of the human body.

2.3.5 Moderate Microtia

Moderate microtia includes those deformities presenting with the following anatomical elements:

1. Auricular lobule

2. Reduced conchal wall and reduced conchal cavity

3. Tragus

4. Incomplete helix

5. Incomplete antihelix

All remaining structures are added to the ear during the second stage of reconstruction.

Moderate microtia presents as two groups of deformities: moderate eutopic and moderate ectopic microtia. The presence of an incomplete helix, conchal cavity, scapha, and lobule is classified by Pitanguy (1967) as typical due to the presence of a rudimentary conchal wall − Rogers (1968) as "cup ear" and "lop ear," and by Tanzer (1975) as "constricted ear." This terminology is also mentioned by Melnick and Myrianthopoulos (1979). However, we call those deformities "moderate microtia" (Fig. 2.5), as it occurred in 179 patients (18.5%). Such a malformation is a deficiency of the helix and scapha in combination with inadequate development of the antihelix. We use the expression moderate microtia because the deformity is an incomplete development of the external auricle and the entire anatomical structure will be used during reconstruction of the new ear. This is the main difference between microtia and moderate microtia in Avelar's classification (Table 2.6). During the last 15 years, some peculiar anatomical anomalies have been found that caused the addition of the terminology "moderate eutopic microtia" (Fig. 2.5) and "moderate ectopic microtia" (Fig. 2.6).

Table 2.6 Incidence of moderate microtia among all microtias

Side of the deformity	Number of patients (percentage according to microtia)	Number of ears
Right side	77 patients (43.01%)	77
Left side	49 patients (27.37%)	49
Bilateral	53 patients (29.60%)	106
Total	**179(18.5%)**	**232**
	Male = 55%	**Female = 45%**

2.3.6 Moderate Eutopic Microtia

It is considered to be "moderate eutopic microtia" when a patient presents with all remnant auricular tissue located at the same level of the normal position of the future auricle (Fig. 2.5). At the Brazilian Ear Institute, there have been 128 such cases (22.22%) among the 576 patients with congenital anomalies (Table 2.7). They presented with anatomical structures that were incorporated into the new ear during the second stage of surgery. These patients did not have complex associated deformities, only facial asymmetry caused by hypodevelopment of the facial bone structures (malar, zygomatic arch, jaw, and maxilla).

Table 2.7 Incidence of moderate eutopic microtia among all moderate microtias

Side of the deformity	Number of patients (percentage according to microtia)	Number of ears
Right side	61 (47.65%)	61
Left side	34 (26.56%)	34
Bilateral	33 (×2) (25.78%)	66
Total	**128(14.6%)**	**161**
	Male = 58.5%	**Female = 41.5%**

2.3.7 Moderate Ectopic Microtia

In this group of deformities, all remnants of auricular tissue are located at an abnormal position, lower than the other side, and require lifting during the second stage of ear reconstruction (Fig. 2.6). The external auditory canal is obliquely directed downward with some degree of hearing deficiency. Therefore, all auricular structures must be totally preserved during reconstruction of the ear. There were 51 cases (8.85%) presenting with this congenital anomaly among the 576 patients with congenital anomalies (Table 2.8).

Table 2.8 Incidence of moderate ectopic microtia among all moderate microtias

Side of the deformity	Number of patients (percentage according to microtia)	Number of ears
Right side	16 (31.37%)	16
Left side	15 (29.41%)	15
Bilateral	20 (×2) (39.21%)	40
Total	**51 patients (8.85%)**	**71**
	Male = 53%	**Female = 47%**

Regarding associated abnormalities, all patients within the group of moderate ectopic microtia presented with quite complex deformities in neighboring regions (face and head), as well as on other segments and organs of the body, such as the chest (also in internal organs), spinal column, or on the lower or the upper extremities. The most frequent combined anomaly was in the heart (cardiac valves, dextrocardia, transposition of the great vessels of the base of the heart, Fallot's tetralogy). Therefore, the Avelar classification includes congenital deformity of the ear correlated with all segments of the human body, as a result of an embryological-anatomical-functional-clinical-surgical study.

2.3.8 Macrotia

The third group in Avelar's classification is macrotia, and the fourth, prominent ear, includes congenital imperfections. Macrotia is an auricle with normal structural architecture of the framework but larger than normal size. This abnormality is a hyperplasia with excessive embryological development; usually young and adult patients complain about this deformity. The surgical treatment requires reduction of the auricular framework (reduction otoplasty) (Avelar 1992) and is performed through incisions on the ear cartilage to reduce its size. (This topic is so important and seen so frequently that all clinical and surgical aspects of it are discussed in Chapter 17 of this book.) On the other hand, there are patients above age 70 who present with macrotia caused by elongation of the ear lobule over the course of their lives. Its correction is a single surgical reduction of the lobule without reducing the cartilage architecture.

2.3.9 Cryptotia

There is another deformity called "cryptotia," described by Warkany (1971) and Melnick and Myrianthopoulos (1979), among others (Fig. 2.1). The term is not included in Avelar's classification because it is very rare and we have not seen even one patient presenting with such an anomaly.

The fundamental basis of Avelar's classification of auricular dysgenesis is the structural architecture of the remnant cartilaginous tissue. A study of anatomical dissections of cartilage elements in congenital deformities shows the presence of folds, reliefs, and depressions, very similar to the normal ear's cartilaginous structures but much smaller. All our patients classified with microtia presented with remnant auricular cartilage with similarity to an ear, but much smaller than a normal one.

At the Brazilian Ear Institute, we have a very interesting and fascinating collection of remnant cartilages that have been removed from patients over a period of 43 years (Fig. 2.7). The Avelar classification is based on research of these rudimentary cartilages found in the auricular area during ear reconstruction. In fact, these pieces of cartilage have characteristics very similar to those of a normal auricle, but are just smaller in size. In our group of patients, the percentage of congenital deformities of the ear is higher in males than in females and much more frequent on the right side than on the left.

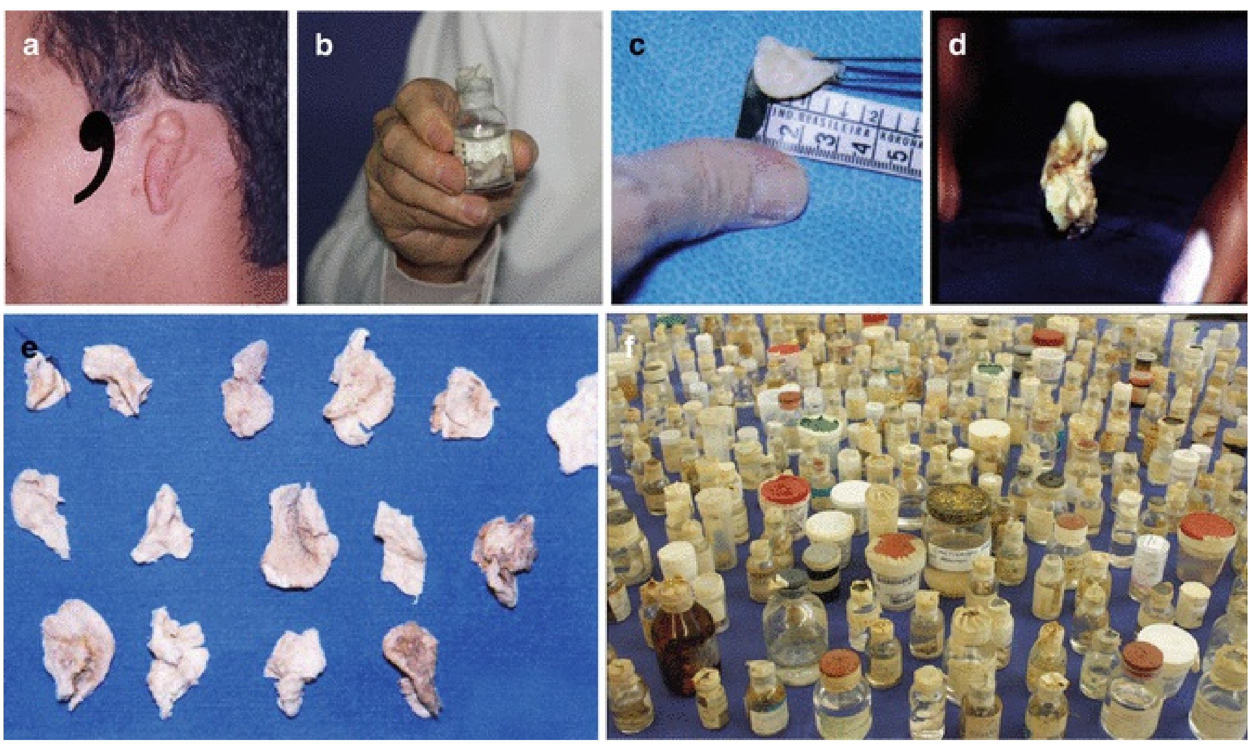


Fig. 2.7 Severe microtia. All patients in this group present rudimentary auricular cartilage that is not

used during reconstruction, so it is always removed during reconstruction. (**a**) A patient with severe microtia. The remaining auricular tissue presents two folds with a similar “comma” shape (,): the superior one always presents the rudimentary ear cartilage; the inferior one is always similar to an earlobe, but is in the wrong position with an upward rotation.(**b**–**d**). A few examples of remaining auricular cartilage. One can see its size in comparison to fingers and fingernails. Those cartilage structures are located under the superior fold. (**e**) Several remnants of auricular cartilage were removed from severe microtia to study and research the shape, which is very similar to normal auricular cartilage. (**f**) Photo of a collection at the Brazilian Ear Institute where there are about 500 samples

2.4 Discussion

Congenital anomalies of the auricle present in very many clinical forms that should be identified before planning as well as performing their reconstruction. Besides the vast variation in the deformities, it is well known that there are numerous associated dimorphisms because the embryological development occurs simultaneously with all organs and regions of the human body. We have always been very concerned about classifying the congenital anomalies of the ear and trying to identify each one. Therefore, Avelar’s classification is the result of 43 years of practice, studying and analyzing the remaining cartilaginous tissue in each patient, which has been very useful (Avelar 1986, 1997). His classification is based on embryological, anatomical, functional, clinical, and surgical fundamentals to identify the deformity of the ear as well as the other segments of the body in order to optimize the relevant technique. Congenital anomalies of the auricle are classified into five groups: anotia, agenesis of the auricle, and microtia which has three different modalities – severe microtia, moderate eutopic microtia, and moderate ectopic microtia.

The *embryological fundament* is based on a comprehensive study that shows that anomalies of the external ear are caused by an alteration in the development of the ectoderm and are limited to the neighboring structures: severe microtia and moderate eutopic microtia.

The *anatomical fundament* is that each group of patients presents with a peculiar anatomy. Patients classified with severe microtia and moderate eutopic microtia do not present with complex anomalies of the body, rather with a minor or medial degree of facial asymmetry.

The *functional fundament* of the classification is based on severe hearing disturbances in patients diagnosed with anotia, moderate ectopic microtia, and agenesis of the auricles.

The *clinical fundaments* are clear because patients with severe microtia as well as those diagnosed with moderate eutopic microtia do not present complex alterations of the face or body.

The *surgical fundaments* are a result of all the factors previously mentioned because the surgical technique for reconstruction is different for each group of patients. Patients with severe microtia always present with a rudimentary lobule in an abnormal position, which is rotated during the first stage of reconstruction to the correct position and location.

Conclusions Congenital anomalies of the auricle are classified into five groups: anotia, agenesis of the auricle, and microtia, which presents three different modalities – severe microtia, moderate eutopic microtia, and moderate ectopic microtia. The auricle is at the center of the anomalies that involve neighboring structures. The frequency of associated deformities diminishes with the distance from the ear. Every patient diagnosed with anotia, agenesis of the auricle, or moderate ectopic microtia always presents with congenital defects in other organs. Patients with severe microtia and moderate eutopic microtia may present with minor or medial anomalies on neighboring regions. The planning for reconstruction depends primarily on the identification of the congenital anomaly in order to choose an appropriate technique. Anomalies of the ear are seen more often in male patients, and twice as often on the right side.

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3. Anomalies Associated with Digenesis of the Ear

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3.1 Introduction

All auricular malformations concerning the absence or reduction of the ear cartilage frequently occur with other abnormalities. Most of them affect the face and the skull, but the torso, internal organs of the chest and abdomen, and upper and lower extremities also present congenital imperfections. For this reason, the associated lesions may be classified into two groups: anomalies in neighboring structures, and anomalies in distant structures Melnick and Myrianthopoulos (1979), and Warkany (1971).

Congenital abnormalities have a complex association with other regions and segments of the human body; thus, they are an important field in ear reconstruction. Very often, congenital anomalies are associated with other deformities of the body that occur during the critical period of embryogenesis referred to by Nishimura and Tanimura (1976) as being between the 3rd and 12th week post-conception in humans. In about the 6th week of embryonic life, the six hillocks that originated on ectodermal thickening begin to grow, following the development of the ears (Rogers 1968, 1974). Such a period may be more precisely placed between the 8th and 12th week of gestation (Avelar and Bocchino 1989). Patients with auricular dysmorphogenesis involving the absence or diminution of the size of the ear cartilage present with one, two, three, or more associated lesions because of combined embryologic disturbances (Tanzer 1975; Spina et al. 1971).

Before performing an operation, a thorough physical examination must be done to identify all deformities. Surgical planning of ear reconstruction may be performed according to the correct diagnosis, as well as identifying correlated dimorphisms of other organs (Converse 1968). It is useful to consider congenital malformations of the ear along with several combined anomalies of other organs and segments of the body.

3.2 Neighboring Anomalies

Neighboring anomalies are those that may occur in any anatomical structure of the face or skull. Most of the deformities are associated with patients presenting with all auricular anomalies. Patients classified with severe microtia or moderate eutopic microtia present with minor or medial degrees of facial asymmetry. However, all patients classified with anotia, agenesis of the auricle, or moderate ectopic microtia present with major facial asymmetry caused by complex hypoplasia of the facial bones.

Cranial and facial lesions are the cause of facial asymmetry. The imbalance of the facial bone skeleton occurs in three degrees: serious, medial, and minor, with the resulting defect in dental malocclusion and diminished size of the homolateral orbital cavity. The soft parts are equally affected to a similar degree, involving the sternocleidomastoid, temporal, and masseter muscles, and greatly worsening the picture of lack of facial symmetry (Avelar 1977, 1978). The skin of the mastoid region is thinner than on the normal side, and hair diminishes in most patients. However, just as often, a low implantation of the hairline occurs, which in some cases makes the planning and reconstruction of the auricle difficult. The homologous labial commissure may be pushed toward the side of the deformity and in some more serious cases seems to undergo traction in the direction and orientation of the ear. The following deformities may occur in association with ear deformities:

1. Pre-auricular tubercle
2. Cleft palate lip (Fig. 3.1)
3. Cleft lip (Fig. 3.1)
4. Cleft palate (Fig. 3.1)
5. Macrostomia
6. Microstomia
7. Agenesis of the tonsils
8. Cleft uvula
9. Agenesis of the lachrymal duct
10. Facial paralysis
11. Paralysis of the posterior palate
12. Hearing impairment
13. Speech defect

Fig. 3.1 A child with anotia on left side associated with a bilateral cleft lip and palate and complex anomaly on the left upper extremity

The most complex deformities in distant or neighboring structures of the auricle occur in patients with anotia, moderate ectopic microtia, and bilateral dysgenesis of the auricle.

3.3 Lesions in Distant Structures

There have been several patients at the Brazilian Ear Institute with a wide variety of anomalies in several parts of the body. Deformities in distant structures are those that may occur on the chest, spinal column, upper and lower extremities, and genitalia, as well as internal organs of the chest (heart, lungs) and abdomen (liver, stomach, kidneys, spleen).

All our patients classified as anotia and moderate ectopic microtia always present complex correlated anomalies on distant regions and organs. The following anomalies are always associated with auricle malformations in patients with anotia or moderate ectopic microtia:

Congenital laxation of the hip (Fig. 3.2)

Situs inversus totalis (Fig. 3.3)

Dextrocardia (Fig. 3.4)

Pectus excavatum (Fig. 3.5)

Phocomelia associated with severe chest deformities (Figs. 3.6 and 3.7)

Anomalies of the heart valves

Fallot tetralogy

Pectus carinatum associated with severe deformities of the column (Fig. 3.8)

Polydactylism

Sindactilia (Fig. 3.9)

Transposition of the great vessels at the base of the heart

Deformities of the spinal column

Agenesis of the thumb (Figs. 3.6 and 3.7)

Congenital torticollis (Figs. 3.10 and 3.11), (Rogers 1968)

Deformities of the chest (Figs. 3.4, 3.10, 3.11, 3.12 and 3.13) (Avelar 2011, 2013)

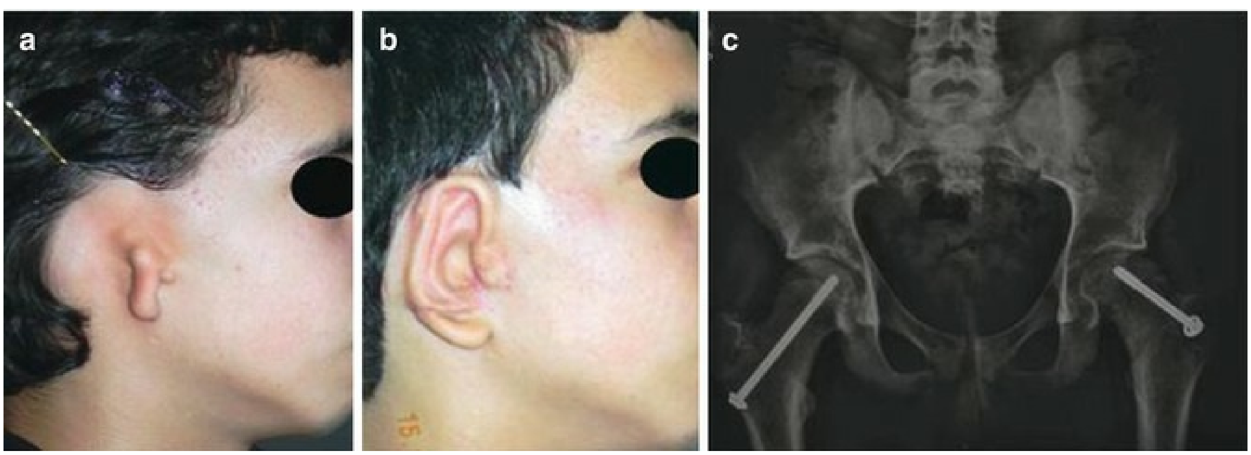


Fig. 3.2 Complex associated anomalies on two patients with anotia. (**a**) Pre-operative photo of a 19-year-old male patient with anotia on the right side. He presented with bilateral congenital dislocation of the hip. (**b**) Post-operative photo after the first stage of ear reconstruction using rib cartilage to excavate the new auricular framework. (**c**) Radiograph after orthopedic treatment. He also presented with a complex anomaly of the face, optic nerves, and polydactyl on his left hand

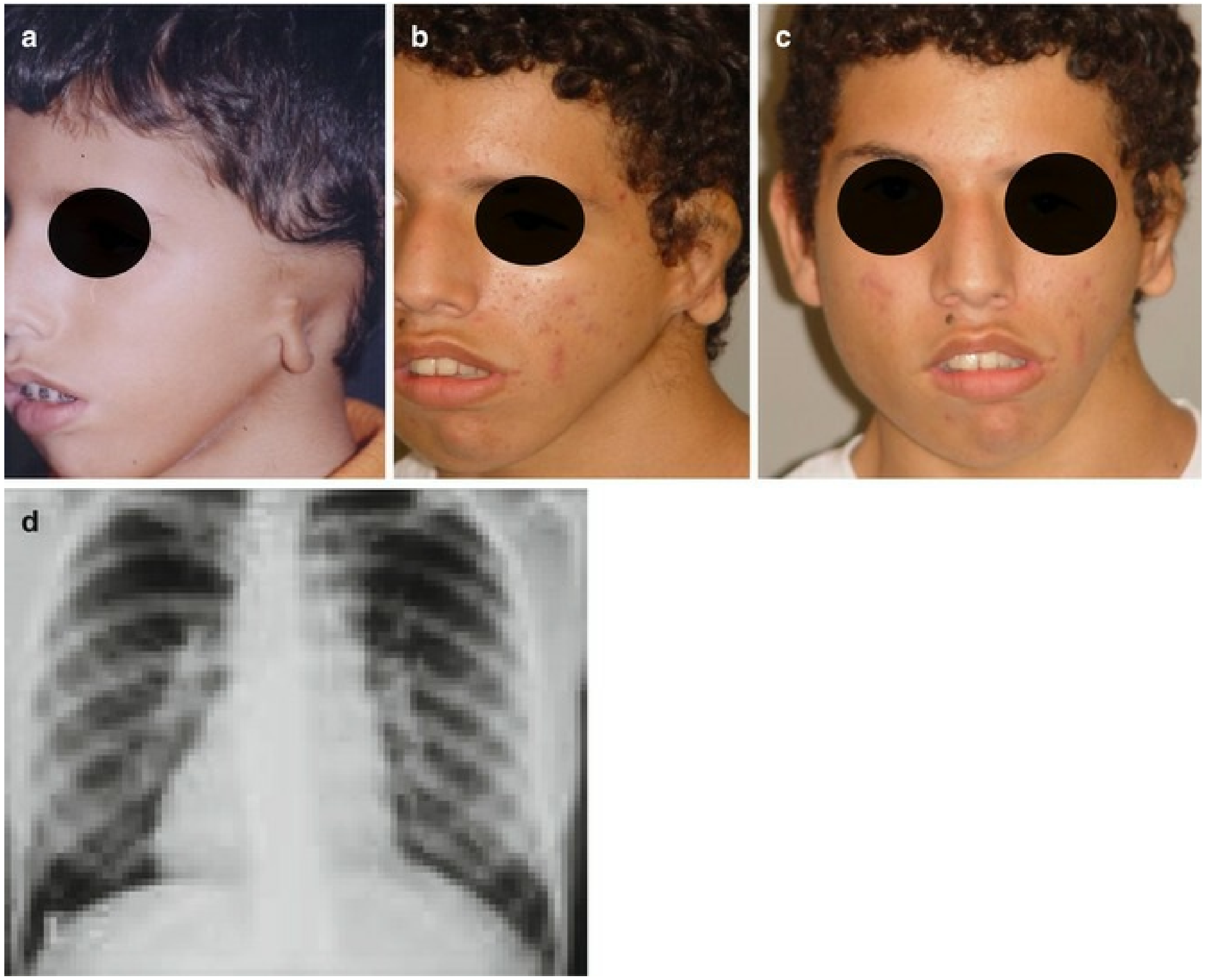


Fig. 3.3 (**a**) An 8-year-old boy with anotia on left side, presenting with complex associated anomalies including facial asymmetry and disturbance of dental arcade and dextrocardia. (**b**, **c**) Photo of the same patient at 16 years, showing post-operative results after two stages of ear reconstruction on the left side. (**d**) Radiograph where dextrocardia is evident combined with situs inversus totalis

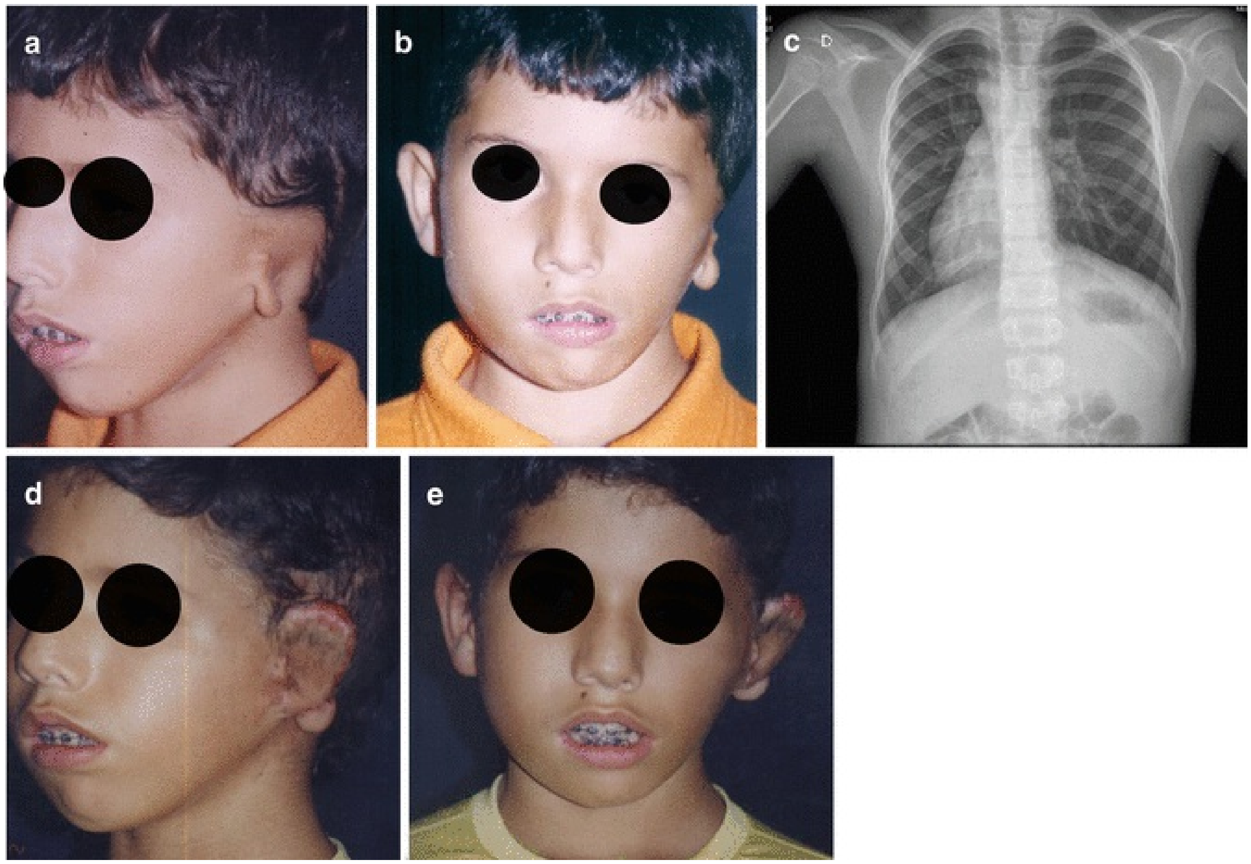
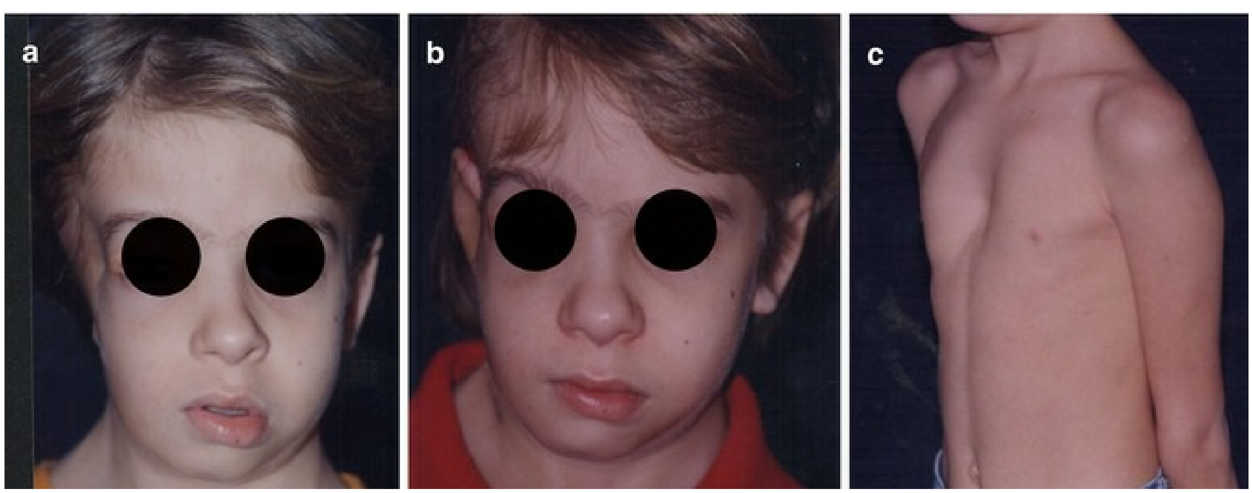


Fig. 3.4 Anotia associated with several congenital anomalies: dextrocardia, deformities of chest wall, facial asymmetry, and disturbance of dental arcade. (**a**) Oblique view of an 8-year-old boy with anotia on left side; (**b**) photo of frontal view; (**c**) radiograph showing dextrocardia; (**d**, **e**) oblique view and frontal view after two surgical stages of ear reconstruction on the left side



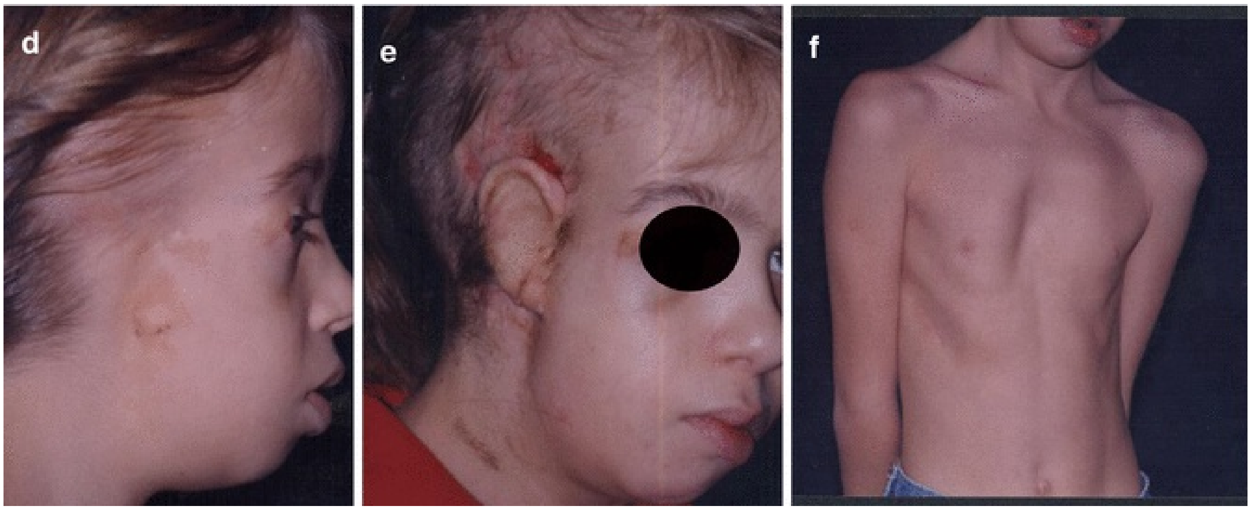


Fig. 3.5 Anotia associated with several complex body anomalies. (**a**) Pre-operative photo of a 10-year-old boy with anotia on the right side and noticeable facial asymmetry. (**b**) Post-operative view after ear reconstruction. (**c**) Oblique view of the thorax. One can see complex anomalies on his chest wall with pectus excavatum. (**d**) Same patient in profile view on the right side showing the absence of the auricle. (**e**) Post-operative view after two stages of total reconstruction of the right ear. (**f**) Oblique view of the torso showing all the spinal column and chest wall deformities

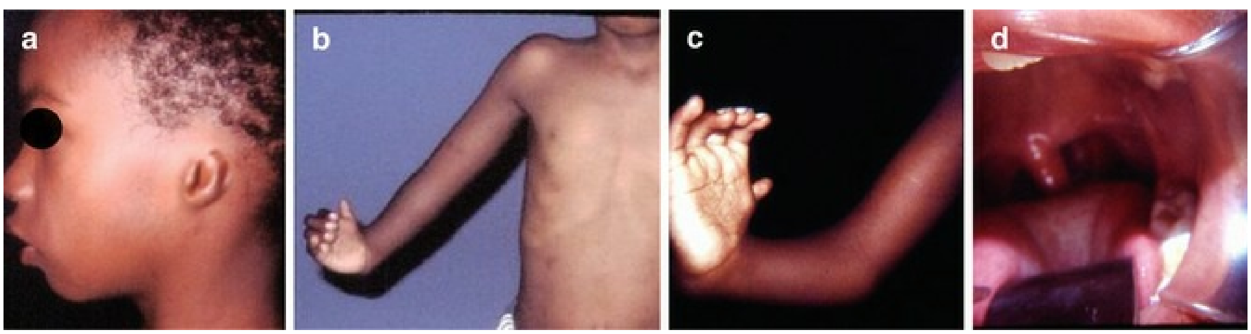


Fig. 3.6 Agenesis of the ear associated with complex deformities in several distinguished regions of the patient's body. (**a**) Bilateral facial palsy, micrognathia. (**b**, **c**) Phocomelia, agenesis of the ante-arm. (**d**) Tonsil agenesis

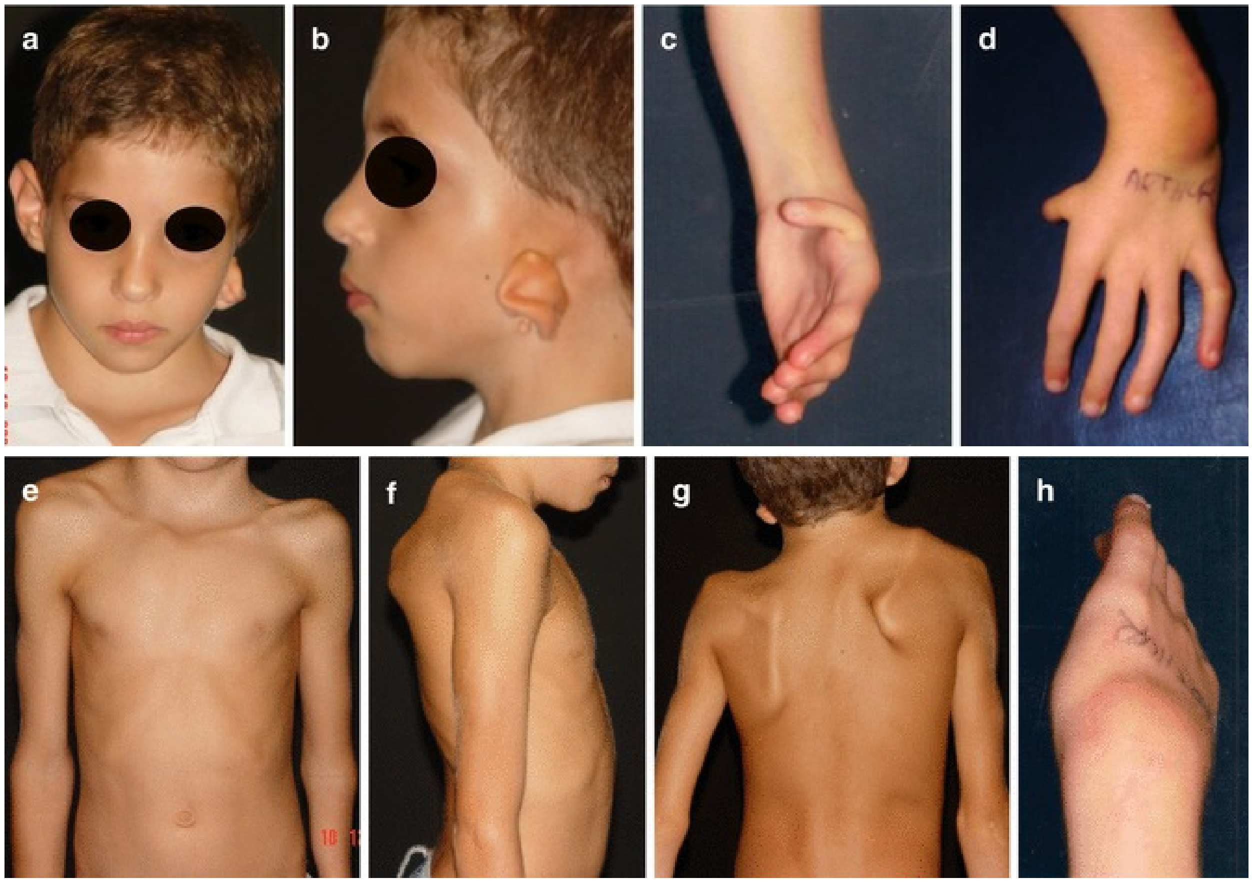


Fig. 3.7 Moderate ectopic microtia associated with face, body, and upper and lower extremities – many-sided anomalies. (**a**) Front view of a 9-year-old boy with pronounced moderate ectopic microtia on the left side with severe facial asymmetry related to the face, torso, and upper and lower extremities – several anomalies. (**b**) Profile view on the left side shows the low position of the remaining segments of the moderate ectopic microtia, which must be lifted during the second stage of ear reconstruction. (**c**, **d**) Photos of the left hand showing the phocomelia and also the absence of a thumb. (**e–g**) Photos of the torso of the same patient in front, right, and posterior views. One can see the severe imbalance of the spinal column and chest wall. (**h**) Photo of his left foot, showing severe deformities with agenesis of muscles, which causes functional disturbance while walking

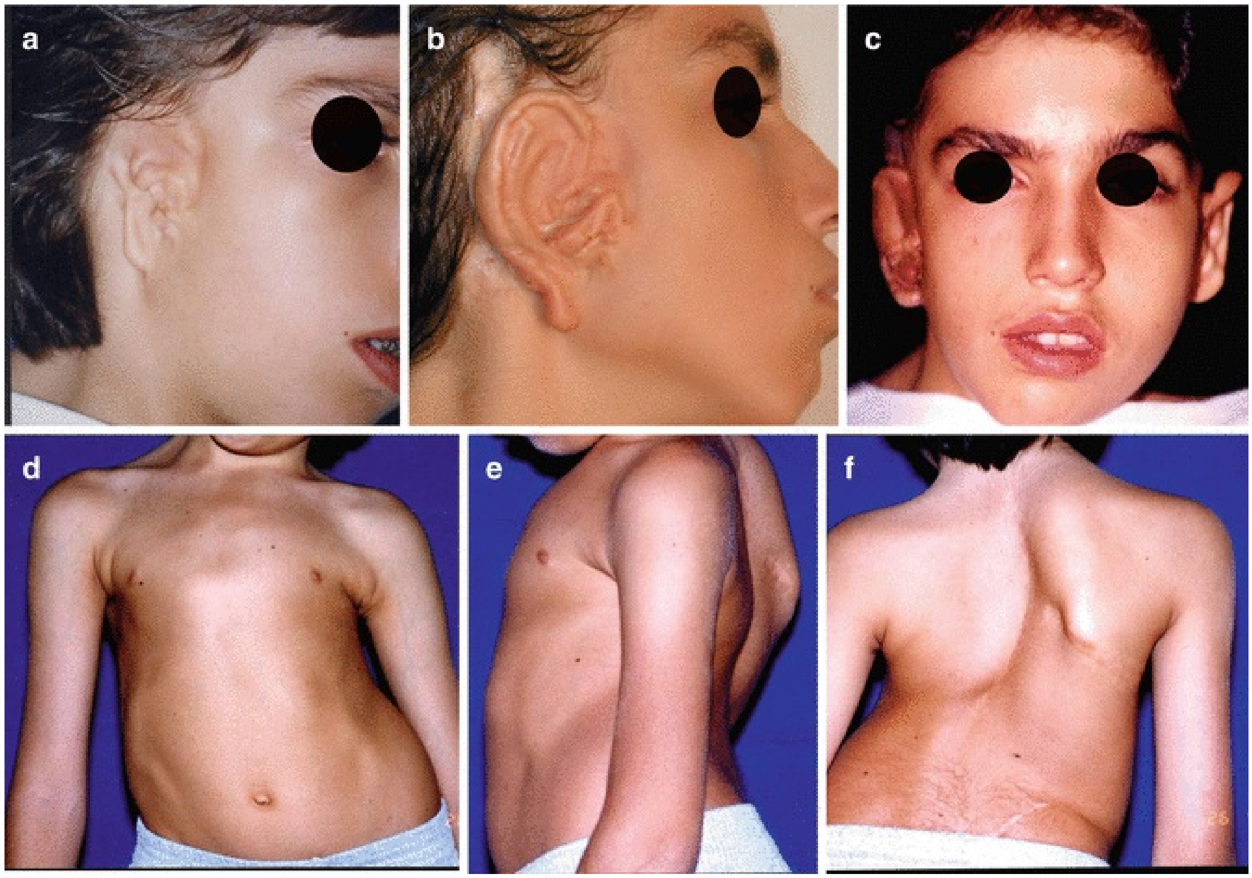


Fig. 3.8 Moderate ectopic microtia associated with complex related deformities of the face and body, pectus carinatum. (**a**) A 10-year-old boy presented with moderate ectopic microtia on the right side – before surgery. (**b**, **c**) Same patient after two stages of ear reconstruction on the right side. (**d**–**f**) Photos of the torso of the same patient in front, left, and posterior view showing severe disturbance of the spinal column and chest wall

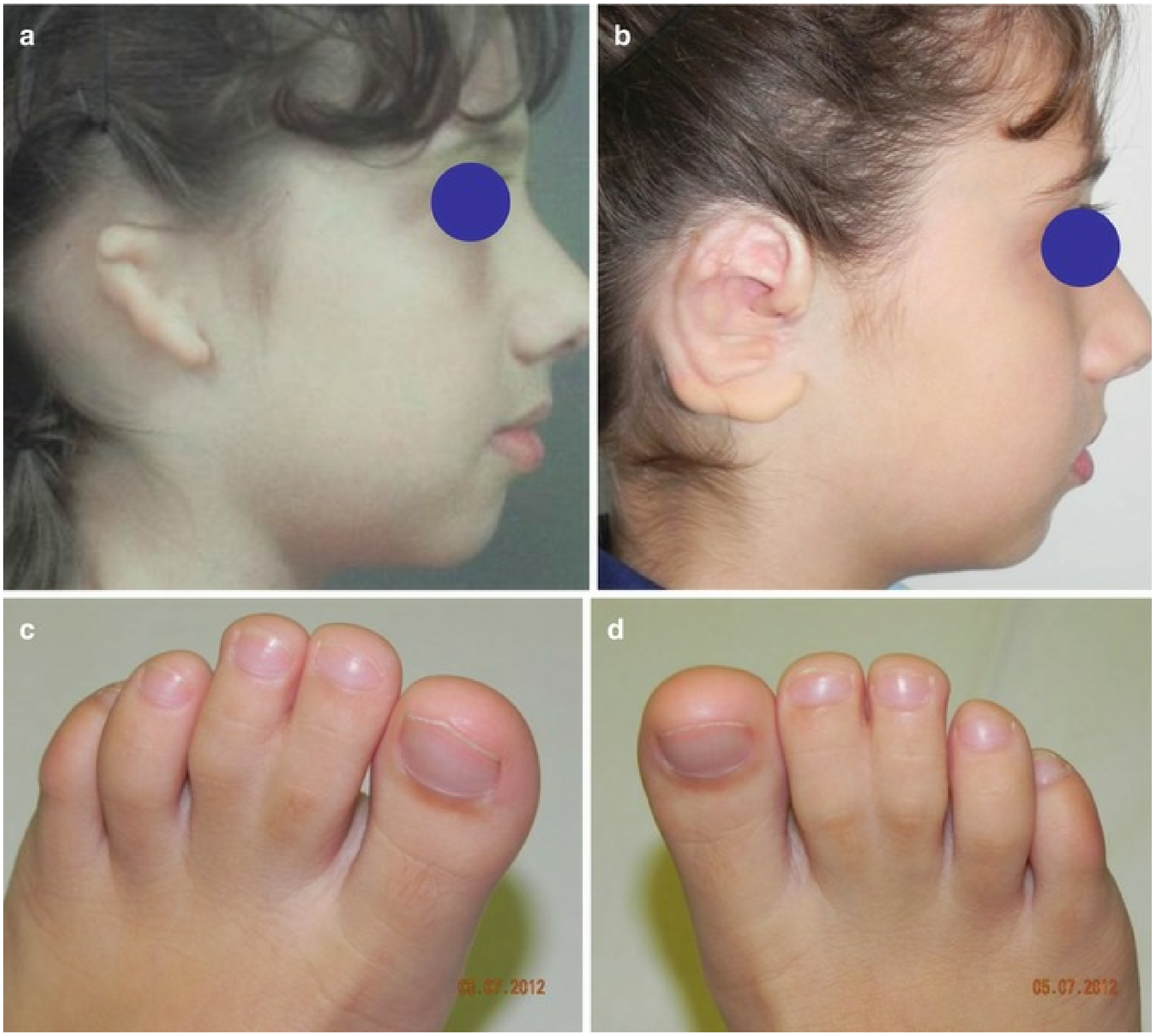


Fig. 3.9 Microtia associated with syndactyly on feet. (**a**) A 7-year-old female in a pre-operative photo of lateral view showing microtia; (**b**) post-operative after first stage of reconstruction; (**c**, **d**) photos of right and left feet

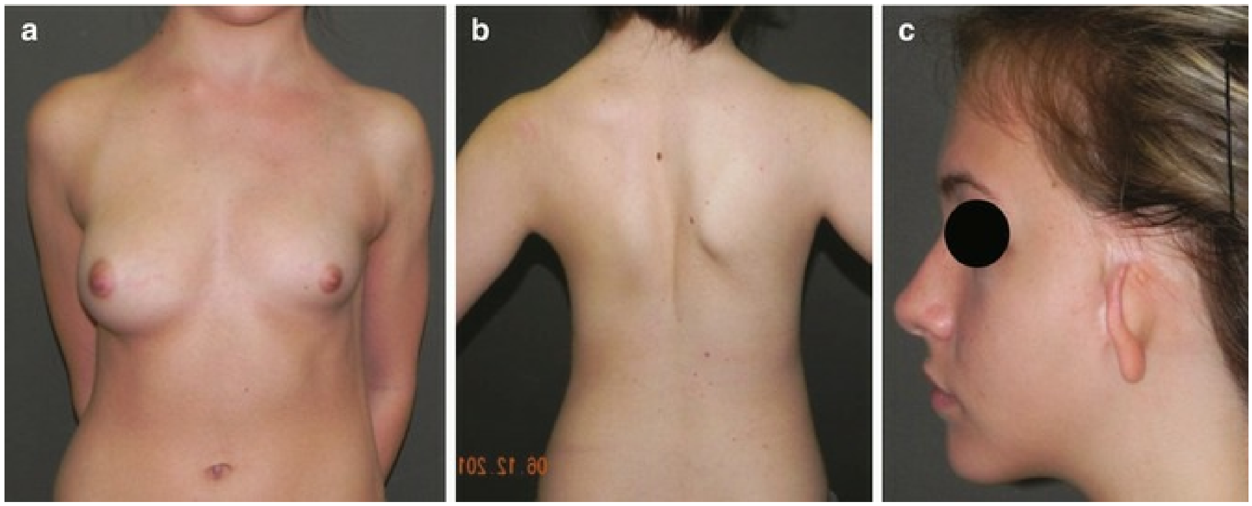


Fig. 3.10 A 17-year-old female patient with dysgenesis of the ear presenting severe associated anomalies: asymmetric breast, chest deformity, and congenital torticollis. (**a**) Frontal view; (**b**) in back view, one can see deviation of the column with asymmetry; (**c**) in lateral view of the face on left side, one can see the congenital deformity of the auricle


a
b
c
d

Fig. 3.11 Bilateral moderate ectopic microtia associated with severe asymmetry of the face, low implantation of the remnant auricles, congenital torticollis, severe hypoplasia of scapular segment, and genitourinary abnormalities. (**a**) Anterior view of the face of an 8-year-old boy; (**b**) posterior view of the head; (**c**) photo of the right ear; (**d**) left side; (**e**) from frontal view, one can see all associated deformities; (**f**) posterior view of same patient

Fig. 3.12 Moderate ectopic microtia on right side. Associated anomalies: (**a**) profile view; (**b**) front view where one can see facial asymmetry; (**c**) posterior view shows congenital torticollis; (**d**, **e**) on profile view of the one can see deformities of the chest; (**f**) posterior view of the torso with severe asymmetry

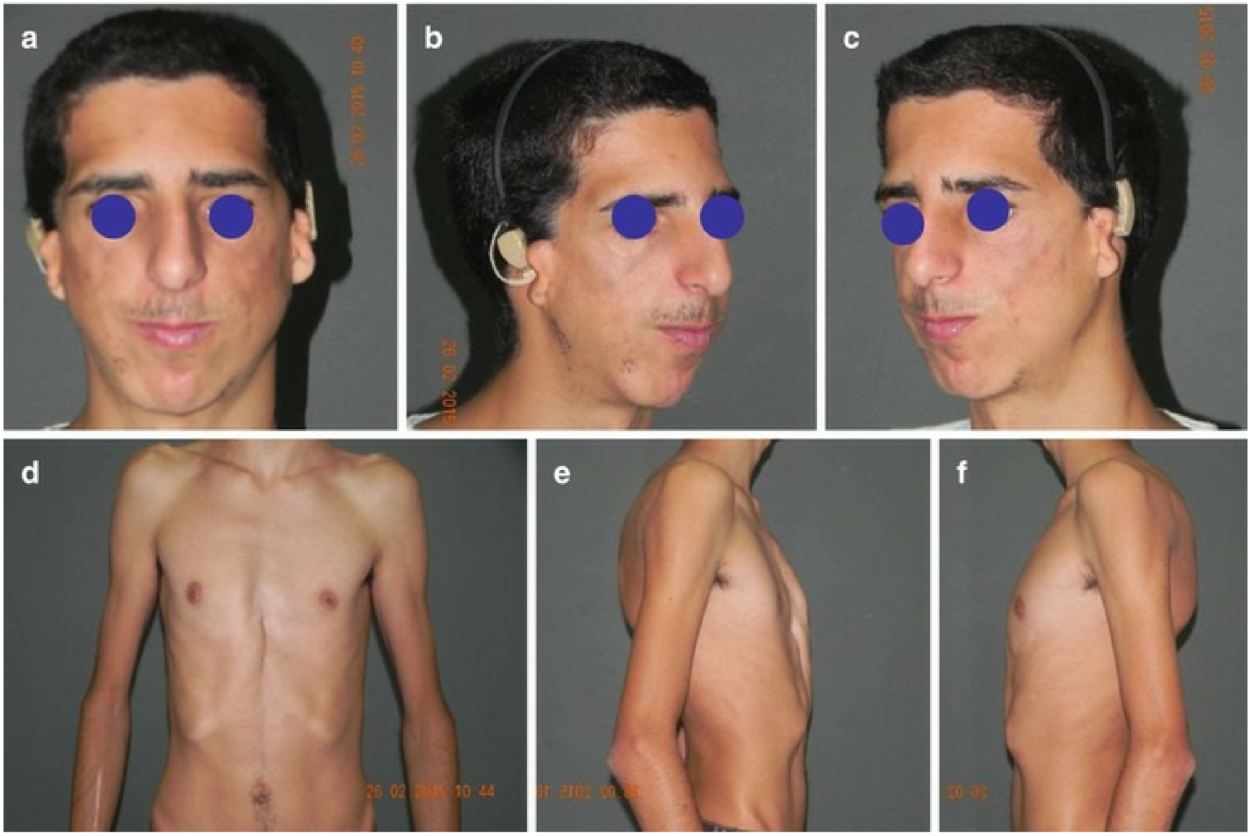


Fig. 3.13 Bilateral severe microtia associated with congenital anomalies of the chest wall with hypoplasia of the costal bones on right side. Photos: (**a**) frontal view of the face with bilateral severe microtia; (**b**, **c**) in oblique view of the same patient, one can see bilateral severe microtia; (**d**) frontal view of the chest with complex asymmetry of the costal ribs; (**e**) right side view showing the severe depression of the right side with deformities of the scapular bone; (**f**) left side view with asymmetric structural of the chest

3.4 Anal Imperforation

3.4.1 Esophageal Atresia

All our patients classified with anotia and moderate ectopic microtia present complex correlated anomalies on distant regions and organs. We have patients presenting with the following anomalies in association with malformation of the auricles:

Situs inversus totalis – 1 patient

Dextrocardia – 1 patient

Anomalies on the heart valvus – 7 patients

Pectus carinatum – 4 patients

Polydactylism – 2 patients

Syndactyly – 6 patients

Phocomelia – 2 patients

Fallot's tetralogy – 3 patients

Transposition of the great vessels at the base of the heart – 3 patients

Deformities of the chest – 4 patients

Deformities of the spinal column – 3 patients

Congenital laxation of the hip – 1 patient

3.5 Hearing Impairments

Congenital imperfections of the auricle are frequently accompanied by hearing deficiencies. In unilateral lesions, hearing was affected in 25% of our patients and in bilateral deformities in 85% of patients. The audiometric examination shows the level of these dysfunctions. Audiometry, which is very useful, is performed as a routine procedure (Avelar 1978, 1979). The imbalance observed in these patients, both in esthetics and hearing, is caused by psychological mechanisms and creates a compensating situation of the postural axis, which constitutes several physiological changes.

Tilting the head can be interpreted as a wish to hide the deformity and/or compensate for the hearing deficiency, with resulting cervical and postural tilt, thus influencing walking and the static-dynamic balance. Both sexes tend to wear their hair long to hide the defect.

The recovery of auditory function has been the main concern of some otologists, as mentioned by Derlacki (1969), but the consensus of surgeons who deal with the problems of auricular dysgenesis is to avoid functional intervention in the case of unilateral lesions. In bilateral deformities with severe functional repercussions, ear surgery to reconstruct the auditory canal in the temporal bone used to be considered an acceptable procedure for hearing recovery. However, nowadays cochlear implants have been more effective, with less damage to the reconstructed ear as well as when it may be performed prior to ear reconstruction. So far, such procedures must be done by otologists with sufficient experience in this field.

We do not agree about internal ear surgery in patients with unilateral lesions due to three main factors: first, every surgery leaves cutaneous scars and often causes fibrosis and hard scar tissue subcutaneously, which are factors that oppose auricular reconstruction; second, there is a risk of injuring the facial nerve (we have three patients with facial paralysis caused by this procedure); and third, there is the possibility of mastoid osteomyelitis (we have two patients who have presented with this complication since they underwent surgery over 7 years ago).

3.6 Discussion

There are many anomalies of several regions of the human body associated with congenital abnormalities of the auricle. Those combined deformities are a constant challenge in plastic surgery, since all problems require adequate treatment. In fact, they present in many clinical forms that should be identified before planning and performing reconstruction. Besides the vast variation of the deformities of the ears, dimorphisms of several regions and organs occur due to embryological development simultaneously with other organs and regions. We have always been very concerned about classifying the congenital anomalies of the ear and trying to identify each one. Therefore, Avelar's classification is the result of a couple of years of practice and comprehensive research, which were very useful (Avelar 1986). Currently, other groups of deformities are included because the patients present with some similarities among them. During this period, a correlation was made between each group of deformities in comparison with others. Therefore, Avelar's classification is a result of embryological-anatomical-functional-clinical-surgical fundamentals, which is a useful correlation between the auricles and other organs of the body.

The embryological study shows that anomalies of the external ear are caused by alterations in the development of the ectoderm and are limited to the neighboring structures: severe microtia and moderate eutopic microtia. On the other hand, moderate ectopic microtia, anotia, and agenesis of the auricles. are found in three groups of patients presenting with disturbances in the development of the ectoderm and mesoderm as well, because the internal and middle ears also present deep anomalies. Those patients present several combined anomalies of the chest, spinal column, upper and lower extremities, and internal organs of the chest and abdomen. It means that those patients had disturbances in the development of mesoderm and ectoderm. Most patients who are classified in these groups had severe anomalies of the heart: Fallot's tetralogy, anomaly communication between ventricles and atrium as well as transposition of the great vessels at the base of the heart. All patients with such anomalies had undergone heart surgery in their first years of life.

The anatomical study shows that each group of patients presents with a unique anatomy. Patients classified with severe microtia and moderate eutopic microtia do not present with complex anomalies of the body, rather with a minor or medial degree of facial asymmetry.

The functional element of the classification is based on severe hearing disturbances in patients diagnosed with anotia, moderate ectopic microtia, and agenesis of the auricles. On the other hand, patients diagnosed with severe microtia as well as moderate eutopic microtia do not present with such complex hearing alterations because the anatomy of the middle and inner ear is well balanced.

The clinical fundamentals are clear because patients with severe microtia as well as those diagnosed with moderate eutopic microtia do not present with complex alterations of the face and body. On the other hand, patients diagnosed with anotia and moderate ectopic microtia present complex anomalies of the body in association with deformities of the auricles.

The surgical fundamental is a consequence of all the factors previously mentioned because the surgical technique for reconstruction is different for each group of patients. Patients with severe microtia always present with a rudimentary lobule in an abnormal position, which is rotated during the first stage of reconstruction to the correct position and location. However, patients diagnosed with moderate eutopic microtia always present with a lobule, rudimentary conchal cavity, and external auditory meatus, which give correct orientation for reconstruction of the ear. Nevertheless, patients with moderate ectopic microtia always present with a lobule and a rudimentary conchal cavity, but in the ectopic position, which must be lifted during the second stage of ear reconstruction. Another situation is that of patients diagnosed with anotia requiring complex reconstruction of the auricle, the external auditory meatus, and the lobule as well, because they all present without those anatomical elements.

Conclusions

Ever since I began to study congenital anomalies of the auricles, it was evident that several deformities of the human body are a constant challenge. In fact, the auricle is at the center of the anomalies that involve neighboring structures. The frequency of associated lesions is similar to the concentric waves on the surface of still waters, into which a stone is thrown. The first waves are higher and stronger, and as they become more distant, they become smaller and less frequent and finally disappear. According to such a comparison with water, associated congenital anomalies are more intense and frequent near the auricle and then diminish the farther they are and become rarer in the segments that are more distant from the ear. Every patient diagnosed with anotia, agenesis of the auricle, or moderate ectopic microtia, presents with severe congenital defects on other regions and organs. Those with severe microtia and moderate eutopic microtia may present with minor or medial anomalies on neighboring regions. The planning for reconstruction depends basically on the identification of the congenital anomaly in order to use an appropriate technique. Anomalies of the ear occur more often in male patients, and twice as often on the right side.

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4. Surgical Principles

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4.1 Introduction

Surgical principles are mandatory steps repairing or reconstructing any kind of deformity of the auricle. They are to be followed before, during, and after surgery. After adequate surgical planning, performing ear reconstruction is the final stage, after several previous stages of preparation. At all stages of the surgery, meticulous attention is required, including observation, investigation, evaluation, palpation of the local tissues, measurement, comparison between the two ears, and a psychological assessment of the patient and his/her parents.

As performing the operation is very complex, the surgeon should follow each pre-operative step in order to adequately prepare the patient. Because of the importance of such organization, the basic information regarding this difficult area has been previously described (Avelar 1990, 1997, 2011, 2013).

4.2 Method

In all procedures involving ear reconstruction, surgical principles must be the main focus, and they are essential steps since each patient must be related to according to the specific aspects of the ear's deformity. Whether the abnormality was caused by traumatic amputation or congenital anomalies, all remaining segments of the auricle must be thoroughly evaluated. Concerning congenital anomalies, it is mandatory to analyze all cutaneous and cartilaginous elements in order to identify the correct diagnostic as well as the adequate classification looking for the correct technique. It is even important to investigate whether other surgery was previously performed. So far, to repair or reconstruct an auricle after traumatic amputation, one must use intensive observation to look for normal tissue in the wrong places, or sometimes mutilated tissue in abnormal positions and locations.

Once again, it is mandatory to ask the patient or relatives about any previous treatment. If the amputated segment was introduced to some other area around the auricle, it is another problem to be solved before reconstruction. Even if some small segment of the ear still remains, they must be carefully preserved since during the surgical planning they may be useful for further procedures. Every effort must be made to make an accurate observation as well as analyze the remaining segments of the auricle trying to be used during reconstruction (Converse 1958a, b).

There are some fundamental aspects that should be considered when ear reconstruction is about to be performed:

1. Analyzing the cutaneous covering of the mastoid region (Fig. 4.1)

2. Creating the missing segment of the future auricular framework (Fig. 4.2)

3. Creating the cutaneous covering of the new auricle (Fig. 4.3)

4. Distending the tissue during surgery (Fig. 4.4)

5. Developing the new layer of the perichondrium (Fig. 4.2)

6. The segments of rib cartilage do not heal between each other (Figs. 4.2

and 4.5)

7. Dressing the wound after the surgery (Fig. 4.6)

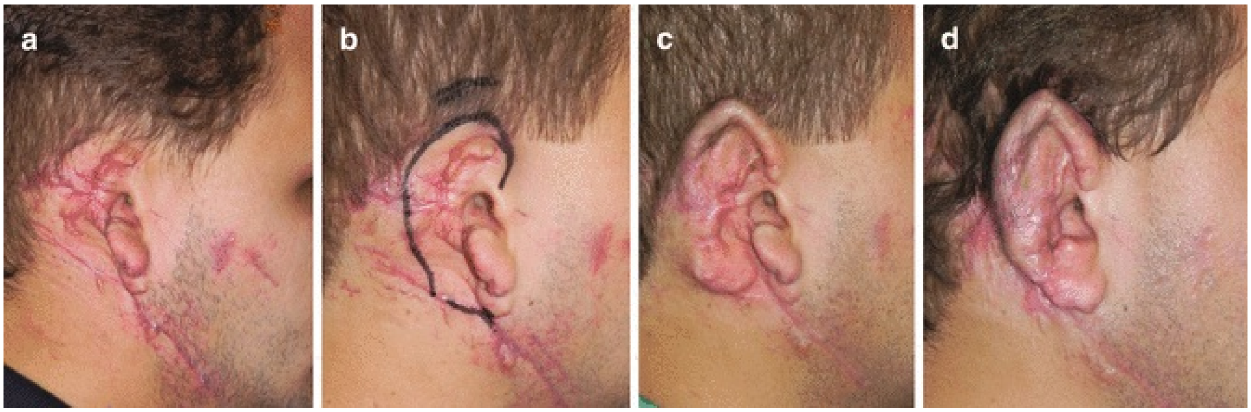

Fig. 4.1 Careful evaluation of the future auricular area. (**a**) Mastoid region presenting multiple scars caused by car accident; (**b**) spatial projection of the future ear; (**c**) the new auricular framework was embedded subcutaneously during the first surgical stage; (**d**) the reconstructed auricle after the second-stage operation

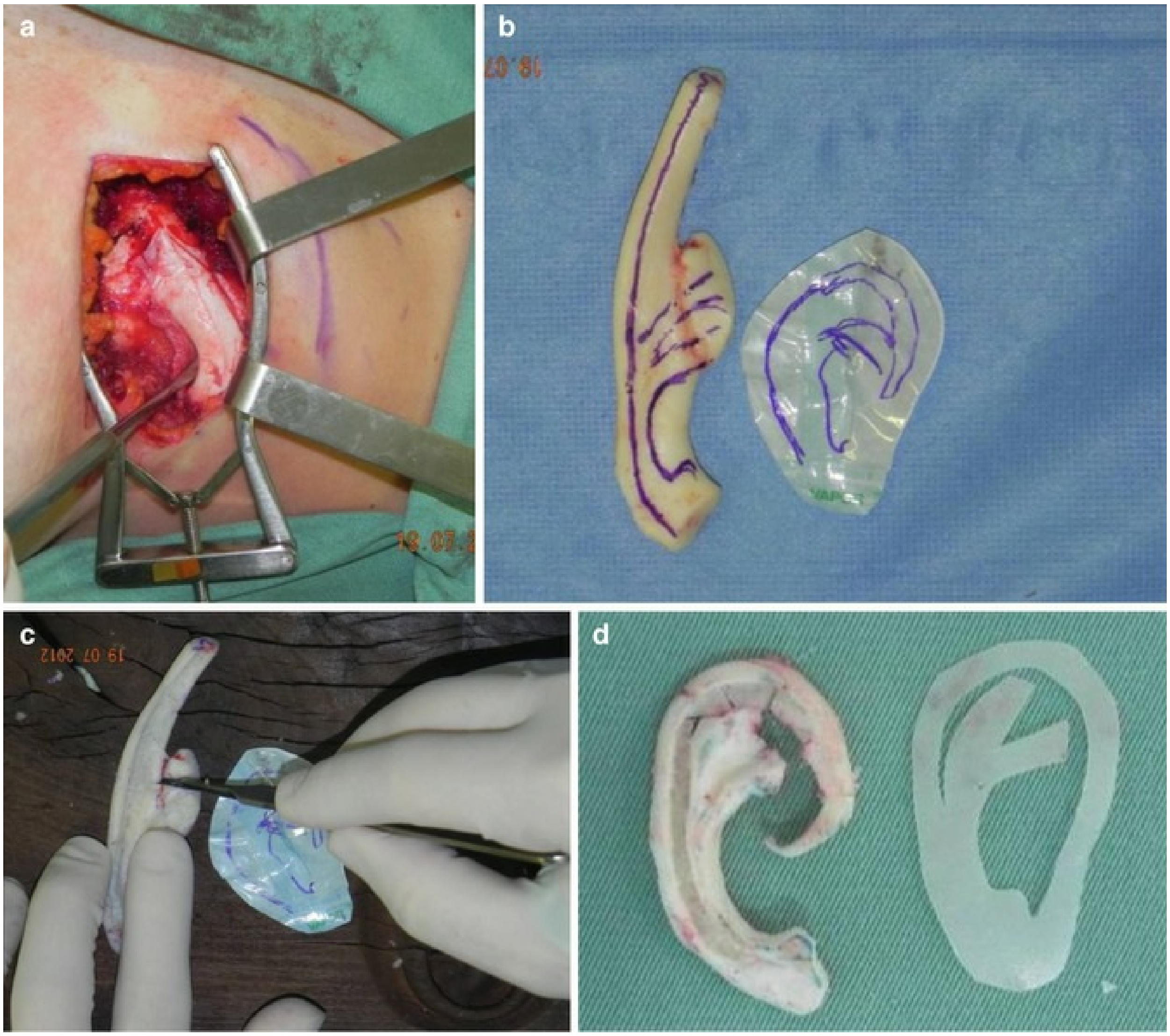

Fig. 4.2 Creation of the new auricular skeleton. (**a**) Removal of the rib cartilage; (**b**) planning the new frame; (**c**) meticulous excavation; (**d**) the new auricular framework

Fig. 4.3 Creation of the cutaneous covering of the new auricle. (**a**) A subcutaneous tunnel is dissected; (**b**) the new frame is embedded through the tunnel

Fig. 4.4 Pre-operative cutaneous enlargement. Distension of the skin of the mastoid region is done during surgery

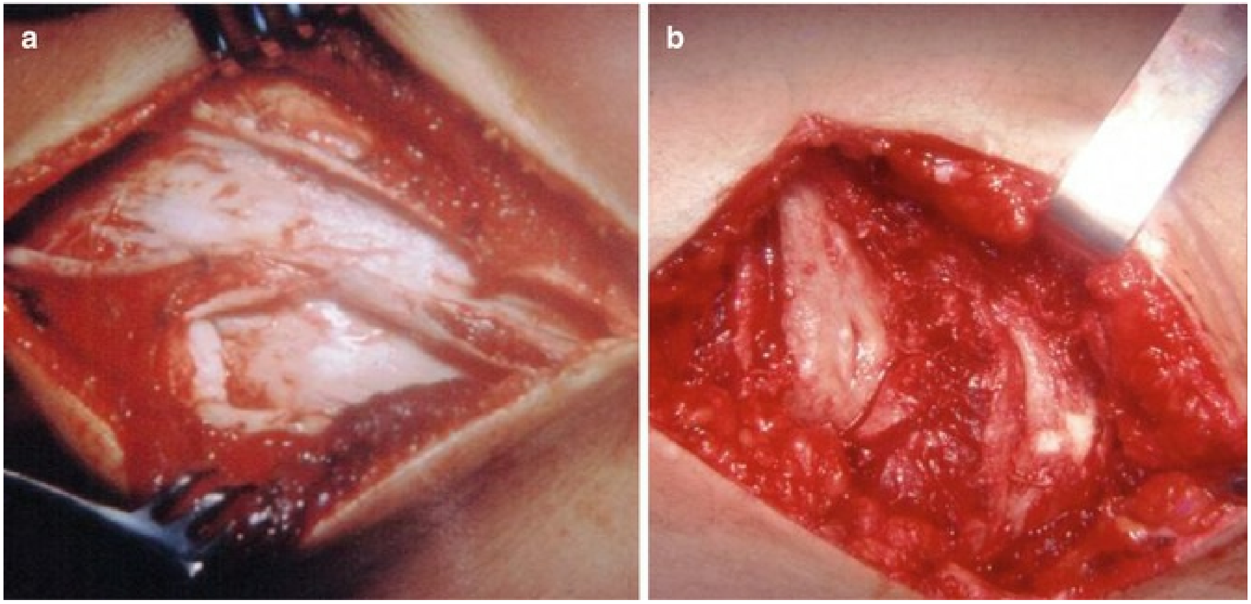

Fig. 4.5 The rib perichondrium must be preserved during removal of cartilage. (**a**) Photo during surgery shows that the rib perichondrium is preserved; (**b**) the perichondrium regenerates a fibrotic tissue that protects the chest wall

Fig. 4.6 Bandaging after ear reconstruction is a fundamental step for protecting the new organ. Pre-operative photos: (**a**) the new auricular framework is already embedded through the subcutaneous tunnel; (**b**) wet cotton is applied around the new skeleton and on the future conchal cavity; (**c**) light compression is put on the reconstructed ear

4.2.1 Analyses of the Cutaneous Covering of the Mastoid Region

Ever sinceI began to perform ear reconstruction didactically, I used to mention the two anatomical elements that are necessary to create: a cutaneous covering, and new auricular skeleton of the future organ (Avelar 1977, 1978, 1979, 1983, 2011, 2013). In fact, the skin covering of the normal ear is a very delicate one that gives a sophisticated and smooth aspect of the most external appendage of the face. To create the cutaneous covering of a new auricle is such a difficult surgical step that each operation requires specific planning before surgery. In patients presenting with total or partial traumatic amputation of the ear, scar tissue formation must be well evaluated in order to plan the reconstruction properly. When patients present with total traumatic amputation of the auricle, it is a mandatory surgical stage to create the skin cover in order to embed the new framework (Fig. 4.1). Before each operation it is important to do adequate analysis of the skin covering of the mastoid region − which is not the ideal one, but it is the best − considering its location on the future auricle.

In congenital anomalies as well as after traumatic amputation, the skin may present specific anatomical characteristics. The cutaneous scars must have achieved complete maturation before the operation is performed. This is very important because otherwise fibrosis that has developed underneath the skin may damage the new auricular framework, causing distortion or even reabsorption of the cartilage (Fig. 4.2). If a patient had previous surgery elsewhere, the surgeon must wait at least 1 year before performing a second operation − the minimum amount of time for the complete healing of scars on the skin and the future new subcutaneous bed. If a second surgery is performed within less than a year, the scar tissue will be destroyed while it is healing and there will be additional damage to the ear. Despite disturbing the local cicatrization, the surgeon will be responsible for unexpected damage to the local tissue, as well as the psychological repercussions caused by the second operation because the patient and his or her relatives will have forgotten about previous surgeons and surgery. Therefore, after careful evaluation of the local skin, the surgeon may follow the guidelines as a basic technique to achieve proper distention of the cutaneous covering (Fig. 4.3).

4.2.2 Creating the Missing Segment of the Future Auricular Framework

As already mentioned, to reconstruct a new auricle it is necessary to recreate two basic anatomical structures: the cartilage skeleton and the skin covering, with their particular shape, size, position, and exact location on the side of the head. In both major groups of deformities of the ear (congenital and acquired) reconstruction of the new organ, the creation of these two anatomical components is essential for achieving good surgical results (Figs. 4.1, 4.2, and 4.3). For this reason it must be well planned and performed at the appropriate time – something that is a constant challenge to a plastic surgeon: imagination, knowledge, and hands-on ability are essential (Avelar 2011).

As I was privileged to learn from Prof. Ivo Pitanguy et al. (1971) during my postgraduate training, using rib cartilage is the best one. Afterwards, during a fellowship at New York University, working under Prof. John Converse, it was again very useful to observe him excavating the new auricular cartilaginous framework, thereby increasing my knowledge and my decision to work in the fascinating field of ear reconstruction (Fig. 4.2); this is the reason for my preference to create the new auricular skeleton by removing the eighth or ninth arch in order to sculpt it by meticulous excavation. No matter the size of the missing segment, in order to repair partial loss of the ear, it is necessary to remove the full thickness of the costal cartilage in order to excavate the new skeleton (Fig. 4.2). When an entire auricle was amputated as well − as in the congenital absence of the ear − usually one rib is enough to create the whole auricular framework by curving it with a special surgical instrument. However, sometimes two costal cartilages must be removed in order to create the new auricular structure.

According to Tanzer and Converse (1964), ear reconstruction received a decided boost by Gillies in 1920, who was the first author to worry about the importance of replacing the auricular framework for reparing missing partial segments or total absence of the auricle. Even he suggested using some kind of material to substitute for the missing segment. Such a remarkable contribution was an important improvement and significant development in the field, since until then only skin flaps or scalp flaps were used. Even more, Converse (1958a, b, 1964) mentioned that in the basic fundament to achieve successful results in ear reconstruction, a surgeon must recreate the missing elements in all patients. Following this unquestionable position, I always create the auricular framework according to each patient’s needs, by removing rib cartilage by careful excavation in order to sculpt according to each deformity (Fig. 4.2) (Avelar 1979, 1997, 2011, 2013; Avelar and Psillakis 1981).

The most important challenge when creating a new auricular framework is excavating the rib cartilage (Fig. 4.2). However, in some repair procedures, only a small segment of the auricle is missing in acquired deformities or congenital anomalies; therefore, it is not necessary to create a completely new skeleton. Nevertheless, when a patient presents with a partial defect and only a small part of the ear is missing, it is essential to create a small segment of the frame (Gillies 1937).

4.2.3 Creating the Cutaneous Covering of the New Auricle

According to my previous descriptions of ear reconstruction, two anatomical structures are the main topics to be created during surgery: cutaneous covering and new auricular skeleton. Hence, the creation of a cutaneous covering on the mastoid region is always a challenge when operating on congenital or acquired deformities of the ear (Figs. 4.1 and 4.3). As previously described (Avelar 1979, 1983, 1986, 1997, 2011, 2013), the skin of the mastoid region is the best skin to use to create the cutaneous covering by a skin undermining or tunnelization procedure followed by rotation, transposition, and distention in order to embed the new auricular skeleton (Figs. 4.1 and 4.3). Once the local skin is dissected, a progressive distention is useful, which is followed by retraction after the cartilage graft is introduced through the subcutaneous tunnel. The skin lies smoothly on the new auricular skeleton, creating the anatomical and esthetic contours of the new ear (Figs. 4.1 and 4.3). During this period, the cutaneous covering must be expanded due to the presence of the frame. This histological phenomenon requires careful cutaneous dissection in order to preserve the full thickness of the skin on congenital and traumatic anomalies as well. Such a cutaneous enlargement is even more important in acquired deformities during the first stage of the operation because the presence of fibrotic tissue requires gradual distention.

Nevertheless, during the second stage of reconstruction I described the cervical cutaneous flap in order to cover the posterior aspect of the new auricle (Avelar 1992, 1994). This flap is the product of the knowledge and surgical principles that I brought from rhytidoplasty to obtain more skin to cover the cartilaginous auricular framework. Neck lifting, which is done with cutaneous undermining followed by traction and is combined with the rotation of the flaps, is usually done to provide useful covering of the new auricle (Fig. 4.3). The cervical cutaneous flap is a very useful procedure during the second surgical stage; even other skin flaps may be created by performing cutaneous undermining in order to reduce the raw area, which helps avoid having to do a skin graft. It is well known that performing a skin graft on scar tissue may create an undesirable postoperative scar retraction that may damage the surgical result, particularly on the retroauricular sulcus. Therefore, creating skin flaps during the second surgical stage may prevent secondary retraction on the reconstructed auricle. I usually adopt surgical principles from rhytidoplasty in most ear reconstruction operations, whether the patient is a child or an adult. Performing neck skin dissection followed by traction and rotation on one side does not increase facial asymmetry in patients with an acquired deformity, even complex congenital anomalies in children.

4.2.4 Distention of Cutaneous Tissue During Surgery

Tissue expansion is not a good procedure for ear reconstruction, since the presence of an expander prosthesis after two weeks develops a thin capsule on the subdermal layer that is not adequate for the new cartilaginous auricular framework. I do not perform such procedures because the excess skin obtained by tissue expansion is not at all useful during ear reconstruction. Nevertheless, performing cutaneous distention during surgery is a very important procedure since the skin covering of the mastoid region is gradually extended (Fig. 4.4) in order to embed the new auricular framework sculpted by excavating the rib cartilage. The use of tissue expansion for several weeks will build up an exuberant area of skin that seems to be a good procedure - but it is not -due to the presence of the thin capsule created under the skin. There are very complex side effects that may occur after the sculpting from where the skin graft was taken on the auricular area for reparation of the bone exposure. Even in such circumstances, it is possible to perform enough distention of the scar tissue formation after skin graft.

Therefore, the distention of cutaneous tissue during ear reconstruction after traumatic amputation is a useful procedure in order to distend the remaining skin covering the mastoid. Its distention is performed during the first stage of reconstruction. Even when there is only a very small segment of cutaneous covering on the mastoid area, it is possible to extend it as much as possible in order to embed it into the new auricular framework (Fig. 4.1).

Nevertheless, in reconstruction for congenital ear anomalies, the use of an intraoperative tissue extension is not a routine procedure because the skin cover presents excellent histological texture without any fibrotic tissue (Fig. 4.3). In congenital abnormalities, as in severe microtia, anotia, moderate eutopic microtia, and moderate ectopic microtia, the skin always presents a natural enlargement of the remnant auricular tissues during embryological development. For some reason the growth of the ear is interrupted, causing the absence of the organ, but the skin could have covered the ear if it had grown normally. Therefore, the cutaneous covering is soft and easy to undermine during reconstruction (Fig. 4.3).

4.2.5 Development of the New Layer of Perichondrium

The raw surfaces under the skin cover and on the subcutaneous bed underneath it, in which the new auricular framework will be embedded, must provide adequate conditions for developing the new layer of perichondrium surrounding the cartilage graft, which is a fundamental condition for the success of the operation. In fact, if the cartilage graft is done under some fibrotic tissues without complete maturation, the new perichondrium may not develop properly and can end up damaging the cartilage, which will hinder the reconstruction. After maturation, the final scar is not an excellent candidate for introducing the cartilage underneath, but it is possible to perform it because the scars may be distended after cutaneous undermining (Fig. 4.1).

After an ear reconstruction, the surgeon and his or her staff must take complete care of the patient for an extended post-operative period. The care after traumatic amputation as well as secondary surgery must be even more meticulous because there is a high risk of complications. The most dangerous complications are skin slough followed by skin necrosis, infection, and cartilage exposition, each of which can result in partial or total extrusion of the cartilage graft performed during ear reconstruction.

The most important element during and after ear reconstruction, I would say, is the perichondrium. In fact, removing the cartilage graft from the rib should be performed carefully to preserve the costal perichondrium in order to develop new rib cartilage. The behavior of the rib perichondriumis very important because the new cartilage will provide excellent protection of the chest wall, and it is even more important to ensure the development of a new perichondrium on the new bed after ear reconstruction.

If local tissues do not present adequate conditions to develop a new perichondrium, the cartilage graft may not survive after surgery. In fact, scar tissue formation in ear reconstruction is an adverse condition under which to perform the operation because the cartilage graft needs an ample blood supply on the new bed to develop its new perichondrium. During a period of 10–15 days after surgery, the cartilage graft requires adequate vascularization to provide the necessary chemical and biochemical elements for its metabolic process. During this period, a new layer of specific cells starts to form around the cartilage graft. If the local tissue does not provide adequate biochemical elements, the graft cannot acquire enough elements to remain alive. After that, a new perichondrium begins to develop around the cartilage. Many adverse conditions cam disturb the normal development of a new perichondrium after a cartilage graft, but two of them may pose great risk: local infection, and trauma. If one or both situations occur, the cartilage graft will not obtain enough chemical and biochemical elements for its adequate metabolic process, and because of this, the surgeon and members of his or her staff must be vigilant with regard to post-operative dressings.

4.2.6 The Segments of Rib Cartilage Do Not Heal Between Each Other

Since cartilaginous tissue is not vascularized, each segment of transplanted cartilage requires its own integration on the new bed, developing its own new perichondrium around itself. Therefore, each segment survives on the new bed, owing to organic characteristics that develop its own perichondrium all around it, which is a unique regenerative process. Because of biological development of the local tissue on the new bed, each segment of cartilage is isolated at the end of the healing process, which does not heal one segment to another. They maintain their places but they do not heal between each other. When isolated stitches are placed between each segment of the cartilage during surgery, they keep the segments close to each other, which helps develop a new perichondrium around it.

4.2.7 The Importance of the Dressing After the Operation

How to bandage the ear after reconstruction is so important that Gillies and Millard (1957) included it as a surgical principle in plastic surgery. They wrote, “The after-care is as important as the planning,” and they emphasized, “or for that matter, the surgery itself.” Their teaching is useful for ear reconstruction because bandaging it immediately after surgery as well as post-operatively involves basic procedures to achieve successful results (Fig. 4.6). The first dressing is put on in the operating room, followed by subsequent dressings according to the surgeon’s orientation for each procedure. Afterwards, for a long time, all patients and their parents must carefully follow the instructions, especially those regarding changing the bandages, and so they must return according to schedule for each visit, under the care of the surgeon and his or her team. The patients or their relatives cannot change the bandages at home because medical care is crucial. If the patient will not able to return regularly to have the dressing changed under medical supervision, it is better not to perform the surgery to begin with.

When a cartilage graft is removed, two regions require bandaging immediately after surgery: the donor area, and the ear. The first is a routine procedure, but the dressing on the ear reconstruction requires special care and must be done according to the surgeon’s plan, which is unique for each patient (Fig. 4.6).

The dressing on the auricular region must be put on with great technical care. I use small pieces of wet cotton placed one over the other in order to press on the conchal area where cutaneous undermining has not been performed and there is no auricular cartilage. A long segment of wet cotton making a C-shaped tube is placed completely around the posterior border of the projection of the helix, without pressing on the cartilage graft (Fig. 4.6). My dressing technique avoids pressing on the skin covering the auricular framework. Afterwards, bandages are wound around the head and kept in place for 5–6 days.

I do not do any external suturing because the skin lies smoothly on the frame underneath. When I began my practice, I used external stitches following the traditional descriptions found in scientific articles and books. However, I found that they can damage the skin because of excessive pressure, which can cause skin necrosis. I used to encounter complications because of the external stitches that bothered both me and my patients, as described in the chapter on complications.

After the first dressing is removed (5–6 days after surgery), another dressing is carefully applied that covers the auricular area without any bandaging around the head. The second dressing is changed every 7–10 days for at least 2 months. The dressing is applied only directly to the ear and is maintained the whole time without any bandage covering the head.

Therefore, before the surgery, patients or their parents must be informed about all the necessary steps and accept the obligation to follow all instructions and medical care after the surgery.

4.3 Discussion

To perform ear reconstruction requires knowledge, hand coordination, imagination and attention, besides meticulous operative and post-operative procedures. Besides performing outstanding surgery, the surgeon must follow surgical principles that are the guideline for the operation as well as the dressing afterward. The skin of the mastoid region is not ideal for ear reconstruction, but it is the best one since its location is the most favorable for the operation. Although the skin there does not provide the best conditions for performing ear reconstruction, following the surgical principles described above, it is adequate for achieving good results and being able to follow the specific plans for each procedure.

In both major groups of origin of ear deformities (congenital and acquired), the skin in the mastoid area must be well evaluated before surgery (Figs. 4.1 and 4.3). If there are severe scars caused by traumatic amputation or previous operations, they must be carefully analyzed pre-operatively since the formation of scar tissue may damage the auricular framework imbedded during the operation. To avoid such problems, the local cutaneous covering must be extended pre-operatively in order to provide satisfactory conditions for introducing the new cartilaginous graft through the tunnel. The local skin must be undermined by dissecting it with scissors or tunnelizing it with a special instrument, carefully keeping its full thickness so it can be extended during the operation (Fig. 4.1). The new auricular framework must be meticulously excavated from the rib cartilage that is introduced through the subcutaneous tunnel. The local tissues must provide adequate conditions for developing new perichondrium around the auricular framework; otherwise, the cartilage graft will not be successful. Local infection or any trauma on the skin covering may damage the auricular cartilage, so proper postoperative care must be taken for at least two months, since any trauma during this period may spoil the results.

Finally, it is useful to mention that a surgeon must begin and finish an operation with the same physical and psychological enthusiasm. If he or she becomes tired during or at the end of the surgery, it means that he or she did not adequately plan all the steps of the operation − as well as the physical conditions. When the operation has been well planned, all the details of the procedure work harmoniously, along with the procedure. I always do the final stages of the operation as well as the stitching with the same enthusiasm that I had for it in the first stages. Even I, however, always learn some new anatomical or surgical detail in every operation I perform. It is both enjoyable and exciting to look forward to the next procedure in order to use the knowledge gained from my own observation.

Conclusions

To successfully perform ear reconstruction, the surgeon must follow surgical principles in order to avoid complications during and after the operation, as well as to achieve good results. The skin of the mastoid region is not ideal for ear reconstruction, but it is the best since its location is the most favorable for operations. The local skin is quite thick and does not slide easily on the mastoid bone, but it is available to undermine − by dissection or tunnelization − in order to introduce the new auricular framework.

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5. The Importance of Surgical Planning Before an Operation

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Keywords Surgical planning – Surgical demarcation – Demarcation before surgery – Spatial projection of the ear

5.1 Introduction

The auricles are two appendages that are projected on each side of the head, presenting a sophisticated anatomical constitution with more than 95% of their surface away from the face and cranium. Ever since I began doing ear reconstructions, it was evident to me that spatial projection is a constant challenge due to location and situation of the organs with very important esthetic reflections on facial contour (Avelar 1977, 1978, 1992, 1994, 1997; Avelar and Angel 1989; Avelar and Bocchino 1989). Therefore, before performing a repair or reconstruction of the auricles, surgical planning is a mandatory step that requires that the surgeon have vast knowledge, experience, and imagination in order to achieve good esthetic results. In fact, such a step must begin at the first appointment when the surgeon sees the deformity in the auricle that has been caused by traumatic amputation or congenital anomalies. It is very important to talk with the patient and/or relatives, and especially to hear about the origin of the abnormality and about previous procedures (even the date of the last one). Such information is essential since it is mandatory to wait at least a year from the last operation before performing any additional ones (Avelar 1987, 1990, 2011, 2013). During consultation, the surgeon should carefully examine the auricular region, the face, and the whole body, because congenital deformities and traumatic amputation may present with other deformities associated with ear anomalies (Fig. 5.1) (Avelar 1989a, b, c).

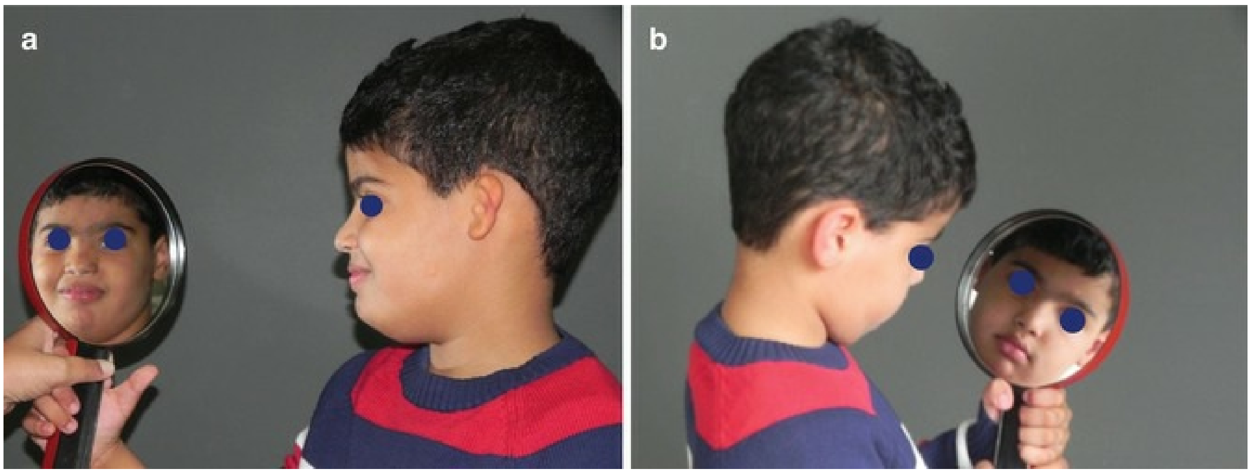


Fig. 5.1 (**a**) and (**b**) It is useful if the patient sees his or her deformity using a mirror in front of the surgeon

I have already mentioned that surgical planning begins during the first appointment when the patient is awake and sitting in front of the surgeon asking questions and is eager for information on the technique, post-operative care, and final results. Sometimes patients ask to see photographs of others who have previously undergone the procedure to find out about surgical results; I allow my nurses to show them photos from my books, emphasizing that the surgical results of my previous patients may not be achieved in his or her case since each patient has his/her own unique surgical needs; it is even written in my “Informed Consent” paper on surgical results that the best possible results will be achieved according to updated scientific knowledge.

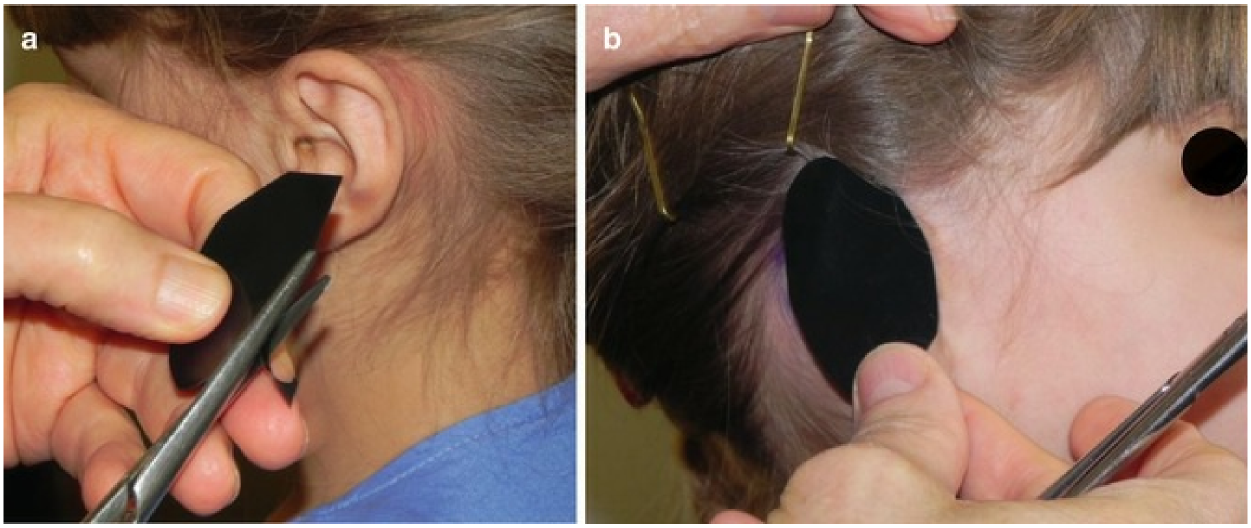
At that moment it is essential to analyze the auricular area regarding all aspects of the skin covering it, as well as the remaining auricular cartilage. The presence of surgical scars is different from those caused by accidents, since previous operations may be have been performed by cutaneous undermining that can jeopardize future surgical procedures. Therefore, scars caused by accidents are less dangerous than those that have resulted from previous operations. Special instruments are necessary for examining all aspects of the surgical region (Fig. 5.2). As for scars that are still healing, it is not recommended to perform additional procedures because the scar tissue may damage the future surgical stages, causing distortion or even absorption of the cartilage graft. On the other hand, scars caused by accidents usually do not damage the full thickness of the skin and do not cause any alteration of the blood supply to the cartilage graft that may be performed during future surgeries (Fig. 5.3).

Fig. 5.2 The instruments thatare used to measure and examine the deformities of the auricular region

Fig. 5.3 The auricular region must be well evaluated before surgical planning. The scars must be well examined regarding the color as well as the direction. All aspects are important for planning the operation. (**a**) A 24-year-old female after total amputation of the right ear, presenting with severe scars caused by trauma; (**b**) a 35-year-old male had his left ear totally amputated in a car accident, presenting with stitches that sutured the wound

5.2 Method

After careful examination of the auricular region, it is the right time to start the surgical planning. During the first appointment, I usually create a preliminary model of the future auricle in order to show the patient and his/her relatives the importance of the future auricular framework during ear reconstruction (Fig. 5.4).


a
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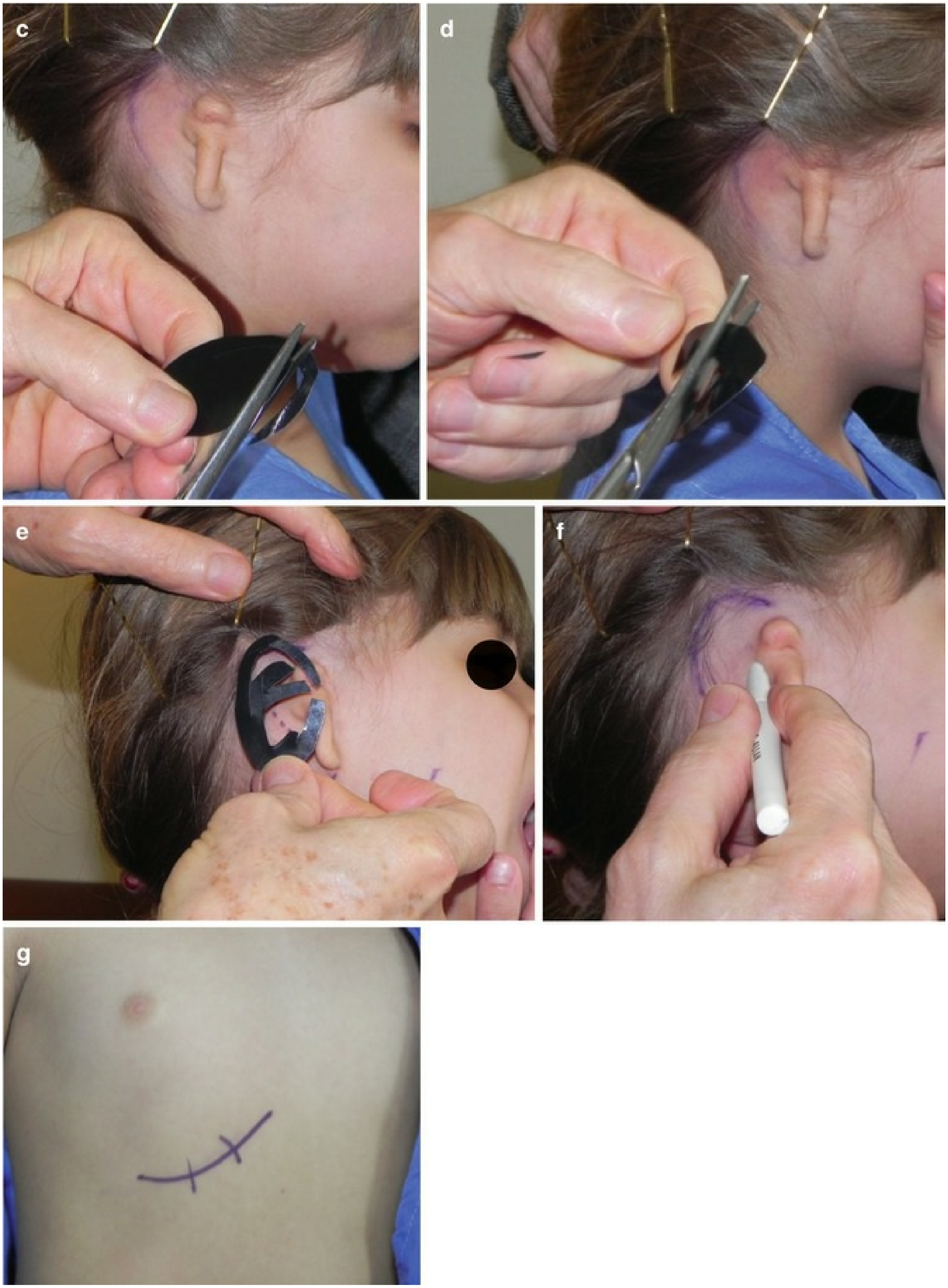
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g

Fig. 5.4 Modeling the new auricular frame, using the opposite ear as a reference. (**a**) The shape and size; (**b**) the future model is checked against the deformity; (**c, d**) the model is then cut with scissors; (**e**) the model is again checked against the deformity; (**f**) the new ear is drawn on the auricular region; (**g**) the incision on the chest wall in a drawing to demarcate the incision for removal of the rib cartilage

No matter whether the abnormality was caused by an accident or is a congenital anomaly, the surgical planning must be the first step of the future reconstruction.

The size and shape of the new auricle are planned during the first consultation, using a model made on X-ray film taken from the opposite auricle as a point of reference (Fig. 5.4). This step was first described by Gillies in 1920 (Tanzer and Converse 1964) when he introduced the necessity of creating a new auricular skeleton to replace the architecture of the new organ. It is fascinating that Gillies (1937) was so concerned about surgical planning that his technique is still being updated. Later, the same procedure was mentioned by Converse (1958a, b, 1964, 1973) and also by Tanzer (1971). Song and Song (1983) and Song (1989) have described outstanding surgical planning for the use of fascial temporal flaps.

I learned similar surgical planning from Prof. Pitanguy when I became fascinated with ear reconstruction during my training in plastic surgery. There were special sessions on surgical planning at the 38th Infirmary at Santa Casa da Misericórdia in Rio de Janeiro, at which all cases were presented for discussion among the professors and residents before surgery. Also, I had the privilege to do a fellowship under Prof. Converse early in 1973 at New York University, where I saw how carefully he planned ear reconstruction, which made me even more enthusiastic about devoting myself to this field.

Therefore, surgical planning is basically facilitated using a model made from an X-ray of the normal ear, which is inverted to show the size and shape of the future auricle on the side of the deformity (Fig. 5.4). The surgeon’s esthetic judgment may determine the location and position of the auricle, because most patients with congenital digenesis have complex facial asymmetry (Fig. 5.4). However, it is mandatory to measure the opposite ear as well as the other side of the face in order to achieve adequate reference points. It should be emphasized that it is not advisable to transpose the correct position and location of the normal hemiface to the opposite side with a congenital ear anomaly; special instruments are used for such a procedure (Fig. 5.2).

For reconstruction of severe microtia, two anatomical points form a reference. The first is the ear lobule, which is always present, but in an ectopic position. After its rotation, it establishes the lower extremity of the reconstructed auricle. The second point refers to a depression on the bone surface where the external canal would be if the patient did not have an auricular anomaly (Avelar 1978, 1986, 1989a, b, c, 2011, 2013). This depression shows the projection of the future auditory canal of the new ear. It is not recommended to open it through the bone, but it is very useful to provide an important reference point when planning the new auricle during reconstruction of severe microtia. This is an important step that may be taken during the first or second surgical stage, in most cases.

Nevertheless, in all patients with moderate eutopic microtia and moderate ectopic microtia − according to my own classification − the external canal, ear lobule, tragus, antitragus, rudimentary conchal wall, incomplete helix, and other auricular structures are present. The terms “severe microtia” as well as “moderate microtia” have already been described (Avelar 2011, 2013). Facial asymmetry is the anomaly most frequently associated with congenital ear deformities because it is even more difficult to determine the future position and location.

In bilateral dysgenesis as well as bilateral amputation of the ears, the surgical planning for the operation is much more difficult and basically depends on the surgeon’s skill and esthetic judgment to establish reference points for the future auricles. The surgeon should keep in mind that even in congenital bilateral deformities there is always some kind of facial asymmetry. During the first appointment, it is useful to measure the auricle as well as its deformities with the use of appropriate instruments (Fig. 5.2).

Additionally, on the day before the surgery, it is useful to see the patient once more to check the size, position, and location of the auricle that will be created the next day (Figs. 5.4 and 5.5). It is recommended that the clinician write down and clearly describe in the surgical plan the measurement of the ears as well as all information concerning the area where the new ear will be reconstructed. Also, more photos are often taken in order to mark important anatomical details that will necessary to know in the operating room during surgery (Fig. 5.6).

Fig. 5.5 Another example of modeling of a future ear. (**a**) The opposite ear is an excellent reference point to measure in order to project the future auricle; (**b**, **c**) the model is placed on the deformity to evaluate all details

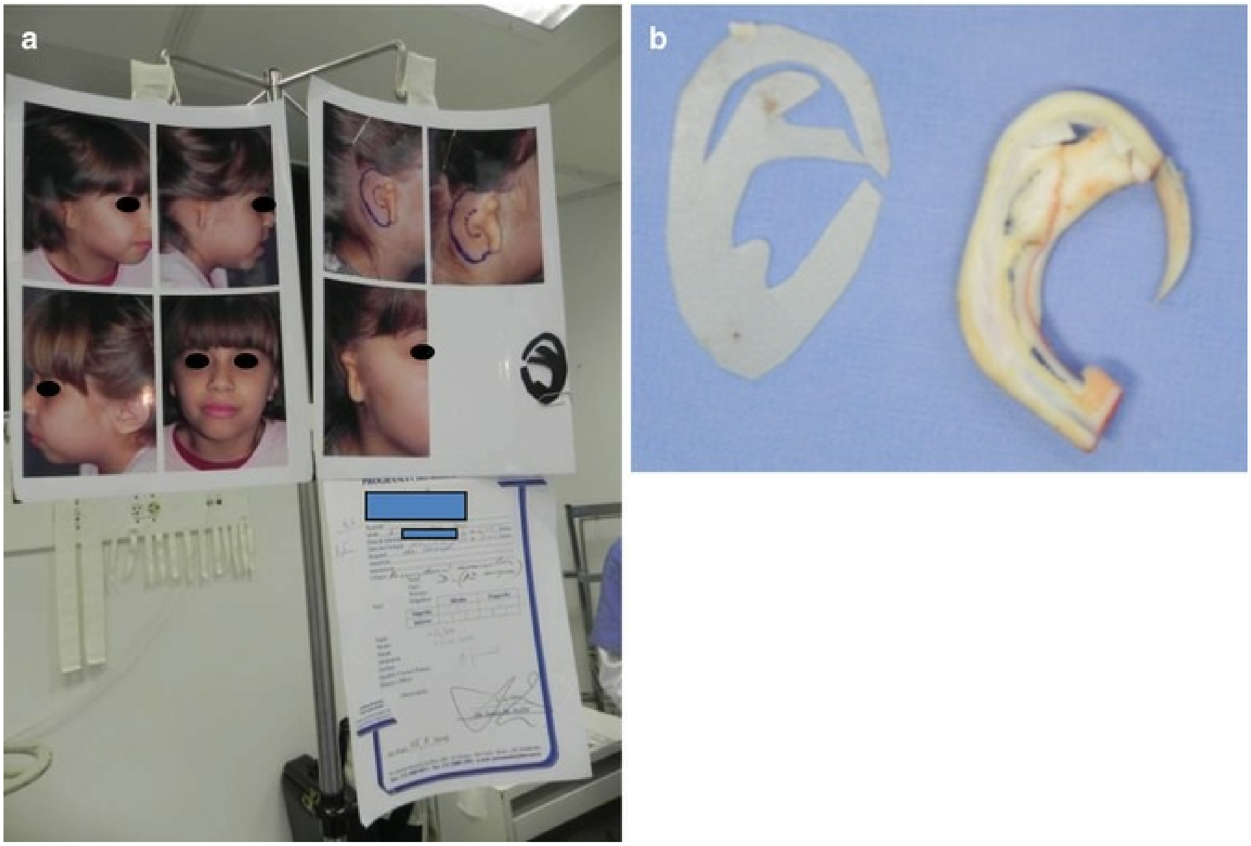

Fig. 5.6 The model of the future ear is useful during surgery. (**a**) The pre-operative photos are placed in the operating room with the surgical plan; (**b**) the new auricular framework was sculpted according to all the information from the model of the ear

5.3 Discussion

Surgical principles and planning for ear reconstruction are important steps before performing any operation because each patient has his or her own particular deformities that require a specific approach for satisfactory treatment. The best time to achieve good surgical results is the first reconstructive operation. Al1 subsequent operations present with fibrotic tissue and subcutaneous scar tissue formation, as well as that on the skin, which are adverse conditions for both patients and surgeons.

Surgical planning is the appropriate way to demonstrate the correct technique for performing each procedure (Pitanguy et al. 1971). During the operation, the surgeon must follow all details of the surgical program and try to carry out what was previously planned. By following the plan step by step, the operation will achieve what was outlined in the surgeon's imagination, even though unexpected situations may arise during an operation − despite the preparation and surgical planning. At the end of each operation, the details that are added to the surgeon’s knowledge may certainly be useful in subsequent operations. I always perform each operation with the care and attention I devoted to the first one in my professional life, and with the faithful and emotional involvement of the last one in my life.

Conclusions Surgical planning is important before any plastic surgery but is mandatory for ear reconstruction because each patient has atypical deformities that require an individual approach for adequate treatment. Whether the operation will repair a congenital or acquired deformity, it is necessary to create two anatomical structures − the auricular cartilage skeleton, and the cutaneous covering. The new auricular framework − with all the anatomical details − is excavated from the rib cartilage. The cutaneous covering may be developed on the mastoid area combined with skin flaps from neighboring regions as well as a skin graft. Some surgical principles are used as guidelines during the operation: creation of new anatomical structures, reliability of the skin on the mastoid area, development of the new layer of perichondrium, enlargement of the cutaneous covering, tissue distention during surgery, the segments of rib cartilage that do not heal between each other, and the application of appropriate dressings and follow-up of patients after the operation.

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6. Post-operative Care After Ear Reconstruction

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Keywords Dressing – Post-operative care – Dressing changes – Bandaging after ear reconstruction

6.1 Introduction

When I began my practice in 1974 in São Paulo City, it was evident to me that ear reconstruction was a field in plastic surgery that warranted surgical improvement to solve several problems. Among multiple challenges, post-operative care was an aspect that intrigued me to introduce some observations and contributions in order to improve surgical results. Although I practice in a very large city in a very large state and in a huge country, I introduced a special approach to post-operative care after ear reconstruction.

No matter where my patients live or how far they are from my institute, they must all come to have their bandages changed according to the requirements of each case. Before the operation is scheduled, I explain the details of the surgery and post-operative care to the patients and their relatives. It is clearly emphasized that the patient must come according to a regular schedule to have the dressing changed under my personal supervision after the operation. Therefore, among all the difficulties involved in creating a new auricle, post-operative care is a special aspect that requires adequate attention and efforts of the surgeon and all members of the staff.

Although I did not learn directly from Gillies (he died in 1960) (Gillies 1937), Prof. Pitanguy did, and he used to mention him quite often. Therefore, in several ways my knowledge comes from both teachers, and this teaching encouraged me to follow their paths in my own practice. This topic is so fascinating that I found it useful to express some considerations to some other surgeons who perform ear reconstructions. To “dress” the ear after reconstruction is so important that Gillies and Millard (1957) included it as a surgical principle in plastic surgery. They wrote, “The after-care is as important as the planning.” They also stressed “… or for that matter, the surgery itself.” Their teaching is so useful for ear reconstruction because putting on the dressing immediately after surgery, as well as post-operatively, is a basic procedure for achieving successful results.

The first dressing is put on in the operating room, followed by other ones according to the surgeon’s decision for each procedure. For a long time afterward, all patients and their parents must carefully follow the instructions, especially those regarding changing the bandaging. Therefore, they must return − according to the schedule − for each operation, under the care of the surgeon and his or her team. The patients or their relatives cannot change the dressing at home because medical supervision is necessary (Fig. 6.1); if a patient is not able to return regularly to have the bandages changed at the institute, it is better not to perform the operation.

Fig. 6.1 The dressing after the first stage of ear reconstruction on microtia with patient in the operating room. (**a**) A wet piece of cotton is introduced inside the new external auditory canal; (**b**) a wet piece of cotton is placed outside of the new frame; (**c**) another piece of cotton is placed on the new ear; (**d**) bandaging is wrapped all around the head, and a dressing applied to the chest (donor area of cartilage graft). (**e**) Adhesive tape is placed on the surgical wound; (**f**) gauze pads are placed over the region and left in place for 1 week

6.2 Method

According to Tanzer and Converse (1964), in the 1920s Gillies was the first author to mention creating a new auricular framework to replace the old one after traumatic amputation or congenital anomalies. Therefore, due to Gillies's remarkable contribution, a wide field was opened in ear reconstruction when several authors wrote about substituting missing segments or the whole auricular framework. My preference is to use rib cartilage to create a new skeleton by excavation (Avelar 1977b, 1978, 1979, 2011, 2013), but there are other organic and non-organic materials described in the medical literature.

6.2.1 Inorganic (Alloplastic) Materials

Nowadays, inorganic materials are no longer used, but over the years several authors described their use; these included Backdahl et al. (1954), who mentioned celluloid; Greeley (1946), who used a tantalum net; Macomber (1960), who described the use of nylon; Rubin et al. (1948), who advocated the use of polyethylene; and Malbec and Beaux (1952), who described the use of an acrylic prosthesis to replace the entire auricular framework. The silastic frame introduced by Cronin (1966) seemed to be the ideal element, but nowadays few surgeons use it due to post-operative complications.

In recent decades, other inorganic materials, such as Medpor, have been reported on by Romo et al. (2009) and Thome et al. (2001) to replace the missing segment of the auricular structure. However, I do not have experience in the use of any kind of inorganic material.

6.2.2 Organic Materials

There are three groups of organic materials: heterograft, homograft, and autograft.

6.2.2.1 Heterograft Materials

Heterograft materials are no longer used because of absorption, infection, and extrusion.

6.2.2.2 Homograft Materials

Several homograft materials are available: nasal septum cartilage, used by Graham (1927); costal cartilage of corpses, used by Brown et al. (1947); and maternal auricular cartilage, first used by Gillies (1937) and later by other researchers (among them Bäckdahl et al. 1954). Auricular cartilage from cadavers was researched by Kirkham (1940), and was later used by Lamont (1944). However, in 1952 Malbec was disappointed in the use of homograft cartilage to obtain auricular framework modeling and recommended the use of an acrylic prosthesis, which was not well accepted among surgeons.

6.2.2.3 Autograft Materials

Costal cartilage research was carried out by several authors, such as Pierce (1930), Aufricht (1947), Peer (1948), and Converse (1950). The cartilage of the opposite ear was tried by Pegran and Peterson (1956) , Steffenson (1965), Gomey (1974), and Davis (1974); however, it did not become popular among surgeons to create a new framework for total ear reconstruction, although they thought it might be useful for minor repair. The use of knee cartilage was tried by Dellepiane-Rawson (1942) and Mir and Mir (1952). Converse (1950) and later Gillies and Millard (1957) tried to use bone to create the auricular framework.

Currently, most surgeons prefer costal cartilage as an autogenous element to construct the new auricular skeleton. Before 1958, sculpting of the auricular framework was not performed well; consequently, the esthetic outcome was poor. In that year, Converse (1958) presented superb results on the modeling of a new frame for the technical refinements of ear reconstruction. An important publication by Tanzer (1959) presented a new systematization of auricular reconstruction in several surgical stages. That was, in fact, a milestone in the history of plastic surgery, because after their contributions, other surgeons became interested in the subject, and the esthetic results improved considerably.

The use of rib cartilage segments was suggested by Pitanguy (1967) and Pitanguy et al. (1971) by suturing one piece of cartilage over another. The technical improvement of sculpting proposed by Tanzer and Converse is followed by most surgeons today. Spina et al. (1971) embraced their teaching with enthusiasm. Other authors, e.g., Brent (1974), Fukuda (1974), Nagata (1993), and Firmin et al. (1974) introduced useful procedures for modeling the new frame. Since my earliest publications, I have had a preference for excavating the new skeleton from a block of costal cartilage, thus performing ear reconstruction in one single surgical stage (Avelar 1977a, 1978, 1986). Much effort was devoted by Song and Song (1983) and Song (1989), using my fascial temporal flaps (Avelar 1977b, 1983); they also performed outstanding reconstruction using rib cartilage.

6.3 The Dressing after Total or Partial Ear Reconstruction

When rib cartilage is removed, two regions require special attention in order to dress the wound immediately after surgery: the donor area and the auricular region (Fig. 6.1).

6.3.1 Dressing the Area of Donor Cartilage

The dressing on the chest wall after removal of the cartilage requires special care since the patient may complain of pain after the surgery. I do not use any kind of drainage after removing rib cartilage since there is no post-operative bleeding. Although the rectus abdominis muscle is sectioned during the operation in order to reach the rib cartilage, hemostasis is carefully done. Therefore, a dressing is mandatory to cover as well as to protect the donor region on the chest wall. After running sutures to close the wound, I use adhesive tape directly on the skin. Afterwards, gauze pads are used; these press delicately on the region (Fig. 6.1).

The next day, a member of my staff visits the patient and the dressing is checked to see if there is a problem in the donor area or on the reconstructed ear. Recently, an 8-year-old female patient vomited the night after the operation, so during the regular visit to the patient at the hospital, a member of my team had to change the bandage. After removing the external bandage, the dressing on the reconstructed ear was problem-free (Fig. 6.2). Therefore, the dressing on the ear must be kept in place for at least 4–5 days.

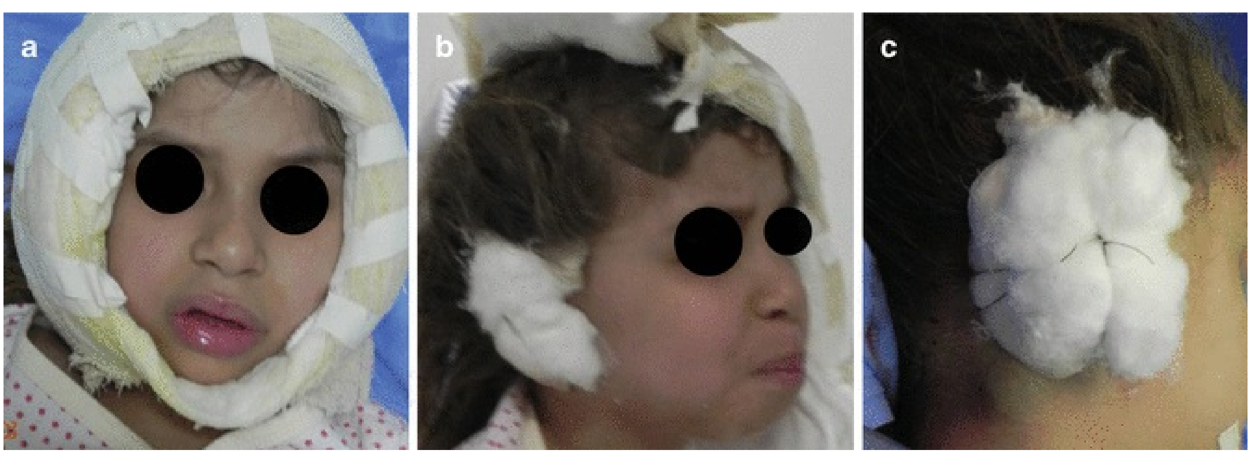

Fig. 6.2 If it is necessary, the bandage may be changed but the dressing on the new ear is maintained for 4–5 days. (**a**) As patient vomited and the bandaged had to be removed, (**b**, **c**) the dressing on the reconstructed ear is reapplied as it was done in the operating room. Another bandage is wrapped around the head

There have been no hematomas among my 1,350 patients who underwent removal of rib cartilage for reconstruction of the auricle. The dressing stays on the chest wall until the patient returns to the institute; then it is removed and adhesive tape is placed over the scar (Fig. 6.1). From that time, the patient can shower, but the adhesive tape should not be removed at home by the patient or parents, since they must be changed every 15 days until 2 months after surgery.

6.3.2 Bandaging the Ear Region After the First Surgical Stage

Reconstruction of the auricle after traumatic amputation, as well as on congenital anomalies, requires a special local dressing on the new ear that must be done according to the surgeon’s plan. Since this dressing must be done with particular technical carefulness, I use small pieces of wet cotton placed one over the other in order to press on the conchal area where cutaneous undermining has not been not performed and there is no auricular cartilage (Fig. 6.1). A long segment of wet cotton making a C-shaped tube is placed completely around the posterior border of the projection of the helix without pressing on the cartilage graft (Fig. 6.1). My dressing technique avoids pressing on the skin covering the auricular framework. Afterward, bandaging is wrapped around the head and kept in place for 5–6 days (Fig. 6.1).

I do not use any external stitches because the skin lies smoothly on the frame underneath the cutaneous covering. When I began my practice, I would use external stitches according to the traditional descriptions found in scientific articles and books, but I found that they can damage the skin because of excessive pressure, which causes skin necrosis (as described in Chapter 16 regarding complications). I used to encounter complications because of the external stitches that would bothered both me and my patients.

After removing the first dressing, from 4 to 5 days after surgery, another dressing is carefully applied that covers the auricular area without any bandaging around the head. The dressing is changed every 7–10 days for at least 2 months after surgery; it is applied only directly to the ear and is held in place the whole time without a bandage covering the head (Fig. 6.3). The patient cannot partake in physical exercise − especially swimming − for at least 3 months post-operatively in order to avoid trauma to the reconstructed auricle.

Fig. 6.3 Bandaging after the first stage of ear reconstruction. (**a**) Usually it is maintained for 4–5 days. (**b**) The external bandaging is removed and the hair is washed; (**c**) afterwards, the dressing on the reconstructed ear is removed; (**d**, **e**) the area of the reconstructed ear is prepared to be covered with a new dressing. (**f**, **g**) A new dressing is applied with a dry gauze pad that covers the reconstructed ear; (**h**) adhesive tape covers the new dressing, which is maintained for 2 weeks

Therefore, patients and their parents must be informed before the operation about all the necessary steps and accept the obligation to follow all instructions and accept medical care after the surgery (Fig. 6.3).

6.3.3 Dressings on the Ear Region After the Second Stage of Surgery

The second surgical stage of ear reconstruction after traumatic amputation, as well as for congenital anomalies, requires special local dressings that protect the new auricle. In fact, the dressing must be applied so it immobilizes all anatomical elements on the anterior and posterior aspects of the reconstructed ear (Fig. 6.4).

Fig. 6.4 The dressing after the second stage of ear reconstruction on acquired amputation with patient in the operating room. (**a**) The second stage reconstruction of the left ear is done; (**b**) A piece of wet cotton is placed behind the new ear by gently pressing on the skin graft;(**c**) a bandaging is done all around the head

The main surgical procedure is done in order to lift the new auricle from the surface of the lateral side of the head where the new framework was embedded during the first surgical stage. A cutaneous incision is made all around the external border of the new helix and below the fascia, which covers the posterior aspect of the new ear on the acquired or congenital anomalies. The raw area behind the new ear as well as in the mastoid region must be covered with the skin graft, which may be taken from the posterior part of the opposite ear or inguinal region. After suturing the skin graft on the posterior part of the reconstructed ear, a special dressing must be applied to immobilize it by compression. Wet cotton is applied to the skin graft, which is then tied by external stitches (Fig. 6.4). Afterwards, bandaging is done all around the head, and this is maintained for 7 days (Fig. 6.4).

The operations take place at the hospital, but the first dressing is removed at my institute 7 days after the second surgical stage. At this time, a new dressing is applied that uses dry cotton on the posterior aspect of the reconstructed auricle; it causes delicate compression that is held in place with adhesive tape (Fig. 6.5). The second dressing is carefully applied and covers the auricle without any bandaging around the head. The dressing is changed every 7–10 days for at least 2 months after surgery. The dressing is applied directly to the ear and is kept in place the whole time without a bandage that covers the head (Fig. 6.5). Usually I perform a skin graft behind the reconstructed auricle by taking from the posterior aspect of the opposite ear, since the texture is quite similar. The donor area heals nicely, and the opposite ear does not show any alteration to its anatomical structures (Fig. 6.6).

Fig. 6.5 Change of dressing after the first stage of ear reconstruction. (**a**) Usually it is maintained for 4–5 days, then the external bandaging is removed, and the hair is washed; (**b**) afterwards, it is dressed with dry gauze behind the reconstructed ear; (**c**, **d**) The reconstructed ear is covered with dry gauze; (**e**) adhesive tape covering the new auricle

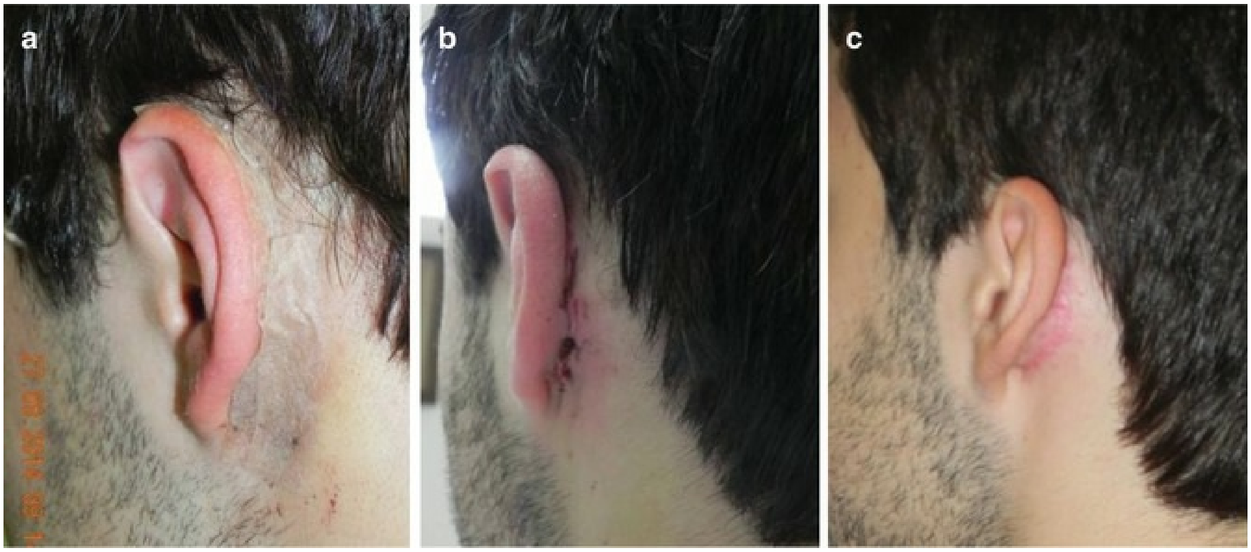

Fig. 6.6 Donor area of skin graft on posterior aspect of the opposite ear. (**a**) Adhesive tape covering the donor area after surgery; (**b**) photo of the donor area 2 weeks after surgery; (**c**) same patient 2 months after surgery

6.4 Discussion

Post-operative care for ear reconstruction is so important that Gillies and Millard (1957) included it as a surgical principle in plastic surgery. They wrote, "The after-care is as important as the planning," and they emphasized "… or for that matter, the surgery itself." Their teaching is so useful for ear reconstruction because the bandaging immediately after surgery, as well as post-operatively, is a basic procedure to help achieve successful results. The first dressing is applied in the operating room followed by subsequent ones, according to the surgeon's plan for each procedure. Patients and parents must be well informed about post-operative care, and they must follow the instructions, especially those regarding changing the bandages. After the first stage of reconstruction, the bandages are removed 4 days after surgery, and they must be changed every 10 days for 2 months. However, after the second stage of surgery, the first dressing is removed 7 days later, and it must be changed again every 10 days for 2–3 months. Therefore, patients must return according to the schedule for eachoperation under the care of the surgeon and his or her team. The patients or their relatives cannot change the dressing at home because medical supervision is necessary. If the patient is not able to return to the institute regularly to change the dressing, it is better not to perform the operation. Several of my patients live far away, but they must come regularly during the postoperative period; I do not allow my patients to change dressings at home, because it is actually a medical procedure.

Conclusions

Post-operative care is so useful for ear reconstruction that is part of the basic procedure for achieving successful results. The first dressing is applied in the operating room, and subsequent ones are applied according to the surgeon's plan for each procedure. Patients and parents must be well informed about post-operative care, and they must follow the instructions, especially those regarding changing the bandaging. Patients must return according to the schedule for each operation, under the care of the surgeon and his or her team. I do not allow my patients to change dressings at home since it is a medical procedure, and they must return regularly for their post-operative care.

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7. Reconstruction of the Tragus

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Keywords Tragus – Creation of tragus – Importance of tragus

7.1 Introduction

The tragus is a small cartilaginous structure located on the anterior border of the auditory canal. It presents a backward inclination protecting the entrance of the external meatus. It is covered by special skin on its anterior and posterior aspects and is important to the ear for its esthetic, anatomical, and functional aspects. The esthetic and anatomical ones represent rebuilding a segment of the complex architecture of the auricle since the tragus is so evident on any description of the normal anatomy, as well as when one looks to the lateral side of the face. However, the functional aspect is even much more important than reinstating the esthetic and anatomy of the external entrance of the auditory meatus, since many patients complain about its absence. In fact, ever since I began professional ear reconstruction, the creation of a tragus has been a constant challenge since there are complex anatomical alterations on congenital anomalies and even much more damage on traumatic amputations.

There are three origins of the absence of the tragus: (A) congenital, (B) traumatic amputation, and (C) iatrogenic (secondarily to rhytidoplasty).

(A) Congenital absence occurs basically on microtia without an external auditory canal (75% of microtia) and anotia. According to my classification, moderate microtia always presents the external ear canal, rudimentary conchal cavity, and, obviously, the tragus. Also there are severe microtia with external auditory canal without a tragus as well. (B) Traumatic amputation may occur due to car accidents, knife injuries, or burns. In such circumstances the tragus was amputated accidentally (Avelar 2011, 2013). (C) Iatrogenic absence that is secondary to rhytidoplasty may occur when the surgeon voluntarily or due to a surgical mistake excises the tragus.

My attention has been directed to include this important topic due to some of my patients' complaints about the absence of the tragus after traumatic amputation, and some others after facial rejuvenation by rhytidoplasty performed elsewhere. They have not referred specifically to the inexistence of the tragus, but they complain about the functional aspects concerning loss of hearing and imbalance of the head, as well as unknown and strange sensations when they are in a windy setting with excessive light from the sun. Regarding this unusual information from my patients presenting total traumatic amputation of the ear, the tragus is a very important segment that should be studied more, and reported on as well.

Due to the absence of the tragus, the entrance to the external auditory meatus has no protection against the light or the waves of the wind. The backward inclination of the tragus is particularly important because it gives more protection to the external auditory canal. On the other hand, patients with congenital anomalies of the ear have not complained about the functional aspects, but only about the aesthetic and anatomical appearance after ear reconstruction (Avelar 1977, 1979, 2013).

7.2 Definitions

There are a few references regarding the tragus. I found some definitions in the *(Dictionary: American Heritage)*: (1) the projection of skin-covered cartilage in front of the meatus of the external ear and (2) any of the hairs growing at the entrance to the meatus of the external ear. According to the *Wiktionary*, it is a small piece of thick cartilage of the external ear that is immediately in front of the ear canal. The word "tragus" first appeared in English in a medical dictionary in 1693 that is credited to (Rufus de Éfeso 97 D.C – 117 D.C) of Ephesus, a Greek physician who lived about 2000 years ago.

7.3 Clinical and Anatomical Alterations

I have several patients at the Brazilian Ear Institute presenting with total traumatic amputation of the external ear and tragus, caused by car accidents presenting remaining segment of the external auditory canal. It is well known that the auditory canal is a profound tube 2.5 cm long, 1 cm in diameter, and covered by the skin inside the temporal bone. Due to its anatomical situation, it is quite rare that a patient presents total avulsion of it, even after severe traumatic amputation. For that reason I do not recommend using the term "anotia" for this, since my patients always have some remaining auditory canal. According to my classification, I call anotia only for congenital anomalies with the total absence of the external and middle ear which means the absence of the external auditory canal as well (Avelar 1986; Avelar and Bocchino 1989).

On the other hand, I have patients who underwent rhytidoplasty for facial rejuvenation elsewhere and complain about total amputation of the tragus. Both groups of patients with an acquired absence of the tragus described hearing deficiencies and also unusual symptoms that included strange sensations when they are in windy places and exposed to sunlight, particularly at a swimming pool or at the beach. Patients in both groups complain that they feel the uncomfortable sensation of too-dry air that penetrates to the external ear canal and is painful.

The patients who come in after rhytidoplasty have normal ears but present with amputation of the tragus. I was intrigued about why patients with total amputation of the ear complain about the same unusual sensation, so I concluded that the problem is that the absence of the tragus changes the movement of the sound waves produces a hearing deficit, even those patients with normal external auricles. Nevertheless in both groups the patients complain about the unusual sensation of dry air through the ear canal and imbalance of the head, which means that the absence of the tragus is responsible for all those symptoms. In fact, the tragus has unusual muscles that control the entrance of the sound waves through the external auditory meatus and is also in charge of protecting the entrance to avoid the penetration of light into the external canal.Therefore, the tragus is an important anatomical element that must be created during ear reconstruction whether necessitated by traumatic amputation or amputation during rhytidoplasty surgery (Avelar 1987, 2002).

7.4 Method

7.4.1 Surgical Technique for Reconstruction

As mentioned, there are three reasons for the absence of the tragus: congenital, acquired, and iatrogenic. Congenital ones occur on patients with anotia and have been in 75% of my patients presenting with severe microtia according to my classification. Reparation of the tragus may be performed during the first or second stage of ear reconstruction. A segment of rib cartilage is excavated, which is embedded subcutaneously in front of the ear in order to create a projection of the skin (Figs. 7.1, 7.2, and 7.3). The segment may be sutured to the new auricular framework to provide stabilization to the new ear. Even when the tragus is created during the second surgical stage, it is necessary to introduce subcutaneously another segment of cartilage. My procedure is done creating a small cutaneous flap in front of the ear through a semicircular incision with posterior concavity which is turned backward (Fig. 7.2). A segment of cartilage, after properly modeling, is embedded and sutured to the base of the cutaneous flap, which turns on the cartilage graft to cover the posterior and anterior aspects. The raw area caused by the donor flap is covered by a skin flap located on the pre-auricular area after wide undermining (Fig. 7.2). The cutaneous flap is pulled backward in a similar procedure performed during rhytidoplasty in the direction of traction. The reconstructed tragus must present an angle of 30° in a backward inclination in order to partially cover the entrance to the auditory meatus to provide its protection.

Fig. 7.1 Reconstruction of the tragus during the first stage of ear reconstruction. (**a**) Preoperative photo of a 9-year-old male with microtia on the right side; (**b**, **c**) same patient during surgery; (**d**, **e**) final results

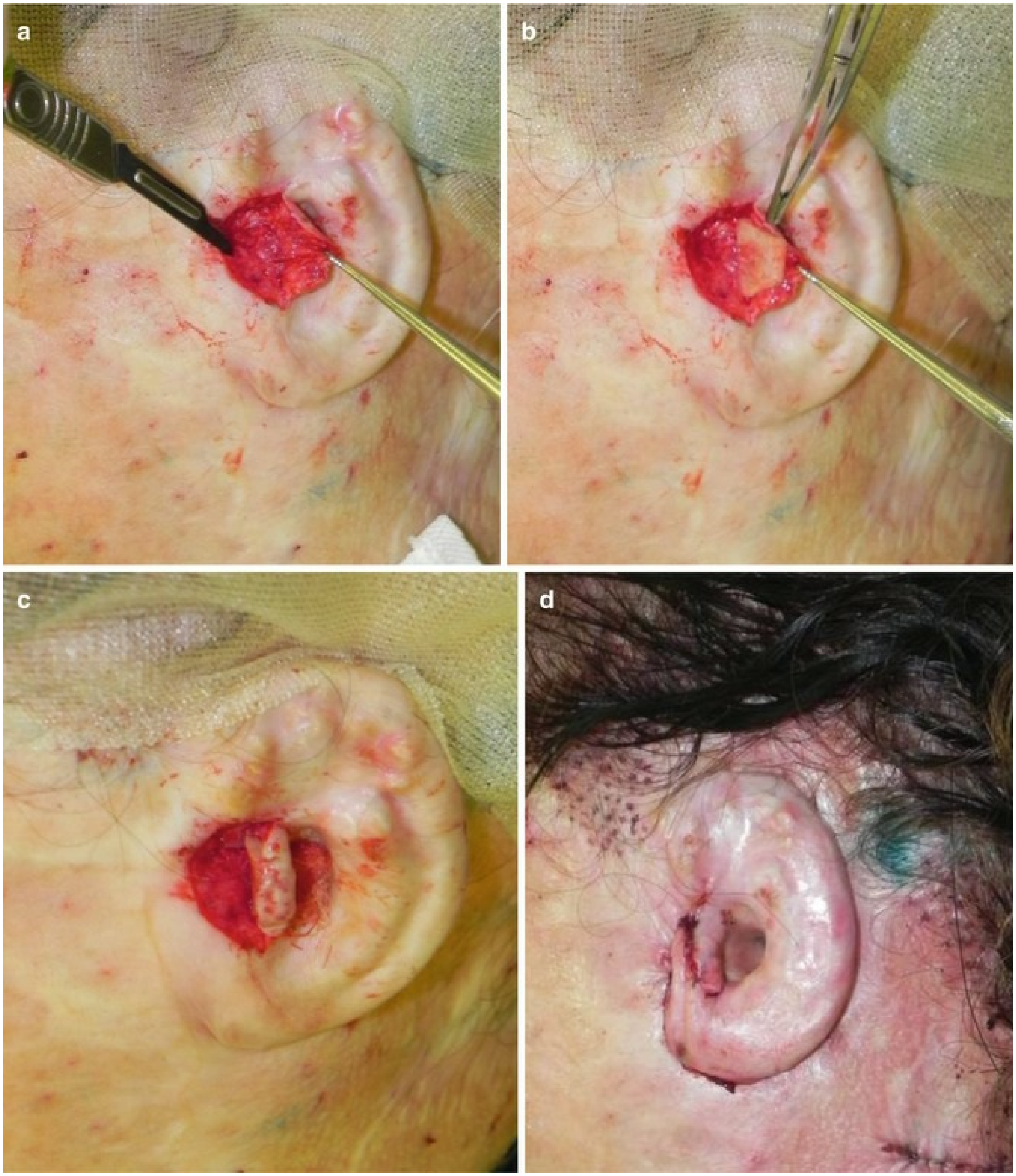


Fig. 7.2 Reconstruction of the tragus. (**a**) A skin flap with posterior pedicle is created in front of the ear. (**b**) a segment of rib cartilage is excavated and placed in front of the skin flap already raised. (**c**) rotation of the skin flap forward to partially cover the anterior surface of the cartilage of the tragus. The raw area is covered by a cutaneous flap from the face that is dissected and pulled backward. (**d**) the final result of the reconstructed ear combined with hair transplantation on the temporal and mastoid regions

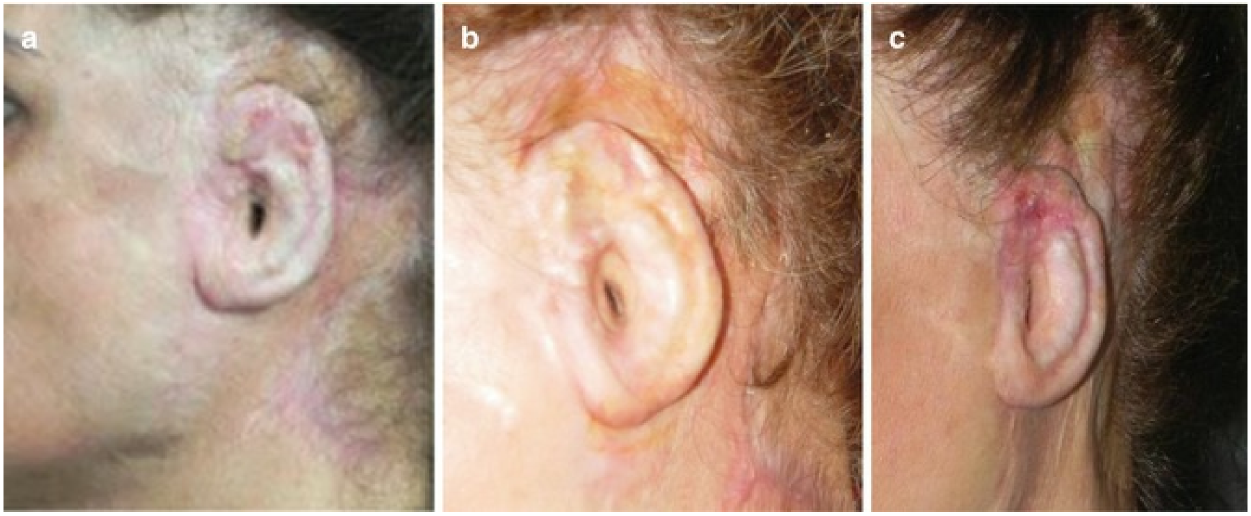
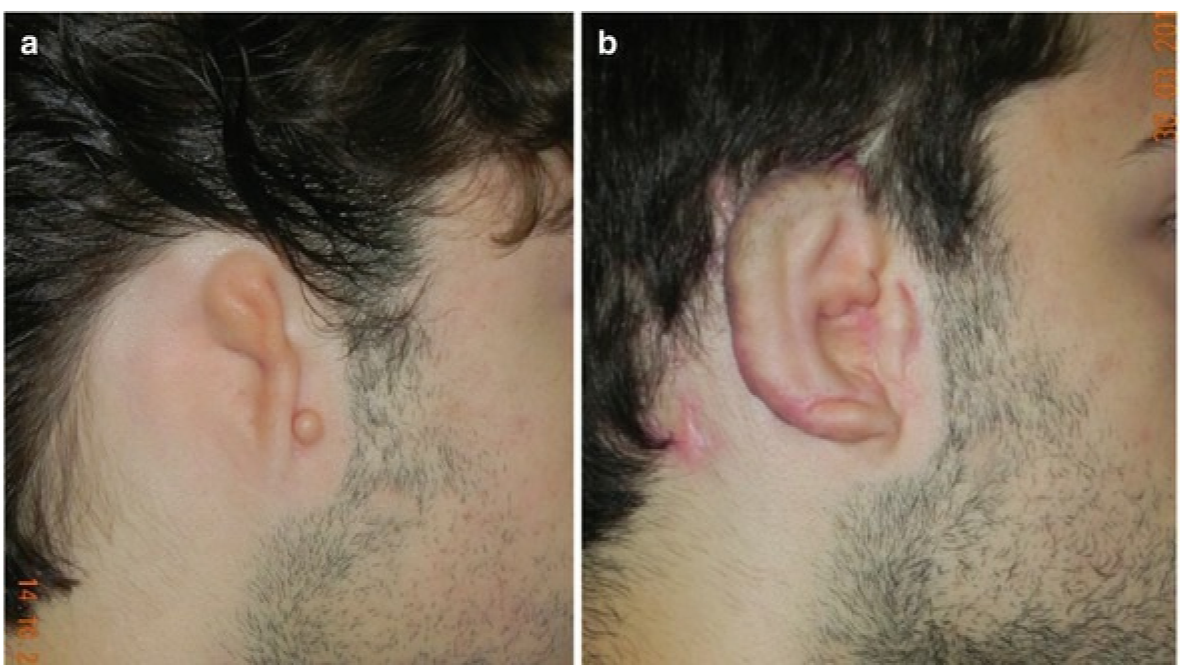


Fig. 7.3 Reconstruction of the tragus during reconstruction of the ear due to severe traumatic amputation. (**a**) Photo showing ear reconstruction with the absence of the tragus; (**b**, **c**) same patient after reconstruction of the tragus following the technique described

This procedure is more difficult to perform on patients after traumatic amputation since the fibrotic cicatricial tissues developed subcutaneously are an adverse condition to creating a skin flap (Fig. 7.2). On the other hand, it is easier to reconstruct the tragus on congenital anomalies since the skin is smoother and presents good conditions to undermine and to fold over the cartilaginous graft (Fig. 7.4).



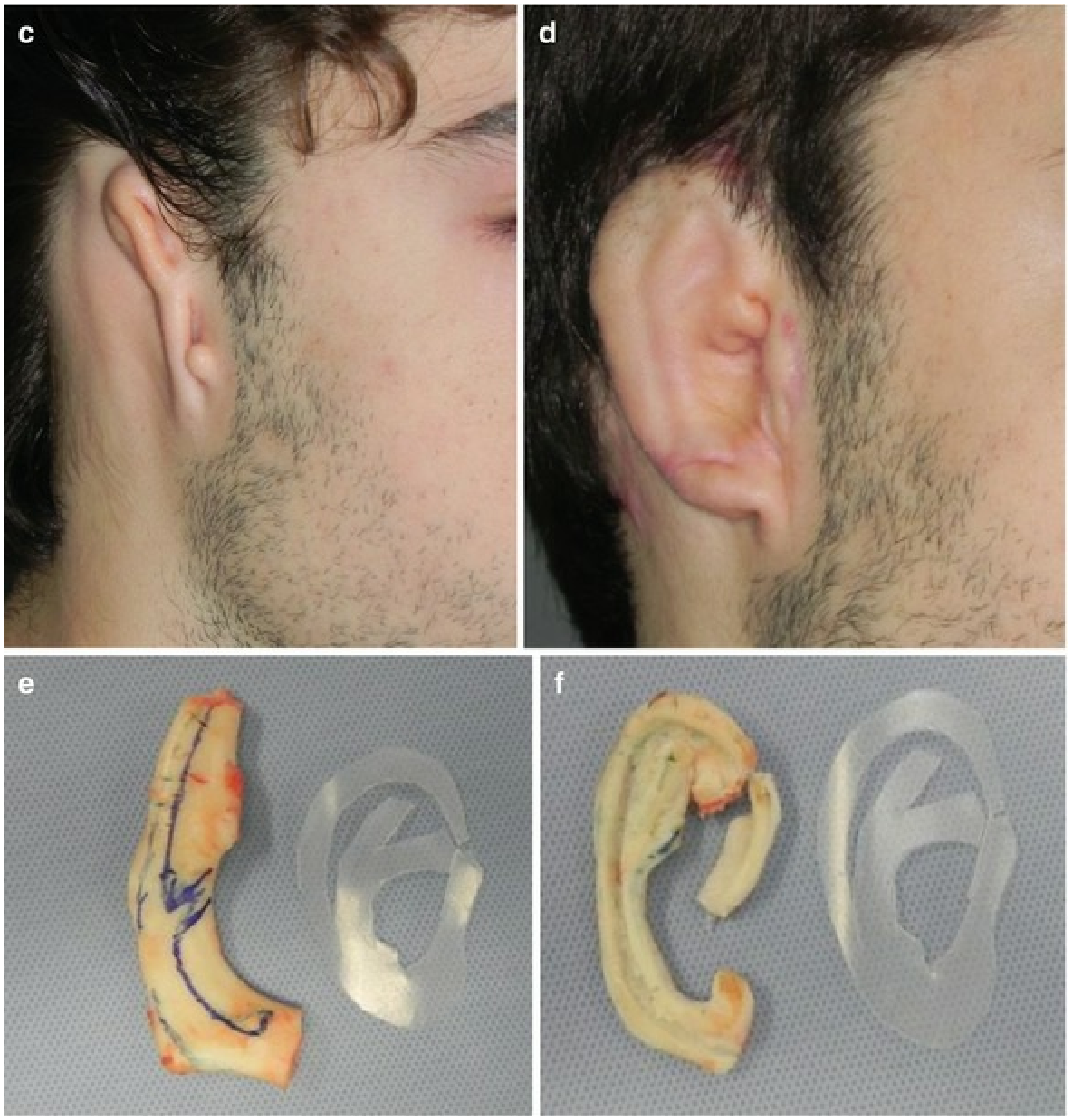
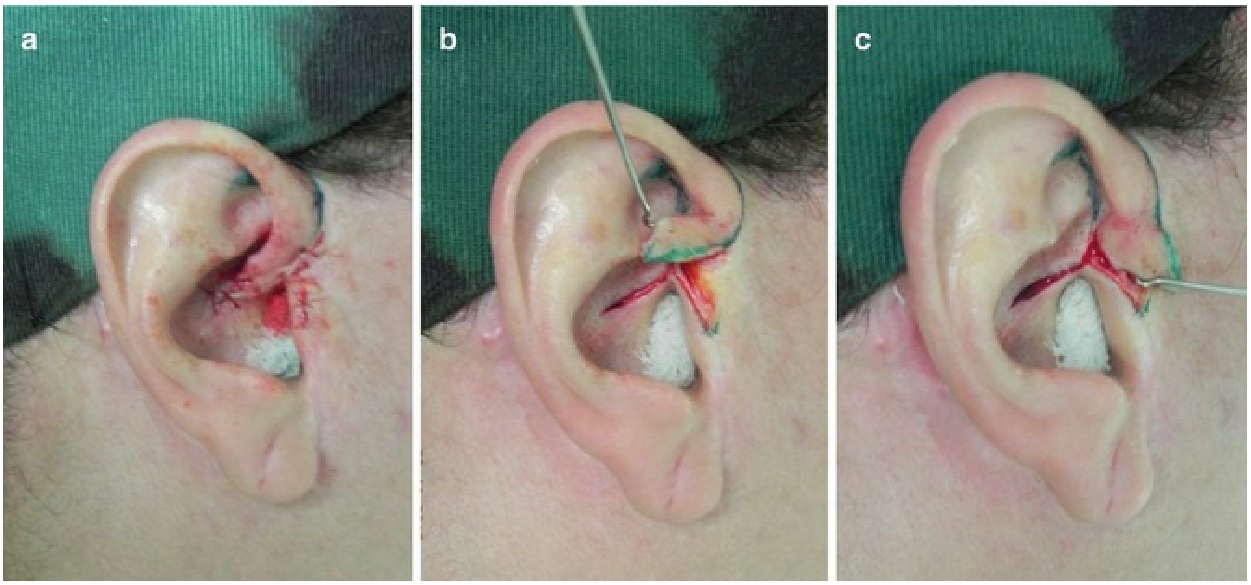


Fig. 7.4 Reconstruction of the tragus combined with ear reconstruction. (**a**–**c**) Pre-operative photos of a 19-year-old male with microtia on the right side; (**b**–**d**) same patient showing the final result after two stages of ear reconstruction and tragus as well as modeling the new framework during first stage of ear reconstruction; (**e**) The ninth rib cartilage is removed preserving the perichondrium; (**f**) the new skeleton is already excavated following the model previously planned

7.4.2 Reconstruction of the Tragus after Amputation during Rhytidoplasty

Amputation of the tragus during rhytidoplasty leaves a scar on the anterior border of the external auditory meatus and normal auricle as well. The operation may be performed under local anesthesia combined with intravenous sedation. A chondro-cutaneous flap draws the conchal cavity inside, with its pedicle anteriorly positioned at the root of the helix (Fig. 7.5). Two incisions are made in order to isolate a segment of skin and cartilage in the conchal cavity. Afterwards, a small composite flap is pulled forward by a hook and sutured on the anterior border of the auditory meatus (Fig. 7.5).




d
e
f
g

Fig. 7.5 Reconstruction of the tragus after amputation during rhytidoplasty performed elsewhere. Preoperative photos showing reconstruction. (**a**) The root of the helix is incised on the conchal cavity; (**b**) a hook is pulling the chondro-cutaneous flap; (**c**) the flap is turned forward to be sutured on the anterior border of the auditory meatus to create the tragus; (**d**–**j**) preoperative; (**e**–**k**) the same patient after reconstruction of the tragus

7.5 Discussion

Although the tragus is a small anatomical element situated in front of the ear, its absence creates complex problems for the patients. There are three reasons for the absence of the tragus: (A) congenital, (B) traumatic amputation, and (C) iatrogenic (as a result of rhytidoplasty). It is an important topic due to some of my patients' complaints about the absence of the tragus after traumatic amputation, and some others after facial rejuvenation by rhytidoplasty performed elsewhere. In both groups the patients complain about an unusual sensation of dry air through the ear canal and imbalance of the head. Therefore it means that the absence of the tragus is responsible for all those symptoms. In fact, the tragus has unusual muscles that control the entrance of sound waves through the external auditory meatus. Also, it is in charge of protecting the entrance to avoid the penetration of light into the external canal. Therefore, the tragus is an important anatomical element that must be created during ear reconstruction caused by traumatic amputation as well as after its amputation during rhytidoplasty surgery.

So far, there have been a few patients presenting with atypical abnormalities on the tragus, such as a cleft tragus, which may cause some discomfort since the entrance of the auditory canal is not totally protected (Fig. 7.6).

Fig. 7.6 Congenital cleft tragus. (**a**) A female patient presenting with congenital cleft tragus with unsatisfactory results after four operations performed elsewhere indicated by *arrow*

My procedure for rhytidoplasty is to do it with an incision at the edge of the tragus in order to preserve it. During the pulling of the facial flap, new skin should cover the tragus and a suitable suture is put in to recreate the tragus.

Conclusions

The tragus is a suitable anatomical structure that is found in front of the auditory meatus. There are three reasons for the absence of the tragus: congenital, acquired, and iatrogenic. Congenital ones occur in patients with anotia, and in 75% of my patients with severe microtia (according to my classification). Reparation of the tragus may be done during the first or second stage of ear reconstruction. A segment of rib cartilage is excavated, which is embedded subcutaneously in front of the ear in order to create a projection of the skin. Reconstruction of the tragus after rhytidoplasty may be performed with local anesthesia combined with intravenous sedation. A chondrocutaneous flap is created inside the conchal cavity at the root of helix, rotated forward, and sutured at the anterior edge of the auditory meatus.

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8. Reconstruction of the External Auditory Canal

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Keywords Auditory canal – Reconstruction of auditory canal – Deformities of the canal

8.1 Introduction

A normal external auricle has a canal through which the sound waves go to the tympanum, and from there to the ossicular chain, and finally to the inner ear. The external canal is a cartilaginous tunnel similar to an “S” shape, located through the temporal bone, with its internal surface covered by special, thin skin. Its anatomy consists of unusual characteristics inside the bone, with two main internal curves.

The first curve is an external one, represented by the projection of the conchal cartilage located on the posterior border of the entrance of the external canal (Fig. 8.1). Such a border is particularly important during prominent ear surgery if the conchal wall is sutured to the mastoid bone, which causes constriction of the entrance to the external auditory canal. Sometimes this constriction can damage the hearing function after the surgery. For this reason, in some cases it is advisable to remove an amount of conchal cartilage in order to avoid such an undesirable complication. The second curve is a small projection in the medial segment of the auditory canal, which is an anatomical detail of the temporal bone (Fig. 8.2).

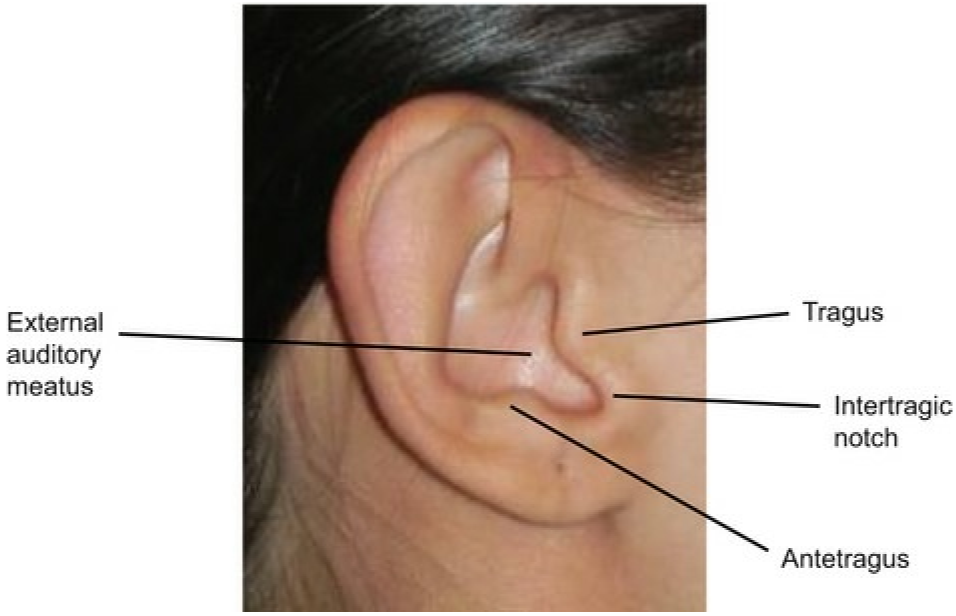

Fig. 8.1 Anatomy of a normal tragus and external auditory meatus, intertragic notch, and antetragus

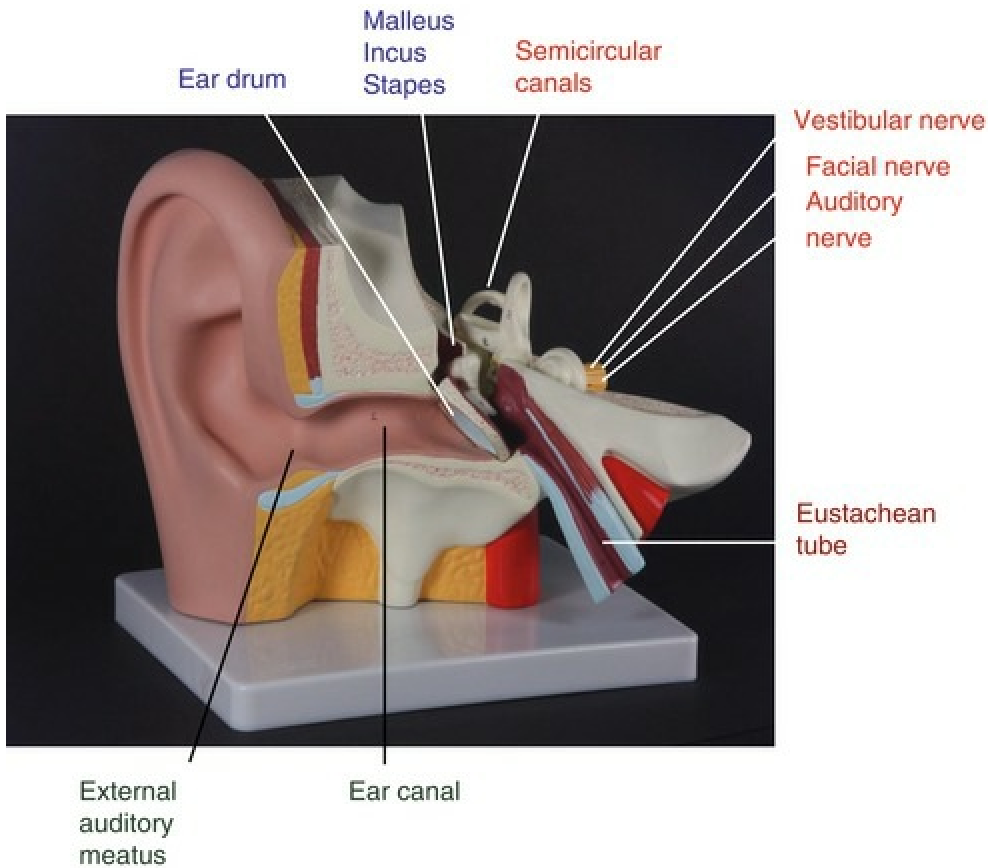

Fig. 8.2 Example of model sample anatomy of the external, middle and inner ear for didactic illustration for patients at the Brazilian Ear Institute

Reconstruction of the meatus is a very complex and difficult procedure that is usually performed to reinstate the esthetic aspects of the ear. So far, the operation may not offer satisfactory functional results, due to scar tissue formation and retraction of the skin that damage the postoperative evolution. For this reason, the results are very poor from the esthetic point of view, as well as being functionally inadequate. Besides all these frustrating aspects, several complications may occur during and after surgery, such as permanent damage to the facial nerve, or chronic osteomyelitis of the temporal bone. I have had a few patients with these complications due to previous operations that caused severe discomfort.

Fortunately, there is a general consensus among otologists against the creation of a new auditory canal in unilateral congenital deformities. However, in bilateral deformities associated with functional impairment, it is suitable to use this procedure to try to improve hearing after reconstruction of the auricle. So far, new techniques these days using cochlear implantation that have been used by otologists have brought about hearing improvement without directly approaching the auricular region, which does not cause any scar tissue formation on the new ear.

8.2 Classification of Meatus Deformities

Basically, there are three groups of pathologies that can cause deformity of the external canal of the auricle: congenital, traumatic, and after tumor resection.

8.2.1 Congenital

At the Brazilian Ear Institute, I have found an absence of the external canal among 75% of the patients with severe microtia without an external canal, and 3% of patients with anotia in all congenital abnormalities of the auricle. The absence of meatus is one of the deformities of severe microtia and anotia, according to my classification. All patients classified as moderate microtia present with an external auditory canal, but only 45% have functional hearing. Therefore, during ear reconstruction, the external canal must be preserved in order to avoid damage to the hearing.

8.2.2 Trauma

Traumatic damage to the external canal may be caused by avulsion of the ear that does not destroy it totally (Fig. 8.3). Among 391 patients treated at the Brazilian Ear Institute for traumatic partial or total amputation of the auricle, I have not seen anyone presenting with total avulsion of the external canal. Even in cases of very severe trauma, there is always some sort of canal vestige covered by its skin or scar tissue with the tympanum inside. Therefore, a surgeon must be sure that there is always some sort of auditory canal underneath the scar tissue that is secondary to cutaneous healing after total amputation of the external auricle. I have had some patients develop a cyst secondary to secretion of internal skin of the remaining auditory canal that was covered by scar tissue formation. For this reason I do not share Davis’s opinion when he calls this total amputation of the external ear “anotia,” because these patients always have some sort of external canal, even very deep and close to the tympanum. I use the term anotia only for the total absence of the auricle without any remnant of ear cartilage.

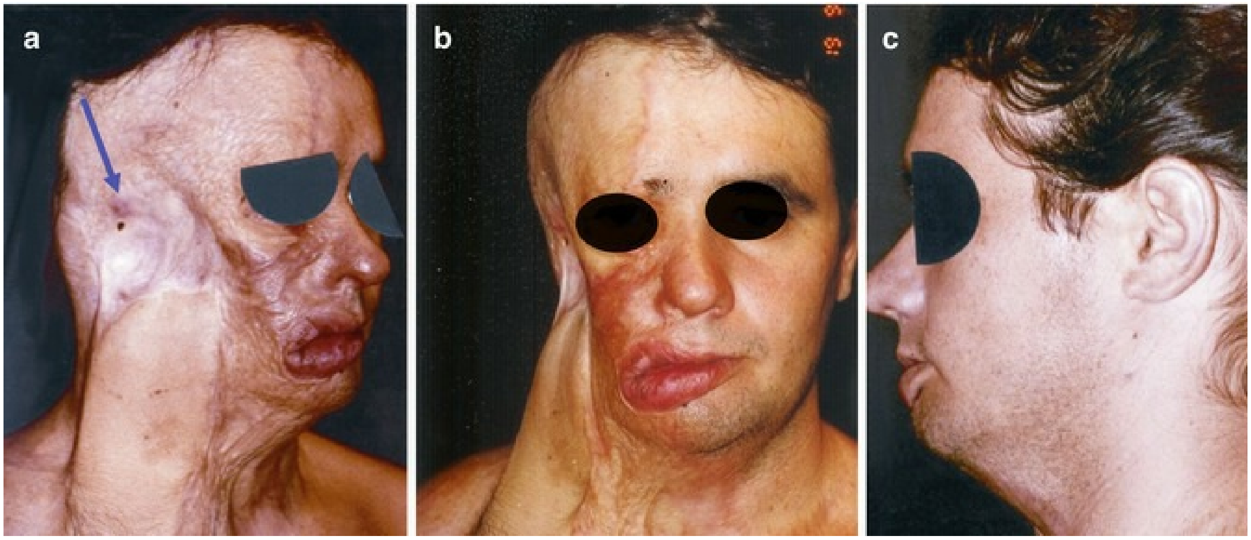

Fig. 8.3 The auditory canal is a very deep structure. (**a**) A 31-year-old male. Lateral view after severe burn from very hot chemical liquid (over 400 °C temperature) resulting in completedestruction of the right hemifacial. The right ear was destroyed, but auditory canal still remained as indicated by the *arrow*; photo (**b**) frontal view showing severe facial unbalance due to the destruction of the right hemifacial; (**c**) photo of the same patient showing theleft side of the face

There are several causes of trauma: burns (fire, hot liquids, and chemical products); mechanical laceration (car accidents, knifings, animal or human bites, etc.); and foreign bodies.

Regarding burns: When the external auricle is burned, the meatus must be well examined no matter what the agent responsible for the injury. The skin covering and the tympanum may be destroyed due to direct contact, or it may be damaged due to secondary infection. Special care must be taken during the treatment to avoid severe consequences afterwards. Even if the external canal is not totally destroyed, it may develop stenosis, causing serious problems. The scar tissue that is formed is very strong, and it may contract over the canal, closing it and keeping a small cavity underneath.

Regarding traumatic amputation of the auricle by car accidents, human or animal bites, knives, or any other instrument that cuts the auricle partially or totally: these do not destroy the canal, due to its location deep inside the temporal bone. Some skin always remains covering the internal surface of the meatus, but sometimes it may suffer severe trauma with laceration of the border, followed by retraction and even closure of the meatus.

At hospital emergency departments, it is quite common to see patients with foreign bodies inside the external canal. A small piece of stone, grain of corn, or bean may penetrate the canal, causing great discomfort. In tropical countries such as Brazil, there is a disease called “miíase” in which the larvae of an insect can grow inside the canal, causing secondary infection and destroying the internal wall. However, external trauma may not be able to destroy all internal canals since the temporal bone gives it important protection.

8.2.3 After Tumor Resection

The absence of or severe stenosis as a result of tumor resection is particularly difficult to repair because of:

(a) Scar tissue formation after surgical resection

(b) Stenosis of the external canal

(c) Inadequate or insufficient normal skin in neighboring regions of the external canal that would be used to create skin flaps

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8.3 Planning the Reconstruction

Hearing deficiency is a serious problem, especially when it is combined with atresia or stenosis of the external meatus. The medical literature has a vast number of publications describing the efforts of many scientists to repair auditory atresia of congenital or traumatic origin, but the problem has not yet been adequately solved. Repair of the external canal by skin graft was performed by Ombredanne (1944), who was probably the first to cover the internal raw surface after perforation of the temporal bone or mastoidectomy.

In more recent publications that looking for better results authors use the skin taken from the internal part of the arm to avoid the growth of hair inside the new canal, as well as to prevent secondary retraction. However, surgeons have been disappointed with the results of skin graft in operations of unilateral deformities. Brondbent and Woolf (1974) reported that they turned the defatted upper fold skin inside out in order to cover the new canal and reach the middle ear in agenesis of the meatus in bilateral deformities. I published an article (Avelar 1986) on the use of double skin flaps from the local area of the conchal cavity. Also, I use cutaneous folds that cover the remaining auricular cartilage to reconstruct external auditory canals (Fig. 8.4), which I used to do during the second stage of ear reconstruction in bilateral and unilateral microtia (Fig. 8.5). It works very well from the esthetic point of view, but does not improve hearing.

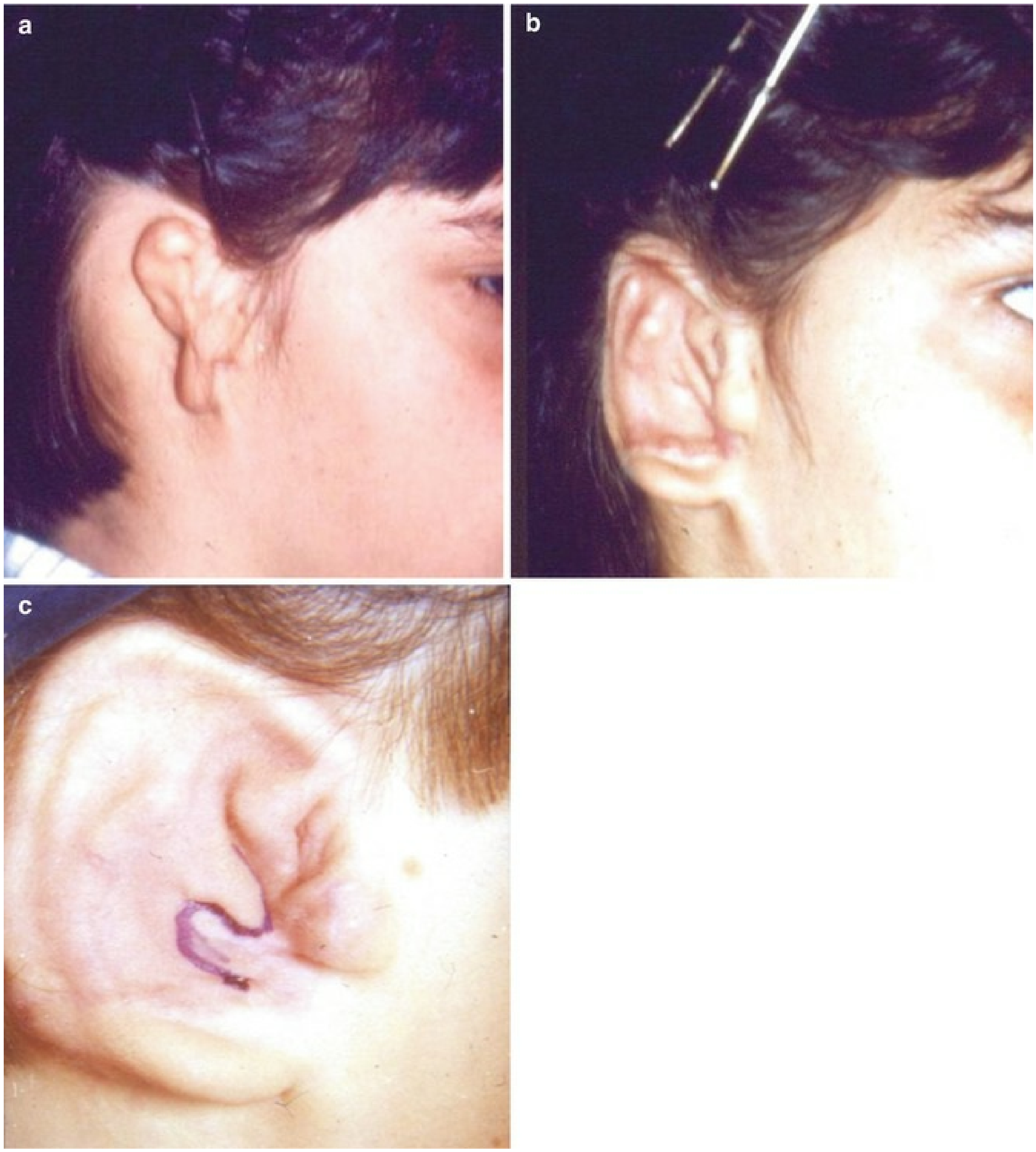

Fig. 8.4 Reconstruction of the external auditory meatus during ear reconstruction on microtia. (**a**) Photo of a patient with microtia before surgery; (**b**) postoperative photograph 1 year after the first stage of reconstruction. (**c**) An “S-shaped” incision is marked with ink on the conchal area

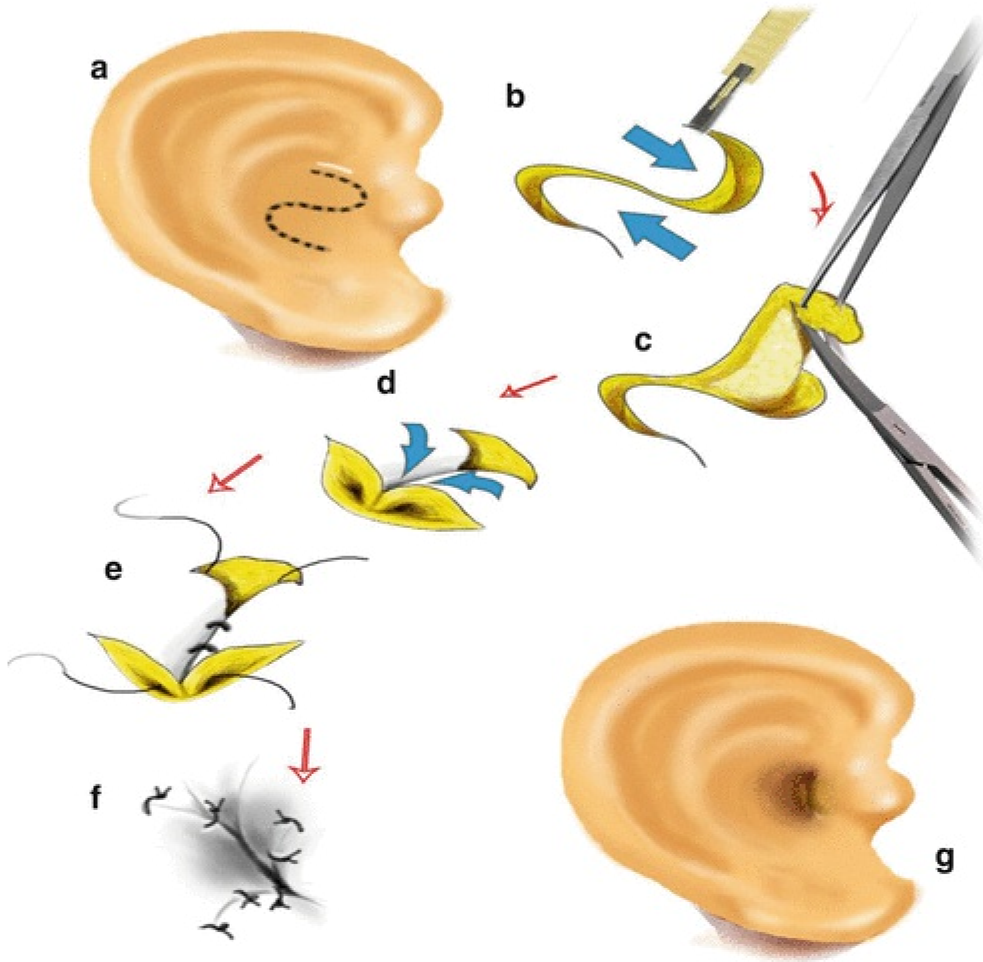

Fig. 8.5 Creation of the external auditory meatus during the second stage of ear reconstruction. (**a**) An "S-shaped" incision is drawn on the conchal area of the reconstructed ear; (**b**) two cutaneous flaps are created after skin incision; (**c**) the flaps are elevated and the subcutaneous tissue defatted; (**d**–**f**) the two cutaneous flaps are stitched together and sutured to the periosteum, creating the external canal; (**g**) after reconstruction of the external meatus

Plastic surgeons and otologists agree that the reconstruction should not be performed when there is unilateral dysgenesis of the external canal, even when patients have severe hearing deficiency on that side. Patients with normal hearing on one side present with good chances to lead normal lives, but reconstruction of the external meatus in patients with bilateral dysgenesis of the external auricle without hearing deficiency (15%) should not be performed. However, in 85% of my patients with bilateral congenital deformities of the auricle together with severe hearing impairment, it is reasonable to try to reconstruct the external ear canal, although hearing improvement is not always achieved. I have my own reasons for being opposed to canal repair:

1. Hearing improvement is not enough to justify the operation.

2. Facial nerve injury during surgery may cause damage to a greater or lesser extent, resulting in definitive facial palsy. I have seen three patients with very severe complications due to facial palsy after canal reconstruction performed by otologists.

3. Chronic osteomyelitis of the mastoid bone. I have seen two patients, operated on elsewhere, with such complications still affecting them many years after the operation.

4. Frustration of the patients and their relatives due to dissatisfaction with the results.

5. Scar tissue formation after surgery is one of the most serious problems in ear reconstruction.

Reconstruction of the meatus is indicated in bilateral deformities with atresia of the external canal combined with hearing deficiency. However, all the reasons described above must be considered prior to the operation. Even in such circumstances, I recommend performing the ear reconstruction before the otologist creates the new canal. I have several patients who needed a good support to hold their hearing aids, who came to me on the recommendation of otologists, since the new organ is a very useful appendage to support eyeglasses. For all these reasons, ear reconstruction is much more than just repairing a facial imbalance, because the new auricle also works as an important structure of the facial contour. Nevertheless, reconstruction of the ear canal is much more a matter of esthetic repair than a procedure to improve hearing. In fact, I prefer to create skin flaps on the neighboring areas and not use skin grafts, due to retraction and later stenosis of the new canal. Also, when using skin flaps, it is easier to clean the new canal, avoiding any trauma to the skin.

8.4 Personal Procedures

Reconstruction of the ear canal requires individual planning according to the origin of the deformity, as described before in the classification. It may be:

A. Reconstruction of the auditory canal in congenital deformities (Figs. 8.4, 8.5, and 8.6)

B. Reconstruction of the external canal after traumatic amputation

C. Reconstruction of the external canal after tumor resection

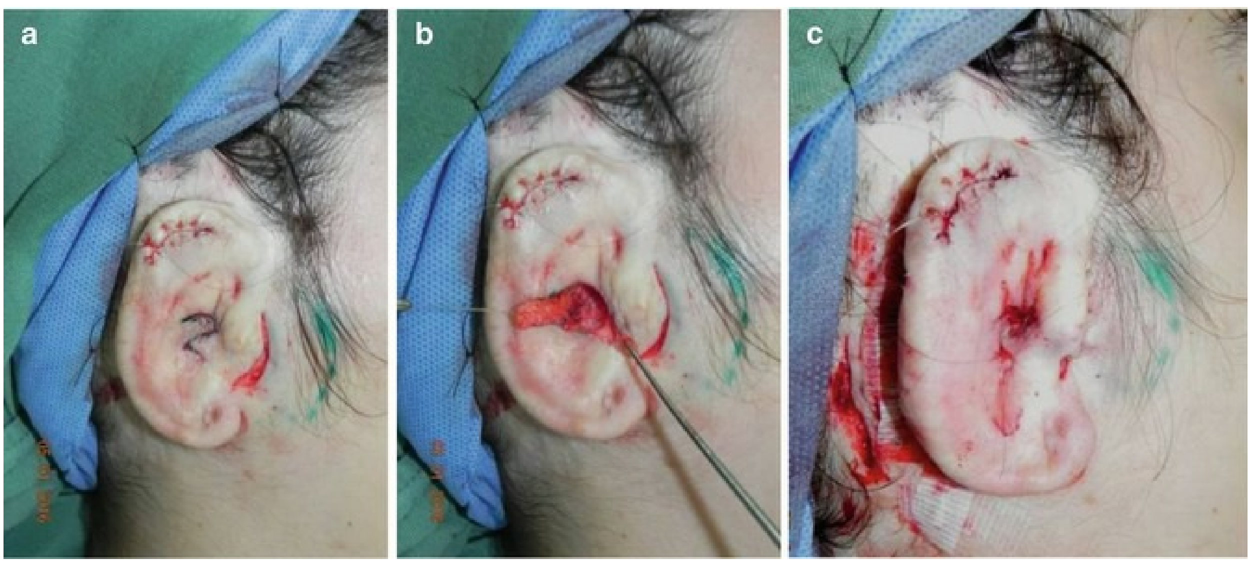

Fig. 8.6 Reconstruction of the external auditory meatus during the second stage of ear reconstruction on microtia. (**a**) Photo showing the "S-shaped" incision on the conchal cavity; (**b**) after cutaneous incisions, the two flaps are raised and defatted; (**c**) after suture of the skin flaps, the external meatus is created

8.4.1 Reconstruction of the Auditory Canal in Congenital Deformities

As described above, the absence of the external canal is a very common deformity (72.6%) in congenital dysgenesis of the auricle. Although I am not enthusiastic about reconstructing the external canal through bone perforation aimed at improved hearing, I do sometimes perform an esthetic procedure looking for harmony of the reconstructed auricle; therefore, my plan for repair does not include perforating the temporal bone. Such an operation should be done by an expert (otologist) with enough experience and using a microscope. Even using all the necessary equipment, there may be several complications secondary to the reconstruction, as mentioned above.

Since my operation is restricted to the level of the skin and the subcutaneous layer underneath, I use a procedure similar to my technique for umbilicoplasty performed during abdominoplasty (Avelar 1976a, b, 1978a, b, 1985, 1999), in which I create a new umbilicus avoiding a scar around the umbilical cavity. In my first cases, I created three triangular flaps with their vertices directed to the center of the future internal cavity; however, after long-term follow-up, I noticed that the skin flaps did not work as well as I had expected. Afterward, I developed a new drawing with an atypical “S” in the center of the future cavity. Through cutaneous incisions, two skin flaps are dissected, and they must be defatted as much as possible in order to enable good rotation from the surface to the depth. The tips are stitched to one another, creating a “gloved finger” with the skin flaps. The end of the “glove finger” is stitched to the periosteum of a depression on the bone surface where the external canal would be if the congenital anomaly had not existed. The subcutaneous tissue is resected all around the new canal in order to widen an esthetic cavity on the reconstructed area (Figs. 8.4, 8.5, and 8.6).

In all congenital deformities of the ear, there is a very thick layer of subcutaneous tissue where the conchal cavity should be. Therefore, when a wide area of subcutaneous tissue is resected, it helps to create the new conchal cavity and the external meatus as well.

The dressing consists of wet cotton without any external stitches. The defatted skin heals nicely on the bone surface without any pressure on it (Fig. 8.7).

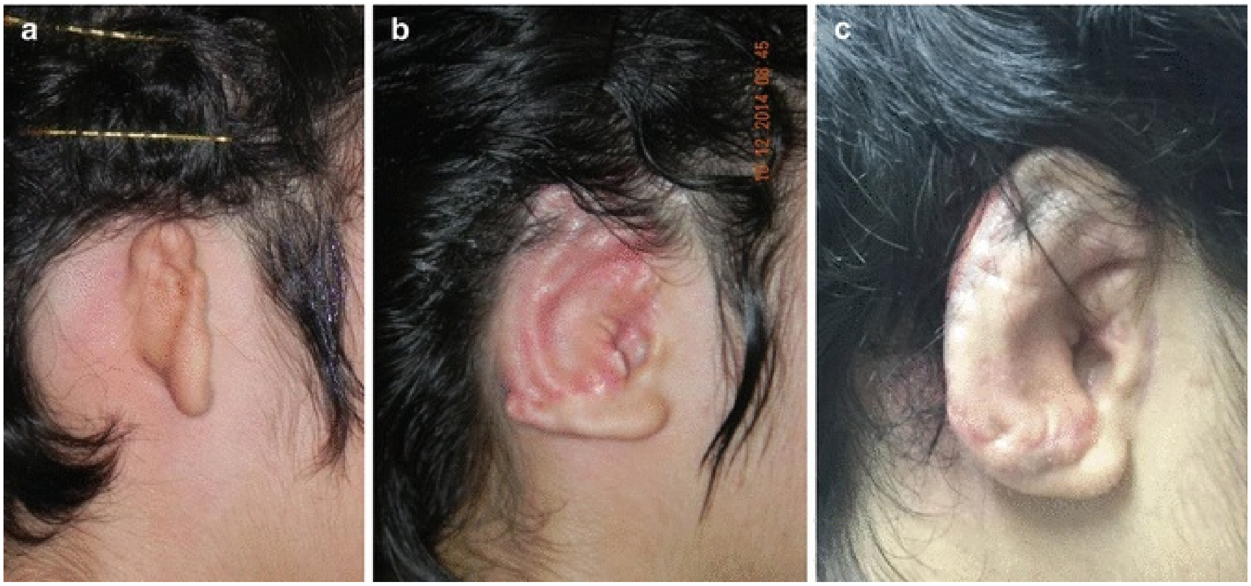

Fig. 8.7 Creation of the external auditory meatus in a patient with microtia. (**a**) Before surgery; (**b**) photo after the first stage of reconstruction; (**c**) same patient after second stage of ear reconstruction and creation of the external auditory meatus as well

All my patients classified with ectopic moderate microtia presented with external auditory meatus with severe inclination in comparison with the position of the future auricle; they also have a considerable level of functional hearing that must be preserved during ear reconstruction. In some cases, the spatial projection of the future auricle shows that the external meatus is so low that it is below the inferior border of the ear (Fig. 8.8).

Fig. 8.8 Patient with moderate ectopic microtia on the right side showing the remnant auricular tissues, which are lower than the normal position. (**a**) Preoperative photo of a 15-year-old male; (**b**) photo after the first stage of ear reconstruction with the new auricular framework. One can see the remaining auditory meatus in the ectopic position; (**c**) same patient after the second stage of ear reconstruction with transposition of the remaining external auditory meatus; (**d**) photo of the final aspect of the same patient after a third operation for remodeling the external canal meatus. (**e–g**) Preoperative photos showing the transposition of the remaining external auditory canal from its inferior location due to a congenital anomaly at the center of the conchal cavity. The remaining auditory canal presents hearing function

8.4.2 Reconstruction of the External Canal After Traumatic Amputation

In all traumatic amputations of the auricle that I have seen at our Ear Institute, as well as at hospital emergency departments, there is always some remaining auditory canal underneath the skin or beneath the scar tissue. Therefore, the technique for reconstruction is quite different from that for congenital absence of the external canal.

If there is some sort of external canal, the surgeon should evaluate it in order to determine the correct location prior to the reconstruction of the missing auricle. In most cases, there is a very small orifice with hard scar tissue around it, and the external secretions from the remaining canal goes through this hole. It does not mean that it is the correct location of the future external canal. Sometimes the external orifice needs to be repaired using cutaneous flaps, in order to create an adequate balance between the external canal and the future auricle. The operation is usually performed under local anesthesia combined with intravenous sedation. While the reconstruction of the auricle is not the purpose of this chapter, it is important to emphasize that the planning of the auricular reconstruction must be in harmony with the repair surgery of the external canal.

When the external orifice is well located, but has stenosis due to fibrotic tissue, the operation is performed creating multiple "Z" flaps around it, in order to open it. Due to "Z-plasty," the normal skin of the remaining external canal will cover the border of the orifice, avoiding posterior retraction or contraction, even in cases where the external skin is fibrotic and there is hard scar tissue. Again, it is important to emphasize that the technical principles of my umbilicoplasty technique are used in order to avoid a surgical scar around the entrance of the future external canal (Avelar 1976b, c,1978a, b,1979).

If the local skin is too hard, and it is difficult to create cutaneous flaps, it is very useful to perform a skin graft in order to lengthen the remaining external canal.

8.4.3 Reconstruction of the External Canal After Tumor Resection

This kind of reconstruction is very individual to each case, due to the amount of tissue resection performed during treatment for the tumor. Therefore, surgical planning must be done according to each deformity. If the tunnel cartilage of the external canal is damaged during the surgical tumor resection, then the reconstruction is even more difficult.

8.5 Discussion

Reconstruction of the external auditory canal is done in order to reinstate the esthetic harmony of the auricle. It is very difficult to improve hearing function in congenital anomalies of the ear, since patients may present with associated deformities that may not be properly repaired. There are three reasons for abnormalities of the external auditory canal: congenital, traumatic, and as the result of tumor resection. In unilateral congenital anomalies of the ear, it is not enough to try to reconstruct the auditory canal in order to improve hearing function. However, in bilateral anomalies with a hearing deficit, it is a normal procedure for an otologist to try to reconstruct it. A plastic surgeon may create the external entrance of the auditory canal, since perforating the temporal bone may damage the facial nerve or cause a severe post-operative infection to develop.

In all patients presenting with total amputation of the auricle, there is some remaining external auditory canal underneath the cutaneous covering. In the emergency room, the surgeon must always be aware that there is some vestige of external canal that can be identified. Even after complete healing of the scars from trauma, it is advisable to find and identify the external canal, since external secretion may develop afterwards.

In congenital anomalies, the external meatus may be created by the use of local skin flaps to be sutured on deep structures. Skin grafts may cause retraction and contraction, with very poor surgical results.

Conclusions

The external auditory canal presents functional and aesthetic behavior, being very difficult to reconstruct. After traumatic amputation of the ear, there is always some remaining external auditory canal in deep structures that must be identified at the emergency room even after the complete healing of cutaneous damage. Patients presenting with congenital absence of the ear should not undergo reconstruction of the external canal since perforating the bone can cause severe complications such as damaged branches of facial nerves and osteomyelitis of the temporal bone. People who have unilateral congenital anomalies have normal hearing in the opposite ear and having a good quality of life.

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9. Reconstruction of the Ear Due to Congenital Anomalies

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Keywords Ear reconstruction – Congenital anomalies – Reconstruction in congenital deformities – Microtia – Anotia

9.1 Introduction

The human ear is an important appendix located on each side of the lateral wall of the head; it is formed by a blade of cartilage covered with delicate skin on its front and back parts. The cartilaginous structure has profound ramifications which are the attachment to the bone planes by ligaments and also forms the external auditory canal. In every organ of the body, there may also be congenital abnormalities of greater or lesser complexity which have been the subject of study and research for thousands of years. The first report of plastic surgery date back to 4000 B.C., that is transcribed by Sushruta, as descriptions in all text books (Avelar 1977, 1979). Such anomalies show a wide range of small changes in the shape and size, reduction, and even complete absence of the organ. My previous publications (Avelar and Psillakis 1981a, b, Avelar 1986, 1997) present studies focusing on classifying deformers of the pinna to facilitate treatment and reconstructive surgical planning.

Since the beginning of my career, intensive efforts have been devoted to the constant search for better solutions to the problems related to reconstruction of the ear. Indeed, each type of abnormality requires an individual surgical technique. (Classifying and describing the various anomalies of the ear are thoroughly described in Chap. 2 of this book.) So far, I have already described the clinical forms and surgical technique for correcting congenital anomalies of the auricle, which are in five groups: anotia, agenesis of the auricle, and microtia, which presents three different modalities: severe microtia, moderate eutopic microtia, and moderate ectopic microtia (Avelar 1986, 2003, 2011, 2013). Each group of deformities requires specific methods for reconstruction due to abnormal anatomical changes. Therefore each one also has associated abnormalities - an important feature when studying congenital abnormalities of the auricle.

The term “microtia” is considered by many authors to be a generic name for several anomalies of the ear. However, one should not generalize this specific word“microtia”because the clinical manifestations presented show us morphological and anatomical differences as well as the choice of the surgical technique for reconstruction and association of other anomalies in various parts of the body.

As it is a very wide field, only the technique concerning treatment for severe microtia is described below. The surgical approaches for reconstruction on anotia, agenesis of the auricle, moderate eutopic microtia, and moderate ectopic microtia are described elsewhere (Avelar 2011, 2013).

All patients classified as having severe microtia present with two anatomical characteristics: the lobule, but in an incorrect position, and rudiments of remnant cartilaginous tissue that is not used in the reconstruction. The remaining segments of cartilaginous tissues are of varying sizes that are quite similar to the normal ear, but with very small dimensions.

9.2 Method

In our previous publications (Avelar 1977, 1979, 1986; Avelar and Psillakis 1981a, b), we described how the reconstructive technique is performed basically in two stages. The patient’s age has to be taken into account, since we should not start rebuilding before age 6 or 7 because the ears are still growing until then and the costal cartilages have not totally developed enough to provide enough thickness to sculpture the new ear framework.

9.3 First Stage of Reconstruction

The four phases of the first stage are:

A. Surgical planning

B. Creating the new cartilaginous framework

C. Creating the cutaneous covering

D. Reconstructing the new ear

9.3.1 Surgical Planning

Surgical planning is an important step that takes place in the office with the patient and family participating in all aspects of it. It comprises two phases:

- Analysis of deformities
- Spatial projection of the future ear

9.3.1.1 Analysis of Deformities

This is an important and complex period that initially corresponds to the physical examination by the surgeon during the first contact with the patient (Fig. 9.1). It is important to ask whether the patient has been previously operated on, and if he or she has undergone surgery, it is vital to ask when the last one took place. One should not do another surgery before completing a full year since the last surgery, because this is the amount of time required for proper healing of the skin and subcutaneous wounds. In the case of previous interventions, the materials that were used in an attempt to create the new auricular framework should be investigated. In patients not previously operated on, the surgeon must also analyze the clinical site to establish the diagnosis and classification of the anomaly.

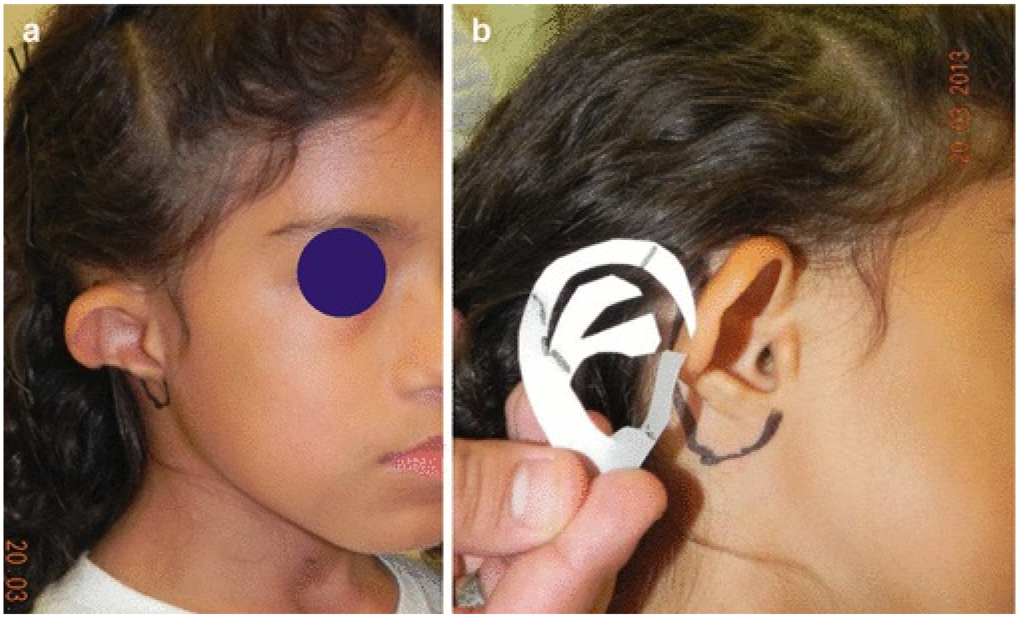

Fig. 9.1 Surgical planning before ear reconstruction in an atypical microtia. (**a**) An 8-year-old female presenting with a typical congenital deformity of the right ear; (**b**) during surgical planning, the new model is created for spatial projection of the future ear

9.3.1.2 Spatial Projection of the Future Ear

The ears are totally external organs that are fixed to the side surface of the head only by the structural basis of the ear scaffold with ligaments and muscles. In fact, before performing the reconstruction, the surgeon must establish the size and shape of the new ear in space, which I call “spatial projection.” To design this, the surgeon can use a model in an X-ray film with the same size and shape as the other ear, according to the description of Avelar (1997) and Avelar et al. (2011a). I learned this from Prof. Pitanguy (Avelar et al. 2011b) during my training. Bilateral deformities fit the surgeon’s esthetic sense for establishing those dimensions because the location is established by the same technical references used in unilateral microtias. In unilateral cases, the mold is then inverted to show the shape of the future ear on the side of the congenital imperfection.

The location and position of the auricle are determined by the physician, keeping in mind that patients always have some degree of facial asymmetry (Fig. 9.1). One should not strictly transpose the dimensions of the normal hemiface to the side of the deformity, because it is not a good parameter in the vast majority of cases.

9.3.2 Creation of the New Cartilaginous Framework

The new auricular framework is sculpted by an excavation of rib cartilage that is removed from the 8th or 9th costal arch (Fig. 9.2).The model created during the spatial projection of the future ear is useful when the new frame is excavated. The full description of how to create the new ear framework are described in detail elsewhere (Avelar 1977, 1979, 1986, 1997, 2000, 2003, 2011, 2013).

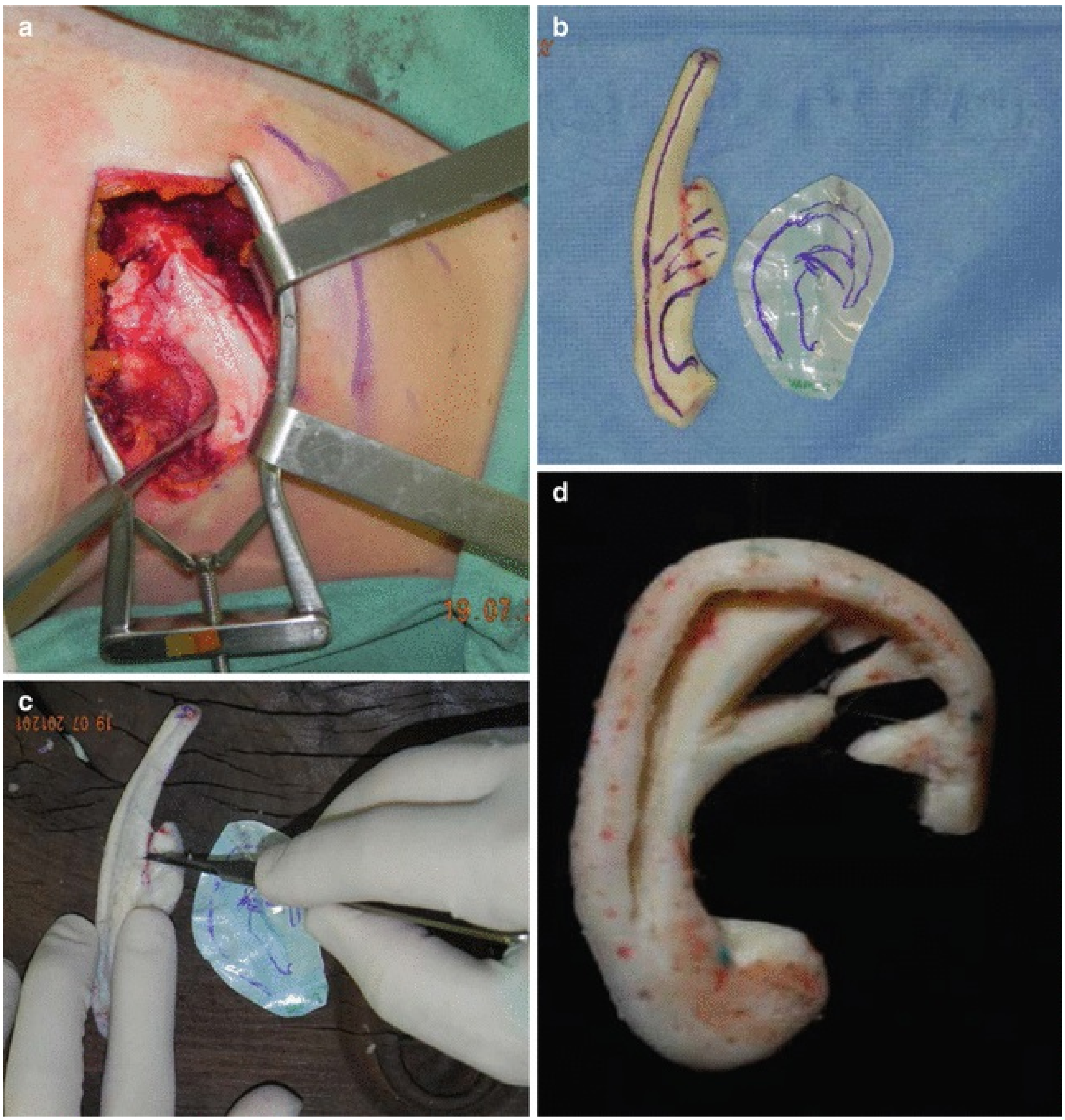

Fig. 9.2 Modeling of the new auricular framework. (**a**) The 9th rib cartilage is being removed; (**b**) the future auricular framework is drawn on the rib according to the model previously done; (**c**) the cartilage is excavated using special instruments; (**d**) the new frame is excavated

9.3.3 Creation of the Cutaneous Covering

According to my concept, all the skin covering the remaining cartilaginous tissue of the microtia should be preserved in order to be used during the operation. All the cartilaginous tissue, however, is resected. Although it is ear cartilage, it should not be used because the shape and size is not adequate for creating the new auricular framework.

When the cutaneous fold is large enough, two horizontal incisions are made in order to divide it into 3 flaps: superior, medium, and inferior(Fig. 9.3). All the remaining cartilaginous tissue is carefully resected (Fig. 9.4). Most of the cartilage is located inside the bone depression where the external canal would be if the auricle had developed normally. After its resection, the bone surface shows a wide cavity that will help create the conchal cavity. It is important to emphasize that there is a branch of the posterior auricular artery, coming from the depth, that irrigates the remaining ear cartilage. The surgeon should tie it before cutting in order to avoid bleeding during or after surgery.

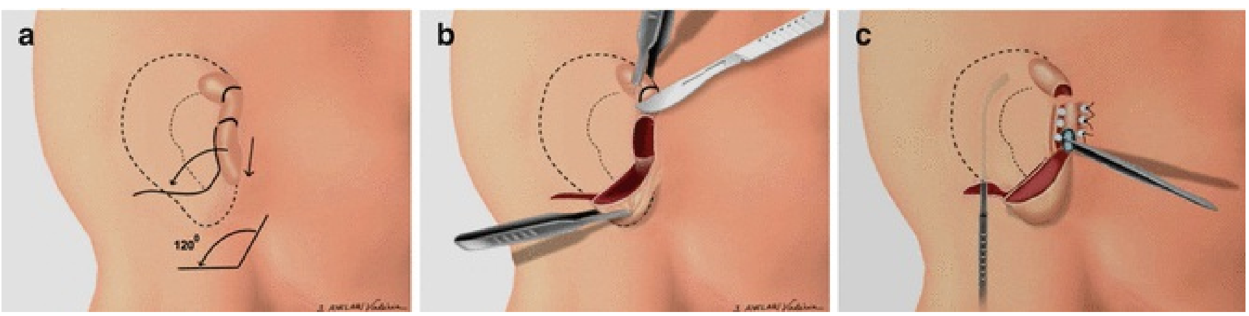

Fig. 9.3 Sequential schemes showing the first stage of ear reconstruction on severe microtia. (**a**) Surgical planning and demarcation of spatial projection of the future ear; the lobule is going to be rotated 120° backward; (**b**) the lobule is already rotated (**c**); with a special instrument, the future helix and antihelix are dissected, and the new tragus is created

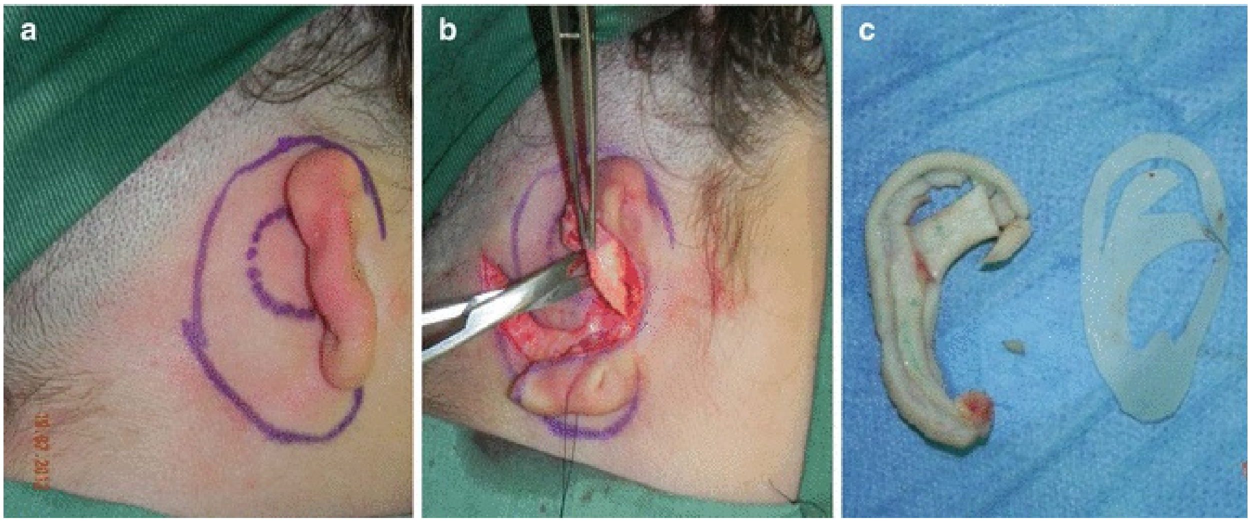

Fig. 9.4 First stage of ear reconstruction on severe microtia during surgery. (**a**) Surgical planning and demarcation of spatial projection of the future ear; (**b**) the lobule is already rotated backward to its normal position and the remnant ear cartilage is being removed; (**c**) the new auricular framework is already sculpted by excavation according to the X-ray model

There have been several cases in which the cutaneous fold was very small, and it is only possible to perform one incision in order to remove all the cartilaginous tissue, as well as to rotate the lower part of the fold in order to create the auricular lobule. In this segment there is no cartilage, only two layers of skin and subcutaneous tissue between them.

When the superior flap is large enough to create the crus of helix, it is rotated upward. The medium flap is sutured to the periosteum, forming a depression which in some cases originates from the auditory canal (Fig. 9.3). A cartilaginous graft is placed under the skin to form the tragus, and the inferior flap is rotated down and backwards, creating a 90° angle for the auricular lobule. A horizontal incision on the mastoid area is performed (Fig. 9.4), followed by undermining of the skin on the area corresponding to the future helix and antihelix; this procedure creates a subcutaneous tunnel (Fig. 9.5). The skin corresponding to the future conchal cavity and the external margin of the ear is not dissected in order to provide vascularization for the new auricle (Fig. 9.5) (Converse 1958; Pitanguy et al. 1971 and Tanzer 1959).

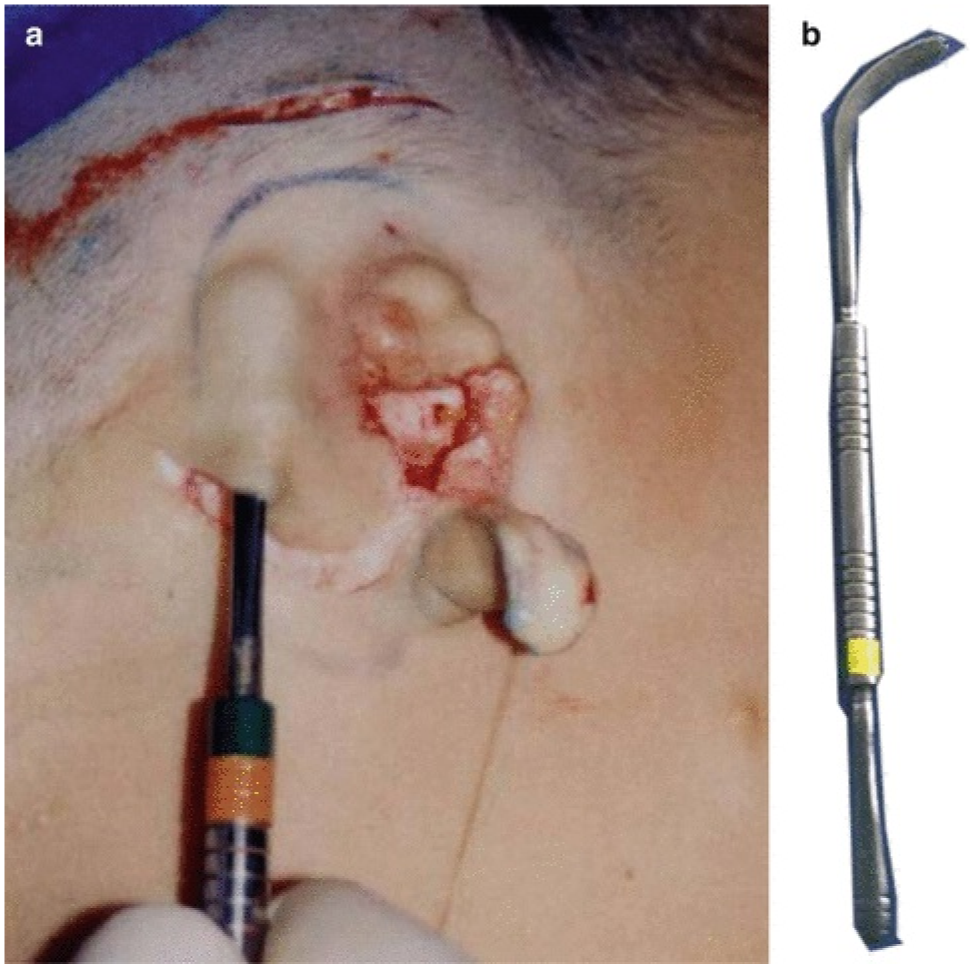

Fig. 9.5 Creation of a subcutaneous tunnel during the first stage of ear reconstruction on severe microtia. (**a**) With a special instrument, the subcutaneous tunnel is being dissected; the lobule is already incised and the tragus was created with cartilage graft; (**b**) the special instrument for dissection of the future helix and antihelix

9.3.3.1 The Tissue Expander During the Operation

The skin corresponding to the future helix and antihelix must be extended before embedding the auricular cartilage. In order to create good conditions for embedding the cartilage graft, a silastic tissue expander is used.

Technique for Reconstruction

9.4 Severe Microtia

This is the most common congenital deformity of the pinna and affects 80% of our patients. (The technical and other considerations for reconstruction are more fully described in the previous chapter of this book.) After spatial projection of the new ear, two skin incisions are made out of future ear area. In the next step, the skin helix and antihelix are dissected subcutaneously by preserving the area of the future conchal cavity (Fig. 9.6). When the skin is adequately dissected, no bleeding occurs because there is no passage of blood vessels.

Fig. 9.6 First stage of ear reconstruction on severe microtia during surgery. (**a**) A "C-shaped" instrument to facilitate embedding the new auricular framework; (**b**) the instrument is introduced through the subcutaneous tunnel; (**c**) the new auricular frame is going to be introduced; (**d**) the new frame is already embedded underneath the skin and the lobule is sutured to its normal position; (**e**) photo of another patient with severe microtia after the new auricular framework is embedded through the subcutaneous tunnel and the lobule sutured to its normal position with the model of the new frame

The new auricular framework is introduced through the subcutaneous tunnel created by tunnelization, as described above. To favor such procedure, I developed a new "C-shaped" surgical instrument that is introduced through the tunnel, and the new auricular framework slides on the instrument. For this reason, it is not necessary to do wide undermining (Fig. 9.6).The dressing is made with wet cotton on the skin outside the new auricle on the framework projection, which is removed 5 or 6 days after surgery. In the same time another dressing is applied on the new ear.

The second stage of reconstruction is performed 6 months later, as per the surgical plans (Fig. 9.7). A cutaneous incision is made outside the border of the auricular framework that was introduced during the first stage of ear reconstruction. The incision goes behind the skin and fascia superficialis underneath in order to protect the posterior aspect of the new ear where the skin graft is performed. I prefer to remove it from the posterior side of the opposite ear when it is normal. When the external auditory canal is not created during the first stage of reconstruction, it must be done now in order to achieve all the anatomical elements of the new ear (Fig. 9.8). After the skin graft is completed, a compression dressing is done with external stitches. This dressing is covered by a bandage that is wound all around the head and is maintained for 7 days. Afterwards, the dressing must be changed every 10 days for at least 3 months (Fig. 9.9).

Fig. 9.7 Surgical planning before the second stage of reconstruction on microtia. (**a**) A 12-year-old male sees the result of the first stage of ear reconstruction on the left side; (**b**, **c**) surgical result after the first stage of reconstruction of the left ear

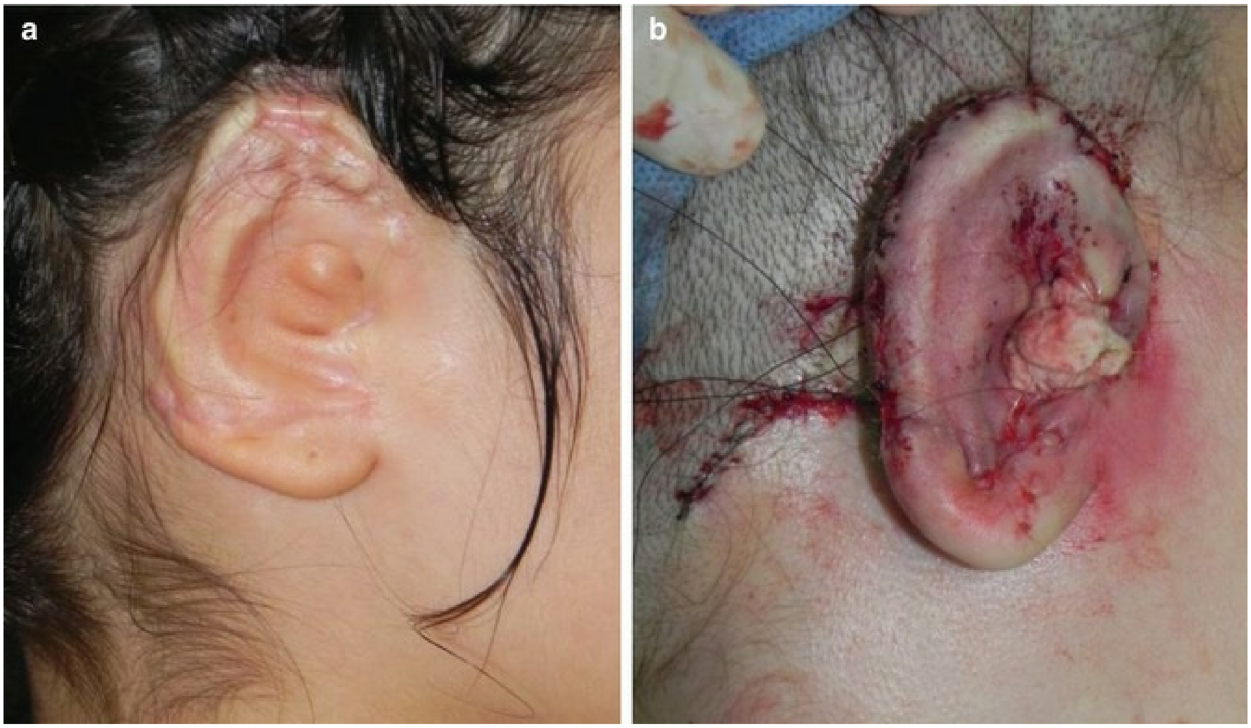

Fig. 9.8 Second stage reconstruction on severe microtia. (**a**) A patient 6 months after the first stage of reconstruction; (**b**) the new auricle was lifted and skin graft performed on the posterior part of the new ear

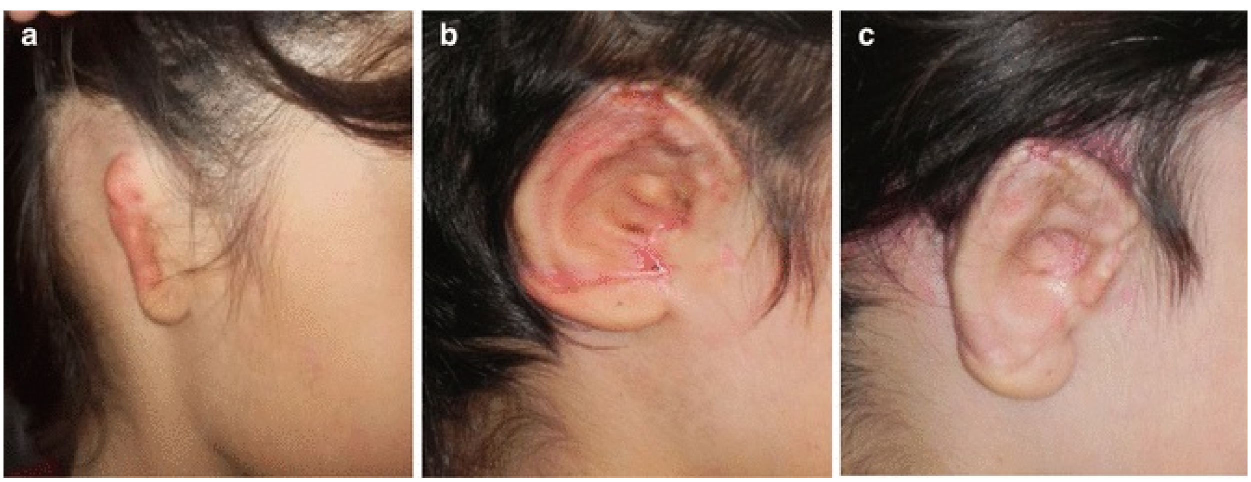

Fig. 9.9 A 7-year-old female patient with severe microtia on the right side. Photo (**a**) before surgery; (**b**) 6 months after first stage of ear reconstruction; (**c**) same patient 1 year after the two stages of reconstruction

The final surgical results may be seen 6–12 months after the second surgical stage. The projection of the new ear has a good appearance, since the posterior aspect of the auricle provides enough distance from the surface of the head (Figs. 9.10 and 9.11).

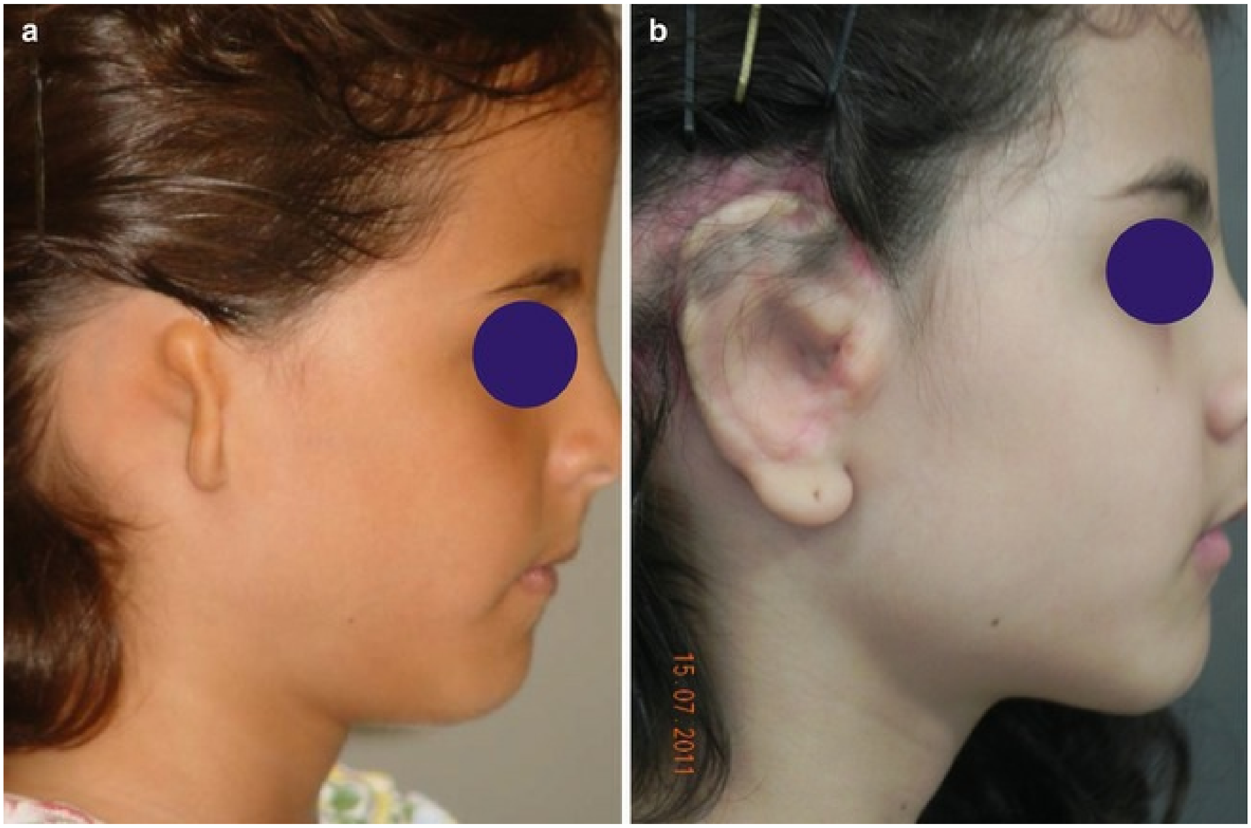

Fig. 9.10 A 9-year-old female patient with severe microtia on the right side. Photo (**a**) before surgery; (**b**) 2 years after both stages of ear reconstruction. As she had a very low hairline on the mastoid region, the new auricular framework was embedded according to surgical planning and the remaining hair will be removed afterward

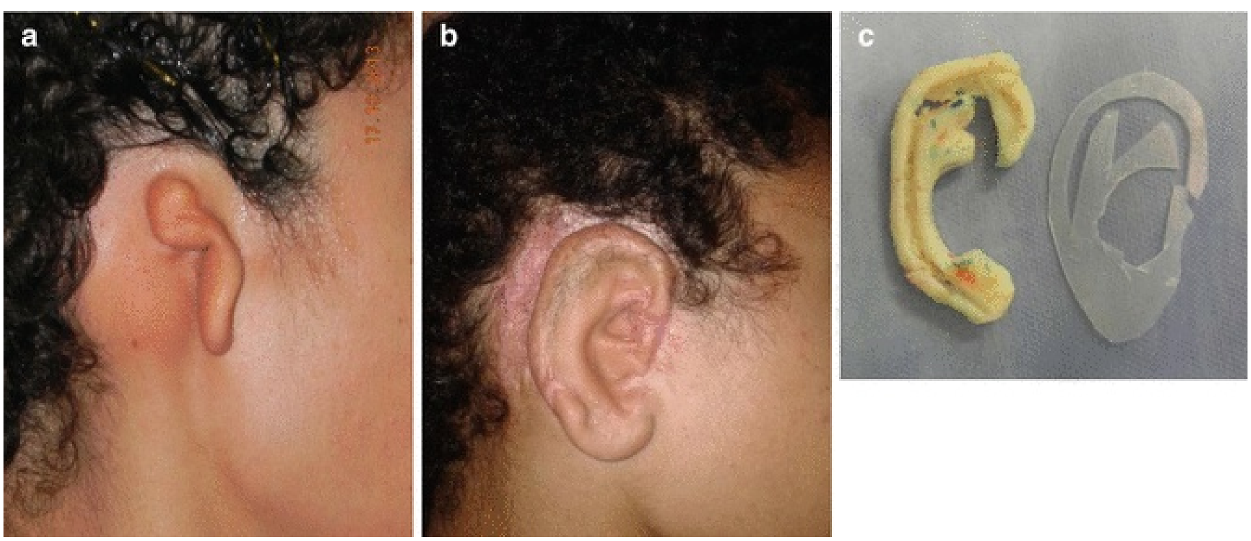

Fig. 9.11 An 8-year-old male patient with severe microtia on the right side. Photo (**a**) before surgery; (**b**) 2 years after both stages of ear reconstruction; (**c**) the new auricular framework excavated on rib cartilage with an X-ray model

9.5 Discussion

Performing auricular reconstruction requires an appropriate way of thinking in the interpretation and use of the remaining tissues in the future organ area. In all clinical modalities, reconstruction usually needs two separate surgeries, and the patients need to be age 6 or 7 or above (Figs. 9.12 9.13, and 9.14). This stipulation is due to several factors, among them the fact that the ear is not fully grown until then. Another important point to take into account is the thickness of the costal cartilage, which before that age has not yet achieved the right conditions for the creation of a new cartilaginous framework. The interval between the first and second reconstructive steps cannot be less than 6 months, so that the grafted cartilage is properly incorporated into the new receptor site.

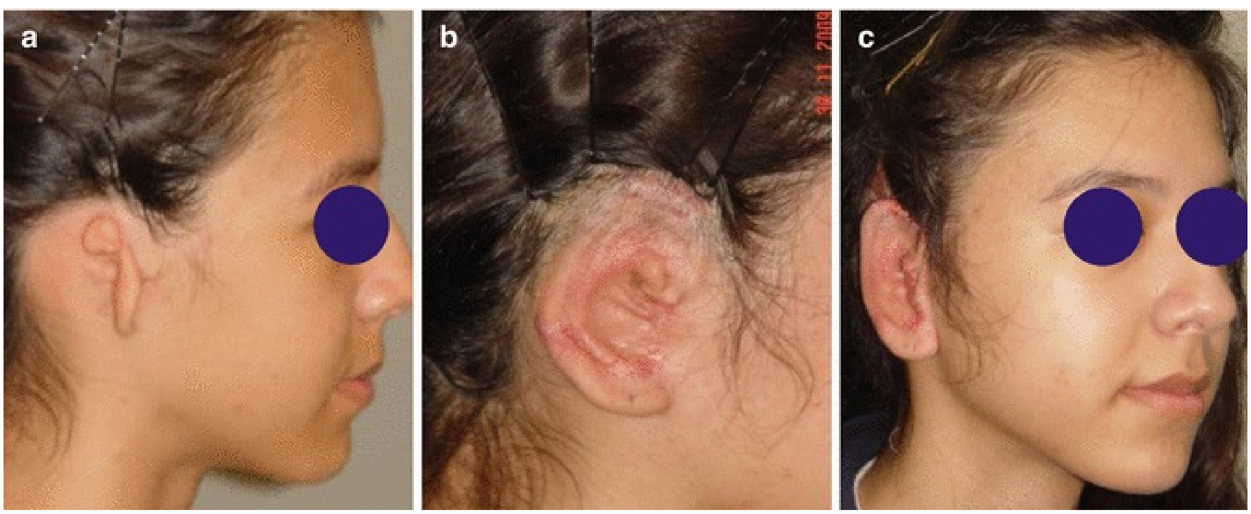

Fig. 9.12 An 18-year-old female patient with severe microtia on the right side. Photo (**a**) before surgery; (**b**) after the first stage; (**c**) 2 years after both stages of ear reconstruction

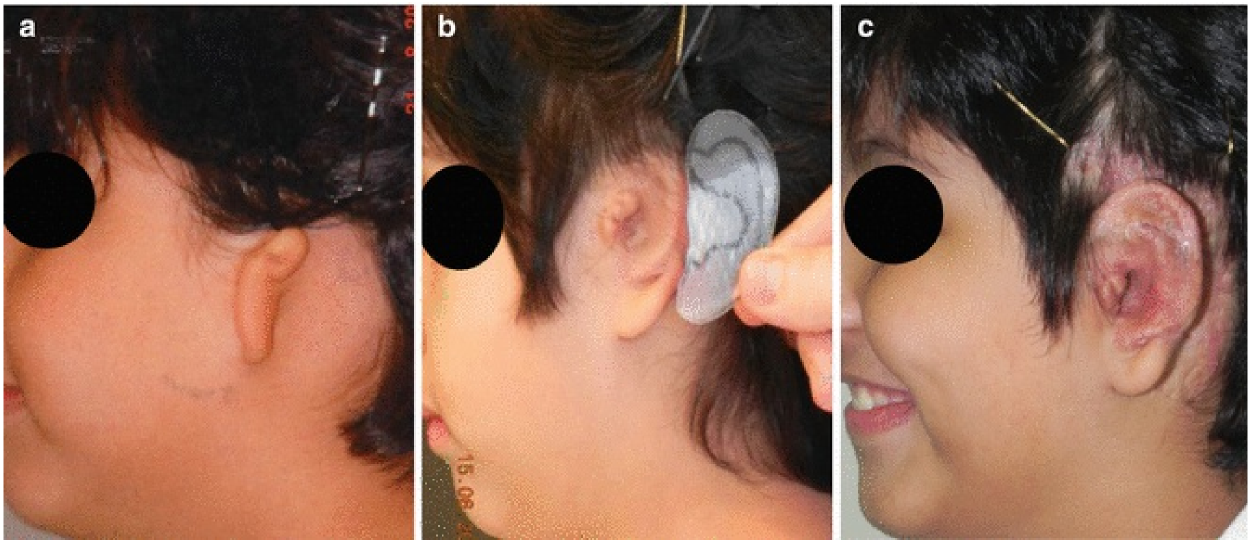

Fig. 9.13 A 7-year-old male patient with severe microtia on the left side. Photo (**a**) before surgery; (**b**) same patient 6 months after the first stage of reconstruction; (**c**) same patient 1 year after both stages of ear reconstruction

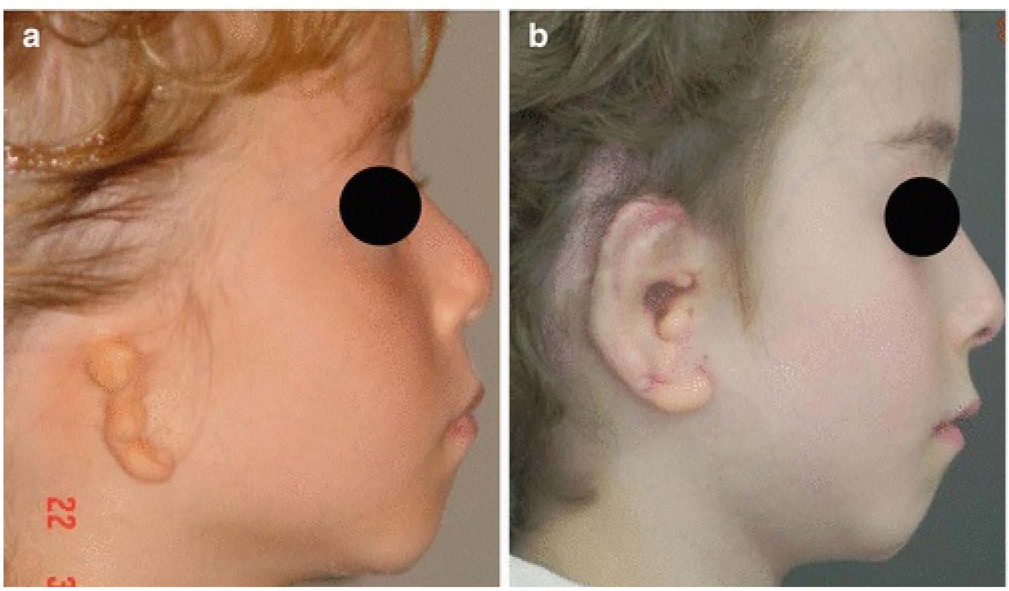

Fig. 9.14 A 7-year-old male patient with severe microtia on the right side. Photo (**a**) before surgery; (**b**) 2 years after both stages of ear reconstruction

In patients with anotia, agenesis of the ear and moderate ectopic microtia-associated lesions are very common and very complex, making it more difficult to reconstruct the facial profile, while in patients with severe microtia and eutopic moderate microtia, facial asymmetry also occurs, but to a lesser degree.

It is worth emphasizing that the cartilage tissue does not present anyvascularization and therefore it needs good vascular bed support from the recipient. The first reconstruction’s technique is similar to that used when treating the various anomalies, considered basic in sculpting the new cartilaginous framework to be introduced in the subcutaneous plane. The second surgery takes on different characteristics. In ear anotias and agenesis, there is an urgent need to create the lobular structure incorporated into the cartilaginous skeleton of the new ear. On the other hand in the forms which I denominate “moderate microtias” there are exuberant condrocutaneous folds that will create the lobule, the conchal wall as well as will cover the posterior aspect of the ear. There are cases where there is no need to perform skin grafts, as the skin fold is sufficient to cover the posterior wall. The dressing after both reconstructive steps is maintained for 5 or 6 days, then bandaged for another 10 days, and then replaced every 15 days for 2 more months after the operation. All dressings should be done under the close supervision of the surgeon who performed the reconstruction.

Conclusions

Reconstruction of the auricle in congenital anomalies is a matter of surgical planning and performing an adequate operation. The new auricular framework is excavated from rib cartilage according to previous preparation. The operation is performed on patients older than 6, since until then the rib cartilage is quite thin. The reconstruction is performed in two stages; the second stage can take place 6 months after the first. The post-operative care is so important after the first and second stages that if the patient is not able to follow the surgeon’s schedule for post-op care, it is better to not perform the operation at all.

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10. Traumatic Amputation of the Ear: What to Do with the Amputated Segment?

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10.1 Introduction

I have already mentioned that any alteration of the size, shape, position, and location of the auricles, they may cause great disharmony to the esthetic balance of the face. Probably no one looks at an ear when it is normal, but if it doesn't exist, most of people will notice it, even from a distance. The missing auricle is responsible for the severe imbalance of the face's contour with important implications for the well-being of the patient.

Due to the location and position, the auricles are exposed to external trauma by cutaneous laceration and partial or even total amputation due to several possible causes. When only the skin is damaged, an auricle may be repaired by a single procedure. Nevertheless, if the cartilage framework is affected, or when the whole auricle is detached, it requires special care − from first aid through to its repair. So far, the final result of the reconstructed ear after traumatic amputation is strongly influenced by immediate treatment of the injured tissues at the emergency room during first aid. I have also described causes of traumatic amputation of the ear (Avelar 2013).

Sometimes, when an auricle is partially amputated by a knife, scissors, human or animal bite, or car accident, it seems as though it will be easy to reimplant it on the remaining segment of the organ (Fig. 10.1). Even more so, when an ear is totally amputated, the surgeon at the hospital's emergency department may want to embed the auricular cartilage subcutaneously in some region of the patient in order to be used during reconstruction of the auricle (Fig. 10.2) (Dowling et al. 1968).

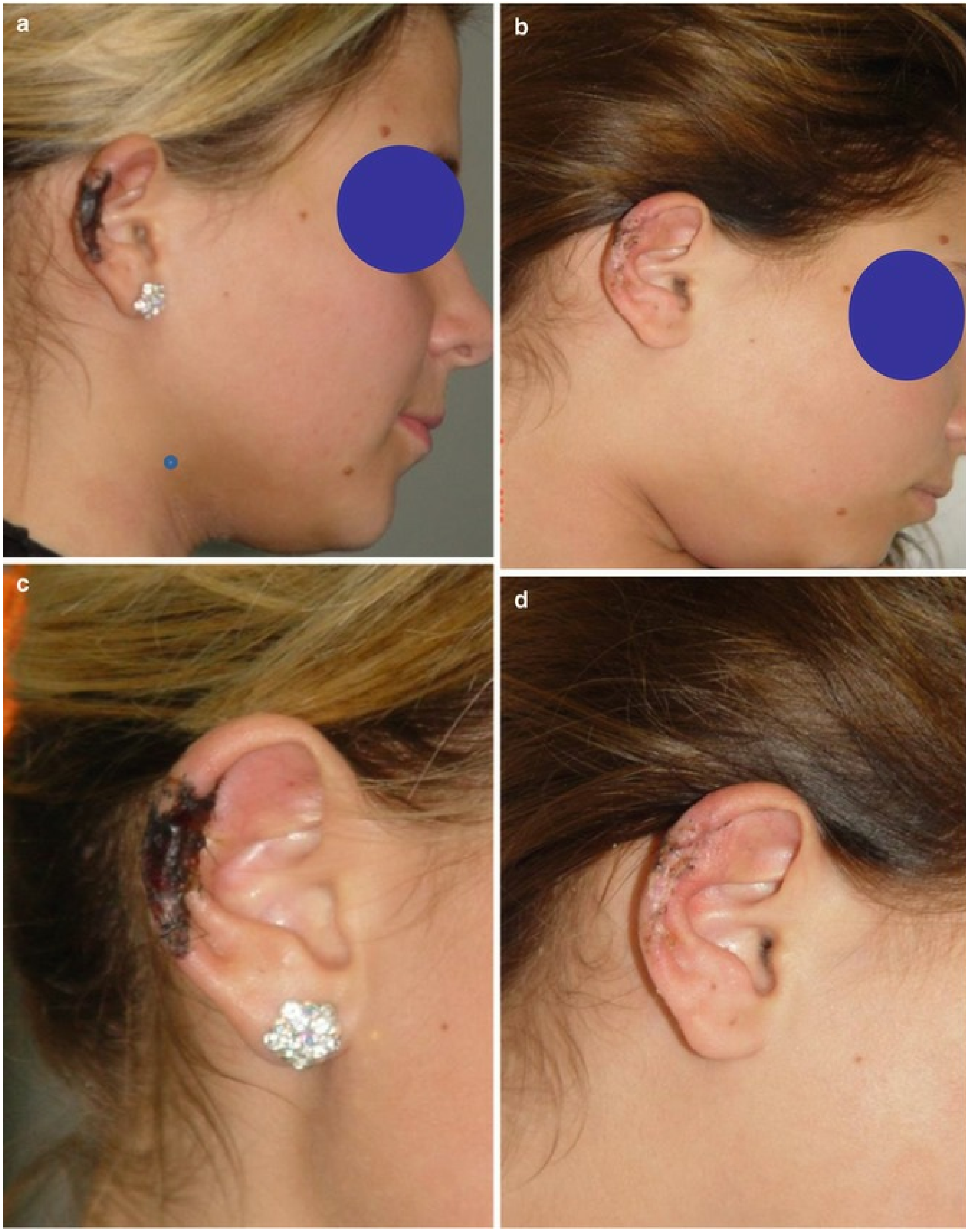

Fig. 10.1 Successful reimplantation of a small segment of the ear caused by human bite. (**a**, **c**) A 22-year-old female presenting the amputated segment of the helix 3 days after trauma; (**b**, **d**) same patient

2 weeks after satisfactory reimplantation

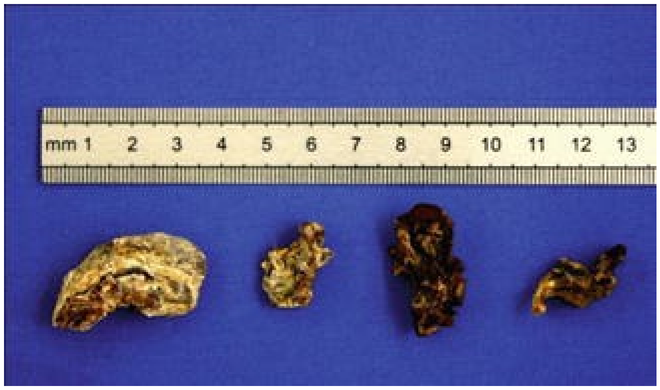

Fig. 10.2 Auricular cartilages removed from patients. These cartilages were inserted in some areas of the patient's body in the emergency room during first aid. The auricular skeletons were removed from the abdominal wall (twice), the inner section of the arm, and the inguinal region. The auricular cartilages do not maintain the same size, shape, and anatomical architecture as a normal ear. Therefore, it is not advisable to perform such a procedure because those cartilages cannot be used during reconstruction owing to complex alterations after insertion inside the subcutaneous panniculus

10.2 Method

10.2.1 What to Do with the Partially Amputated Segment of the Ear

When auricles are partially damaged by a burn (fire, hot liquids, cold temperature, chemical liquids, or electricity) or by infection, the amputated segment is destroyed and therefore cannot be reimplanted on the remaining auricular structure (Avelar 2009). Nevertheless, when the amputated segment has been cut off by a knife, scissors, or human or animal bite, and seems to be in good condition, it is not recommended to suture on the remaining segment of the ear (Figs. 10.3 and 10.4). No matter whether the patient is an adult male or female or a child, if the avulsed segment presents auricular cartilage, it will not be successful.

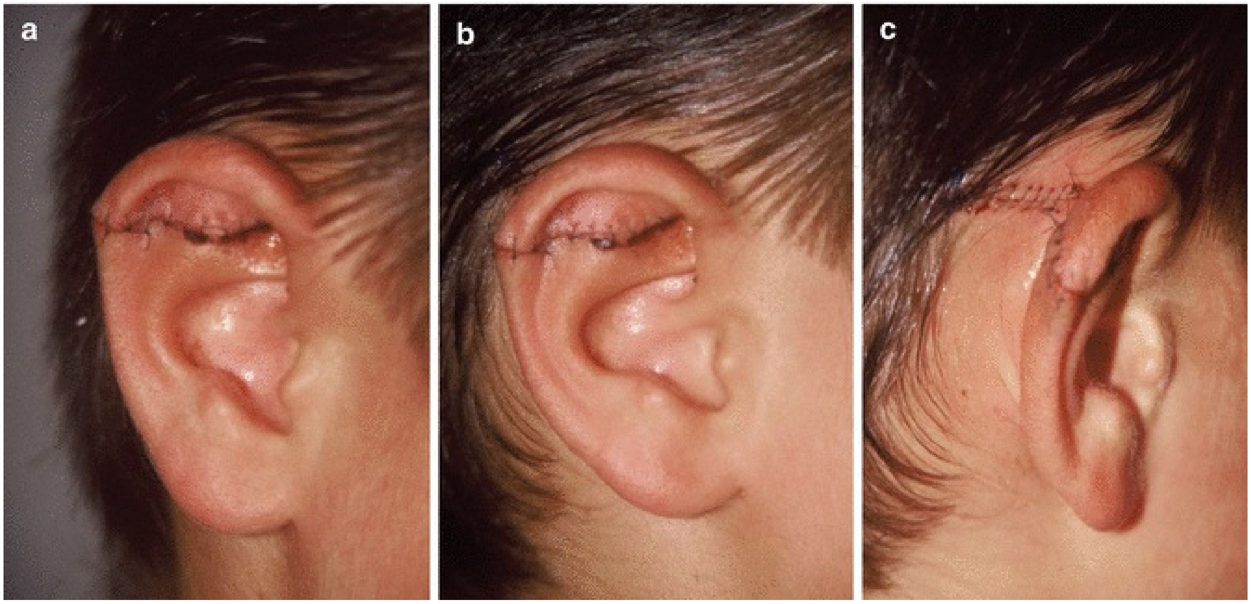

Fig. 10.3 Good result after suturing of a partial amputation of the upper pole of the right ear. (**a**) Oblique view showing the result after 2 weeks; (**b**) lateral view presenting a small pedicle of the helix supplied the whole segment; (**c**) posterior view showing the suture behind the auricle as well as on the mastoid region, caused by avulsion of the upper pole of the auricle

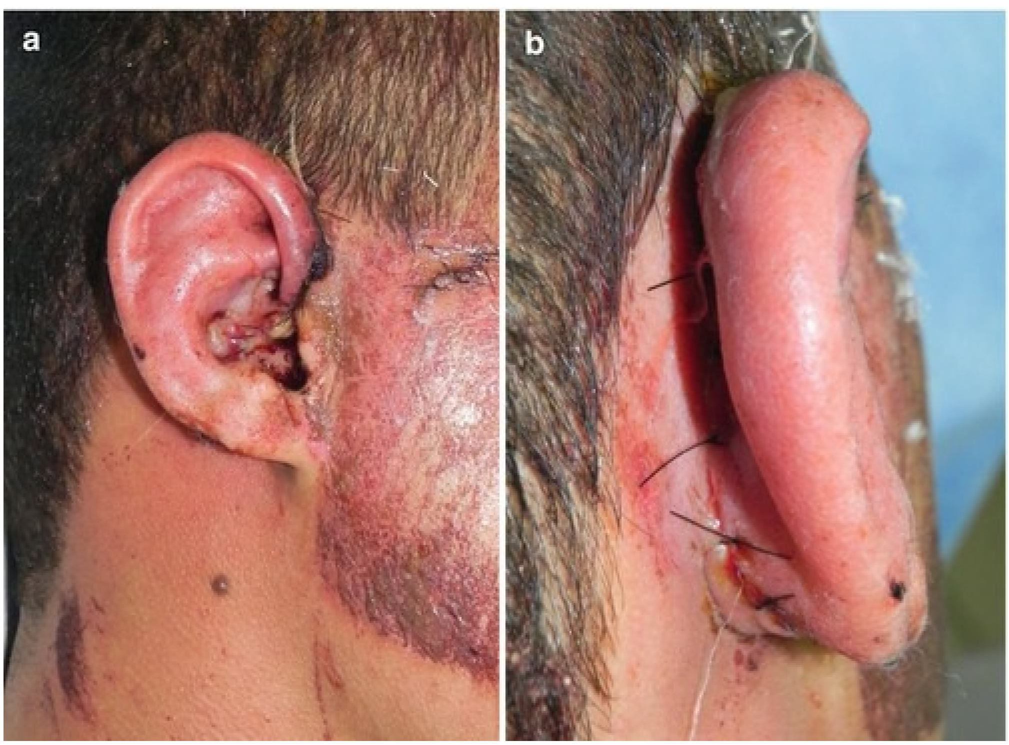

Fig. 10.4 Good result after suturing of almost complete avulsion of the right ear. (**a**) Lateral view showing the results 7 days after implantation with a small pedicle of the helix supplying the whole segment; (**b**) posterior view showing the suture behind the auricle on the mastoid region, caused by the

avulsion of the total segment of the auricle

There have been 14 patients at our Brazilian Ear Institute who presented with a partial segment of the auricle that was already sutured to the remaining structure of the ear. Some of them came 2–4 days after trauma and reimplantation as well, but the color of the segment already showed signs of cutaneous slough, with evidence of necrosis (Figs. 10.5 and 10.6). They mentioned that the implantation procedures were performed using a good technical approach and even covered the auricle with antibiotic bandages (Figs.10.5 and 10.6). So far, I have not seen even one patient who was treated with so much care after reimplantation who had successful results. On the other hand all the patients I have treated at our institute came with high expectations of good results, but after few days showed necrosis of the segment (Figs. 10.5 and 10.6). All my patients were so disappointed and frustrated by the unsuccessful result that I was encouraged to write this chapter and to show the poor results.

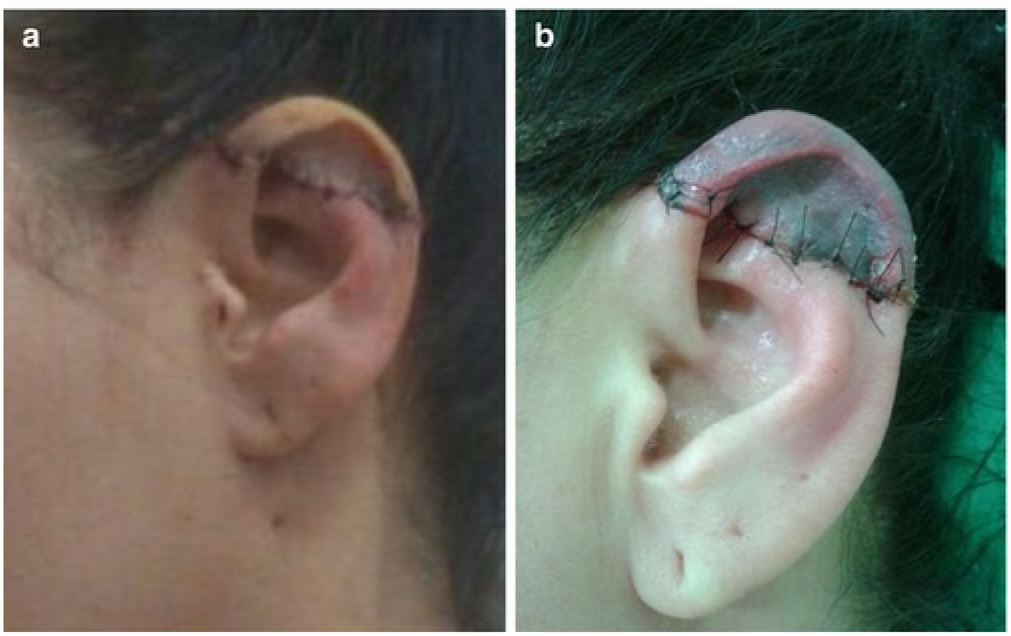

Fig. 10.5 Unsuccessful reimplantation of the upper pole of the left ear caused by human bite. (**a**) A 20-year-old female presenting total amputation of a segment of the upper pole that was sutured a few hours later; (**b**) the same patient 5 days after reimplantation, showing necrosis of the amputated segment

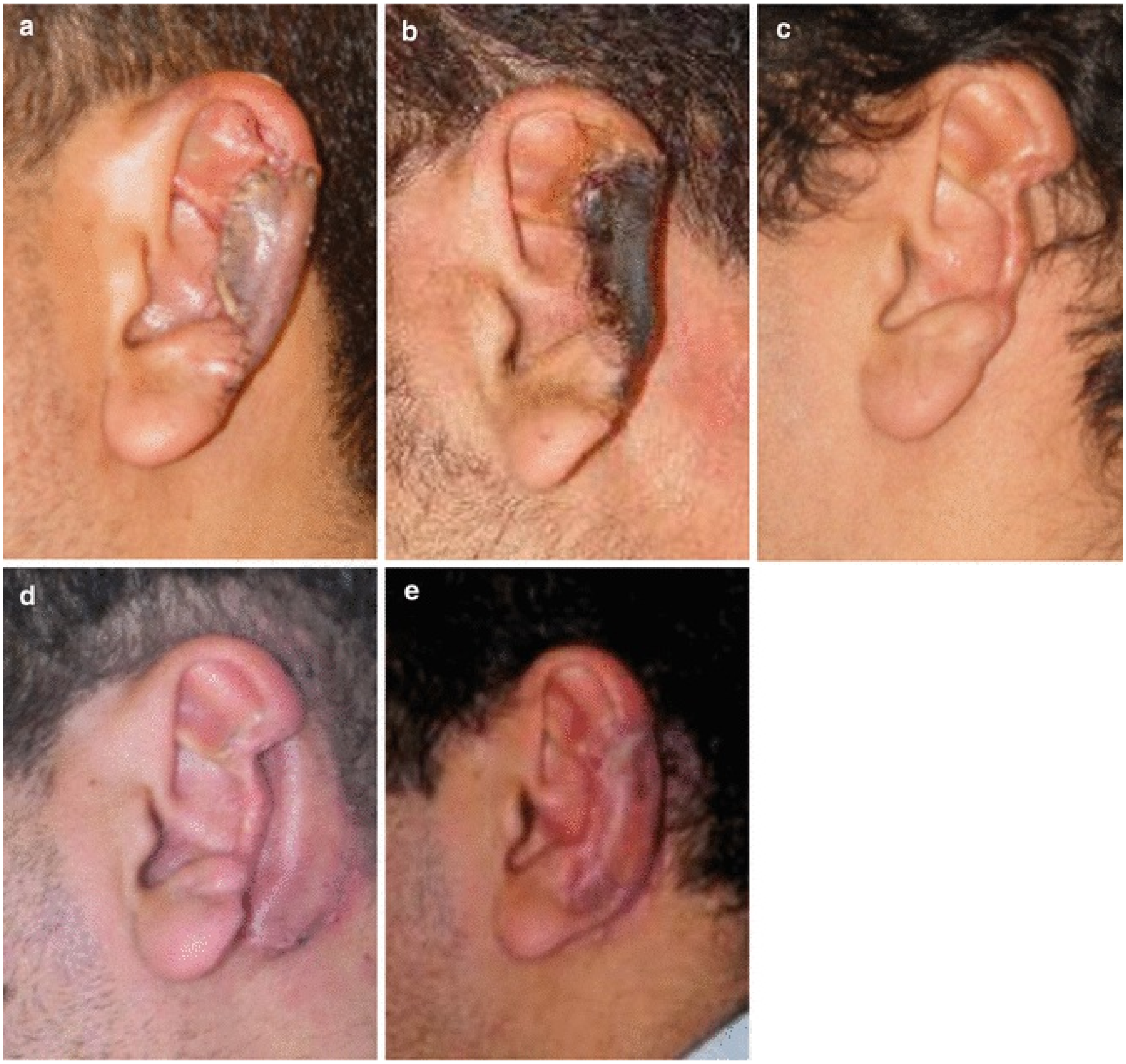

Fig. 10.6 Unsuccessful reimplantation of a partially amputated left ear caused by a human bite. (**a**) A 35-year-old male patient presented with amputation of a segment of the ear that had been reimplanted elsewhere. (**b**) the same patient 5 days later with necrosis of the segment. (**c**) the final aspect of the ear after reimplantation 6 months later. (**d**) after the first stage of ear reconstruction with costal cartilage inserted underneath the skin on the mastoid area. (**e**) final result 1 year after the second stage

If the amputated segment of the ear presents a cutaneous pedicle, even a very small one, it is advisable to carefully suture on the remaining segment, because it may be successful. The bandaging must put light pressure on the reimplanted segment that will require adequate postoperative care over the following 10–15 days (Figs. 10.3 and 10.4).

If the emergency department has a good microsurgery team that can perform the procedure adequately, the final results may be successful. There are several publications in which the authors have presented one or two cases of partial success, re-utilizing the same ear cartilage. Such procedures (re-utilizing the ear cartilage or performing skin dissection) can worsen the deformity because the wound can become infected or potentially infected and develop a severe secondary infection. In the first stage, according to Mladick et al. (1971), the amputated segment is introduced subcutaneously in a “pocket” created underneath the mastoid skin. In a publication, Destro and Speranzini (1994) reported a case of re-utilizing the auricular framework of the amputated ear in a procedure similar to the one described by Mladick in 1971. Besides having very poor results from the esthetic point of view, the ears do not present good projection on the lateral side of the head. Even worse than the unsatisfactory results are the exposure of the patient to the risk of infection with elimination ofthe cartilage graft and the consequent waste of an operation. It is well known, and I have emphasized this problem in the chapter on secondary ear reconstruction, that these situations are very difficult to resolve.

10.2.2 What to Do with a Total Amputated Ear

When one or both auricles are totally destroyed by burns (fire, hot liquids, cold temperatures, chemical liquids, or electricity) or any kind of infection or tumor (cancer, hemangioma), even marshalfights, it is not possible to reimplant it or them, since the auricular structures cannot be identified. However, when one or both auricles are totally avulsed due to a car accident, cutting instrument (knife, scissors), amputation by avulsion of the scalp, or human or animal bites (for example: dog, horse, cow, camel, among others), the auricular structures may be in good condition. If a microsurgery team is available in the emergency department, it is possible to perform an effective procedure. As there is no emergency assistance at our Brazilian Ear Institute, it is not possible to perform such treatment in order to reinstate the blood supply to the amputated auricle. Due to such a lack of surgical recovery treatment, I do not have experience regarding successful reimplantation of amputated auricles.

So far, I have performed ear reconstruction necessitated by several origins of acquired deformities on 391 patients (Avelar1983, 1992, 1993, 2013; Avelar et al. 1984).In all my patients, I have seen a very wide variety of treatments that have not been successful during first aid at hospital emergency departments (Figs. 10.5 and 10.6). I have removed ear cartilages from some regions of the human body where surgeons have embedded them through a subcutaneous level, expecting them to be useful for later reconstruction (Fig. 10.2). Thus, I have taken auricular cartilage out of the abdominal wall, the inner section of the arm, or the inguinal area. It is worth mentioning that the auricular cartilages do not maintain the same anatomical organization regarding the size, shape, and anatomical characteristics as a normal ear. Therefore, it is not advisable to perform such a procedure since those cartilages cannot be used during reconstruction, owing to complex alterations after insertion inside the subcutaneous tissue (Medeiros et al. 2009; Tanzer and Converse 1964).

Nevertheless, the worst place to insert the auricular cartilage of the amputated ear is underneath the skin on the mastoid region (Figs. 10.7, 10.8, and 10.9). I consider this procedure the most disastrous one since it damages the local subcutaneous tissue and fibrosis under the skin on the region develops. I have already mentioned that the skin on the mastoid region is not the ideal skin for ear reconstruction, but it is the best one, due to its location.

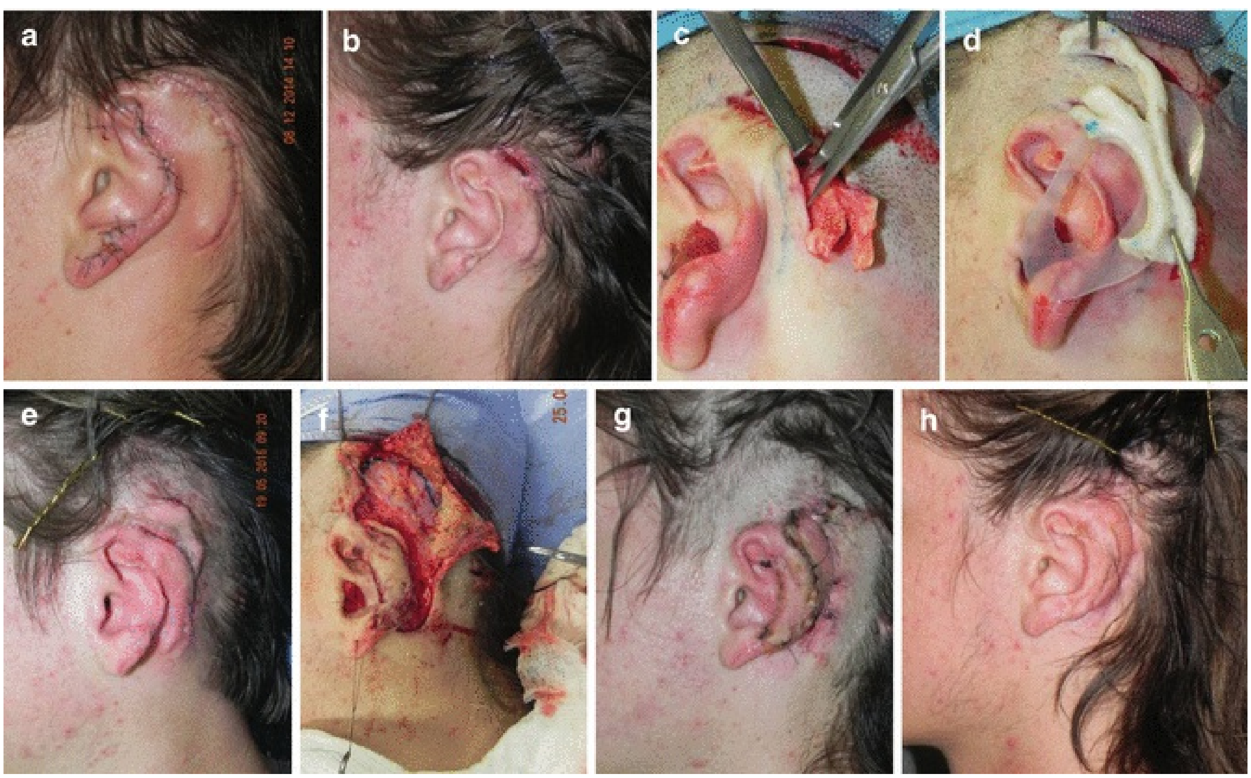

Fig. 10.7 Partial amputation of the left ear of a 19-year-old male patient caused by a car accident, with insertion of auricular cartilage underneath the skin on the mastoid area. (**a**) Appearance of the region 15

days after implantation of the ear cartilage; (**b**) the same patient 5 months after implantation of the cartilage showing that it became flat without any esthetic detail of the auricle. One can see a raw area on the upper border due to necrosis of the skin; (**c**) First stage of reconstruction. The cartilage previously inserted is being removed. (**d**) A new auricular framework was meticulously sculpted on the rib cartilage creating all the esthetic details that will be introduced through the subcutaneous tunnel. Due to a previous procedure, it was very difficult to do a subcutaneous dissection without too much bleeding (**e**) same patient 6 months after the first stage of reconstruction; (**f**) the new auricle was lifted from the head and the fascial flap was raised to cover the posterior aspect of the new ear with a skin graft on the posterior part of the auricle; (**g**) same pacient, three months after surgery; (**h**) same pacient, six months after surgery

Fig. 10.8 Total amputation of the right ear of a 28-year-old male patient caused by a car accident. (**a**, **b**) The natural auricular framework was introduced elsewhere under the skin on the mastoid area that was expected to be used during reconstruction. That procedure is not useful for reconstruction and made the operation more difficult because it was necessary to remove it at least partially. (**c**) A perioperative photo showing that small pieces of auricular cartilage previously inserted under the skin were removed. The new auricular framework was meticulously excavated from the costal cartilage according to the surgical plan. (**d**) The same patient 6 months after the first stage of ear reconstruction with all esthetic details of the new auricular framework embedded during the first stage. (**e**) the same patient after the second surgical stage of reconstruction performed according to the described technique

Fig. 10.9 A patient with total traumatic amputation of the left ear due to a car accident. The amputated ear cartilage was embedded underneath the skin on the mastoid area during emergency treatment at another plastic surgery unit. (**a**) One can see that all the reliefs of the auricular skeleton were damaged due to pressure of the skin. (**b**) a model of the opposite side was done in order to plan the reconstruction. One can see how the auricular skeleton was flattened under the cutaneous covering, which is wider than the normal ear, and it does not present any projection and reliefs or the esthetic details of an ear; (**c**) A model with a ruler showing the normal dimension of the future ear; (**d**) after the first stage of reconstruction when the new auricular skeleton was excavated on the rib cartilage and introduced underneath the skin after removal of the cartilage erroneously inserted elsewhere

Usually, all acquired ear deformities may be reconstructed using my technique in either two or three surgical stages. When the mastoid region has some rawness due to traumatic amputation of the ear, it is recommended to wait until complete healing, without any cutaneous undermining of the local skin (Figs. 10.10 and 10.11). To perform the second stage of reconstruction, it is necessary to wait at least 6 months after the first one, which is the acceptable amount of time for the complete healing of subcutaneous tissue, as described in my previous publications (Avelar 1987, 1997, 2011, 2013).

Fig. 10.10 Severe total amputation of the left ear, because parents brought the amputated cartilage of the auricle, but it was not inserted anywhere. (**a**, **b**) After the accident; (**c**) the ear cartilage after removal of the skin covering; (**d**) the same patient 3 months after the wounds healed; (**e**) final result after two-stage reconstruction of the left ear using the rib cartilage to sculpt the new frame

Fig. 10.11 Unsuccessful reimplantation of the lower segment of the right ear amputated by a horse bite. (**a**) A 22-year-old woman presented with suturing of the amputated segment of the ear that had

been performed elsewhere. (**b**) The same patient 6 days after reimplantation, with necrosis of the entire segment. (**c**) Two months after removing the necrotic segment of the lower half of the ear. (**d**) First stage of ear reconstruction with the new auricular skeleton excavated on costal cartilage. (**e**) The same patient 1 week after insertion of the cartilage graft underneath. (**f**) The same patient 6 months after the first stage of reconstruction; (**g**, **h**) the second stage of reconstruction; (**i**) final result 1 year after the second reconstructive surgery

10.3 Discussion

Partial and total amputations of the auricles are very common problems caused by several kinds of trauma, all of which have serious consequences for patients. Before surgery, it is necessary to (1) investigate the cause of the accident; (2) assess previous surgical treatments; (3) carefully evaluate the mastoid area and neighboring regions of tissue trauma; and (4) perform suitable surgical planning (Pitanguy et al. 1971).

Usually when ears are amputated by cutting instruments, car accidents, or human or animal bites, it is recommended to wait until there has been complete healing of the wound before performing reconstruction. Its reconstruction may be performed according to the effective procedures described by Adams (1955), Antia (1974), Antia and Buch (1967), Argamaso and Lewin (1968), Brant (1969), and Brown et al. (1947). If the patient or relative brings the amputated segment of the ear, the doctor at the first aid center should not try to reimplant it or embed the auricular cartilage underneath the skin on the mastoid area, subcutaneous abdomen, or any other region because the cartilage will not be useful in the future. I do not recommend performing such a procedure since those cartilages cannot be used during reconstruction due to complete destruction of the anatomic structures of the sophisticated architectures with peculiar characteristics that nature creates. The worst region to embed the auricular cartilage is underneath the skin on the mastoid region, since such a procedure can ruin the best cutaneous covering for reconstruction of the ear in the future. On the other hand when one or both auricles are totally destroyed by a burn (fire, hot liquids, cold temperature, chemical liquids, or electricity) or any kind of infection or tumor (cancer, hemangioma), even martial arts fights, it is not possible to reimplant it or them since the auricular structures cannot be identified.

Microsurgical procedures are so useful when an outstanding team is available in the hospital's emergency department. When such resources are not available, the best thing to do is not to try to use the auricular cartilage, but to wait until complete healing of the wounds and afterwards perform ear reconstruction using rib cartilage to model the new skeleton.

Reconstruction of the auricle may be done using my technique in at least two surgical stages. If there is any raw area caused by avulsion of the skin on the mastoid area, it requires proper treatment in advance without any cutaneous undermining on the mastoid region. The second surgical stage of reconstruction may be performed 6 months after the first one, as I have previously described (Converse 1964; Crikelair 1956).

Conclusions

Traumatic amputation of the ear requires proper treatment beginning with first aid at a hospital emergency department. When the auricle is destroyed by cancer, or for any other reason, the auricular cartilage is also totally damaged. So far, when the ear is amputated by a sharp instrument or human or animal bite, it is not recommended to try to embed the ear cartilage subcutaneously under the skin on the mastoid region or any other region of the body. In fact the conduct of the auricular cartilage is not favorable for use in reconstruction afterwards. After the scars heal, reconstruction of the ear after amputation is a continuous challenge because each patient presents with individual problems that must be thoroughly evaluated preoperatively. It is important to identify the reason for the amputation.

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11. Reconstruction of the Ear after Traumatic Amputation

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11.1 Introduction

The auricles are two organs strategically located on the lateral side of the head with important reference points in the esthetic balance of the face. When both ears are normal in size, shape, location, and position, they may be not noticed when one looks at a face. But if there is some anatomical alteration, most people will notice its absence or an abnormality, even from a distance. So far, it is useful to classify the deformities of the ear in order to use the most appropriate surgical technique. For this reason, the problems encountered regarding the origin as well as the treatment of the traumatic defect of the auricles, are described.

Trauma to an organ is one of the by-products of technological development and is responsible for a great number of human mutilations that need reconstruction. Among all the segments of the body, the auricles, due to their location on each side of the head, are very vulnerable to external trauma. Adults as well as children can suffer partial or total loss of the auricles, causing unesthetic physical deformities with severe psychological repercussions.

When only the skin is damaged, the auricular trauma is not so important, since it is easily repaired. However, if the cartilage framework is affected, a great deal of care and attention are needed, not only when giving first aid, but also in the reconstruction. Usually, the patients look for a plastic surgeon when the most acute phase has already passed, and one can see scars with deformities, retractions, and several kinds of irregularities. The success of the reconstruction after trauma depends primarily on the immediate treatment of the injured tissues, something that must be satisfactority treated during first aid. Also, it requires replacing the missing auricular skeleton, which is accomplished by cartilage graft being removed from the rib and excavated according to each case.

11.2 Classification and Clinical Study of Acquired Ear Deformities

Traumatic ear deformities may present with partial or total damage of the auricular framework, no matter what the etiological factors that caused the accident (Fig. 11.1).

Cause	Side			Patients	Ears
	Right	Left	Bilateral	total	(n°)
Car acident	47	41	8	96	104
Otoplasty	3	7	67-	77	144
Human bite	16	18	-	34	34
Burn	16	19	14	49	63
Animal bite	18	21	-	39	39
Tumor	11	9	5	25	30
Piercing	19	11	-	30	30
Hemangioma	4	5	-	9	9
Amputation by knife	7	8	3	18	21
Amputation by scalp	3	5	2	10	12
Stunned rigidity	-	-	1	1	2
Acumputure	2	1	-	3	3
TOTAL	182	145	100	391	491

Fig. 11.1 Etiology of acquired deformities among 391 patients and 491 ears

11.2.1 Burns

Auricular defects caused by burns are etiopathogenic and difficult to treat, requiring adequate care of the whole body as well as of the auricles (Fig. 11.1). I have already mentioned that a burn caused by fire does not usually destroy the deep layers of the skin and subcutaneous tissue (Avelar 1987, 1989, 2009, 2011, 2013; Avelar et al. 2009). The superficial surface of the skin may be very severely burned, but the fire does not involve the whole cutaneous covering and deep layers. However, when fire reaches the auricles, it may affect the perichondrium and the cartilage as well, followed by secondary infection. It is important to mention that firemen or any others who work in very hot environments may present with burns on the nose, throat, and lungs that are caused by breathing. Consequently, surgeons at emergency departments should examine the patients, taking into consideration the care of the body as a whole. When a burn is caused by hot oil or another hot liquid, it damages the full thickness of the skin as well as the deep layers underneath, which destroys the whole cutaneous covering (Fig. 11.2).

Fig. 11.2 Partial reconstruction of the right ear after traumatic amputation caused by a burn. (**a**) A 7-year-old male patient with partial amputation of the right ear; (**b**) the same patient 8 years later; (**c**, **d**) after two surgical stages using the rib cartilage to excavate the new auricular framework

11.2.2 Iatrogenic

Ear deformities caused by esthetic or reconstructive surgeries, or by another surgeon trying to create an external canal, are classified as iatrogenic or secondary reconstruction. In Fig. 11.1, one can notice that among the 491 ears on which I performed ear reconstruction after traumatic amputation, 144 (29.3%) were caused by secondary correction due to unsatisfactory results after prominent ear surgery. Most of them are bilateral reconstructions, since both organs presented anatomical alterations (Fig. 11.1). As this topic is very complex and a constant challenge, I have dedicated a chapter of this book to describe my concepts and surgical approach for reconstruction of the auricles for reparation of several kinds of deformities of the ear (see Chap. 15).

11.2.3 Bites

Lesions caused by bites (human as well as animal) show a peculiar pathogenicity due to severe tissue trauma followed by secondary infection, caused by the teeth that penetrate deep into the tissue through the holes and wounds. This was described by Brant (1969), and a few years later in an instructive publication, Pitanguy emphasized the medical treatment as well as social problems regarding human bites (Pitanguy et al. 1971).

Among the 491 ears that I repaired because of traumatic amputation (Fig. 11.1), 73 were amputated by human bites (34 ears) and those caused by animal bites (39 ears) were partially or totally destroyed (by dogs, cows, horses, camels, or others). Therefore, 14.8% of my patients came to me because of human or animal bites (Fig. 11.1). All my patients presented with unilateral amputation, since the reaction of the victim after trauma is to protect the ear already damaged and seek medical care. Such deformities are so frequent and so important that I have dedicated a chapter of this book to a discussion on them (see Chap. 12).

Whether the trauma was caused by a human or animal bite, first aid should be given carefully. When the ears are destroyed by animal bites, it is fundamental to try to identify the animals since it is a public health problem. I have had several patients who did not think about this and the family killed the animal immediately after the accident. This reaction is understandable, but it is very important to have information about the animals and the diseases that their bites can transmit. In Brazil, it is obligatory to inform the public health care (Centro de Controle de Zoonoses (CCZ)) about animal bites, in order to keep them (patients and animals) under government supervision (see full description in Chap. 12). In my previous publication, I mentioned that there are 15,000 cases of animal bites every year that cause some sort of damage to humans (Avelar 2013).

11.2.3.1 Human Bites

All the patients with an ear defect resulting from a human bite came to me months or years after the trauma. The amputation of the ears occurred in one of two situations – either during a sexual act or during a physical fight:

1. *During a sexual act*.

   The auricular lobule is the segment most frequently damaged, although some other parts of the body may be traumatized.

2. *During a fight*

   The upper pole of the ear is the most vulnerable, although the lobule is also very often damaged. During my specialization and training period with Prof. Pitanguy, I was impressed by some of the cases of human bites at his unit at theSanta Casa de Misericórdia do Rio de Janeiro Hospital. I spoke with him about some of the cases and he motivated me to find out how many patients with this problem he had operated on. I found out that 20 patients had already undergone ear reconstruction due to human bites. Due to a very high number of patients, Prof. Pitanguy decided to publish an article about 11 patients who presented with partial or total amputation of the ear (Pitanguy et al. 1971). That publication was my first scientific activity regarding ear reconstruction, and it was a memorable one for me. It motivated me to devote much effort to this field, and it was also my first presentation at a congress (Avelar 1971, 1972).

11.2.4 Car Accidents

I have had several patients who underwent ear reconstruction due to traumatic amputation caused by car accidents (Fig. 11.1). It is really amazing to see adults and children presenting partial or total avulsion of the ear caused by this kind of trauma. It looks like some kind of very sharp instrument passed close to the lateral surface of the head, cutting one or both of the auricles. Most of my patients do not remember how it happened, and they did not feel anything after the trauma. Some of them were able to identify and find their auricles among the parts of the car destroyed during the accident (Fig. 11.3); others reported that they saw blood running down their shoulders before feeling the absence of the auricle. Some patients took the amputated ear to a hospital emergency department, hoping to have the organ reimplanted. When a surgeon tries to reimplant or introduce the auricular cartilage under the skin during first aid, he or she can make the trauma worse because any skin undermining causes even more damage to the local and neighboring tissue.

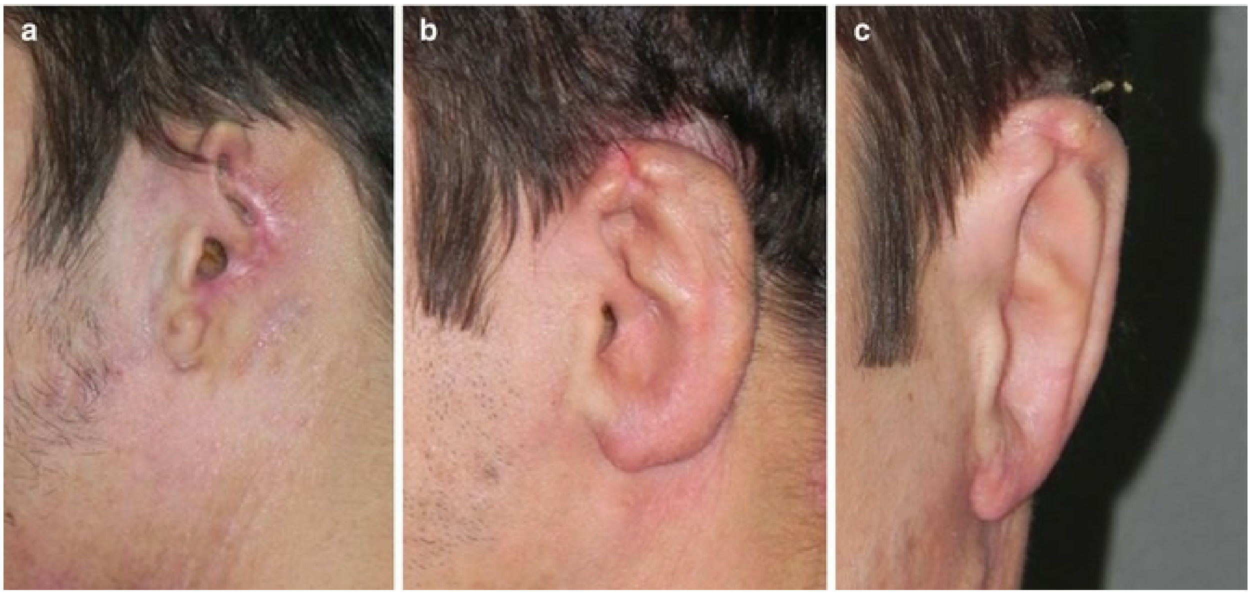

Fig. 11.3 Total reconstruction of the left ear after traumatic amputation caused by a car accident. (**a**) A 19-year-old male patient with total amputation of the left ear; (**b**, **c**) the same patient after two surgical stages using the rib cartilage to excavate the new auricular framework

Whatever the cause of the deformity, it is necessary to wait for complete recovery of the cutaneous wounds. The cicatricial tissue is not an obstacle, since it is limited by the skin, and for this reason it is not necessary to wait for tissue maturation (Fig. 11.4).

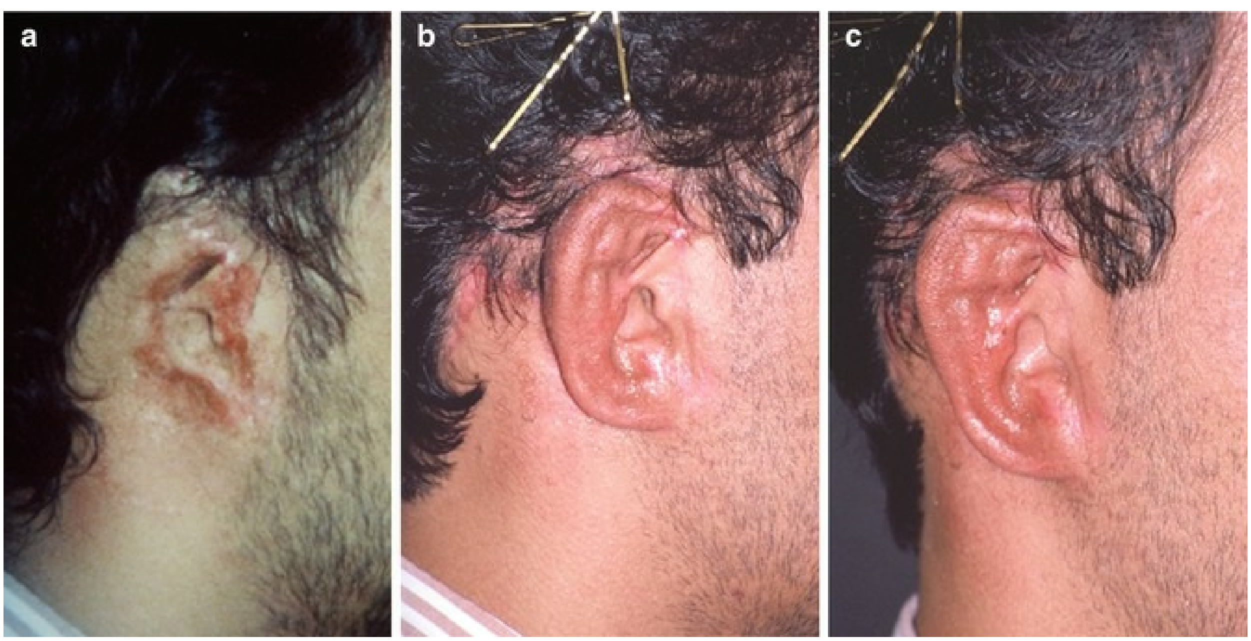

Fig. 11.4 Total reconstruction of the right ear after traumatic amputation caused by a car accident. (**a**)

A 21-year-old male patient with total amputation of the left ear; (**b**, **c**) the same patient after two surgical stages using rib cartilage to excavate the new auricular framework

Traumatic amputation of any segment of the human body is a terrible problem for everyone. Partial or total loss of the ear represents a physical and psychological trauma that requires special attention, from first aid through to the final reconstruction.

I have performed 491 reconstructions of the ear due to acquired deformities. I have my own concepts concerning the trauma itself, and also about the wrong procedures at the emergency departments. My personal method of creating the new auricular framework is described in previous publications (Avelar 1987, 1989, 1992, 2009, 2013; Avelar et al. 2009). I prefer to use rib cartilage, since it is the best material for sculpting the new framework, and it doesn't matter whether the deformity is congenital or acquired (Fig. 11.5). When giving first aid in emergency deparments, there is a tendency to try to reimplant or reuse the auricular cartilage of the amputated ear, and the patients and their relatives usually think that the ear cartilage is the best material to repair the defect. However, in my experience, that material (the auricular cartilage) is not as good as it seems to be. The cartilage does not have enough resistance to support the tension of the skin covering the mastoid region, where the new ear will be reconstructed. I am personally opposed to trying any surgical procedure, especially by surgeons who do not have enough experience to perform skin undermining on the mastoid area, and are looking for immediate reconstruction (as described in Chap. 10).

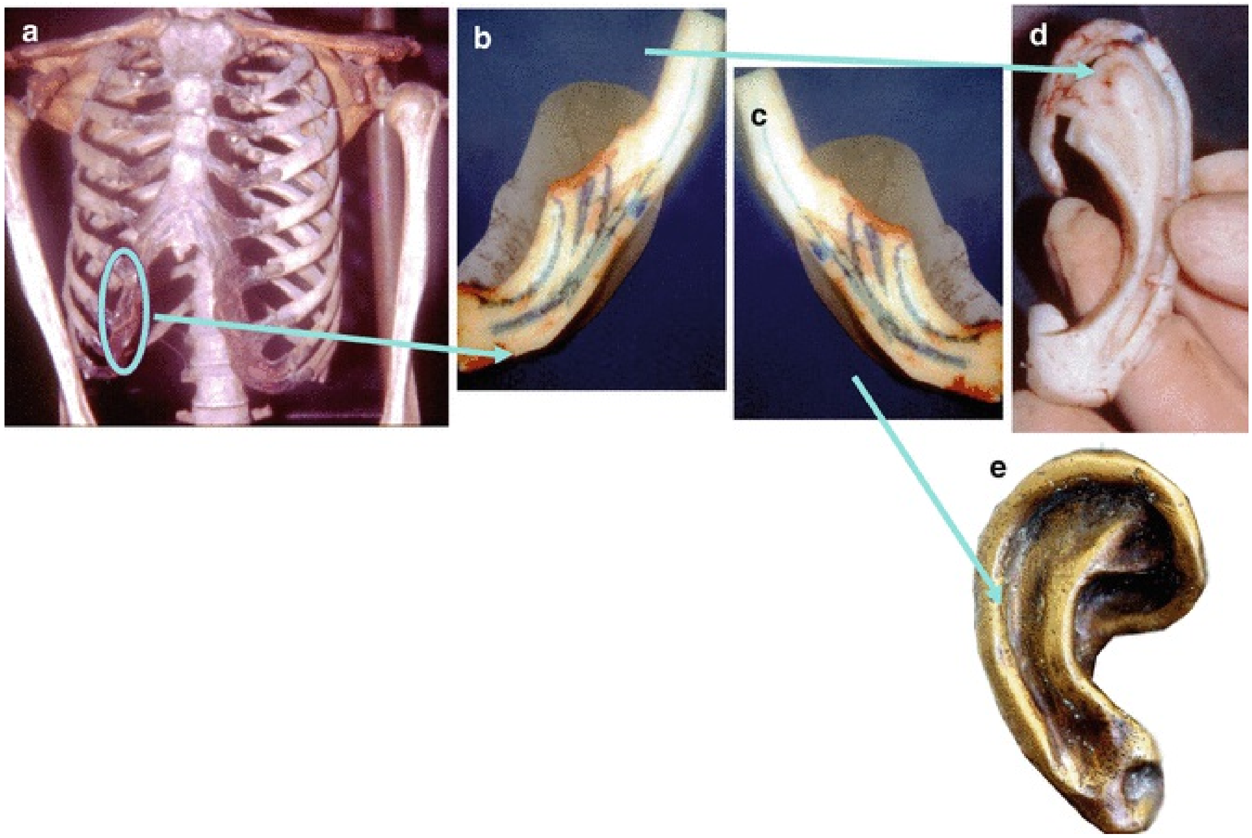

Fig. 11.5 Removing the costal cartilage to model the new auricular framework. (**a**) A chest skeleton showing the rib bones and cartilage. The 8th and 9th costal cartilages are indicated with a circle; (**b**) the ninth was removed. This curvature is adequate for excavating the skeleton for the left ear; (**c**) If one reverses the rib cartilage 180°, it is adequate for sculpting the right frame; (**d**) the new frame for the left ear is already excavated; (**e**) a bronze model of the *right* ear shows a useful orientation for excavating the right ear

In another chapter I wrote that the first operation is the best opportunity to perform the reconstruction of the ear (Avelar 1987, 1992, 2013). Whenever cutaneous undermining is performed, in order to embed the auricular skeleton, some kind of scar tissue will develop that can hinder future surgical stages. For these reasons I recommend not performing any reconstructive procedure at the emergency treatment units, because skin undermining can only increase the difficulties when it comes to the definitive reconstruction.

11.3 Partial Reconstruction of the Ear

In partial lesions of the ear with loss of the cutaneous and cartilaginous structures, it is necessary to reuse the remaining elements. These difficulties have presented a constant challenge to surgeons who encounter such deformities. For study purposes, I will classify the techniques as composite grafts, using local flaps of the ear, neighboring flaps, distant flaps, and tubular flaps.

11.3.1 Composite Grafts

This is a simple procedure but requires meticulous care during and after surgery. The first reference to composite grafts of the ear was reported by Day (1921). This subject was emphasized by Adams (1955), who performed a composite graft of cartilage and perichondrium that adhered to both sides of the cartilage. Also, Pegran and Peterson (1956), repaired the entire thickness of the auricular wall (Nagel 1972; Cardoso and Sperli 1969). My contribution to this field is the use of a large graft of an extensive retroauricular area including conchal wall and going beyond the limits described by the authors in the medical literature (Avelar et al. 1984).

11.3.2 The Use of Local Flaps of the Ear

There are many techniques that use the flaps of the ear itself. The technique described by Malbec (1931) is very useful when repairing partial defects of the ear, as well as for reconstruction of the auricle after tumor resection and even for reduction otoplasty. A combination of triangular resections is also an adequate procedure. In 1952, Cronin described the use of flaps to repair the helix; in 1967, Antia used an incision bordering the helix on the anterior side of the ear, preserving the posterior wall, followed by sliding a chondrocutaneous flap. Argamaso and Lewin (1968) described the evolution of Antia's procedure; Orticochea (1970) advocates the use of a conchal flap pediculated on the inferior rim of the helix, aiming at an upward rotation and reconstructing part of the helix and scapha. Recently, Medeiros et al. (2009) described advancement of the chondrocutaneous composite flap for the reconstruction of helix and lobule defects.

11.3.3 Neighboring Flaps for Reconstruction

These flaps increase the possibilities of transferring an element near the ear to complete its repair. Brown's method (1947) was very important at that time, and it mentioned the use of local flaps in auricular reconstruction. Crikelair (1956) used retroauricular flaps with superior pedicles to repair the upper part of the helix. The reconstruction of the scapha, using flaps of the sulcus with a cartilage graft in the second stage, was advocated by Converse (1964). The flap suggested by Kazanjian (1958) and by Owens (1959) was supplemented by Renard (1981). However, the methods using the skin of the mastoid with cartilage graft in the first stage, advocated by Converse in 1958, seem to be the simplest and least sophisticated techniques that can be used by surgeons who are less familiar with the pathology (Fig. 11.4).

11.3.4 Distant Flaps and Tubular Flaps

According to Tanzer and Converse (1964), the use of tubular flaps was started by Tagliacozzi (1597), that was very important in the history of auricular reconstruction. It seems that it was Pierce (1930) who introduced the technique, transferring the cervical tube to reconstruct the helix. Several authors followed this methodology; among them was Stefanoff (1948), using a tube in the auriculomastoid sulcus. Padgett (1938) suggested an extensive cervical tubular flap to repair a vast area of the ear. In 1950, McNichol advocated the use of tubular flaps from the arm to reconstruct the helix, using the Tagliacozzi procedure.

A very ingenious procedure requiring several stages was the tubular flap suggested by Dufourmentel (1958), tubulating the temporal superficial artery. Although the method requires only two or three stages, it is not very popular. On the other hand, the classical results have always been publicized, even though they require several stages and leave anesthetic cicatricial areas in all the stages. My cervical cutaneous flap (Avelar 1992) is a useful technique to be used during the second stage of reconstruction on congenital and traumatic amputation of the ear. The use of this flap may reduce the raw area, thereby avoiding extensive skin grafts.

11.4 Total Reconstruction of the Ear

In every case of acquired lack of an auricle, it is advisable to wait for maturation of the cicatricial tissue. The operation follows some surgical principles of my technique as previously described (Avelar 1987, 1989, 1992, 2013). Once the spatial projection of the new ear is determined, and using the opposite ear as a reference, two cutaneous incisions are performed on the superior and inferior extremities (Fig. 11.6). Through these incisions, a skin flap corresponding to the future helix and antihelix is dissected, creating a subcutaneous tunnel. The conchal area is not undermined because it will be the main pedicle of the reconstructed ear.

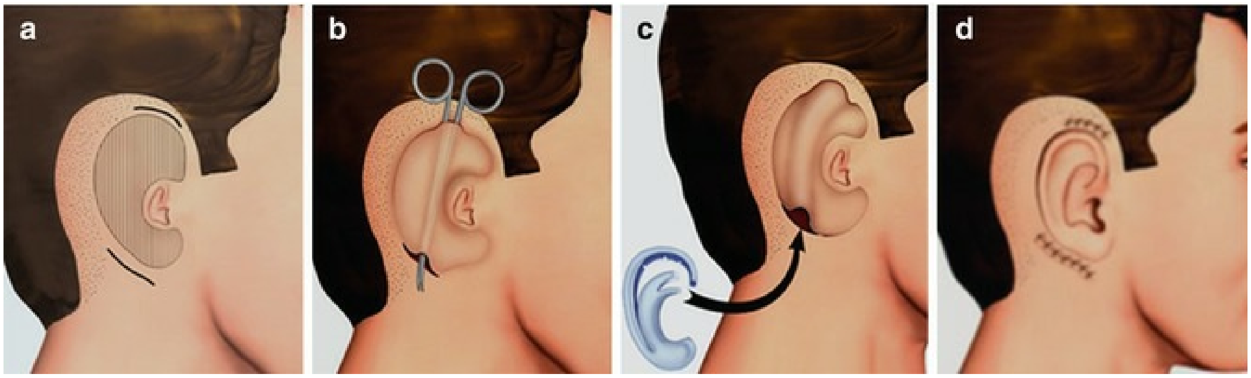

Fig. 11.6 Sequential drawings of the first stage of reconstruction to demonstrate Avelar's technique for total amputation. (**a**) Surgical planning for reconstruction. The projection of the future ear is done; two cutaneous incisions are drawn, one *above* and one *below* the projection of the future ear; (**b**) Cutaneous undermining is performed on the projection of the future helix and antihelix, creating a subcutaneous tunnel; (**c**) The new auricular framework is excavated on the costal cartilage and embedded through the subcutaneous tunnel after skin distention during surgery; (**d**) The scheme of the final aspect after the first stage of total ear reconstruction after traumatic amputation

The skin flap is carefully dissected on the subcutaneous layer, keeping in mind the presence of the posterior auricular artery below this fascial flap, as described in a previous publication (Avelar and Psillakis 1981). If the fascia is not damaged, there is no bleeding after the dissection. Even the hemostasis is quite simple because the vascular network below the skin should be preserved. The skin flap also has good vascularization due to the rims of the new ear and the conchal area. A tissue expander is introduced through a subcutaneous tunnel in order to provide skin distension only during surgery. I do not recommend classic tissue expansion because it is not necessary. For 1 hour, the skin is extended enough to facilitate embedding the new auricular framework. While I remove the rib cartilage and perform the modeling of the new skeleton by meticulous excavation, a regular balloon is introduced through the subcutaneous tunnel. Within 15 minutes, the balloon makes a regular distension of the skin when it is open; wait for 5 minutes. Again, the balloon distends more during 15 minutes and is successive with alternative maneuver in an hour or an hour and a half, during which the subcutaneous tunnel achieves good distension. Then the new auricular framework is introduced through the subcutaneous tunnel already distended according to the surgical plan (Fig. 11.7), and the cutaneous incisions are sutured.

Fig. 11.7 First stage of reconstruction on traumatic amputation of the left ear. (**a**) New auricular framework excavated on rib cartilage; (**b**, **c**) photos taken during surgery showing introduction of the new framework through the subcutaneous tunnel using my “C” instrument

I do not use any kind of drainage because there is no space for it since the new skeleton is introduced through a narrow subcutaneous tunnel. Some small pieces of wet cotton are applied on the future conchal cavity and another “C-shaped” piece is placed around the projection of the new auricular framework. The bandaging presses on the reconstructed ear very smoothly, and it is maintained for 5 days; then it is removed and another one is applied and must be changed every 10 days for at least 2 months.

The second stage is performed 6 months later under general anesthesia. A cutaneous incision is made all around the projection of the future ear, and the new ear is lifted from the surface of the head. The raw area behind the new auricle is grafted with the skin in the traditional way (Fig. 11.8). My cervical cutaneous flap is a useful procedure to be utilized during the second stage of reconstruction.

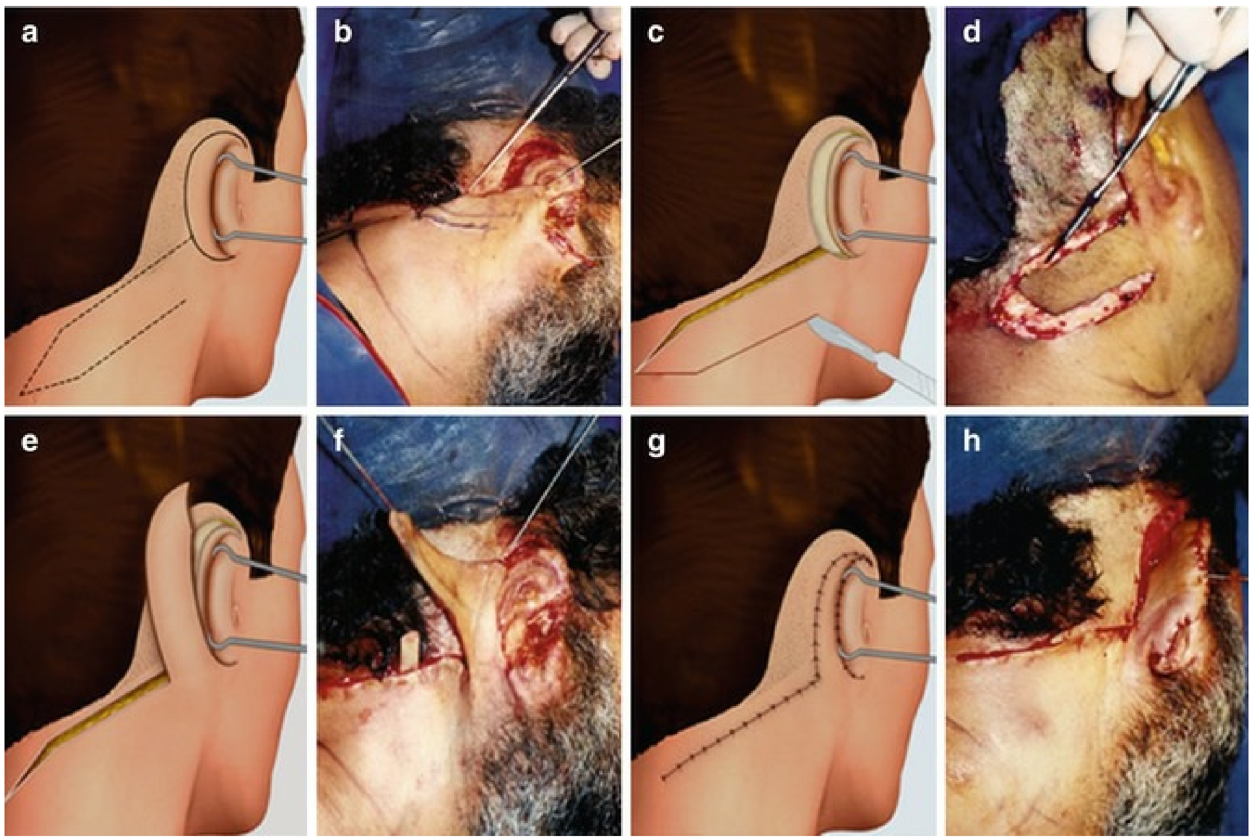

Fig. 11.8 A sequence of schemes and photos during surgery to demonstrate the second stage of reconstruction using the Avelar technique for total reconstruction of the ear in patients with total amputation. (**a**) The scheme shows the surgical plan for creating the cervical cutaneous flap, which will be rotated *upward* to cover the posterior aspect of the ear; (**b**) a photo during the operation shows the creation of the cervical cutaneous flap on the *right* side of a male patient; (**c**) the scheme shows the cutaneous incisions to create the cervical cutaneous flap and lift the new auricle with its cartilaginous framework previously embedded; (**d**) A perioperative photo showing creation of the cervical cutaneous flap on the *right* side of a male patient; (**e**) The drawing shows the rotation of the cervical cutaneous flap; (**f**) a photo taken during the operation shows the rotation of the flap; (**g**) the drawing shows the cervical cutaneous flap that has been sutured behind the ear; (**h**) a photo showing the final aspect after suture of the flap covering the posterior surface of the ear

At the end of the operation, a compressive dressing is put over the skin graft; this is maintained for 7 days and it is then removed at the institute. Afterwards, another dressing is applied on the posterior part of the reconstructed ear; this dressing is changed every 10 days for at least 2 or 3 months. The final results are achieved 1 year after the operation (Figs. 11.9, 11.10, 11.11, and 11.12).

Fig. 11.9 Bilateral total reconstruction of the ear after traumatic amputation caused by a knife. (**a**, **c**) A 51-year-old male patient with bilateral total amputation of the ear; (**b**, **d**) after two-stage reconstruction

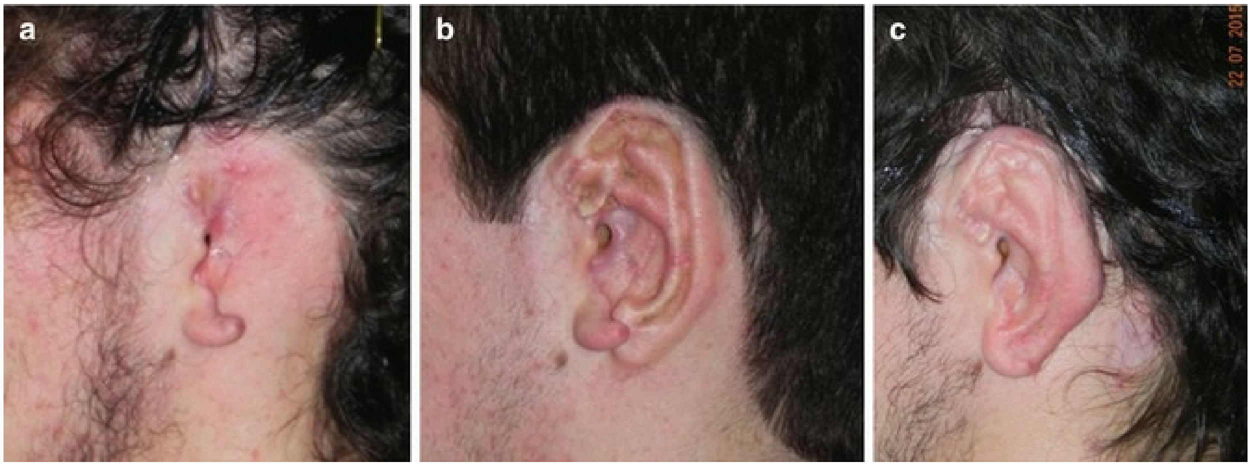

Fig. 11.10 Total reconstruction of the left ear after traumatic amputation caused by a car accident. (**a**) A 22-year-old male patient with total amputation of the left ear; (**b**) after first stage reconstruction; (**c**) the same patient after two surgical stages using the rib cartilage to excavate the new auricular framework

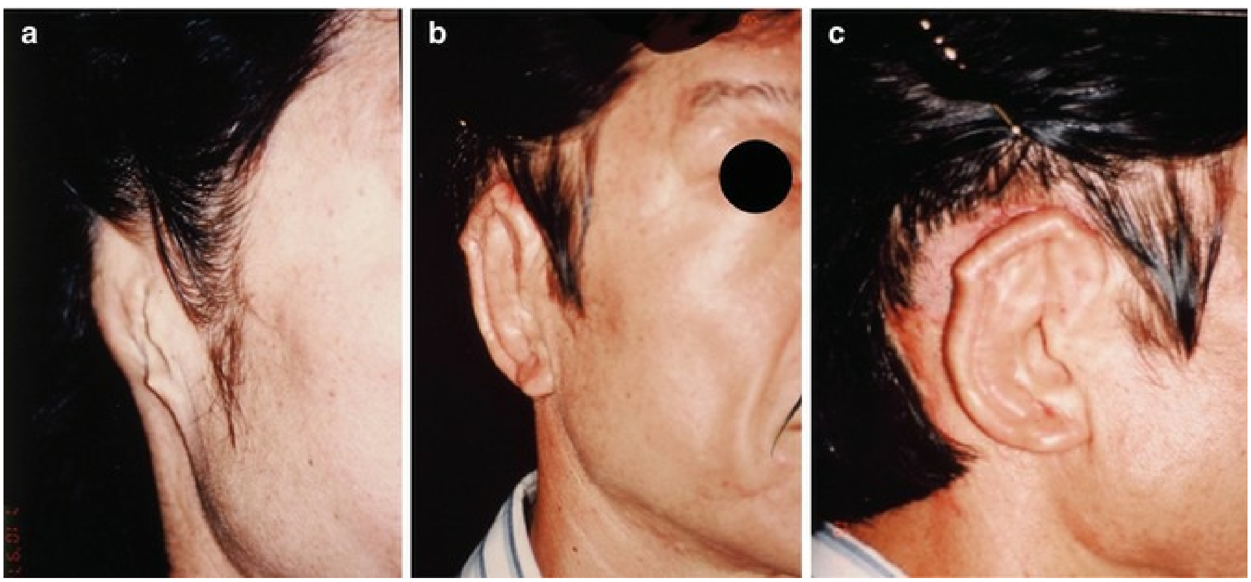

Fig. 11.11 Total reconstruction of the right ear after traumatic amputation caused by a car accident. (**a**) A 62-year-old male patient with total amputation of the right ear; (**b**, **c**) the same patient after two surgical stages using the rib cartilage to excavate the new auricular framework

Fig. 11.12 Total reconstruction of the left ear after traumatic amputation caused by a car accident. (**a**) A 49-year-old male patient with total amputation of the left ear; (**b**) after the first stage reconstruction; (**c**) the same patient after two surgical stages using the rib cartilage to excavate the new auricular framework

11.5 Discussion

Ear reconstruction is a very difficult field of plastic surgery, but the specific topic regarding traumatic amputation is even more complex, because the patient has lost part of his or her normal organ and is eager for it to be repaired. From a psychological point of view, the problem is even worse, because the patients and their families have many expectations regarding results, which sometimes are not possible to be met. Showing photographs of other patients who have undergone surgical reconstruction is not reassuring for the patients, nor is it a guarantee of satisfactory results because (1) the final results of ear reconstructions are not the same; (2) the traumatic amputation of one patient's ear is different from that of another patient's ear; and (3) the reaction and behavior of the cutaneous covering as well as the new auricular cartilage framework are not the same in every operation.

For these and for several other reasons, the surgeon should keep in mind that each patient is a new and complex challenge. Also, the local tissue destroyed due to the trauma presents a wide variety of clinical forms in relation to the scars, as well as to the degree of damage of the normal ear cartilage, which requires careful evaluation before surgery.

The cases illustrated in this chapter represent a few examples of reconstruction after partial or total amputation of the external auricle. This does not mean that another deformity, which looks similar, should be treated using the same procedure in order to achieve comparable results. This chapter is an illustration and an orientation guide for surgeons who face these kinds of problems in emergency departments, or after complete healing of the wound. The skin of the mastoid region is not ideal for performing ear reconstruction, but it is the best, due to its location. Distension of the local skin is a useful procedure during surgery. I do not recommend using a tissue expander for a few weeks since the excess skin afterwards is not useful during reconstruction.

Conclusions

Repairing any defect of the auricle after trauma is very different from those due to congenital imperfections. The skin of the mastoid area is much thicker and firmer after a trauma than it is in congenital deformities, and the behavior of the auricular framework is not similar because it may suffer much more pressure under the skin. The hairline is usually much lower in trauma patients than in congenital anomaly patients, and consequently the hairless skin is smaller. In non-operated patients with congenital abnormalities, there isn't any cicatricial tissue on the skin or underneath the cutaneous covering. For these reasons, the operation and the postoperative period are different, since the local tissue presents abnormalities that modify the surgical results.

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12. Reconstruction of the Ear After Human or Animal Bites

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Keywords Human and animal bites – Wounds caused by bites – Diseases transmitted by bites – Ear reconstruction – Ear damage

12.1 Introduction

The injuries caused by human bites and animal bites show a peculiar pathogenicity caused by severe tissue trauma followed by secondary infection. The tip of the tooth that deeply penetrates the tissue through the holes and wounds introduces pathogenic bacteria (Brant 1969). In an instructive publication, Pitanguy et al. (1971), Boland (1941) described the effects of human bites. Whether the trauma is caused by a human or animal bite, first aid should be administered carefully (Fig. 12.1).

Cause	Side			Patients	Ears
	Rigth	Left	Bilateral	total	(n°)
Car acident	47	41	8	96	104
Otoplasty	3	7	67-	77	144
Human bite	16	18	-	34	34
Burn	16	19	14	49	63
Animal bite	18	21	-	39	39
Tumor	11	9	5	25	30
Piercing	19	11	-	30	30
Hemangioma	4	5	-	9	9
Amputation by nife	7	8	3	18	21
Amputation by scalp	3	5	2	10	12
Stunned rigidiyt	-	-	1	1	2
Acumputure	2	1	-	3	3
TOTAL	182	145	100	391	491

Fig. 12.1 Etiology of acquired deformities among 391 patients and 491 ears

Among 391 patients (491 ears) operated on at the Brazilian Ear Institute for acquired amputation (34 patients), 34 were caused by human bites. On other hand, 39 patients (39 ears) had trauma caused by animal bites. Therefore, a total of 73 patients (73 ears) had human and animal bites, which represented 14.86 % of all patients with traumatic detachment of the ears treated at the institute. For this reason, such damage to the auricle is a public health concern as well as a social problem that is very important to discuss. Another fact is that the right ear was damaged by an animal bite in 18 cases and the left in 16; consequently, the left ear was damaged in 21 cases caused by animal bite and 18 by human. Another curiosity is the observation that all patients with partial or total detachment of the auricle present with only unilateral trauma, since the victims do not allow damage the other auricle.

In all cases of animal bite, it is very important to identify the animal in order to find out which disease(s) it may have transmitted to the victim. However, since some patients are not aware of this, they usually kill the animal. It is obligatory to inform the public health authorities about animal bites in order to keep patients and animals under government control.

According to the Web site of São Paulo's Municipal Secretary of Health, 15,000 new cases of bites by dogs and cats present at public hospitals every year (Avelar 2013). In this official information, there was no reference to trauma to the auricle, but it is a great social and health problem. As described in Fig. 12.1, a considerable number of patients present with ears injured by human or animal bites. So far, they have required adequate treatment during the acute period to prevent the transmission of serious diseases as well as to reconstruct the ears.

Both human and animal bites injure and can cause pathology in the victims, since the teeth can transmit local infection and other diseases (Fig. 12.2). The human bite is reminiscent of primitive instincts and wild cannibals, and is a form of physical struggle. The teeth are strong and sharp, and thus can be used as natural weapons.

Fig. 12.2 Partial detachment of the right ear caused by a camel bite. The patient came from the Middle East for reconstruction of the medial segment of the ear. Photos (**a**, **b**): Pre-operative aspect of a A 32-year-old man presenting aesthetic deformity of the propeller and anti-helix and partial absence of the conchal wall

12.2 Surgical Considerations

Most of the patients presented for treatment several months or years after the trauma (Figs. 12.3 and 12.4), although a patient did come in immediately after the detachment. Two young males brought in the detached segment, asking for reimplantation, but the correction procedure was not carried out because there was no chance of good results. It is recommended to wait 2–4 months − an adequate amount of time for complete healing of the wound − before beginning reconstruction of the auricle. Four patients (two female and two male) came to the institute with the amputated segment already sutured onto the remaining ear. Nevertheless, such a procedure is not correct since it is difficult to achieve successful results after re-implantation.

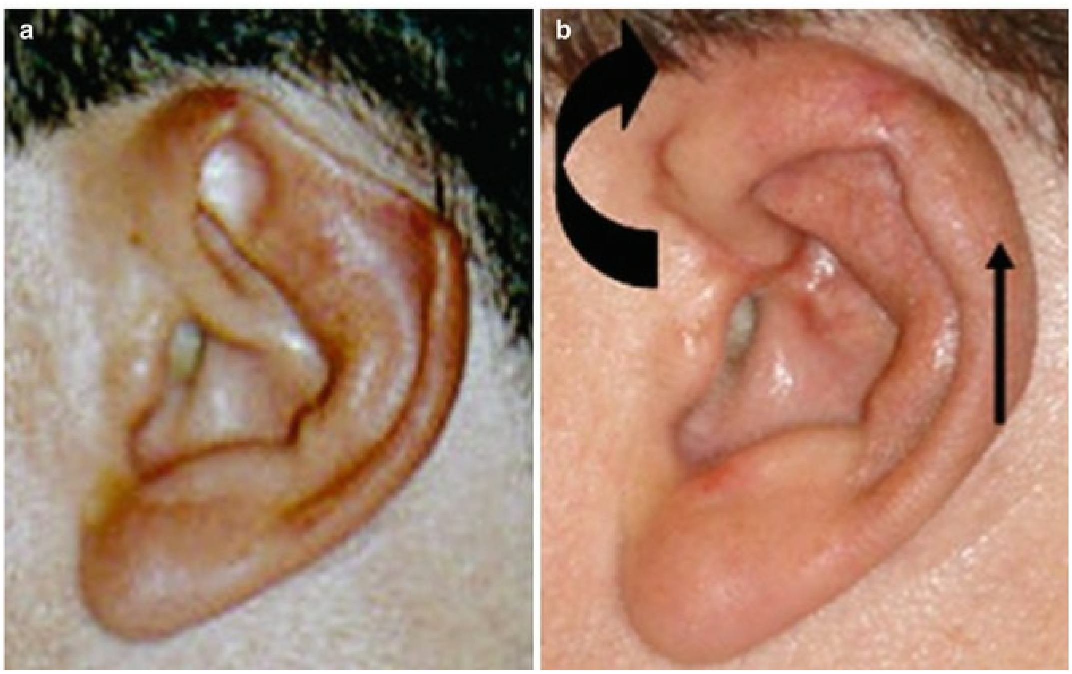


Fig. 12.3 Reconstruction of *upper segment* of left ear caused by human bite. (**a**) Pre-operative photo of the left ear of a 32-year-old male patient presenting with the wide absence of helix; (**b**) the reconstruction was performed by advancing the remaining segments of the posterior and anterior helical margin (Antia's technique), indicated by the *arrows*

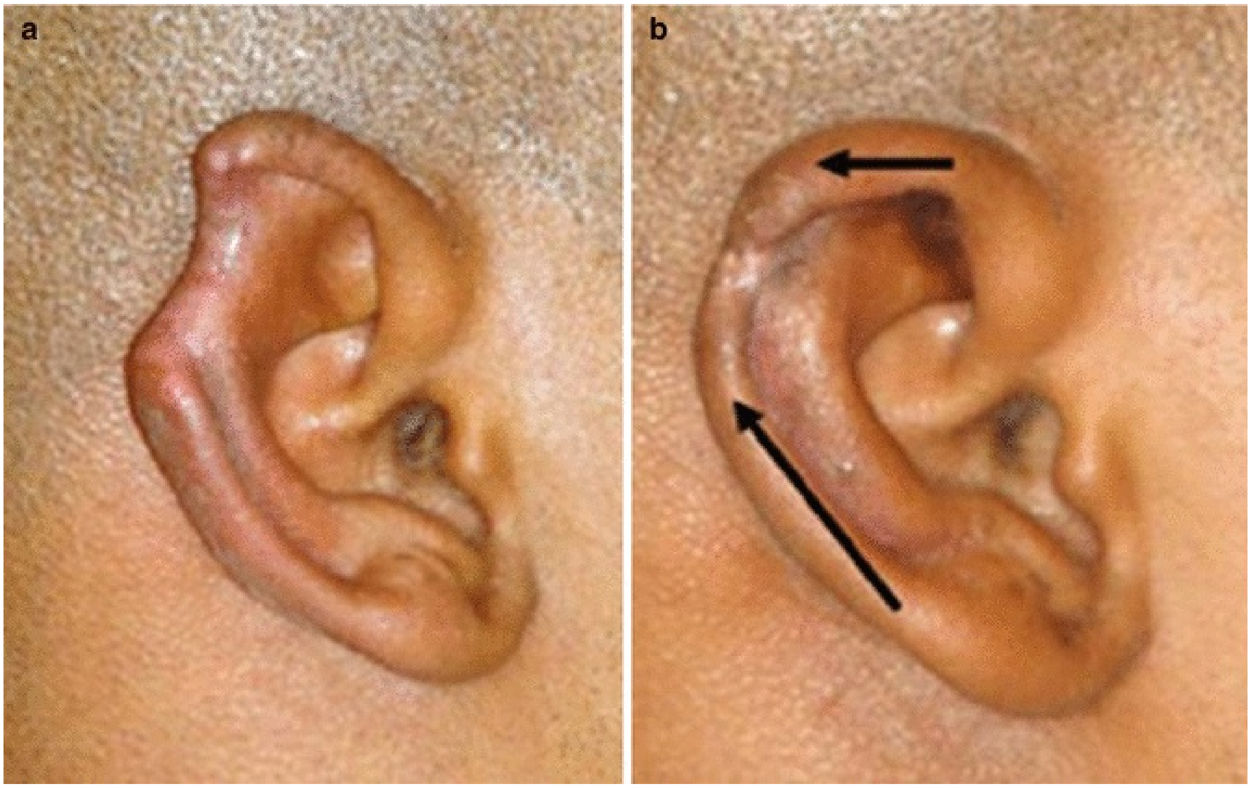


Fig. 12.4 Repair of the helix of the right ear caused by human bite. (**a**) A pre-operative photo of a 24-year-old male patient with partial detachment of the superior segment of the helix of the right ear; (**b**) The surgery was performed using Antia's technique in one single-stage reconstruction through *upward* and *backward* advancement of the chondrocutaneous flap, as indicated by the *arrows*

Some of the ear deformities caused by human bites were the result of sexual acts or physical fighting (Fig. 12.5); the auricular lobe is the ear segment most frequently damaged during sex. However, several other parts of the ear may be detached and require subsequent reconstruction. During physical struggles, the upper pole of the ear is the most vulnerable, as described by Pitanguyet al. (1971) and Avelar (1971, 1972) although the lobe may also be injured. Due to this, partial or total destruction by a human or animal bite is a peculiar cause of ear injuries that is a constant challenge during reconstruction.

Fig. 12.5 Total reconstruction of the right ear caused by a human bite during a sexual act. (**a**) Pre-operative photo of a 21-year-old-male patient presenting with the absence of the whole auricular cartilaginous frame; (**b**) same patient after first stage reconstruction with the new frame excavated from

the rib cartilage; (**c**, **d**) the final result 2 years after second stage reconstruction

The traumatic loss of any segment of the human body is tragic; partial or total loss of the ear represents a physical and psychological trauma that requires special attention, from first aid to the final stages of reconstruction. Psychological repercussions ensue whenever patients look at their physical deformities, especially of the ears, and they always remember the moment that caused the detachment. Therefore, reconstructing an auricle implies much more than correcting a physical deformity because it restores the harmony of the human body and minimizes suffering (Figs. 12.6 and 12.7). The surgical techniques are meticulously described in Chap. 11 of this book, following explanations of what is possible to do to assist victims of trauma to the ears.

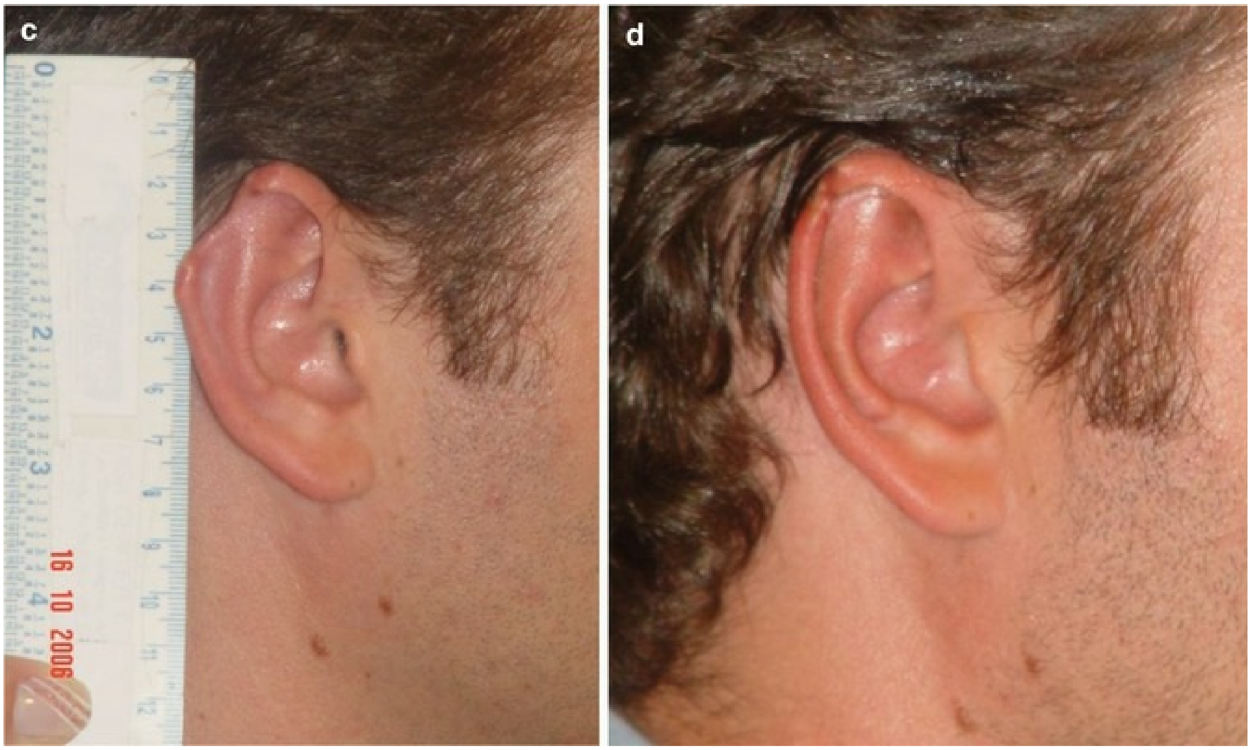


Fig. 12.6 Reconstruction of upper segment of right ear caused by human bite. (**a**) Pre-operative photo of a 26-year-old male patient presenting with wide absence of helix; (**b**) reconstruction was performed by advancing the segments of the posterior and anterior helical margin (Antia's technique); (**c**) close-up of the missing segment; (**d**) the defect is repaired

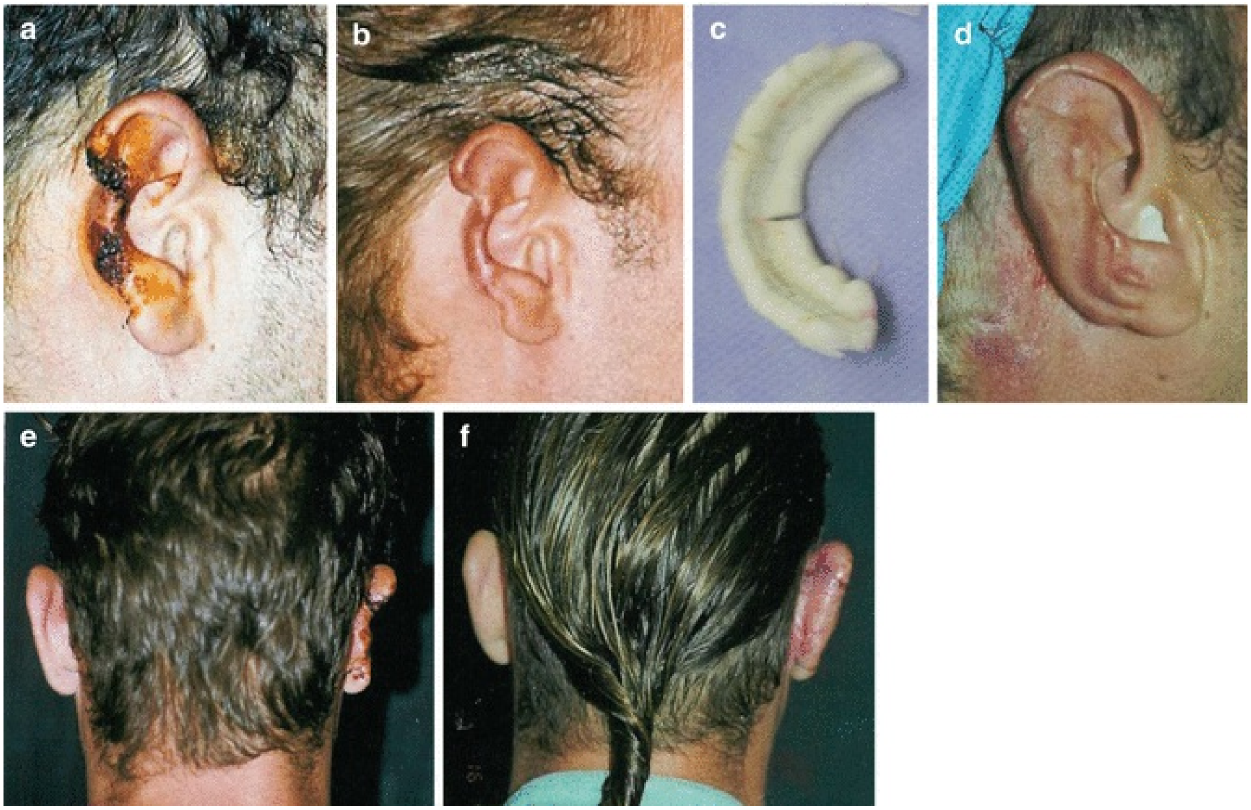


Fig. 12.7 Partial reconstruction of the right ear caused by human bite during a fight. The surgery was planned by removing rib cartilage of the missing segment of the ear. (**a**) A 24-year-old male came to me a few hours after partial detachment of the right helix, antihelix and conchal wall. Presented with fibrotic tissue on lobe on right side due to trauma and also due to four previous surgeries performed elsewhere; (**b**) same patient 1 year after reconstruction of the lobe; (**c**) an incision was made along the scapha from the ascendent root of the crus helix to the inferior segment of the helix; (**d**) a segment of condro-cutaneous flap is removed to facilitate rotation and advancement of the upper helix; (**e**) sub-perichondral undermining of the posterior flap is performed; (**f**) an "L-shaped" rib cartilage graft is removed in order to be inserted between the two cutaneous flaps: the one after advancement from up downwards, and the other coming from the remaining segment on the lower part of the auricular lobe. By incisions and advancement of the condro-cutaneous flap downwards, combined with the advancement of a cutaneous flap coming from the inferior segment of the remaining lobular tissue and Dr. Juarez

12.3 Pathology

The wounds resulting from bites can be incised − cuts, punctures, and even maceration, according to the actions of specific teeth (incisors, canines, and molars, respectively). Furness (1968) presented a method for diagnosing these injuries as well as how to investigate and identify the aggressor. An interesting publication by Barnes and Bibby (1939) that reviews 341 cases of human bite published by several authors found five cases of death and 14 detachments as a result of this type of aggression. Flick (1929) reported one death, and an amputation of one hand and one thumb.

The teeth − through skin or mucosa − reach other deep structures penetrating bacterial agents capable of developing into infections. A useful study regarding these infections in hands by Manson and Koch (1930) may explain the spreading that these wounds can do, because the oral cavity is usually contaminated with virulent live bacteria that are beyond the normal flora. Reviewing studies of various authors on the bacteriology of wounds are unanimous in the findings. The most frequent bacterial agents were *Staphylococcus aureus*, *Streptococcus hemolyticus*, *Staphylococcus albus*, and *Fusiform bacilli*.

12.4 Disease Transmission

Several diseases (blastomycosis, actinomycosis, and others) as reported by Pitanguyet al. (1971) were caused by transmission via human bites. The continuity determined by the teeth through the skin leaves a gateway to specific or non-specific pathogens. John Flick (1932) described cases of *Treponema vincentii* that produced an infection in the hands, since one patient died of gangrene and another had to undergo amputation of the hand. Also, Flick (1929) reported the death of a patient due to infection followed by gangrene. Robson (1944) reported a case of actinomycosis secondary to human bite. Even a case of syphilis was described by Touraine (1938) and Boland (1930), who wrote that 40 % of the patients presented positive serologic reactions. There is no reference to the transmission of tetanus by this kind of injury, as mentioned by Crikelair and Bates (1950); however, it is necessary to use tetanus antitoxin in patients with a human bite, if the skin or mucous membrane is injured.

12.5 Method

Partial or total reconstruction of the auricle to repair deformities caused by a human or animal bite presents an individual approach for each case since each patient presents with specific abnormalities (Fig. 12.8). It is not our purpose to describe the techniques here, since they can be found in detail in Chap. 11 (Figs. 12.9, 12.10, and 12.11). Nevertheless, it is beneficial to mention that reconstructive procedures should not be performed immediately in hospital emergency departments. It is mandatory to identify the animal or human that caused the injuries. The wounds must be properly treated in order to remove foreign matter and avoid any cutaneous or mucous incisions. Treatment with antibiotics is adequate at this time, as well as informing the public health authorities, and it is obligatory to administer standard preventive anti-tetanus medication.

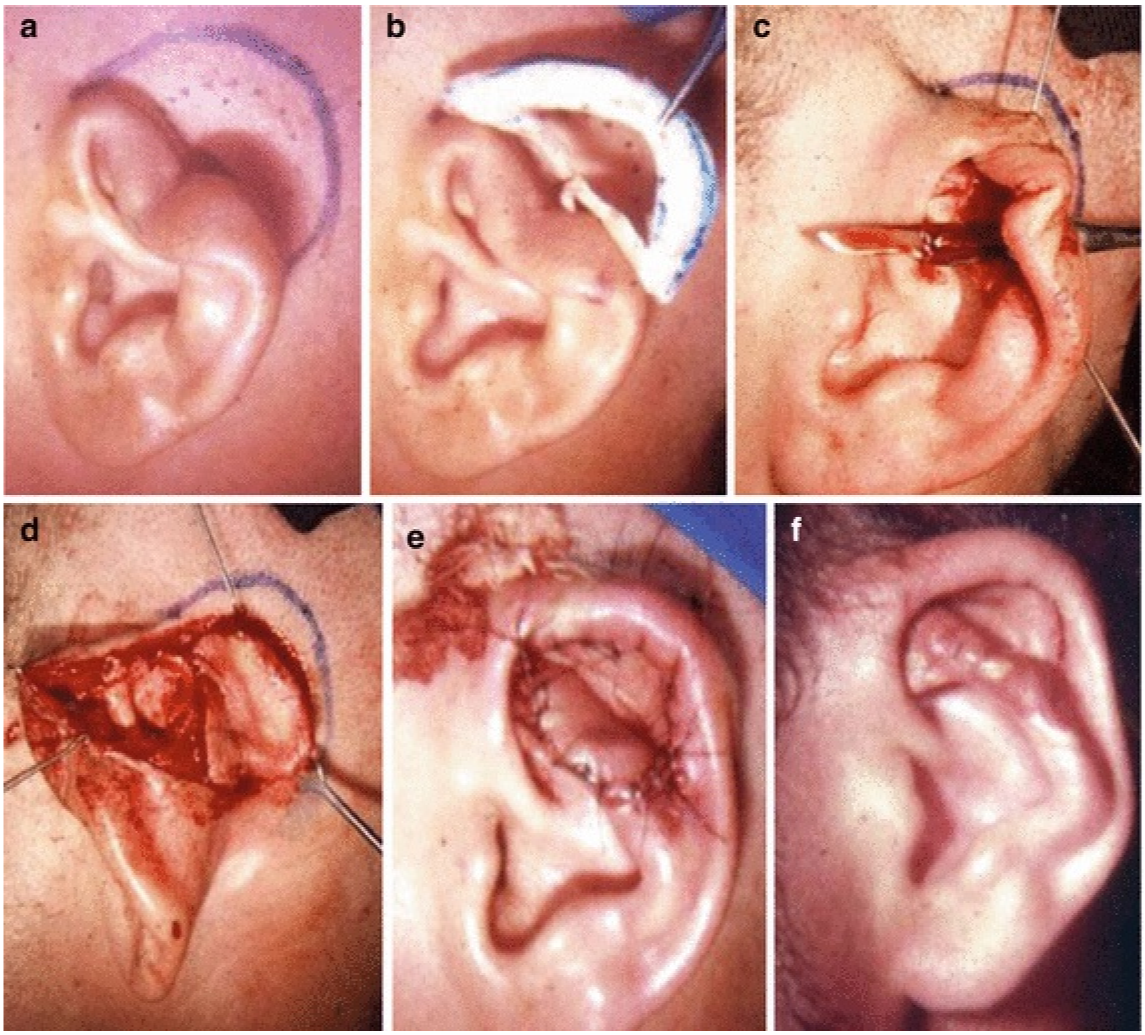


Fig. 12.8 Partial deformity of the *upper pole* of the left ear caused by severe infection followed by a mosquito bite in a child. The reconstruction was performed in one single stage in these sequential photos during surgery. (**a**) A preoperative view of the left ear of a 23-year-old male patient with surgical planning of the operation; (**b**) the missing segment of the auricular frame will be replaced by "D" cartilage graft already excavated; (**c**) a cutaneous incision is being made from inside to outside to create a bipedicled flap; (**d**) the auricle is pulled forward and an "island" skin flap was created on the mastoid area; (**e**) the "island" flap is transferred forward to create the scapha and sutured to the helix and remaining segments of the ear; (**f**) the final result 1 year after reconstruction

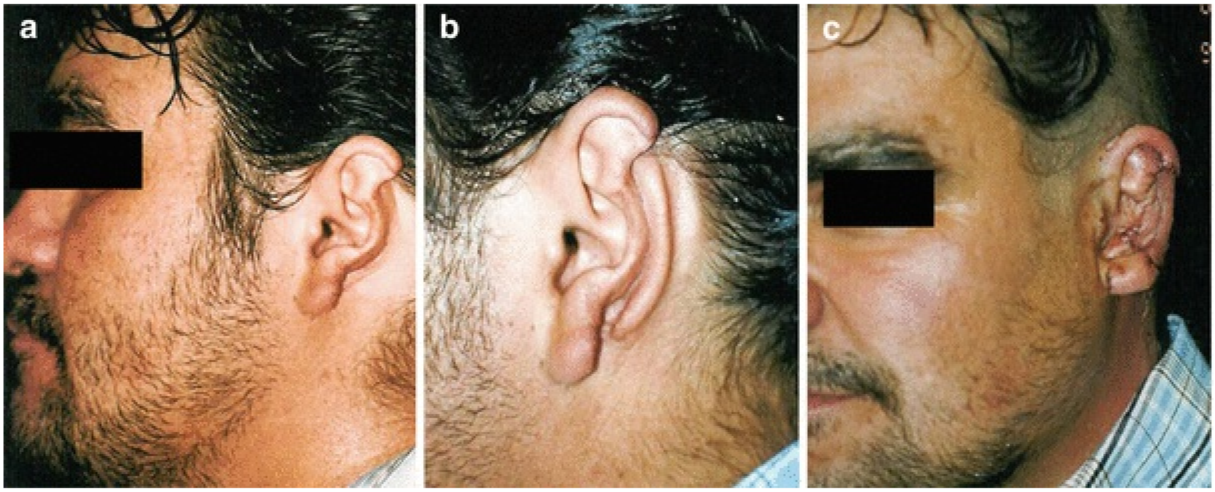


Fig. 12.9 Reconstruction of the upper segment of the posterior border of the left ear caused by a camel bite on a patient that came from the Middle East. (**a**) Pre-operative photo of a 36-year-old male patient presenting with a wide lack of helix, antihelix and conchal wall; (**b**) photo shows the patient after first stage of reconstruction with the new frame excavated in rib cartilage; (**c**) the final results 2 months after the second-stage reconstruction

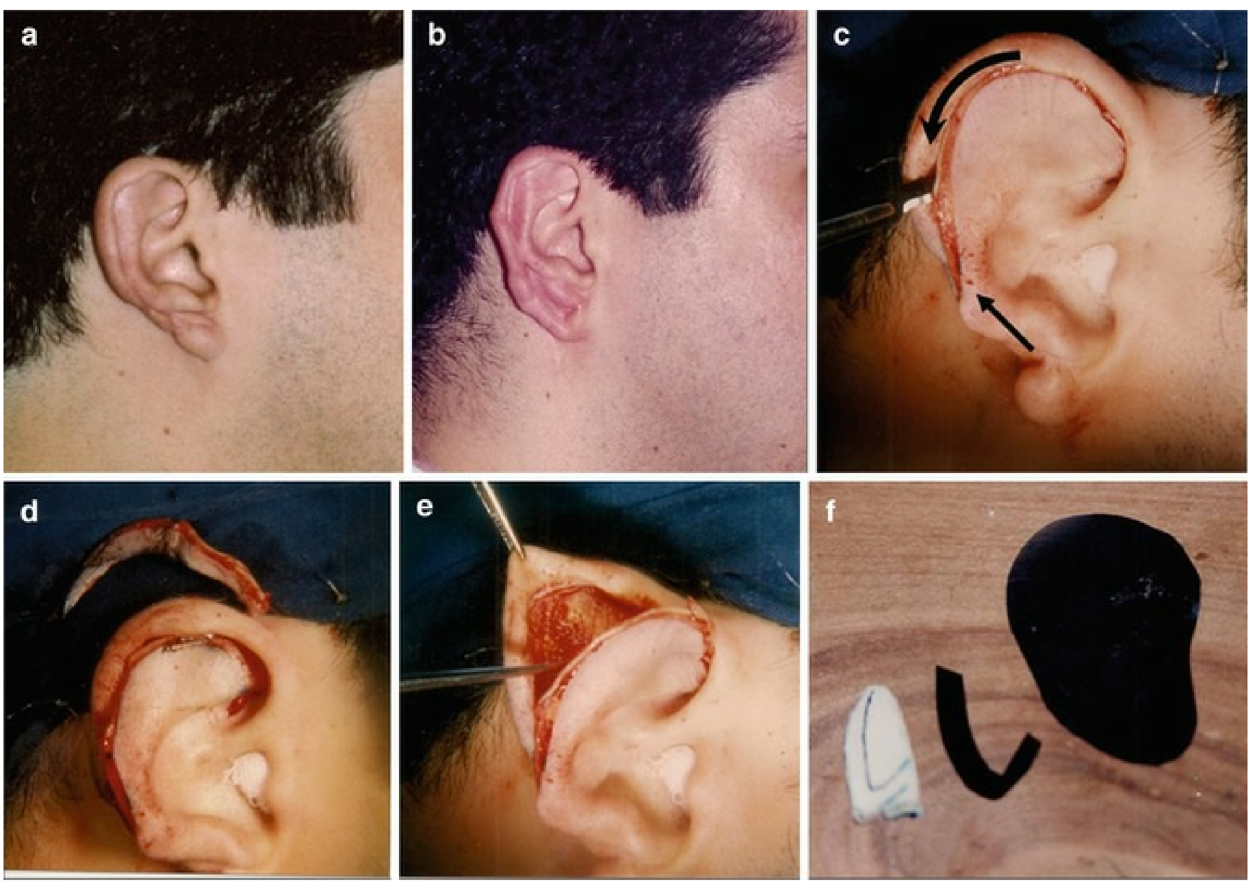


Fig. 12.10 Reconstruction of the lower third of the right ear caused by a dog bite. The surgery was planned by incisions and advancement of the condro-cutaneous flap downwards, combined with the

advancement of a cutaneous flap coming from the inferior segment of the remaining lobular tissue and cartilage graft. (**a**) A 23-year-old male patient presented with fibrotic tissue on the lobe on the right side due to trauma and also due to four previous surgeries performed elsewhere; (**b**) Same patient 1 year after reconstruction of the lobe; (**c**) an incision was made along the scapha from the ascendent root of the crus helix to the inferior segment of the helix; (**d**) a segment of condro-cutaneous flap is removed to facilitate the rotation and advancement of the upper helix; (**e**) sub-perichondral undermining of the posterior flap is done; (**f**) an "L-shaped" rib cartilage graft is taken to be inserted between the two cutaneous flaps: one after the advancement from up downwards, and the other from the remaining segment on the lower part of the auricular lobule

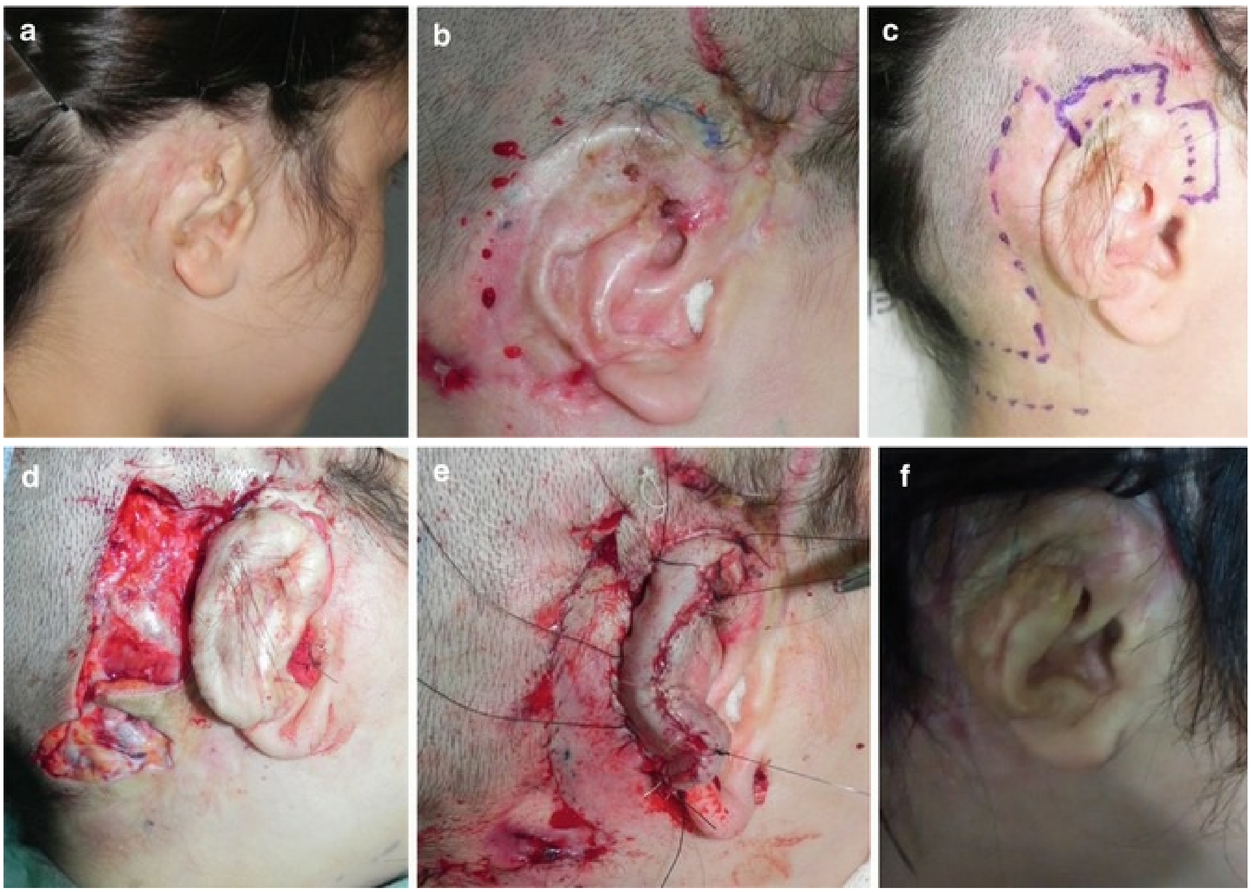
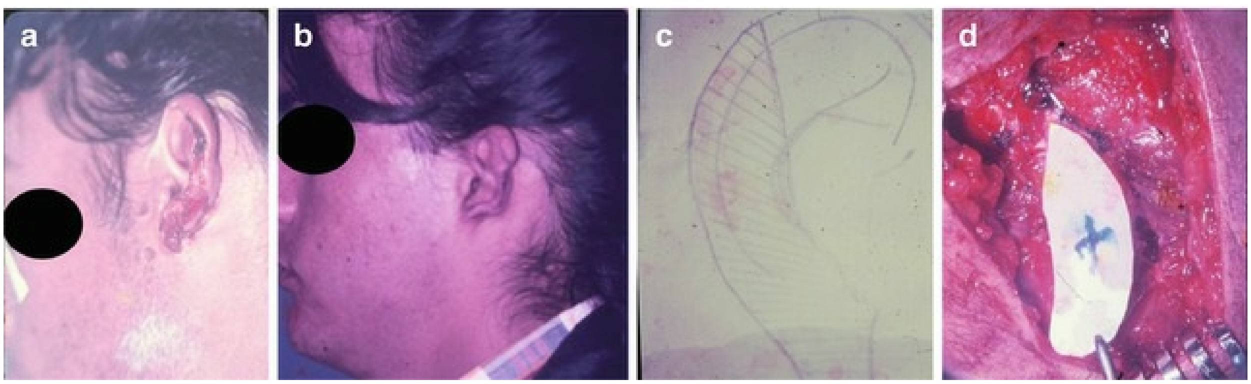


Fig. 12.11 Severe deformity of the right ear caused by dog bite followed by complex infection. The reconstruction was performed in three stages. (**a**) A preoperative view of the right ear of a 9-year-old female patient with multiple scars due to destruction of local skin; (**b**) after first stage of reconstruction with insertion of the new auricular framework. (**c**) The surgical planning of the second stage reconstruction; (**d**) two cutaneous flaps are drawing; (**e**) the auricle is lifted from the side of the head;(**f**) the cutaneous flaps were rotated up and backward; the final result two years after three stages reconstruction

12.6 Discussion

Any repair or reconstruction of deformities caused by human or animal bites presents a unique approach for each case, since each patient presents with specific abnormalities. A partial or total reconstruction of the auricle should not be performed immediately in the emergency department at the hospital. Firstly, the wounds must be carefully evaluated before repairing deformities caused by human or animal bite (Fig. 12.12), and the surgeon should not cause any further damage to the areas injured by the teeth of the aggressor (human or animal). It is important to identify the animal or human that caused the wound, which must be properly cleaned in order to remove foreign matter and avoid any cutaneous or mucous incisions. Treatment with antibiotics is adequate at this time, as well as informing the public health authorities.



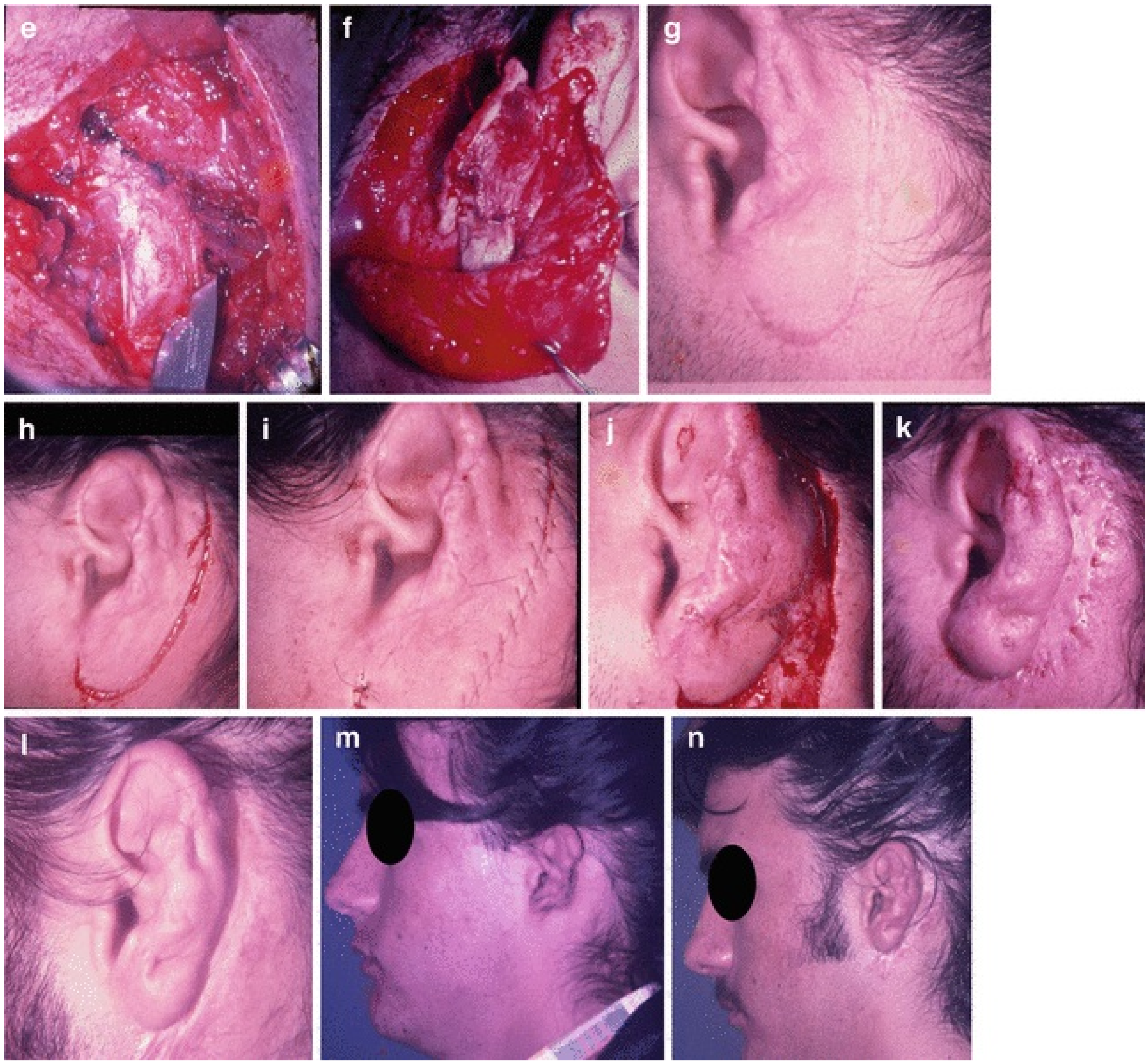


Fig. 12.12 The first patient I performed partial reconstruction of the ear on in 1976. A 19-year-old-male patient had the lower half of his left ear severed by a horse bite. Photo (**a**) He came to me 2 days after the accident; (**b**) 1 month after the detachment; (**c**) the surgical planning I did that time for reconstruction of the lower half of the left ear; (**d**) the model of the new frame is placed on the rib cartilage; (**e**) the cartilage was removed in segments, using a knife, following the procedure I learned from Prof. Pitanguy; (**f**) the new frame is sutured to the remaining auricular cartilage; (**g**) the skin flap covers the frame; (**h**) 3 months later, a second stage was done with new skin deley; (**i**) suturing the skin; (**j**) 2 weeks later, the third stage of reconstruction was performed with a skin incision, the new ear was lifted, and skin grafted behind the new ear; (**k**) the results 2 weeks later; (**l**) the same patient,6 months after surgery; (**m**) my first patient before reconstruction, showing the missing segment of the lower half of the ear; (**n**) 2 years later the first patient I performed ear reconstruction on, showing the final post-operative results

It is not recommended to reimplant the detached segment of the auricle;

reconstructive procedures must be performed after the wounds have completely healed, and only after acceptable surgical planning; also, each patient's surgery requires an individual approach. When any part of the ear is missing, it must be replaced with meticulously removed rib cartilage. It is not our goal to describe the techniques here, for they can be found in detail in Chapter 11; nevertheless, it is important to mention that reconstructive procedures should not be performed immediately at the emergency departments of the hospitals. It is mandatory to identify the animal or human that caused the injuries. The wounds must be treated in order to remove foreign matter and avoid any cutaneous or mucous incisions. Treatment with antibiotics is adequate at this time as well as informing the public health authorities, and it is imperative to administer preventive anti-tetanus medications.

Conclusions Human and animal bites are an unusual cause of deformity to ears, requiring immediate treatment and attention: identifying the aggressor (human or animal); taking good care of the wounds on the skin or mucosa; not performing any surgical procedure immediately, but waiting until the wounds are completely healed; and not performing some tentative of reimplantation. It is advisable to prescribe antibiotics, administer preventive anti-tetanus medication, and inform the public health authorities; in addition, the patient must be under medical care until the wounds are totally healed.

When the detached segment of the ear includes auricular cartilage, re-implantation is not recommended, nor is introducing the cartilage into subcutaneous tissue of any other area. Repair or reconstruction of the auricle must be done only after sufficient surgical planning, and the surgery must be done using the proper technique. Whenever a segment of ear cartilage is missing, it is necessary to replace it; the best material to use is taken from rib cartilage removed from patient.

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13. Late Follow-Up After Ear Reconstruction

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Keywords Surgical results – Later follow-up – Esthetic result – Ear reconstruction

13.1 Introduction

Reconstruction of major or minor defects of the auricle on congenital and acquired deficiencies has motivated my work for the past 43 years. In the beginning I used the Pitanguy's method, that I'velearned whith him during my specialization period, as well as the Converse's methods when I was his fellow student afterward, and from useful publications by Tanzer (1959, 1971, 1964) and Converse (1958a, b, 1964). As each operation requires so much care and attention due to many clinical variations, during my career I always had to modify each procedure that I performed. Beginning with my first patients, I saw that some surgical details were evident during each procedure, which were once useful to use on subsequent operations to solve unique difficulties. Such a concept has kept my mind open to find new ways for the scientific development of new skills. Even these days I come across surgical details that constantly improve my knowledge and are useful for solving the problems of subsequent operations. For these reasons I have developed new techniques in order to achieve better surgical results without any serious complications. During a long period of intensive work in this challenging field of ear reconstruction, my personal contributions were published as well as presented at plastic surgery congresses (Avelar 1977, 1978, 1986, 1992, 1997, 2003, 2011, 2013).

I have completed over 1200 total or partial auricular reconstructions on congenital anomalies (Fig. 13.1) as well as on traumatic amputations of the ear (Fig. 13.2). Many associated congenital anomalies were found among most of my patients; these are described in my previous publications (Avelar 2013). Craniofacial anomalies, cleft lips and palates, hypoplasia of the facial bones, facial asymmetry, anomalies of the upper and lower extremities, genitourinary defects, all types of heart defects, deformities of the chest wall and vertebral columns, and anus imperforation were among the anomalies that were present in most of my patients.

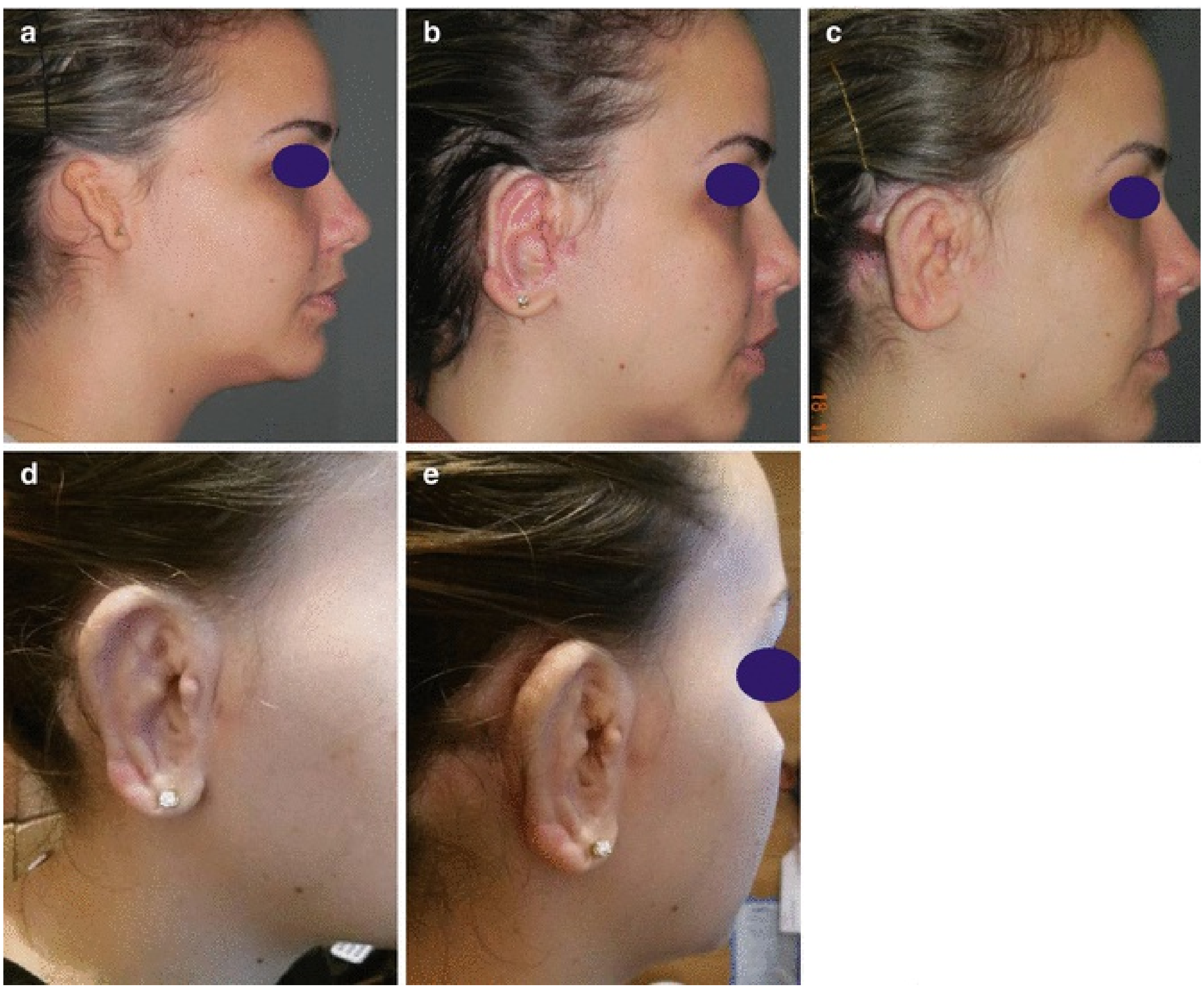

Fig. 13.1 A 19-year-old female with microtia on the *right side*. Photo (**a**) before operation; (**b**) after two-stage reconstruction of the rib cartilage to excavate the new auricular framework; (**c**) after second-stage reconstruction with skin graft behind the new auricle; (**d, e**) the same patient 6 years after operation

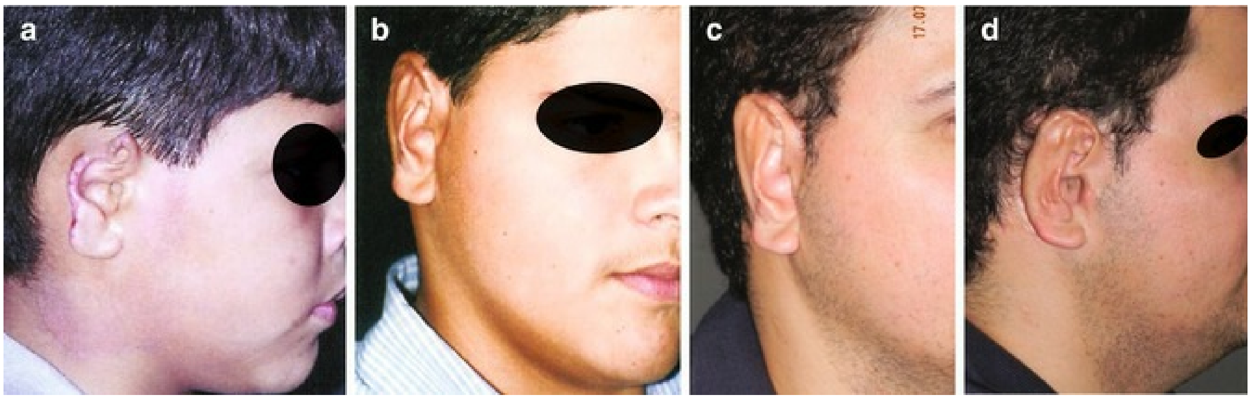

Fig. 13.2 An 8-year-old male with severe amputation of the right ear caused by dog bite. Photo (**a**) before operation; (**b**) 1 year after two-stage ear reconstruction of the rib cartilage to excavate the new auricular framework; (**c**, **d**) the same patient 22 years later, presenting the same anatomical structures of the reconstructed ear

A review of the family histories disclosed that there is no predisposition to congenital anomalies among my patients. So far, there have been only two groups of brothers presenting microtia or other kinds of abnormalities of the ear. Despite this, I have more than 300 patients who got married after their operations and none of them has even one child with a congenital anomaly of the ear (Fig. 13.3), so I am certain that there is no genetic transmission from my patients' parents, something I always communicate to parents at the first appointment when patients present with congenital abnormalities of the auricle.

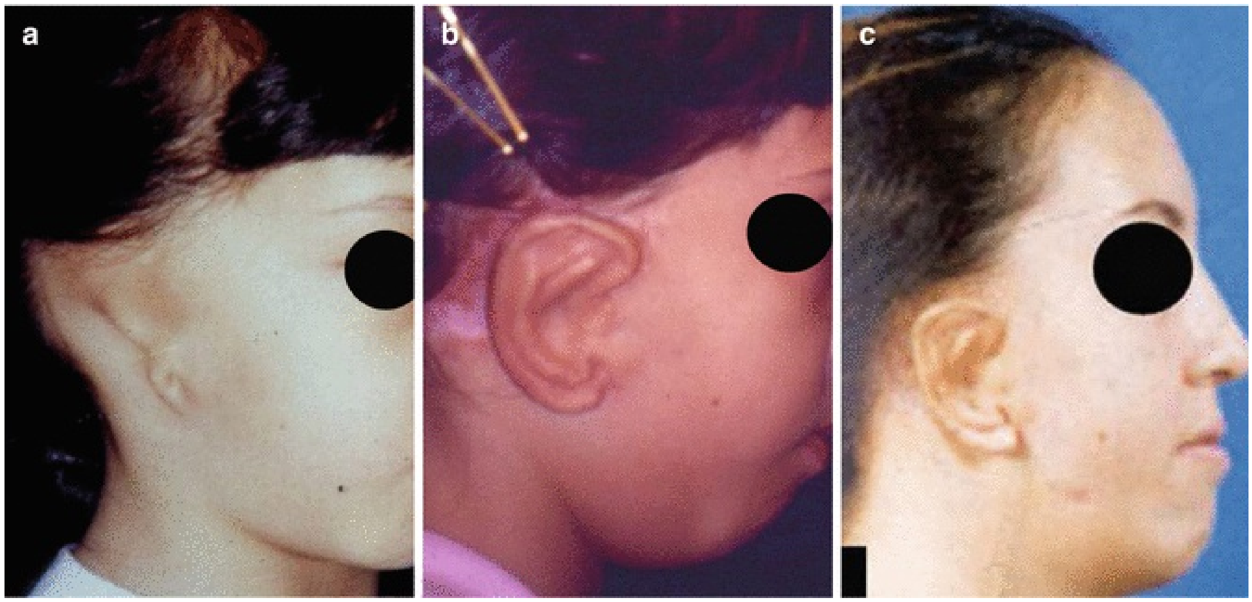

Fig. 13.3 A 7-year-old female with anotia on the right side. Photo (**a**) before operation; (**b**) 1 year after two-stage ear reconstruction of the rib cartilage to excavate the new auricular framework; (**c**) the same patient 21 years later presenting the same anatomical structures of the reconstructed ear

I used to perform ear reconstruction in children aged 6 years and older due to adequate development and thickness of the rib cartilage to provide for curving the new auricular framework (Fig. 13.4). On the other hand my oldest patients were a male and a female about 65 years old. The length of time since embedment of the cartilage framework is 40 years without any damage to the new skeleton. However, usually patients at age 30 or over may present with rib cartilage that is too hardened and which is very difficult to sculpt by excavation.

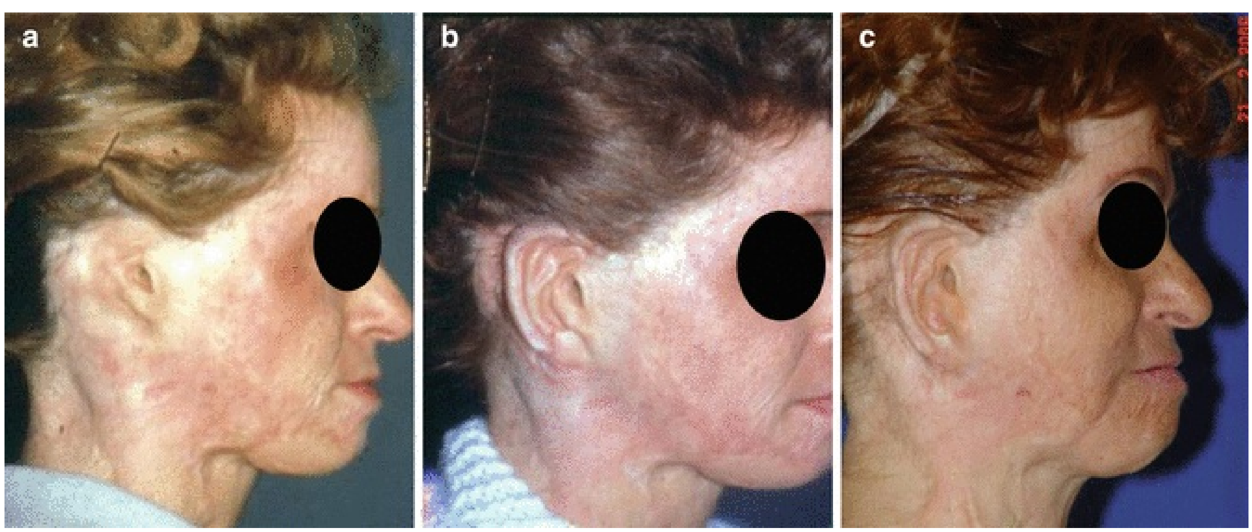

Fig. 13.4 A 19-year-old female with total amputation of the right ear with burned face and neck caused by fire. Photo (**a**) before operation; (**b**) 1 year after two-stage ear reconstruction of the rib cartilage to excavate the new auricular framework; (**c**) the same patient 21 years later presenting preservation of the same anatomical structures of the reconstructed ear

Reabsorption of the cartilaginous auricular framework may take place only in cases of technical failure, such as post-operative infection, excessive pressure of the cutaneous covering on the cartilage grafted, and an inadequate blood supply on the receptor bed of the auricular skeleton (Fig. 13.4).

My preference is to remove the 8th or 9th costal arch, and I have removed over 1300 rib cartilages to sculpt total or partial auricular frameworks without any tearing of the pleura (Fig. 13.5). According to my technique, the costal perichondrium is not resected when the cartilage is removed. I always emphasize that there is no synchondrosis between each costal cartilage and the perichondrium is dissected all around the rib in order to be removed. So far, such a concept is dissimilar to that recommended by Tanzer (1971), since he had four cases of pleura perforation. Even he mentioned synchondrosis, which does not exist between two rib cartilages.

Fig. 13.5 Removal of the rib cartilage with preservation of the perichondrium in its place to avoid any damage to pleura. (**a**) The 8th or 9th rib cartilage is removed; (**b**) the new frame is demarcated on the rib having a model on X-ray film; (**c**) it is sculpted by meticulous excavation. (**d**) the new skeleton is created in a block, curving the cartilage with careful hand work

When I operated on my second patient 43 years ago, I used a silicone prosthesis to replace the ear frame, but it was unsuccessful due to infection and extrusion afterward. After that terrible outcome, I decided not to use it anymore. In my earliest cases, it was usually expedient to carry a couple of mattress sutures crossing the skin and auricular framework as described by Converse (1958a, b) as well as by Tanzer (1959). I used to have some complications, so after a few cases such external stitches were not done anymore, thereby reducing the number of complications after surgery. The conchal cavity is created by the thickness of the rib cartilage in one single block (Fig. 13.5d).

The depths of the scapha and triangular fossa are created on the same block of costal cartilage. The natural curve of the rib often provides useful support for an auricular framework of moderate size and is well concealed by the overlying helix and, in fact, contributes to the contour of the helical sulcus (Fig. 13.6). No severe complications permanently marred the final appearance of the ear. So far, Tanzer has reported that some extrusion of metal sutures used in constructing the framework occurred in 20 cases, usually through the medial grafted surface (1971). Due to such complications, I do not use any metal sutures, which even nowadays are used by other surgeons.

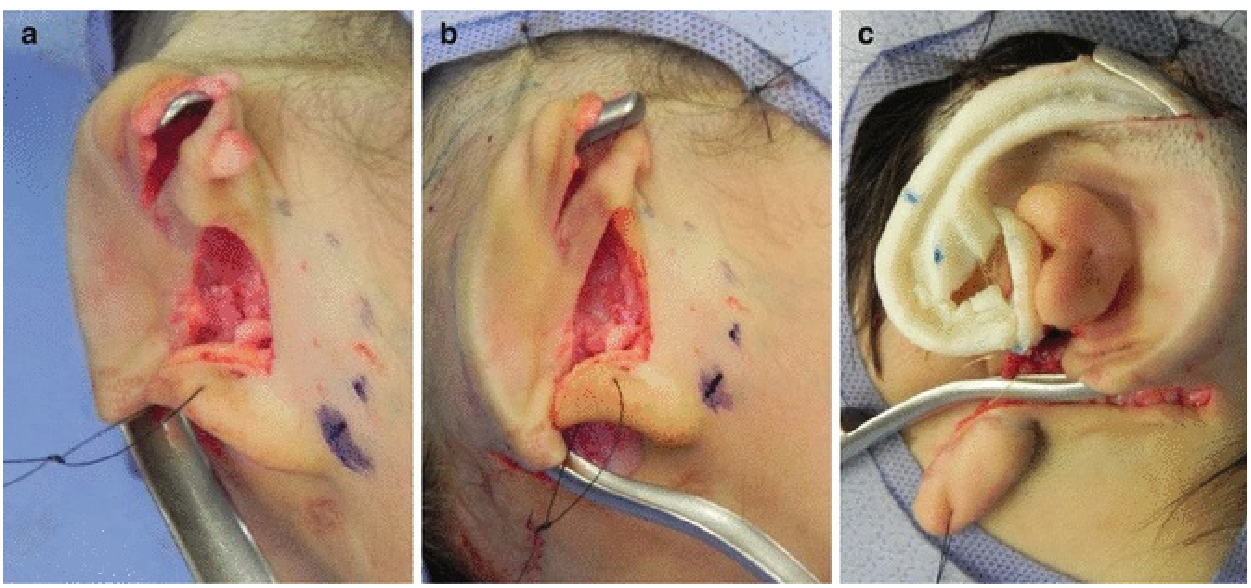

Fig. 13.6 Reconstruction of an ear with microtia (**a**) A subcutaneous tunnel is created by dissection of the future helix and antihelix; (**b**, **c**) a "C" instrument is introduced through the tunnel to facilitate embedding the new frame

Also, Tanzer (1971) mentioned tears during the removal of rib cartilage that occurred in five cases, with no untoward effects; he also described three seromas of the abdominal wall at the site of banking of excess cartilage that required aspiration. I have had no such problem among any of my patients who underwent ear reconstruction by removing costal cartilage to excavate the new frame (Fig. 13.6).

13.2 Technique of the Two-Stage Method

My first stage of ear reconstruction on severe microtia is quite complex, since the remnant cutaneous fold that is always present − but in the wrong position − is rotated to its natural position. Also, the new auricular framework is sculpted by meticulous excavation and embedded through the subcutaneous tunnel to create all anatomical and esthetic details of the future auricle (Fig. 13.7). I do not create a wide pocket to embed the new auricular frame, as described by Brent (1974, 1984); as he performs wide cutaneous undermining, he uses suction drainage after surgery. It is not necessary to use any drainage with my technique, since a very narrow tunnel is created just to introduce the new auricular framework.

Fig. 13.7 The new ear is planned during the first appointment. (**a**) The size and shape are taken from the opposite auricle as reference; (**b**, **c**) the model is then prepared in front of the patient and parents; (**d**) the new model is placed on the deformity to demonstrate the surgical planning

A contour pattern of the normal ear is first traced on X-ray film (Fig.

13.6), cut out, and reversed. That is the surgical planning that is essential before the operation, and I always do it during the first consultation in front of the parents when the patient is a child (Fig. 13.8). When traumatic amputation is reconstructed, surgical planning is also done prior to the operation and spatial projection is an essential step (Fig. 13.9). A tissue expander is a useful procedure during the first stage in order to extend the skin covering of the mastoid region, and then the new frame is introduced through the subcutaneous tunnel (Fig. 13.10). I do not recommend a tissue expander during the first few weeks as the traditional procedure, since the excessive cutaneous covering may disturb the reconstruction procedure.

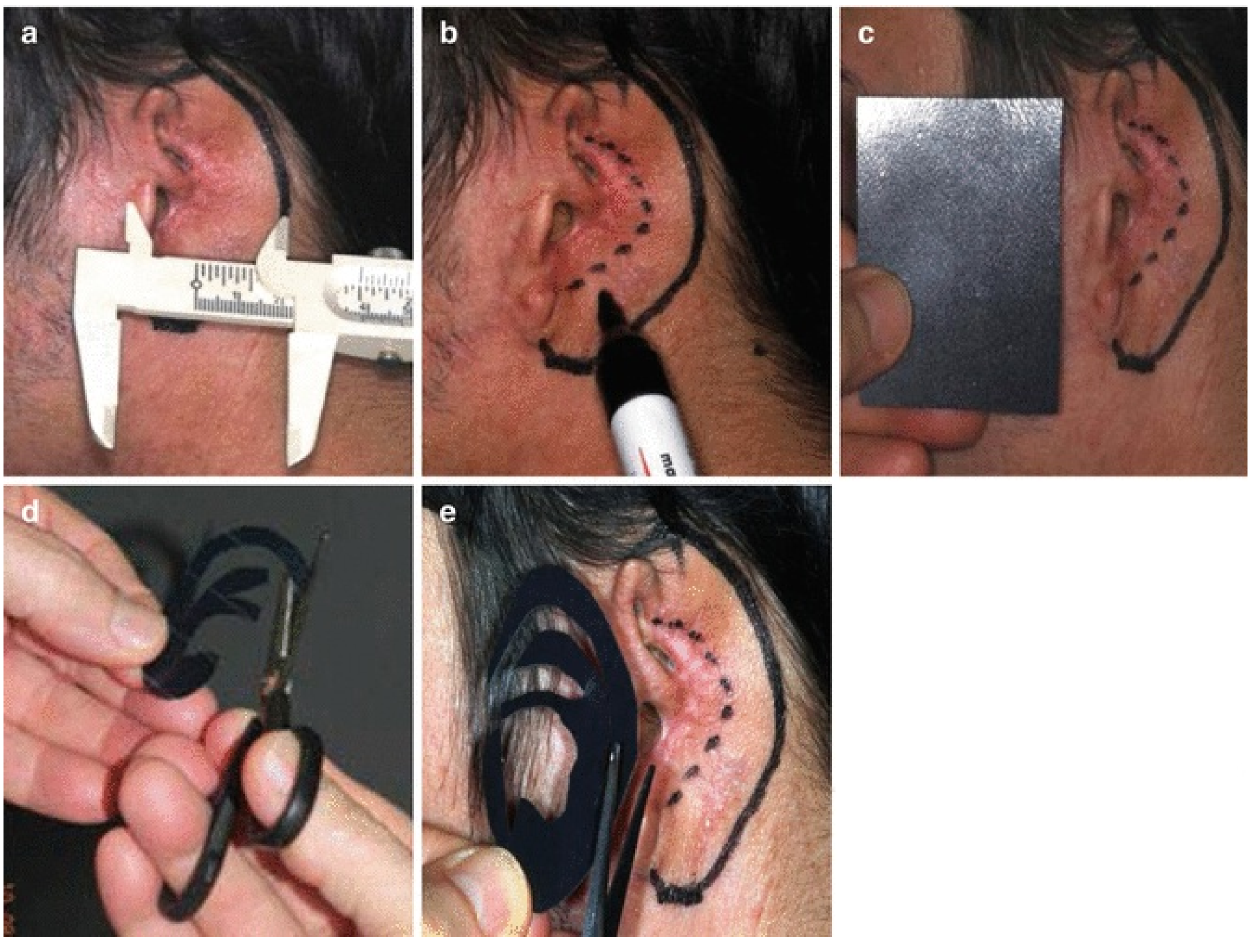

Fig. 13.8 Importance of surgical planning and spatial projection before reconstruction of the ear detached by traumatic amputation. (**a**) by using a paquimeter, the size and shape of the future ear are established; (**b**) the location and position of the future auricle are marked, using the opposite ear as reference since it is normal; (**c**) The model of the future auricular skeleton is carefully created using X-ray film; (**d**, **e**) the model is then placed into the area of the projected auricle

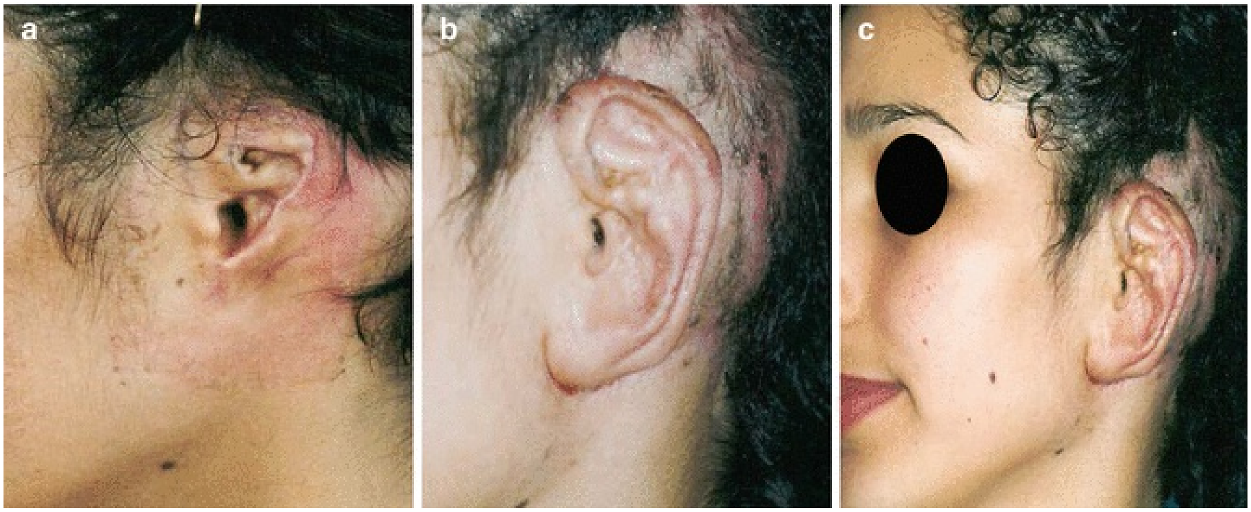

Fig. 13.9 A 20-year-old female with total amputation of the left ear caused by a car accident. Photo (**a**) before operation; (**b**) 1 year after two-stage ear reconstruction of the rib cartilage to excavate the new auricular framework; (**c**) the same patient 6 years later, presenting preservation of the same anatomical structures of the reconstructed ear

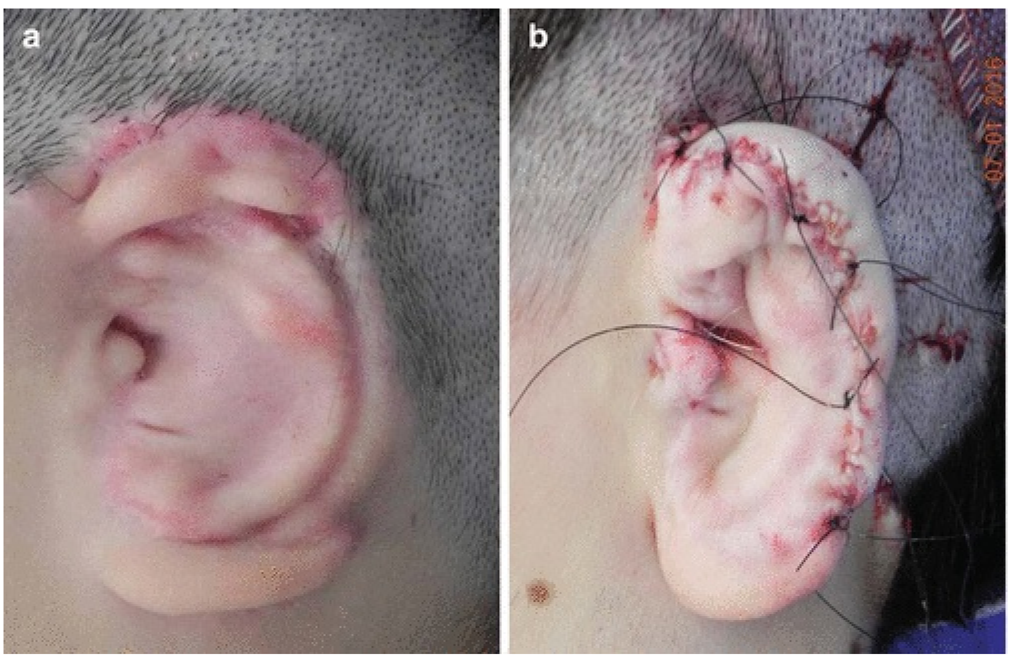

Fig. 13.10 Second stage of ear reconstruction on the *left side*. (**a**) a photo of an auricle after the first stage of reconstruction; (**b**) the same patient just after the second surgical stage when the new ear was lifted and skin graft was performed on the posterior aspect of the new ear

The elevation of the new ear from the side of the head is done during the second stage of reconstruction, when the auditory canal, the tragus, and other anatomical details are sculpted (Fig. 13.10). My method has been described in detail elsewhere, and it provides a very high level of good surgical results (Avelar 1979a, b, 1986, 1992, 2011, 2013).

When in 1977 I described my temporal-parietal flaps having the temporal vessels as its pedicle, it became possible to reconstruct a new auricle in one single stage (Avelar 1977) (Fig. 13.11). Afterwards I introduced some modification in that only one flap was raised, since the auricle was totally reconstructed (Avelar 1978). Later a simplified method was described to make it possible to reconstruct the ear without creating and rotating the fascial flaps, which was the final major modification of my technique (Avelar 1979a, b). Afterwards, modifications have often been added to my basic technique, since the reconstruction is performed in two surgical stages. Therefore, the fascial flaps are not raised in primary cases, because they are very useful for the treatment of complications after surgery, as has been described in previous publications (Avelar 1979a, b, 1980, 1992).

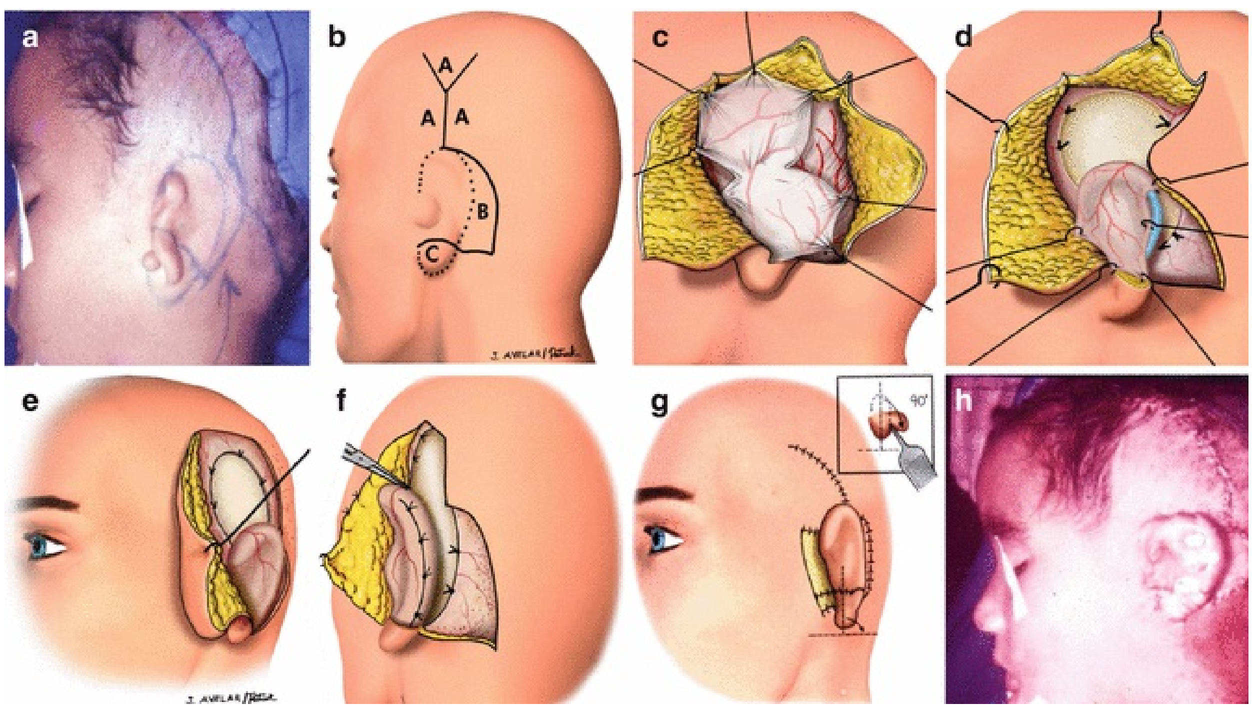

Fig. 13.11 Creation of the temporoparietal fascial flap is a useful resource for ear reconstruction. (**a**) A patient with microtia; (**b**) cutaneous incisions; (**c**) the fascial flap is raised; (**d**) rotation of the flap from upward to downward; (**e**, **f**) the flap covers the anterior and posterior aspects of the framework; (**g**) the cutaneous flap lies smoothly on the new ear; (**h**) the same patient after total ear reconstruction in one single surgical stage

13.3 Results

In my 43 years of practice, I have regularly obtained very good surgical results according to my own evaluation as well as from the patients and patients' parents and the members of my staff (Figs. 13.12 and 13.13). I used to organize New Year's events with several of my patients; it was a remarkable moment since many patients had come from far away to join us, and it was a good opportunity for me to evaluate the final results in a long-term follow-up after the operations (Fig. 13.14). Due to personal analyses and interviews, I came to the conclusion about the efficacy of my methodology (Fig. 13.15).

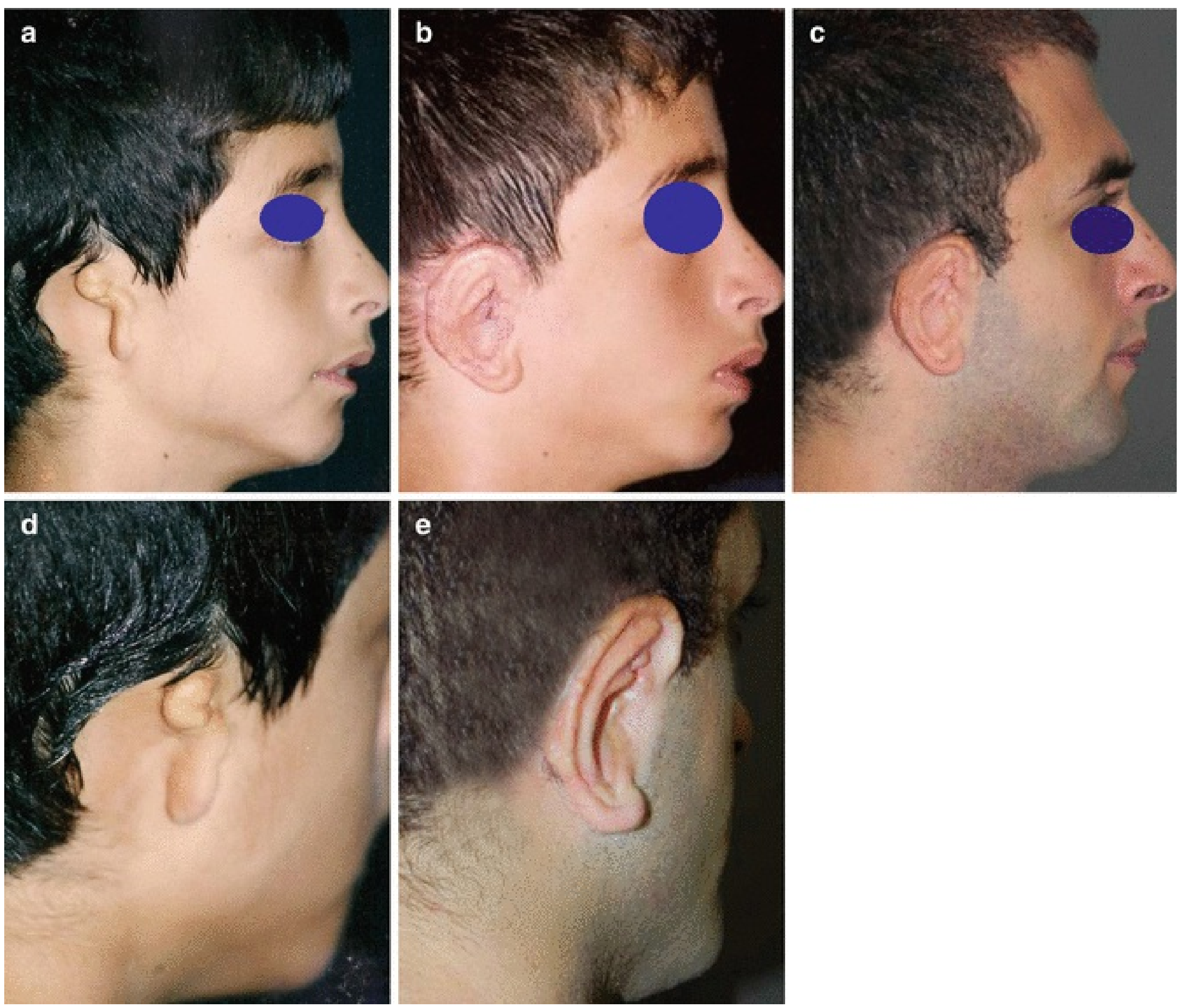

Fig. 13.12 Later follow-up after ear reconstruction on severe microtia. Photos (**a**, **d**) An 8-year-old

male patient before surgery; (**b**) the same patient 1 year after two-stage ear reconstruction; (**c**, **e**) the same patient at age 22 (12 years after ear reconstruction)

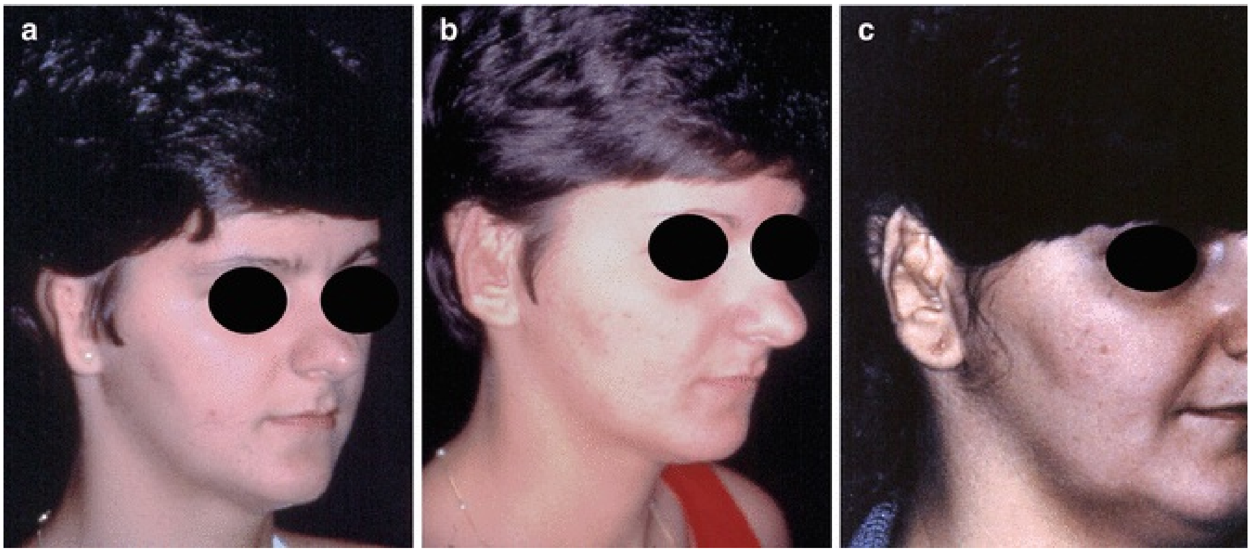

Fig. 13.13 A 17-year-old female with moderate eutopic microtia on the right side. Photo (**a**) before operation; (**b**) 6 months after the two-stage ear reconstruction of the rib cartilage to excavate the new auricular framework; (**c**) the same patient 12 years later

Fig. 13.14 Photo of a group of patients who came to the Brazilian Ear Institute to attend the annual meeting held in December 1997

Fig. 13.15 A 6-year-old female with anotia on the right side. Photo (**a**) before operation; (**b**) 1 year after two-stage reconstruction; (**c**) the same patient 7 years later; (**d**) the same patient in a frontal view before surgery; (**e**) the same patient 7 years after ear reconstruction

In primary reconstructions of congenital deformities, the late surgical results last in excellent conditions without any major modifications regarding the shape, position, size, and location of the reconstructed ears (Fig. 13.16). Nevertheless, to rebuild an auricle after a traumatic amputation is much more difficult due to the fibrotic tissue that develops after an accident and even poor skin covering, since the mastoid region is the only one with available skin for reconstruction (Figs. 13.4 and 13.9). I have mentioned that such a cutaneous covering is not the ideal one, but that it is the best one for reconstruction of the ear due to hairless skin and its location. Such observation results show that the auricular cartilages do not change even long after the operations (Fig. 13.2).

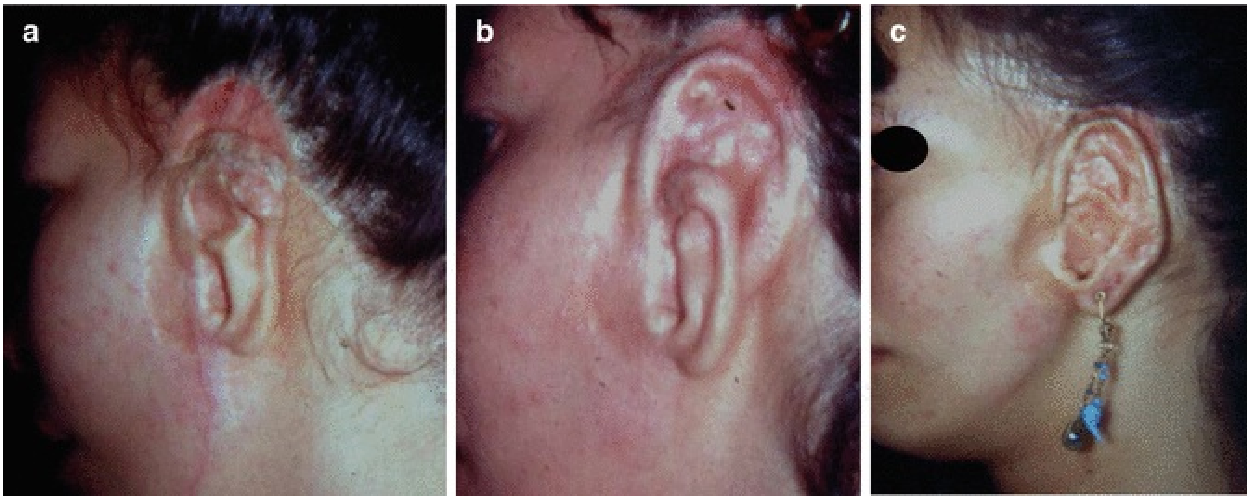

Fig. 13.16 Secondary reconstruction of the left ear after four surgical stages performed elsewhere, showing several scars from the previous operations. Photo (**a**) A 19-year-old female patient after several unsatisfactory surgeries performed elsewhere; (**b**) the same patient 6 months after first-stage ear reconstruction using a new auricular framework sculpted on the rib cartilage. (**c**) the final results 6 years after the second surgical stage

So far, to reconstruct an auricle after previously unsuccessful surgery is even more difficult due to the presence of scar tissue underneath the cutaneous covering. I recommend waiting at least a year after the last procedure has been performed, even by well-qualified surgeons. To plan a secondary operation requires even more knowledge, experience, and adequate surgical demarcations because fibrotic tissue may not be undermined during that time. Above all, severe complications are more frequent, especially due to skin necrosis, infection, exposure of auricular cartilage framework, and poor neighboring of cutaneous covering (Fig. 13.16).

Congenital anomalies of the auricle are classified as anotia, agenesis of the auricle, and microtia, which can be divided into three different subdivisions: severe microtia, moderate eutopic microtia (Figs. 13.17 and 13.18), and moderate ectopic microtia. My classification is a result of studying and analyzing the remaining cartilaginous tissue resected from my patients. For a long time, a correlation was made between each group of deformities in comparison with others; it is therefore a result of embryological-anatomical-functional-clinical-surgical fundamentals, which is a useful correlation between the auricles and other organs of the body.

Fig. 13.17 A 16-year-old female with moderate eutopic microtia on the *left side*. Photo (**a**) before operation; (**b**) 6 months after the first-stage reconstruction of the rib cartilage to excavate the new

auricular framework; (**c**, **d**) the same patient 7 years later

Fig. 13.18 A 17-year-old male with moderate eutopic microtia on the right side. Photo (**a**) before

operation; (**b**) 6 months after the first stage ear reconstruction of the rib cartilage to excavate the new auricular framework; (**c**) the same patient 1 year after the second stage of reconstruction; (**d**) the same patient 7 years later

My embryological study shows that anomalies of the external ear are caused by alterations in the development of the ectoderm, and they are limited to the neighboring structures on patients classified as severe microtia (Figs. 13.1 and 13.12) and moderate eutopic microtia, which do not present any complex associated anomalies of the body (Figs. 13.13, 13.17, and 13.18). All patients presented with minor or medial degrees of facial asymmetry, and always with a rudimentary lobule in an abnormal position, which is rotated to the correct position and location during the first stage of reconstruction.

Patients are classified as moderate ectopic microtia, anotia (Figs. 13.3 and 13.15), and agenesis of the auricles, presenting disturbance of development of the ectoderm and mesoderm, because the internal and middle ears also present deep anomalies. All those patients presented with several combined anomalies on the chest, spinal column, upper and lower extremities, genitourinary system, or internal organs of the chest. They may present anomalies of the heart, Fallot's tetralogy, transposition of the great vessels of the base of the heart, and several other deformities. All patients with such anomalies had undergone heart surgery in their first years of life. Patients classified as moderate ectopic microtia always present with a lobule and a rudimentary conchal cavity, but in the ptotic position, which must be lifted during the second stage of ear reconstruction.

The surgical fundament is a consequence of several factors, since the technique for reconstruction is different for each group of patients. However, all patients diagnosed with moderate eutopic microtia present with a lobule, rudimentary conchal cavity, and external auditory meatus, which give correct orientation by rotation of those structures during the second stage of ear reconstruction (Figs. 13.13, 13.17, and 13.18). In other situations, patients are diagnosed with anotia that requires complex reconstruction of the auricle, the external auditory meatus, and the lobule as well, because they all do not present those anatomical elements (Figs. 13.3 and 13.15).

My last analysis concerns congenital anomalies, known as traumatic amputations; There is currently no specific study on cartilage shrinkage, since adequate evaluation before surgery should be a mandatory procedure (Figs. 13.3 and 13.16). Even careful pre-op evaluation is another fundamental procedure for all patients presenting with congenital anomalies (Fig. 13.19a) as well as traumatic amputation of the ear (Fig. 13.19b).

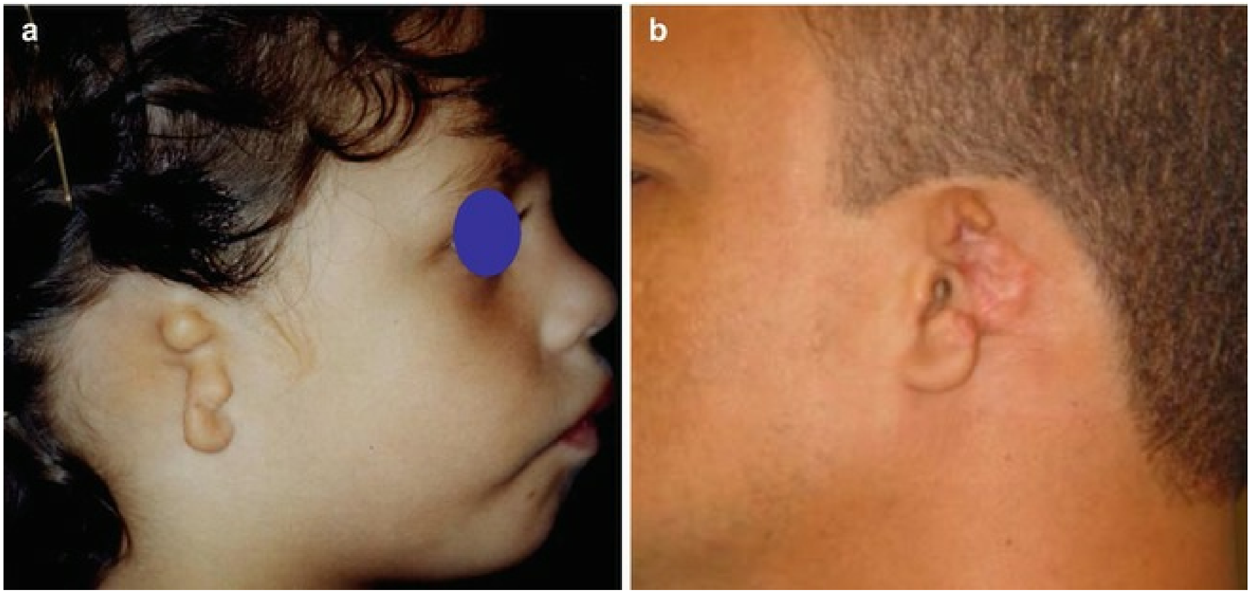

Fig. 13.19 Importance of careful examination of the deformities in order to plan ear reconstruction. (**a**) A 7-year-old male with severe microtia on the right side. (**b**) A 19-year-old male patient presenting with traumatic amputation of the left ear caused by a car accident

13.4 Discussion

The results of my surgery establish my method as a reliable means of reconstructing congenital as well as acquired deformities. The surgical principles are used meticulously, which represents successful wound healing – with particular attention to the control of postoperative care. The procedure is very adaptable to any situation, but repairing it after an unsuccessful attempt may not bring good results. Performing such reconstruction presents adverse conditions due to previous surgical scars that are unfavorable steps both pre- and post-operatively. My way of excavating the new auricular framework can be easily performed with suitable esthetic results; a surgeon must spend enough preparatory time excavating following the surgical planning. It is a matter of manual coordination, imagination, proper surgical planning, patience and the good environment in the operating room. The patient must return regularly for at least 2 months after surgery for postoperative recovery, and the bandaging must be changed according to the surgeon’s instructions and properly scheduled in order to maintain active supervision of all tissues during the healing process.

Conclusions

Ear reconstruction is a constant challenge in plastic surgery, and when performing it on congenital anomalies, it is possible to achieve good results with minimal complications due to the presence of enough soft cutaneous covering. On the other hand, rebuilding an auricle after traumatic amputation is much more difficult due to scar tissue resulting from damage to the local tissue. Secondary ear reconstruction is even more complex, since the presence of scars from previous surgeries may damage the new surgery's results.

Since I started my practice, my preference has been to excavate the new auricular framework on the rib cartilage. Reabsorption of the cartilaginous skeleton may occur only in cases of technical failure such as post-operative infection, excessive pressing of the cutaneous covering on the grafted cartilage grafted, or an inadequate blood supply on the receptor bed of the auricular framework.

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14. Secondary Reconstruction of the Ear

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Keywords Secondary operation – Secondary ear reconstruction – Ear reconstruction

14.1 Introduction

In the beginning of the twentieth century, when plastic surgery began to show signs of outstanding scientific development, auricular reconstruction was already considered to be one of the most difficult fields. Nowadays, this concept is still true, although technical progress has improved the esthetic results. Meanwhile, a great many patients have undergone several ear reconstruction surgeries without obtaining satisfactory results.

I have had many patients at the Brazilian Ear Institute who underwent between 3 and 8 − or in some cases even more than 20 − operations by other surgeons, presenting with very bad results. Due to the difficulty of the reconstruction, I don’t like to use the term “sequela” in patients who have been operated on, because it does not represent the true efforts of the surgeons. Although they use their knowledge, technical capability and hand skills, as well as modern scientific information and much care, the patients show very poor results nonetheless (Figs. 14.1 and 14.2). So far, the medical literature has not offered adequate publications regarding secondary reconstruction of the auricle, and this is why I have dedicated a whole chapter to the subject.

Fig. 14.1 Secondary reconstruction on a patient with moderate ectopic microtia after three unsuccessful operations performed elsewhere. (**a**) A 39-year-old male patient presenting with several scars due to previous operations on the *left side*; (**b**) close-up showing complex deformities; (**c**) same patient 2 months after the first stage of reconstruction; (**d**, **e**) same patient 1 year after first stage

Fig. 14.2 Bilateral microtia after three stages of operations performed elsewhere with tentative plan to reconstruct the auricles. (**a**, **g**) Pre-operative photos showing bilateral microtia with multiples scars secondary to previous operations; (**b**, **h**) same patient after two surgical reconstructive surgeries; (**c**) the *arrow* on the anterior side of the chest indicates a severe depression on the *left side* of the rib margin due to previous resection of the rib cartilage performed elsewhere; (**d**) the 9th and 10th rib cartilages from the *right side* were removed; (**e**) the 9th rib was divided into two main segments in order to model both auricular frameworks; (**f**) the two segments of the cartilages after division

Ever since I began my professional activities in 1974, I have been very interested in ear reconstruction, and I conducted much research on the subject, trying to offer better solutions to minimize the suffering of patients and improve the esthetic results. Unquestionably, reconstruction of the pinna is much more a matter of esthetic surgery, due to the great importance of the organ for the balance of the face (Avelar 1978, 1979).

In my practice, I have obtained more than 90% good results, 7% acceptable ones, and 3% that can be classified as poor in secondary reconstruction. However, in primary operations − whether for congenital or traumatic amputations − I have a 98% record of good results and 2% of acceptable ones. The satisfaction of patients and their relatives, as well as my own, has given me the enthusiasm, energy, and courage to continue using my surgical technique (Fig. 14.2). Nevertheless, ear reconstruction is still a difficult undertaking, even among very well-qualified plastic surgeons. I usually say that reconstruction of the auricle is a challenge that needs something more than just being a well-trained surgeon.

A specialized surgeon must have − besides knowledge − good hand coordination, imagination, creativity, talent, and must be able to closely identify with all possible problems concerning ear reconstruction. Personally, I feel that God gives me special inspiration and protection before, during, and after the surgery. In fact, to perform this sort of reconstruction, the surgeon must be involved scientifically and emotionally with all the circumstances concerning the operation.

For these reasons, repairing an ear deformity requires a lot of attention when planning, before surgery, and during the operation, as well as much care in the post-operative period to avoid unexpected complications; however, if one occurs, the proper treatment must be given as soon as possible in order to preserve the good relationship between patient and surgeon, which is extremely important.

Secondary auricular reconstruction is a difficult aspect of neo-otoplasty, because each case must be considered a new surgical challenge. Due to the great variety of clinical forms, it is impossible to establish a methodology to treat the numerous cases with a specific technique. In fact, each patient requires special attention without following strict guidelines capable of orienting the correction of the diversified pathology.

According to Tanzer (1974), the problems encountered in secondary ear reconstruction are similar to those encountered in traumatic ear. I would add that in ears that have been operated on previously without satisfactory results, the situation is much more complex and serious than in acquired lesions. In secondary ear reconstruction, it should be emphasized that the scar tissue is not only on the skin but also underneath it (Figs. 14.1 and 14.2); this means that the skin has been previously undermined, so there is cicatricial tissue on the subcutaneous plane. These scars represent a very difficult situation during reintervention because they block cutaneous vascularization. Besides these difficulties, there is another serious problem concerning the vascularization of the new auricular framework: it needs an excellent bed to provide adequate nutrition for the cartilage (Fig. 14.3) (Tanzer 1969). Also, in cases of traumatic amputations of the ear, the local skin is not undermined after partial or total tearing of the organ. Consequently, any secondary surgery is more difficult (Fig. 14.4) Pitanguy (1967).

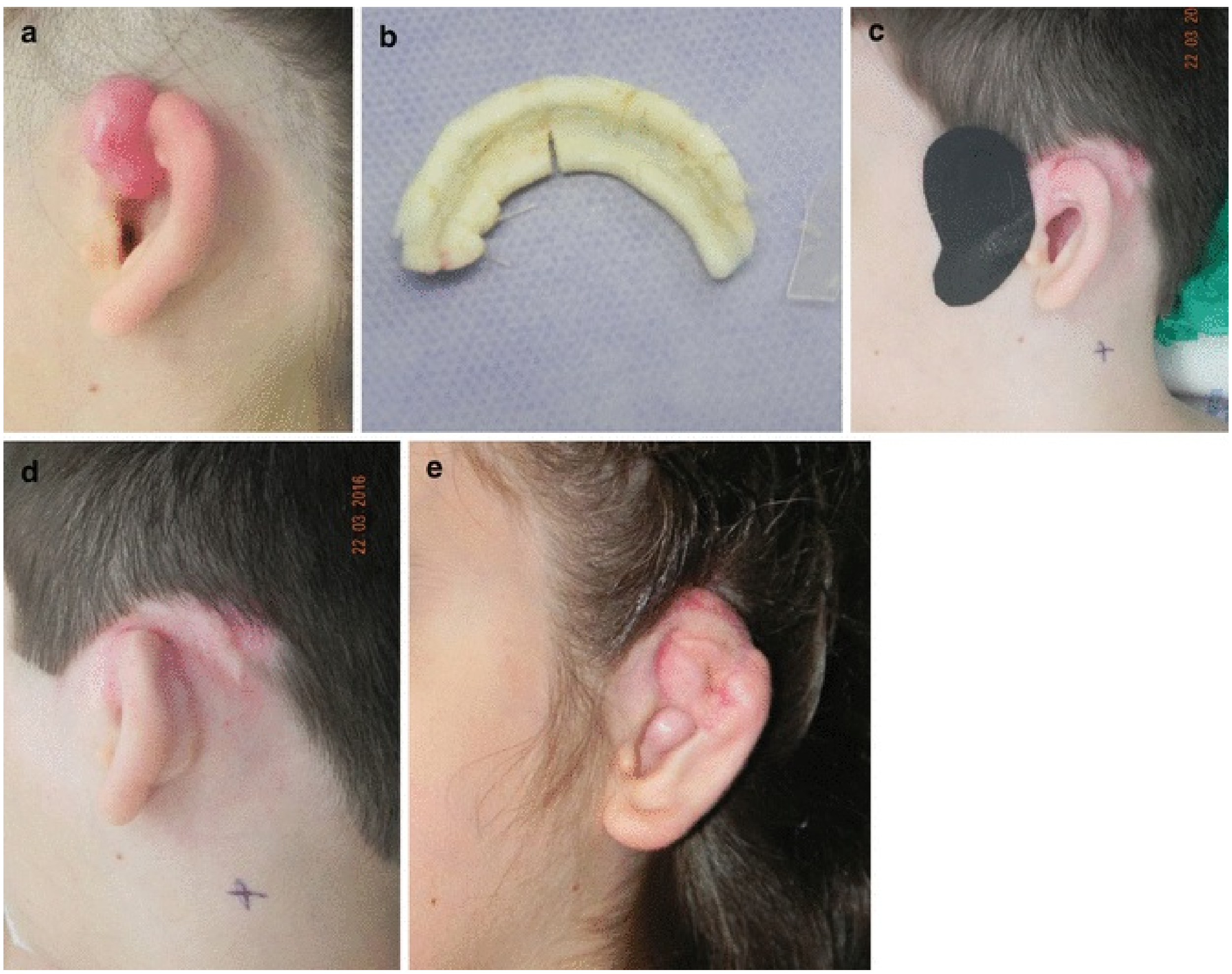

Fig. 14.3 Secondary reconstruction of the left ear with moderate ectopic microtia. (**a**) Photo showing severe hypertrophic scars due to two previous operations performed elsewhere trying to reconstruct the auricle; (**b**) a segment of framework is already excavated to create the upper pole of the ear; (**c**) same

patient after the first stage of reconstruction with the new frame already embedded underneath the skin on the temporal region; the model of the new frame on X-ray film on the side of the auricular region; (**d**) same patient 1 year after the first stage of reconstruction; (**e**) same patient 6 months after the second surgical stage of reconstruction

Fig. 14.4 Secondary reconstruction of the *upper pole* of the left ear in moderate microtia. (**a**) Pre-operative photo on lateral view of a 49-year-old male patient 6 years after unsatisfactory surgery performed elsewhere. (**b**) Surgical planning with model of the future segment of framework; (**c**) same patient 1 year after two surgical stages of ear reconstruction by the use of a cartilage graft sculpted to create the *upper pole*. (**d**) same patient in oblique view showing the deformity on the upper pole due to lack of cartilage; (**e**) the final result after the two surgical stages

14.2 Method

Analyzing the cases of my patients who had already undergone ear reconstruction previously by other surgeons, I consider it mandatory to analyze the following aspects (Avelar et al. 2009, 2011, 2013):

A. Date of the last surgery

B. Kind of framework material used

C. Cutaneous scars

D. Presence of remnant cartilage from the congenital ear dysgenesis or due to previous surgery with cartilage graft

E. Quality of the skin and extension of the hairless area

F. Insufficiency of auricular framework

G. Distortion of the framework

14.2.1 Date of the Last Surgery

Usually patients who have undergone surgery are anxious to obtain good results and insist on repeating the operation as soon as possible. It is up to the surgeon’s conscience not to give in to the pressure from patients and their families. The reintervention should not be done before at least 1 year from the last surgery. The cicatricial process has several phases until its final stage, which takes about a year or more, depending on the conditions of the previous surgery. If another intervention is done before the end of this cycle, it means new aggression to the cicatricial tissue, promoting even more trauma on the scar tissue. Therefore, when the natural process of healing is not respected, the subsequent phases of the cicatricial process are lengthened. Thus, the final results present scars that are even worse than before, e.g., hard, fibrotic, and unesthetic. It is also important to emphasize that if a new cartilage graft is necessary, the situation becomes even more difficult (Fig. 14.3). Although cartilage graft is a fundamental procedure, in most cases of auricular reconstruction, it should be done with good skin covering;

otherwise, the new skeleton may damage the skin. Cartilage exposure needs immediate treatment in order to save the new auricle (Avelar1986, 1989a, b, c; Avelar and Bocchino 1989).

This is the time to say that 45% of my operations for ear reconstruction are performed without cartilage graft, since patients present an unesthetic appearance of the auricle due to small defects that do not need more cartilage. Most of the secondary operations after prominent ear surgery may be performed without cartilage graft, so surgeons must keep this surgical possibility in mind (Avelar 1989a, b, c).

14.2.2 Type of Material Used to Fabricate the Framework

It is imperative to study the patient's medical history, and the surgeon should try to find out as much as he can about previous operations. It is also mandatory to find out about the auricular framework used in the unsuccessful surgeries (Fig. 14.4). If a silastic implant was used and there was infection and extrusion of the prosthesis, one must bear in mind that there is significant tissue disorder underneath the skin. Besides the cutaneous undermining during surgery, the alloplastic prosthesis develops capsule formation around itself and on the deeper layer of the skin flap, so there are already two factors that have damaged the subcutaneous tissue and that must be well analyzed before any reoperation. When planning a secondary reconstruction, the local tissue must be well evaluated, because any skin undermining will be very difficult due to the hardness of the fibrotic scar tissue below the skin.

Nevertheless, if during a previous operation, costal cartilage or any other autogenous elements were used, it means that cutaneous dissection was previously performed on a wider area. The fibrotic tissue, however, is not as hard as that developed after silastic prosthesis extrusion. In conclusion, regarding the type of framework provided in the previous operations, it is important to emphasize that a small scar on the skin does not mean a small amount of scar tissue underneath it.

14.2.3 Cutaneous Scars

Every surgical scar on the local skin of ear reconstruction means a horizontal interruption of vascularization of the cutaneous flap. On the other hand, due to the cutaneous undermining, an irrigation obstruction on the depth of the skin also occurs (Figs. 14.5 and 14.6).

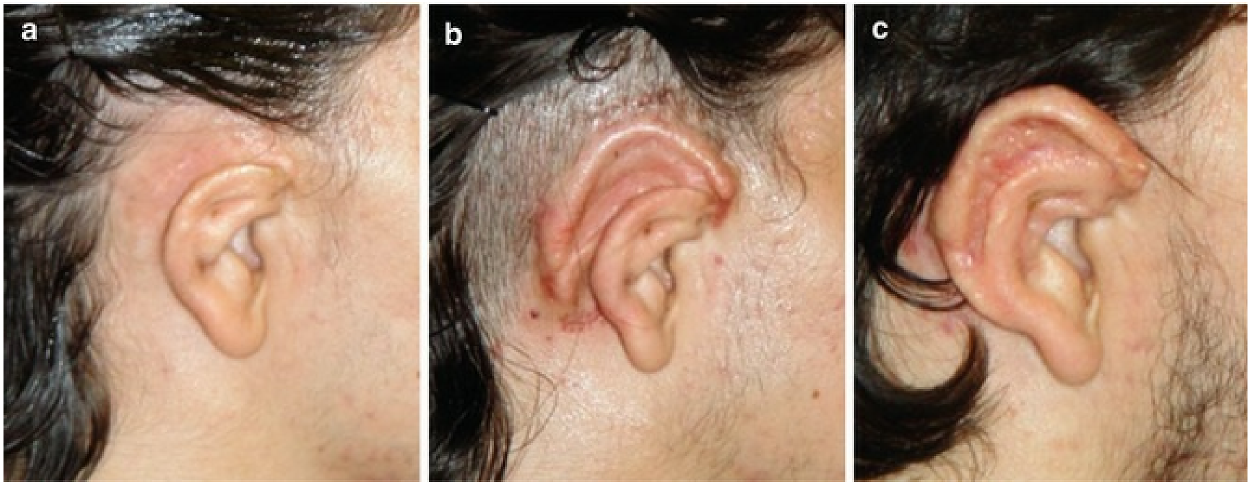

Fig. 14.5 Secondary reconstruction of the *upper pole* of the right ear in moderate microtia. (**a**) A 20-year-old male patient 3 years after unsatisfactory surgery performed elsewhere; (**b**) the same patient 6 months after the first stage of ear reconstruction by the use of a cartilage graft sculpted to create the *upper pole*; (**c**) the final result after the second surgical stage

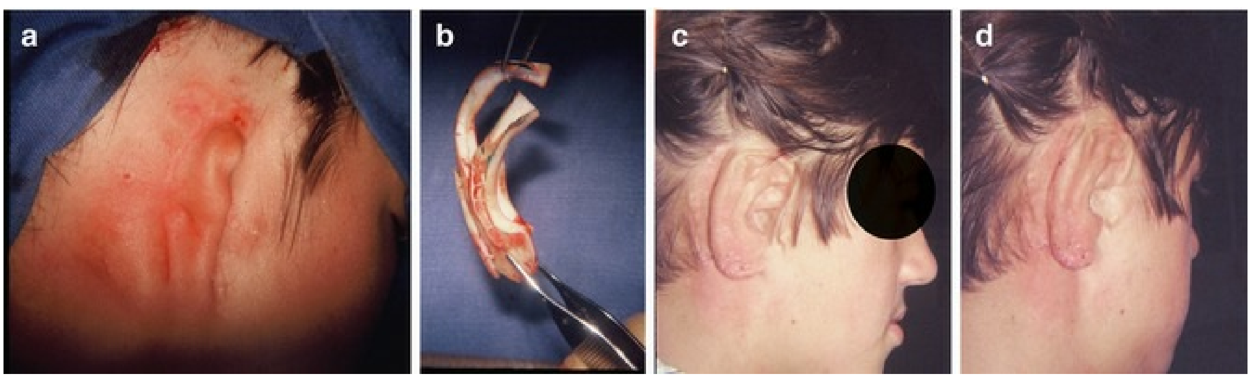

Fig. 14.6 Secondary reconstruction of the right ear after an unsuccessful operation when the cartilaginous auricular framework inserted during surgery extruded totally due to severe infection a few weeks after surgery; (**a**) before secondary reconstruction, one can see the scars on the posterior border of the remnant cartilage and lobule of microtia; (**b**) the new auricular framework excavated on the rib cartilage; (**c**, **d**) photos of the same patient after two surgical stages of reconstruction

Vestiges of cutaneous tissue rotation (lobular or other) mean movement of the skin flaps, creating scars in different areas. Such an observation is of fundamental importance when planning new flaps. If possible, the new skin incisions should be made in the same place as before, with small areas of undermining, i.e., just enough to embed the cartilage graft or flap rotation (Fig. 14.7).

Fig. 14.7 Reparation of the upper pole of the left ear after unsatisfactory surgical result of a previous operation. Photos (**a**, **c**) before reparation showing an unesthetic aspect on the *upper pole*; (**b**, **d**) 2

months after repair of the left ear

14.2.4 The Presence of Ear Cartilage Remnants from Dysgenesis or Surgical Graft

The presence of remaining cartilage of the congenital imperfection requires total resection in order to facilitate the cutaneous undermining and the placement of the new auricular cartilage block. As to the previously grafted cartilage (at other surgeries), one should analyze the convenience of reusing it.

My experience has shown that it is possible to reuse these fragments of cartilage, and I defend this procedure in order to avoid cutaneous undermining of tissue that has been surgically manipulated. Unquestionably, laying the cartilage skeleton on the auricular bed creates a vast raw area, allowing local bleeding and consequently a vast region of cicatricial tissue that is inadequate for cartilage graft.

14.2.5 Quality of the Skin and Extension of the Hairless Area

The skin of the mastoid region is not ideal for reconstruction of the ear, but it is the best skin, since it is located on the future auricular region. Any reintervention without taking into consideration the scar tissue of previous surgeries may damage the remaining normal skin, making the planning of future surgeries even more difficult. Besides, it is worth analyzing the hairline implantation on the upper limit of the mastoid region to determine the size, shape, and position of the future ear. Even considering the discomfort and the disagreeable esthetic aspect of hair in the reconstructed ear, one should not modify the reference points in the projection of the new ear.

In my practice, I have had a few cases where hairy skin covered the new auricular framework. I have solved the problem by performing a small resection of hairy skin at another surgery, under local anesthesia, without causing any harm to the desired result. I believe that it is better to remove hairy skin on the reconstructed ear at another surgery than to embed the new auricular framework in an ectopic position.

14.2.6 Insufficiency of Auricular Framework

It is not difficult to evaluate whether there are partial or total deficiencies of the auricular framework. When it comes from previously grafted cartilage, one should plan the lacking block following the dimensions of the ear of the opposite side (if there is one). In such circumstances, it is necessary to remove one or two costal cartilages in order to sculpt a new framework by excavation, according to the description of primary cases (Fig. 14.8).


a
b
c
d
e
f

Fig. 14.8 Secondary reconstruction of the right ear after 5 operations performed elsewhere, showing several scars from previous operations. Photos of (**a**, **b**) a 21-year-old female patient after several unsatisfactory surgeries; (**c**) besides several scars, several segments of the auricular framework are missing. Distension of the skin is being done using a surgical instrument; (**d**) perioperative photo showing the new auricular skeleton on the ear; (**e**, **f**) the same patient 6 months after the first stage of ear reconstruction with the use of a new auricular framework sculpted on the rib cartilage

When encountering these problems, the surgeon should not follow the apparently easier and shorter routes and expect good results. Once the lack of a framework segment is diagnosed, it is necessary to replace it with cartilage graft. If this is not done, it may cause future problems, due to the lack of a framework. A cutaneous fold cannot always substitute the cartilaginous reliefs, which are responsible for the esthetic aspect of the reconstructed ear. After a long post-operative period, the results show that several esthetic details on the auricular relief are “erased” by lack of a supporting element and retraction of the cicatricial tissue of the skin.

I would also like to emphasize that a great number of patients operated on elsewhere show insufficient framework due to cartilage reabsorption (Figs. 14.4, 14.5, and 14.6). It is equally important to stress again that the cartilaginous tissue requires an adequate receptor bed with rich vascularization, and blood and organic liquids are necessary to feed the cartilaginous metabolism. Reabsorption of the grafted framework may occur if the cicatricial tissue does not offer good conditions. On the other hand, when the skin that covers the cartilaginous skeleton shows fibrosis and rigid cicatricial tissue, it causes pressure on the cartilage underneath, which also leads to reabsorption (Fig. 14.8).

There is a third factor to be considered when it comes to cartilage reabsorption: post-operative infection. Even when promptly diagnosed and treated, such complications can lead to partial or total loss of the cartilaginous framework.

To summarize, there are three factors that produce cartilage reabsorption: (1) vascular deficiency of the receptor bed; (2) excessive pressure on the cutaneous covering; and (3) infection.

14.2.7 Distortion of the Framework

The position and location of the new ear are important reference points in surgical planning. There may be postoperative factors able to change the position of the framework (Figs. 14.1 and 14.2).

In severe craniofacial dysmorphies, it is very difficult to establish these points. When the reconstructed ear presents a size and shape compatible with the opposite ear, it is not advisable to reoperate, other than making small corrections that will not affect the framework. The superior and inferior poles can show some deviation from the normal axis. The solution is skin grafting on the posterior wall for its repositioning.

In the early years of my career, I had two cases in which the cartilage to reconstruct the helix had folded over itself, changing the esthetic aspect. There was an "erasing" of the reliefs, thus affecting the results. To avoid such distortions, I changed the technique for the fabrication of the framework, creating a wide basis for the relief of the helix.

14.3 Reconstruction of the Ear

As I have shown in this chapter, the diagnosis of the lesion is a fundamental factor of the surgical program. To help the treatment of other deformities, I present some examples of my own experiences with descriptions of the procedures and illustrations in each case (Figs. 14.4, 14.5, and 14.6).

14.4 Discussion

Ear reconstruction is a constant challenge to create new auricular frameworks and good cutaneous coverings when trying to achieve better surgical results. Undoubtedly, reconstruction of the pinna is much more a matter of esthetic surgery due to the great importance of the organ concerning the balance of the face. Reconstruction of the auricle after traumatic amputation is more difficult, since the skin covering the mastoid area is not ideal, but it is the best due to its location on the future auricle. However, performing secondary reconstruction is even more difficult because of surgical cutaneous scars resulting from previous operations. Another problem is the suffering of patients and their relatives due to dissatisfying surgical results. Therefore, ear reconstruction is still a difficult undertaking, even among well-qualified plastic surgeons. I usually say that reconstruction of the auricle is a challenge that needs something more than just being a well-trained surgeon.

A specialized surgeon must have − besides knowledge − coordinating, imagination, creativity and talent, and the ability to closely identify with all problems concerning ear reconstruction. In fact, to perform this sort of reconstruction, the surgeon must be involved scientifically and emotionally with all aspects of the operation. For these reasons, repairing any ear deformity requires a great deal of attention when planning, before the surgery, and during the surgery. and much care in the post-op period to avoid any unexpected complications; however, if there is a complication, proper treatment must be given as soon as possible in order to preserve the good relationship between patient and surgeon, which is extremely important.

Due to the great variety of clinical forms, it is impossible to establish a methodology to treat the numerous cases with one specific technique. In fact, each patient requires special attention without following strict guidelines capable of orienting the correction of the diversified pathology.

The problems encountered in secondary ear reconstruction are much more complex than those after traumatic ear; these are due to scars on the cutaneous covering that is not only on the skin, but also underneath it. This means that the skin has been previously undermined, so there is cicatricial tissue on the subcutaneous plane. These scars represent a very difficult situation during reintervention and, even more so, post-operatively. Besides these difficulties, there is another serious problem concerning the vascularization of the new auricular framework: it needs an excellent bed to provide adequate nutrition for the cartilage.

Before performing a secondary operation, the surgeon must properly evaluate several aspects of the patient to analyze the following: date of the last surgery; kind of framework material that was used; cutaneous scars; the presence of remnant cartilage from the congenital ear dysgenesis or due to previous surgery with cartilage graft; quality of the skin and extension of the hairless area; insufficiency of the auricular framework; and distortion of the framework. Each topic must be well analyzed before surgical planning.

Conclusions

Performing secondary ear reconstruction is much more difficult than a primary operation because of the presence of scar tissue formation due to previous surgeries. Besides, another problem is the psychological aspects, since the patient and relatives are already frustrated by unacceptable results. Surgical planning must be done after careful examination of the region regarding the presence of scars and insufficiency of the auricular framework.

Also, in cases of traumatic amputations of the ear, the local skin is not undermined after partial or total tearing of the organ. Consequently, any secondary surgery is more difficult.

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15. Reconstruction of the Auricle Secondary to Prominent Ear Surgery

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Keywords Reparation of the ear – Correction of ear deformity – Secondary correction of the ear – Correction after prominent ear surgery

15.1 Introduction

Prominent ear is the most frequent of all congenital defects of the auricle, and it is estimated that the incidence is about 5–7% of the population. Most of the patients present with bilateral deformity with evident asymmetry, but sometimes it is unilateral. It can be noticed at birth, and it usually gets worse as time goes by. Most domestic attempts to solve the problem using tape, bonnets, or other devices will not give good results. There are, however, some reports of successful correction using tape from the moment of birth until the first few months of life (Samis 1982). Anatomically, prominent ear is characterized by a poorly developed antihelix and an increased conchal-scaphal angle.

Clinically, the anatomical parameters that determine “normality” in relation to the implantation of the ear to the skull are very important for the correct evaluation of the pathology. The angle between the ear and the skull (cephalo-auricular angle) is about 20–30°. On the other hand, the angle between the scapha and the concha (scapha-conchal angle) should measure about 90°, although it can reach 105°, according to Barsky (1950), or even 120°, according to Stenström et al. (1968).

The treatment for prominent ear would seem to be an easy procedure but it is not, since several problems may arise. I used to use a Pitanguy technique called an “island technique,” which achieved very good results. Before planning the operation, the surgeon should examine each auricle in detail and make a comparison between the two, since most patients present with complex asymmetric auricles. Besides observing the physical alterations, it is very important to consider the psychological aspects. The operation should not be performed if the patient is not concerned about the problem. Very often, the parents are eager to solve the organ’s alteration at an early age, before the child notices the problem. The surgeon, however, should not agree to the operation influenced by the opinion and pressure of the parents. Sometimes the problem doesn’t bother the child, and thus the operation should not be performed. The surgeon’s obligation is to orient the parents, but he should not let their opinion interfere in the final decision.

Unsuccessful results after a procedure for esthetic treatment of prominent ear may occur due to surgical difficulties that present an unesthetic appearance of the auricles. This may be the result of inadequate pre-op evaluation, poor surgical planning, the operation having taken place under sub-standard hospital conditions, poor surgical technique, inadequate post-operative care, local infection after surgery, correcting a very short time after primary surgery, or the many other causes of severe deformities of the auricles.

Ear deformities caused by esthetic or reconstructive surgeries or by the surgeon trying to create an external canal, are classified as iatrogenic or secondary reconstruction. In Fig. 15.1, one can see that from 491 auricles or ear reconstructions after traumatic amputations that I have performed, 144 (29.3%) were necessitated by secondary correction due to unsatisfactory results after prominent ear surgery (Fig. 15.1). Most of them are bilateral reconstructions, since both organs presented with anatomical alterations (Figs. 15.2 and 15.3). As this topic is so complex and a constant challenge, I have dedicated this chapter to describing my concepts and surgical approach for the reconstruction of the auricles and for reparing several deformities of the ears.

Cause	Side			Patients	Ears
	Right	Left	Bilateral	Total	(n°)
Car acident	47	41	8	96	104
Otoplasty	3	7	67-	77	144
Human bite	16	18	-	34	34
Burn	16	19	14	49	63
Animal bite	18	21	-	39	39
Tumor	11	9	5	25	30
Piercing	19	11	-	30	30
Hemangioma	4	5	-	9	9
Amputation by nife	7	8	3	18	21
Amputation by scalp	3	5	2	10	12
Stunned rigidity	-	-	1	1	2
Acumputure	2	1	-	3	3
TOTAL	182	145	100	391	491

Fig. 15.1 Etiology of acquired deformities among 391 patients and 491 ears

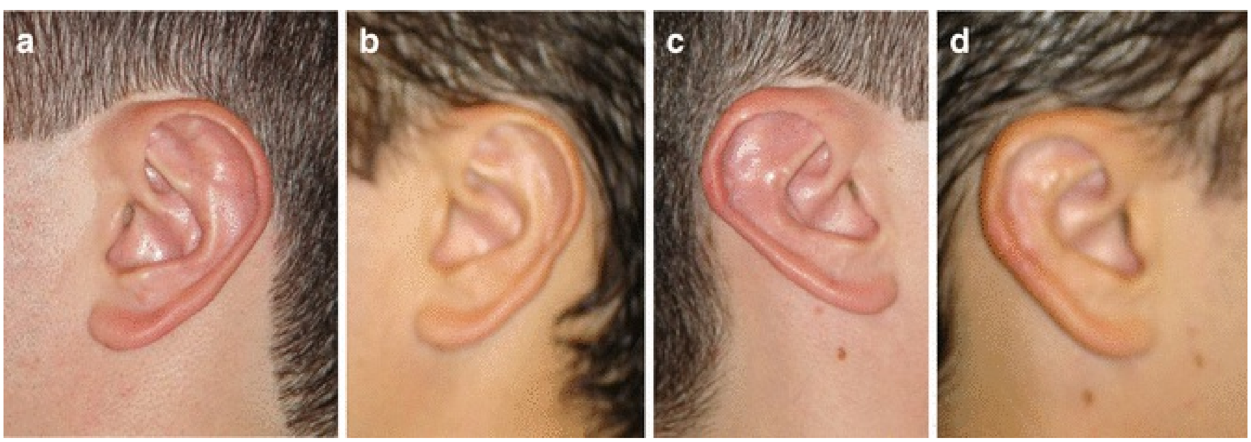
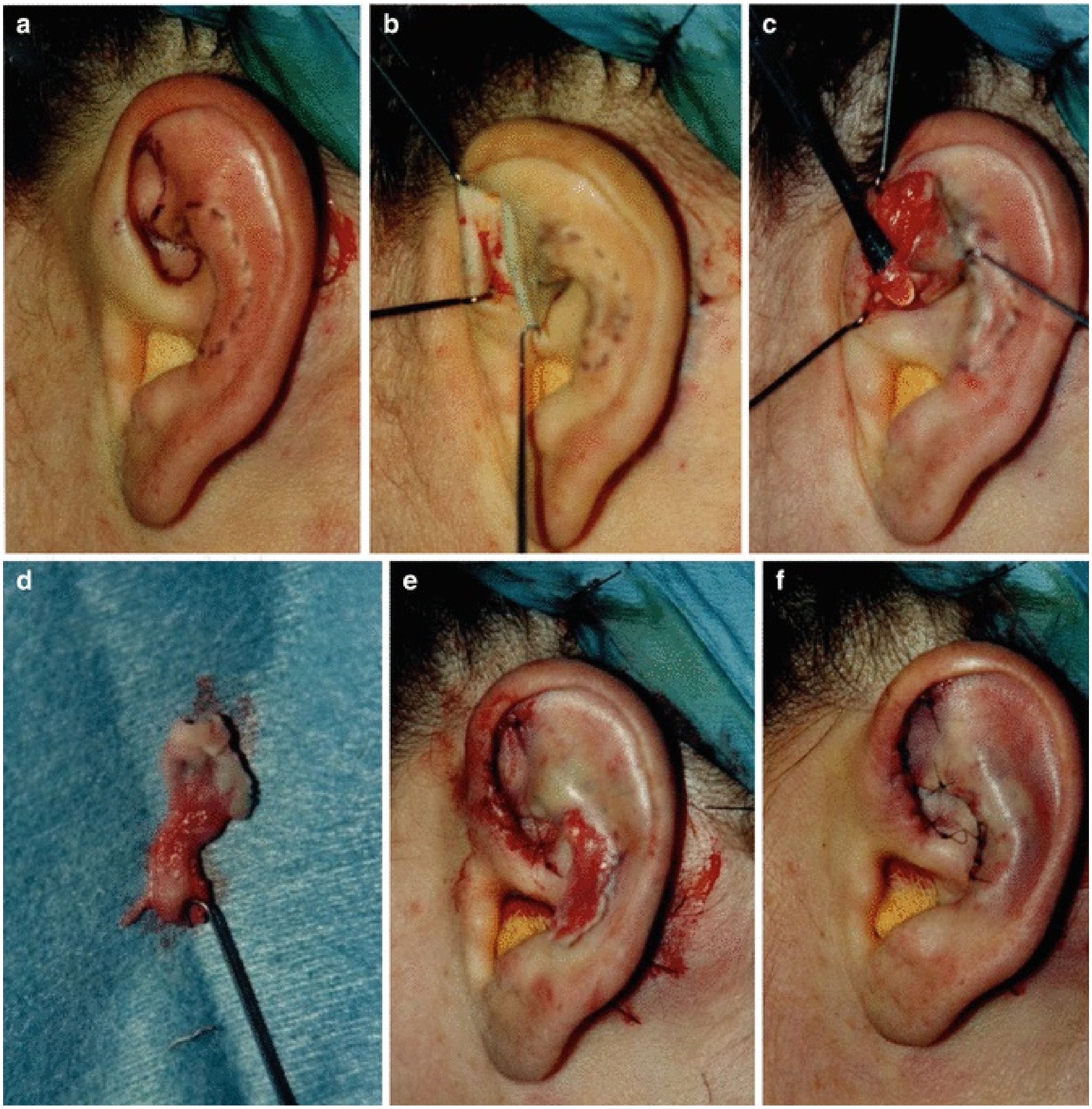


Fig. 15.2 Correction of antihelix. A 24-year-old male underwent two stages of operations for prominent ear surgery. (**a**, **c**) Before reparation of unsuccessful prominent ear; (**b**, **d**) same patient 1 year after bilateral reparation of the antihelix



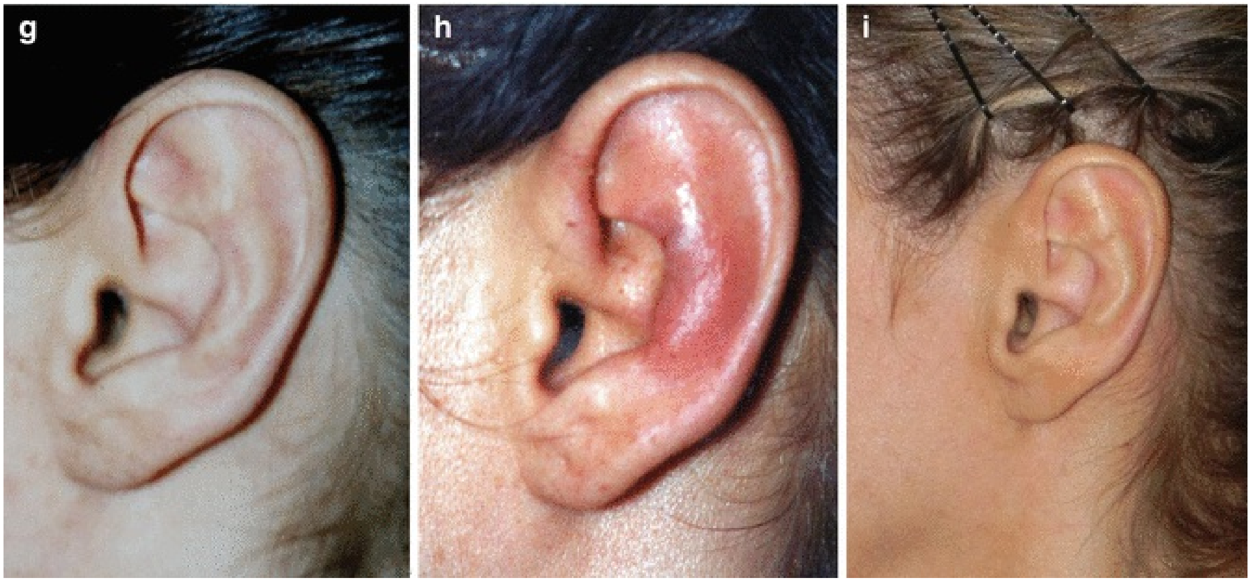


Fig. 15.3 Unesthetic result on antihelix after surgical correction of prominent ear. (**a**) Irregularities on antihelix on the left ear; (**b**, **c**) perioperatively showing resection of the perichondrium on the posterior aspect of the root helix; (**d**) the perichondrium graft; (**e**) it is placed on the antihelix; (**f**) the perichondrium is introduced underneath of the skin on the antihelix after surgery; (**g**) pre-operative aspect of the antihelix; same ear 1 month after operation; (**h**) same ear 20 years after surgery; (**i**) late post operative photo of the same patient after perichondrium graft

15.2 Method

Before performing a secondary operation for the correction of an unsuccessful result, the patient must be thoroughly examined by the second surgeon. The second operation should not be done before a year has passed since the first one, because scar tissue formation is still in its natural evolutio-healing has not achieved proper maturation (Figs. 15.4 and 15.5). If the second procedure is done too soon after the primary one, that is the most frequent and serious mistake. If the patient is unhappy with the surgical results and the surgeon is anxious to solve the problem, the second operation should not be performed immediately. Such a situation is the most frequent problem among all the patients I have performed a correction on, or even reconstructed (Fig. 15.6). Most patients underwent two, three, or even more operations by the same surgeon with an interval of a few months between each procedure. It is advisable that the second surgery wait at least 1 year after the last operation.

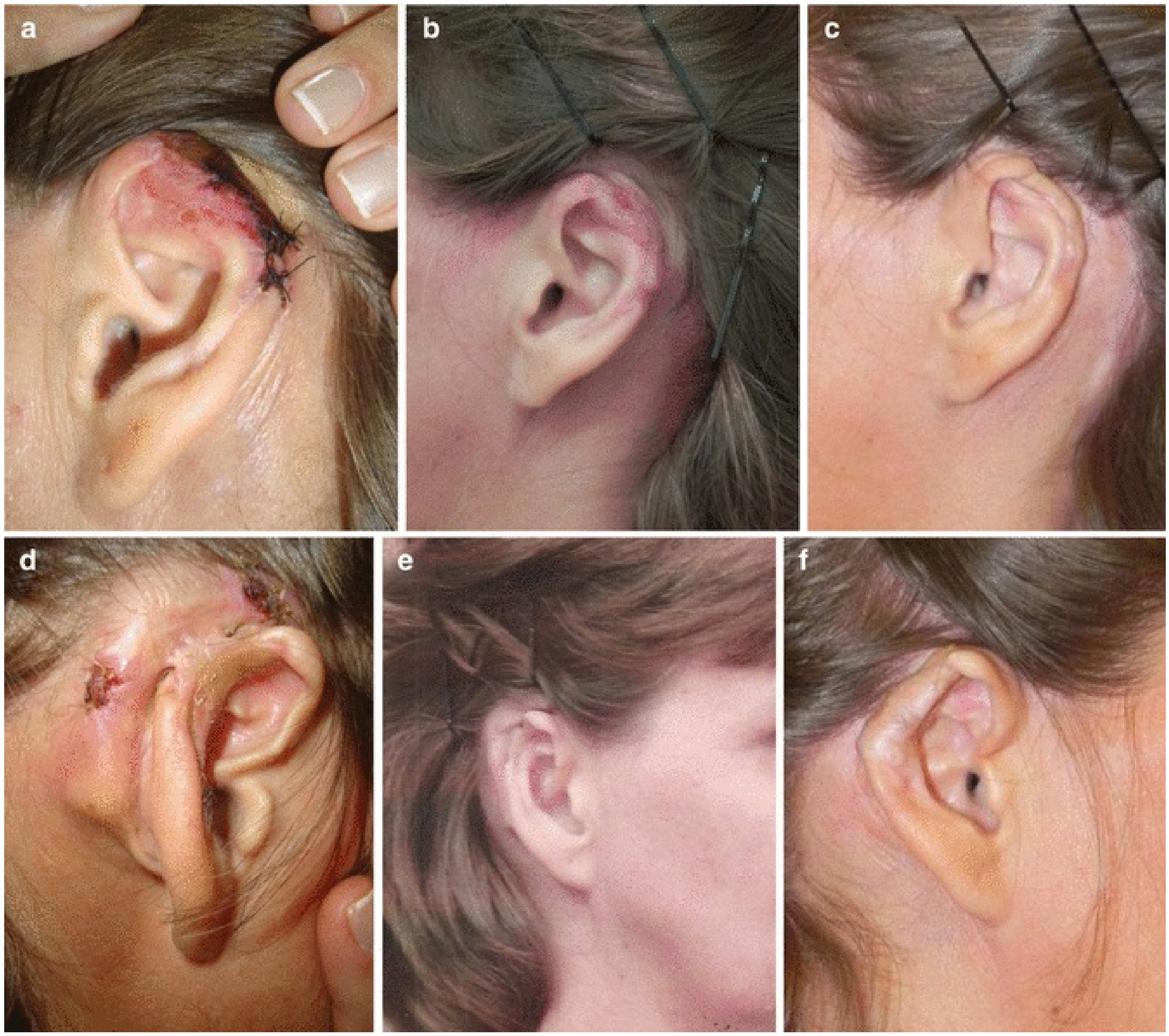


Fig. 15.4 Severe unfavorable results in a 42-year-old female patient after prominent ear surgery performed elsewhere. (**a**) On the left side, she presented missing segment of helix with necrosis after 3 operations performed over 2 months; (**b**) one year later she underwent cartilage graft to complete the helix in two surgical stages; (**c**) final results 1 year later; (**d**) on the right side, she presented a cartilage grafted underneath the skin on the mastoid region performed by another surgeon trying to repair the previous unfavorable results; (**e**) the cartilage grafted was removed and excavated in order to create the missing segment of helix on the right ear; (**f**) final results 1 year later

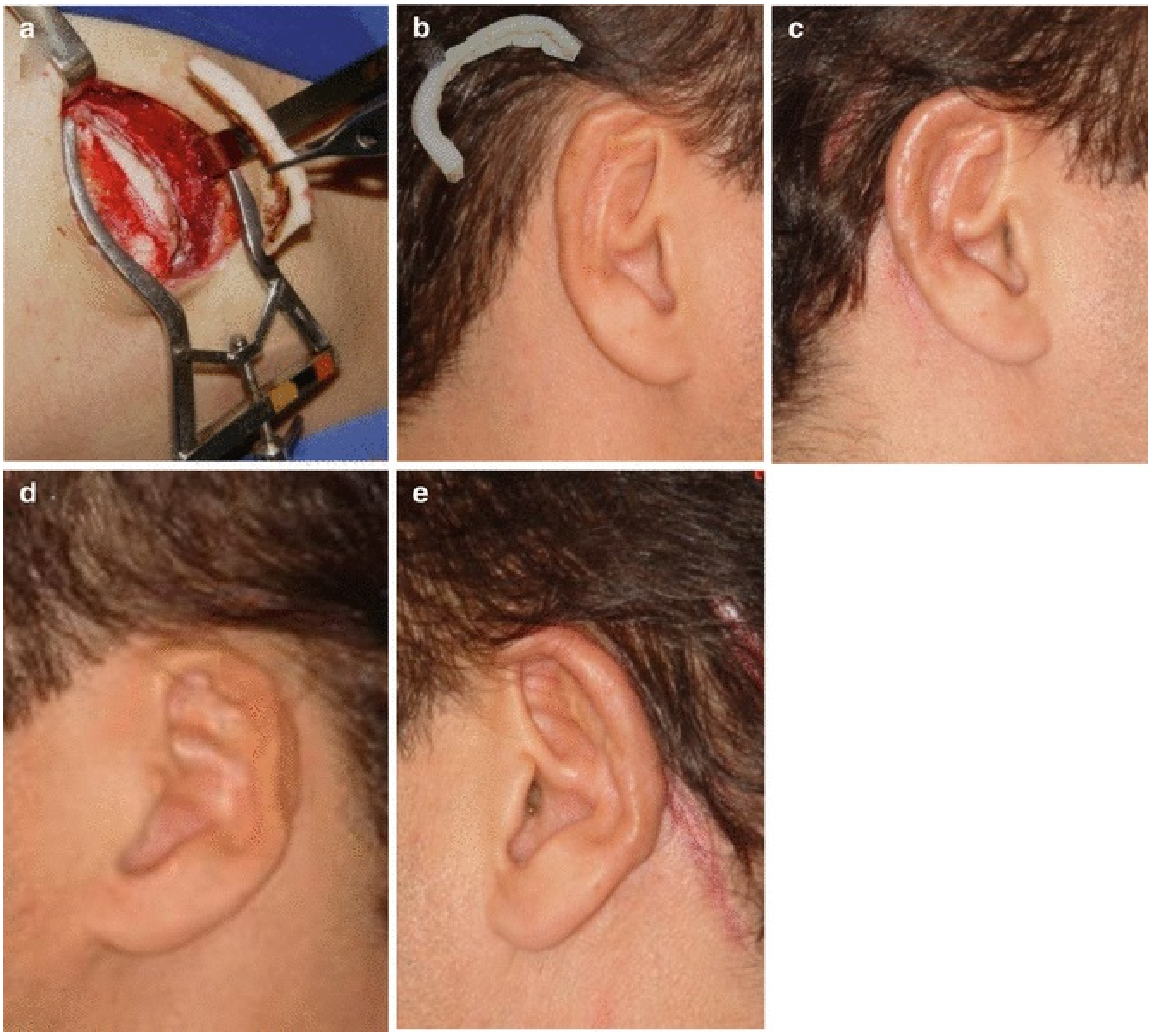


Fig. 15.5 Unfavorable results after prominent ear surgery. A 32-year-old male patient presented with severe deformities due to missing cartilage of the helix on both sides after previous operations performed elsewhere. (**a**) Pre-operative photo showing resection of a rib cartilage to excavate two cartilage grafts for both helixes (**b, d**), right and left sides before surgical correction of unfavorable results; (**c**, **e**) Two years after reconstruction of the helix with cartilage graft on both sides

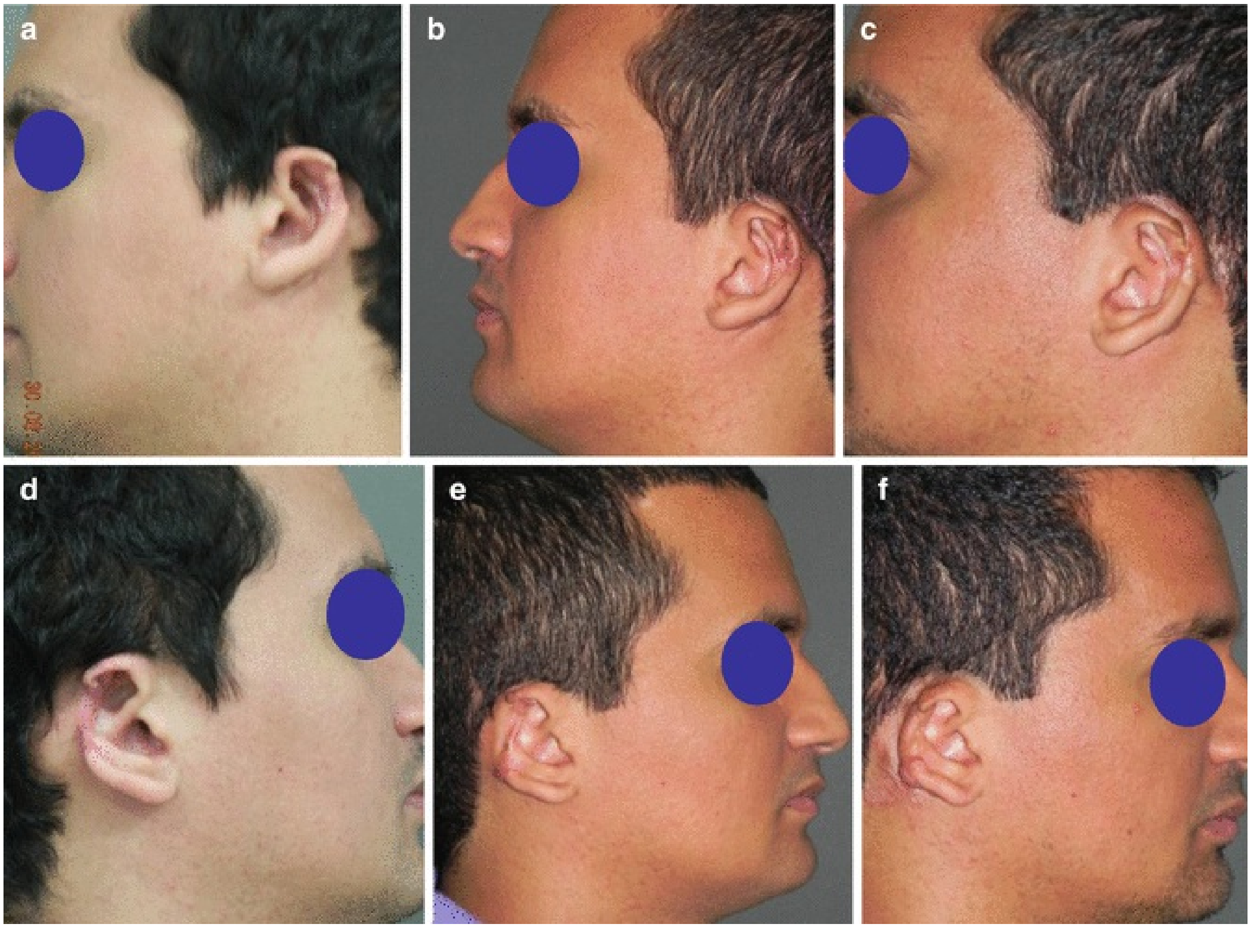


Fig. 15.6 Severe unfavorable results in a 28-year-old male patient after four prominent ear surgeries performed elsewhere. (**a**) On the left side, he presented with a missing segment of helix due to previous operations performed over 4 months; (**b**, **c**) one year later he underwent a cartilage graft to complete the helix in two surgical stages; (**d**) on the right side, he presented with a missing segment on the helix caused by previous unfavorable surgeries; (**e**) the cartilage grafted was excavated and introduced inside the covering of the skin in order to create the missing segment of the helix on the right ear; (**f**) final results 1 year later, after two stages of reconstruction

Prominent ear is the result of one or more of the alterations mentioned below, according to Samis (1982):

empty Lack of helix when the free rim of the ear is unfolded with lack of the helix sulcus

empty Lack of or flattening of the antihelix and of the anterior and posterior branches of the triangular fossa due to the increase of the scapha-conchal angle empty Increase of the concavity and dimensions of the concha, with displacement of the auricular framework forward, due to the excessive amplitude of the cephalo-conchal angle

It is well known that the ears are completely developed by age seven. Any growth after that may be considered insignificant. There are some changes (such as the lengthening of the lobule), but the cartilaginous structure does not change very much. As a child grows, begins to have a social life, and goes to school, the possibility of having a traumatic experience increases. Friends and the kids at school start making fun of the child, calling him names such as “Dumbo” or other comic book characters. Therefore, the best time to do the surgery is around age 5, when the emotional problems have not yet reached their peak, and the unavoidable daily jokes can be prevented. Statistically, the highest percentage of surgeries is carried out at ages 5–15, and constantly decreases as the years go by.

15.3 Planning the Operation

After talking to the patient, the surgeon should examine each auricle and check all the alterations. The first step is to analyze the shape and size of the auricle. Sometimes the prominent ears seem to be too large (macrotia), but after careful examination using light pressure with the fingers, it is possible to show the patient and the parents that the organ has a normal size.

Sometimes, even though the anatomical elements may be normal, a hypertrophic conchal wall may project them laterally away from the head. In this case, the operation should repair the size of the conchal wall. This occurs more frequently on the antihelix. If it is flat or absent, the conchal cavity goes straight to the helix, projecting the auricle far away from the head. In such circumstances, the operation has to create the antihelix, reducing the conchal cavity.

The lobule is also a difficult problem regarding prominent ear. Since it doesn’t have any cartilage in its anatomical structures, its rotation must be carefully carried out in order to be harmonious with all the anatomical elements of the auricle.

15.4 The Operation

There is no specific procedure for treating every patient, since each one presents a specific deformity that requires adequate analysis and evaluation; for these reasons, each patient should be treated according to his/her deformities, but a few topics should be noted in advance: (1) the date of the last procedure, for which the secondary operation should not be performed less than a year after the last procedure; (2) evaluation of scars from previous operations; (3) a psychological evaluation of the patient and relatives; (4) the emotional stability of the patient (emotionally unstable patients should not undergo another procedure); and (5) the expectations of the results, which should not be beyond those that are possible to achieve.

Multiple scars on the ears from earlier operations may have damaged the skin as well as the shape of the auricle, requiring specific approaches (Fig. 15.2). Even the position of the auricles may change, presenting a backward rotation that is very difficult to reinstate.

Superficial irregularities on the antihelix may occur when the surgeon cuts the auricular cartilage in the primary operation. For that reason I do not recommend making any incision on the cartilage in order to create the antihelix. Even in the use of rasp the anterior aspect of the cartilage may get damaged and destroy the perichondrium, causing unesthetic irregularities (Fig. 15.3). My preference is to rasp on the posterior aspect of the cartilage in order to facilitate the creation of the antihelix by suturing it with Mustardé's stitches (Avelar 1986, 1997, 2011, 2013). At the preoperative evaluation, regarding the damage to the perichondrium, I concluded that its correction was performed by a perichondrium graft removed from the same auricle as described and shown in Fig. 15.3. So far, the final results show a smooth surface in the antihelix that lasted for more than 20 years with the same regularity.

As mentioned above, one of the most dangerous situations is to perform repeated operations in a very short time, even though the patient and surgeon are unhappy and anxious to achieve new, better results. It is a matter of interrupting the regular, natural healing process of the surgical wounds, and for that reason, the surgeon must wait at least 6 months before reoperating on his or her patients after prominent ear surgery (Fig. 15.4), even if a cartilage graft had been performed by another surgeon who attempted to solve the problem.

Quite often, patients present with severe damage to the helix caused by infection or repeated procedures without adequate criteria. The cartilage of the helix is the thinnest and most delicate one, and is easily damaged during or after the surgery. Several patients have had to have cartilage grafts on one or both ears, and a rib cartilage must be removed and carefully excavated in a fashion similar to that done bilaterally during ear reconstruction (Figs. 15.5 and 15.6). Very rarely, only one ear presents severe damage of the cartilage of the helix, requiring unilateral reconstruction performed by cartilage graft removal from the 8th or 9th costal arch (Fig. 15.7).

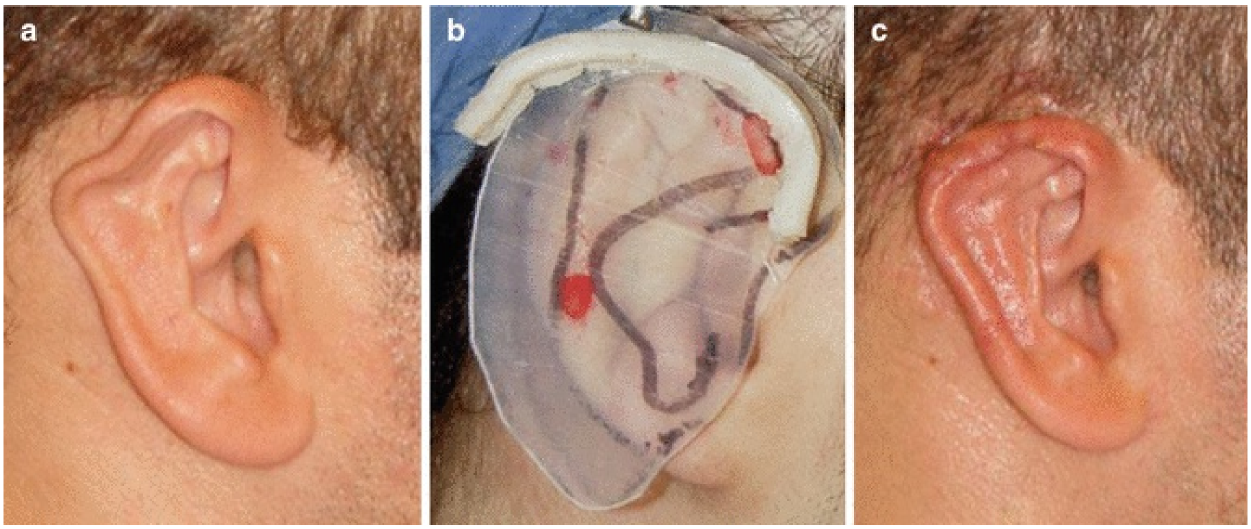


Fig. 15.7 Reconstruction of the helix on the right ear caused by four unsuccessful procedures for the treatment of a prominent ear. A new segment of the helix was excavated on the costal cartilage. (**a**) A 24-year-old male patient presenting with an unesthetic contour of the right ear with severe deformities on the helix and cutaneous scars owing to previous operations; (**b**) the surgical planning was modeled on X-ray film to show the size and shape of the new frame to be grafted; (**c**) the same patient 1 year after reconstruction of the helix, created by excavation of the new frame on the rib cartilage and grafted during surgery

On other hand, infection after prominent ear surgery is one the most dreaded situations since the cartilage does not present adequate vascularization. For this reason, it is mandatory to do proper preparation before surgery, because the anatomy of the ears may present pathogenic bacteria causing a disaster after the surgery (Fig. 15.8). It is mandatory to treat the infection with antibiotics and to avoid any procedure while the infection is still active.

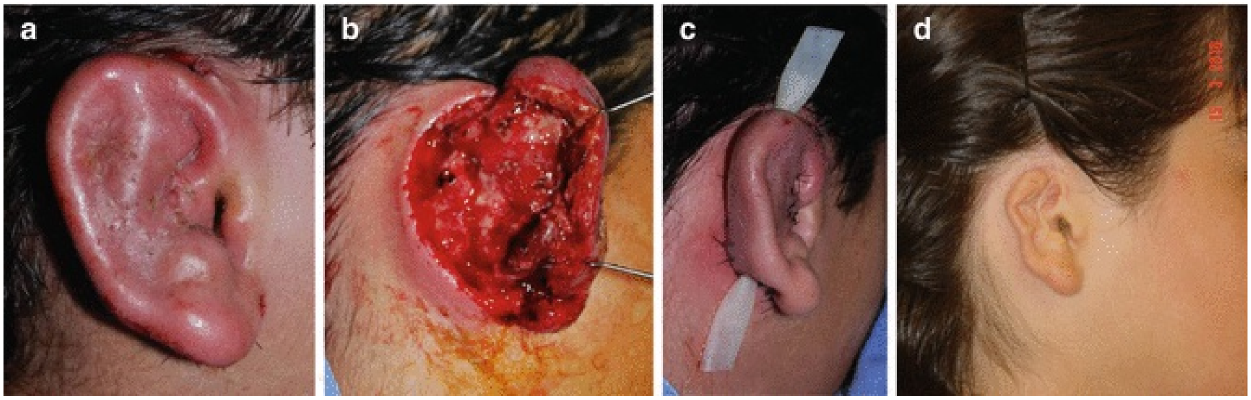


Fig. 15.8 An 11-year-old patient presenting with serious local infection 8 days after prominent ear surgery. (**a**) External appearance of the right ear with swelling as well as other signs of local infection; (**b**) posterior view of the ear after removing all stitches put in during operation; (**c**) drainage on the posterior aspect of the ear associated with local and systemic antibiotics. (**d**) the same patient 1 year after treatment of local infection, showing cutaneous retraction that requires an auricle reconstruction

An unusual situation is the association of unsuccessful procedures for the treatment of prominent ears. I had a patient who, after an unesthetic result after two surgeries, underwent another approach by a physician who was not a specialist, and who gave her an injection of PMMA (polymethyl methacrylate acid), trying to achieve better esthetic results. With that, the problem became even more complex, since the reaction of the local tissue was in the opposite direction of the purpose. The auricle became very swollen with an irregular surface, due to absorption of the ear cartilage as well as to a foreign body injected elsewhere. Therefore, the surgical plan was to remove as much of the unusual injected material as possible and also create a better architecture for the auricular cartilage (Fig. 15.9). Fortunately, the problem was only in one ear, since the patient did not agree to an injection of PMMA in both auricles.

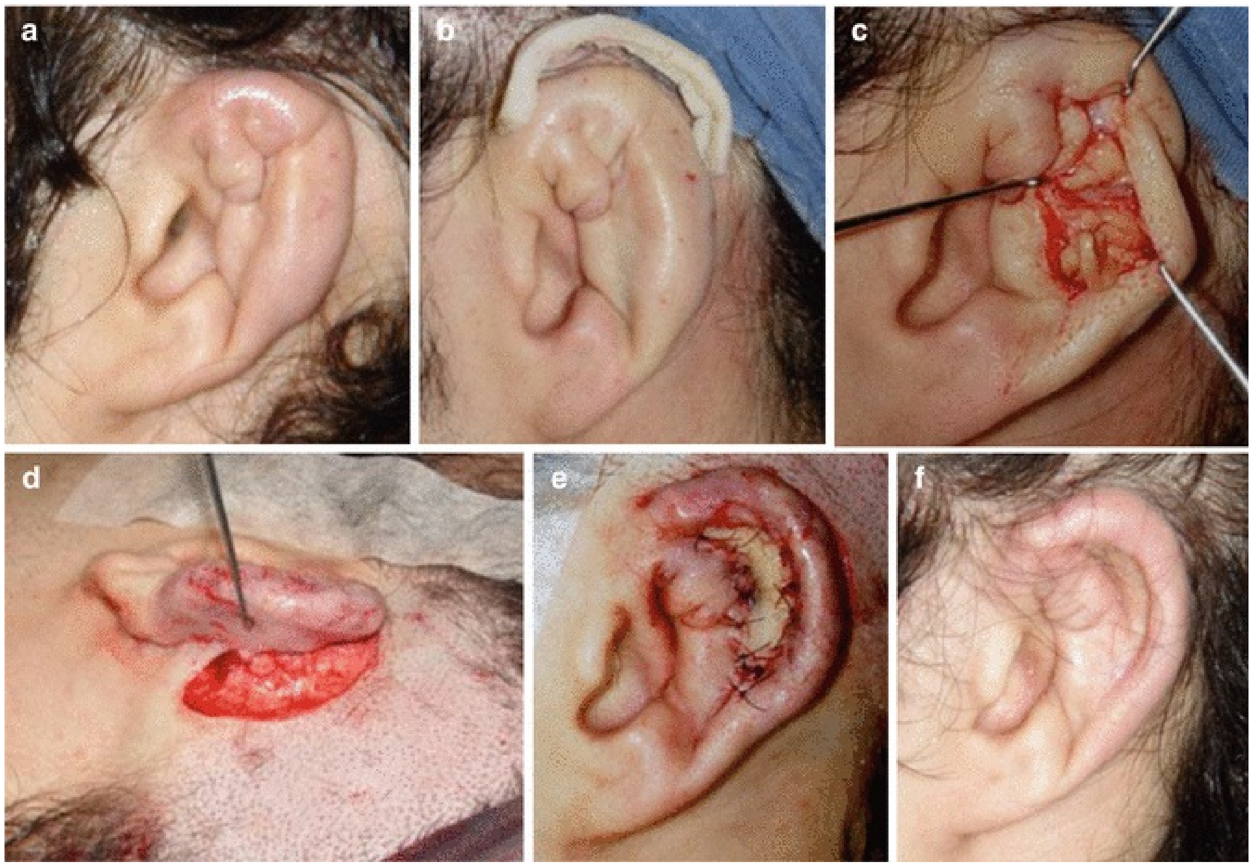


Fig. 15.9 A combination of unsuccessful procedures for the treatment of prominent ears. After unesthetic results achieved primarily by ear surgery, the patient underwent injections of PMMA (polymethyl methacrylate acid) to obtain a better esthetic look, but the result was not achieved. The surgical plan was made considering both the correction of irregularities on the auricular cartilage and the removal of a foreign body from the ear. (**a**) The left ear of a 22-year-old male patient with an ungraceful appearance with anesthetic irregularities on the helix, antihelix, and conchal cavity on all segments of the auricle because of previous procedures; (**b**) during the operation, showing the left ear with the new segment of cartilage graft already sculpted to be inserted underneath the skin of the helix area; (**c**) an incision was made on the scapha through which one can see some portions of para-Methoxy-N-methylamphetamine that was removed; (**d**) posterior view of the ear. Following the surgical plan, an island skin flap was created on the anterior border of the mastoid area and advanced forward to improve the scapha **c**–**f**. (**e**) Notice the island flap already sutured to improve the scapha. The new frame of the cartilage is embedded subcutaneously through the helix. (**f**) The final surgical result 1 year after a complex reconstruction process

A very acute problem came to the Brazilian Ear Institute due to a patient complaining about too much pain after prominent ear surgery. The parents mentioned that just after operation, the 8-year-old boy complained of constant pain in both auricles. First, the surgeon removed the bandaging 6 days after the operation, saying that everything is fine, but she immediately put on another bandage. As the patient was suffering from that, he came to our institute looking for a solution. After removing the bandages, I saw that both ears had skin necrosis on a wide area (Fig. 15.10). I believe that there was a mistake in the use of an anesthetic solution. Instead of injecting an anesthetic, probably another kind of medicine was injected during the operation under general anesthesia, so after surgery the patient complained about too much pain.

Fig. 15.10 Bilateral severe complications after prominent ear surgery performed 10 days earlier, probably due to injection of toxic product instead of anesthetic. (**a**, **d**) An 8-year-old boy presented a wide area of cutaneous necrosis on the right and left ears; (**b**) The necrotic cutaneous tissue was removed and the auricular cartilage was preserved. A fascial flap was raised with skin graft on it; (**c**) the same patient 6 months later; (**d**) left side of the same patient, showing cutaneous necrosis on the antihelix area; (**e**) an "island" cutaneous flap was raised from the posterior auricular sulcus to cover the antihelix; (**f**) same patient 2 years later

To create the antihelix is the main reason a surgeon performs prominent ear surgery, and so, the antihelix is the segment of the ear that is most often affected and presents abnormalities after operation. Quite often it is necessary to employ my fascial flaps (Avelar 1977, 1978) in order to repair severe irregularities on the antihelix (Figs. 15.11 and 15.12). The fascial flap was created on the mastoid region with an anterior pedicle in order to be rotated forward to embed it between the skin and the auricular cartilage of the antihelix area.

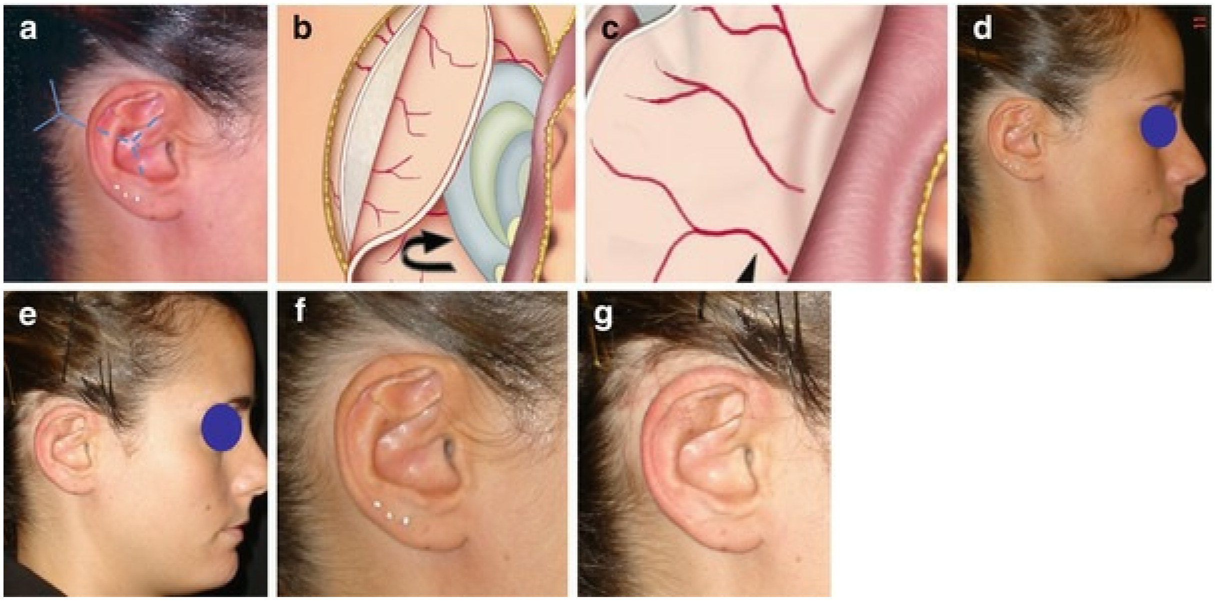


Fig. 15.11 Unesthetic results in a 21-year-old-female patient after three prominent surgeries on the right ear performed elsewhere. (**a**) One can see severe irregularities on the antihelix due to previous operations. *Blue lines* show the cutaneous incision behind the ear and on the mastoid region as well; (**b**, **c**) schematic drawings showing the creation of a fascial flap on the mastoid region. The fascial flaps were raised, passing behind the conchal cartilage and rotated forward to be introduced between the skin and the triangular fossa; (**d**, **f**) a patient before the correction of the unesthetic results; (**e**, **g**) the same patient 1 year after surgical correction

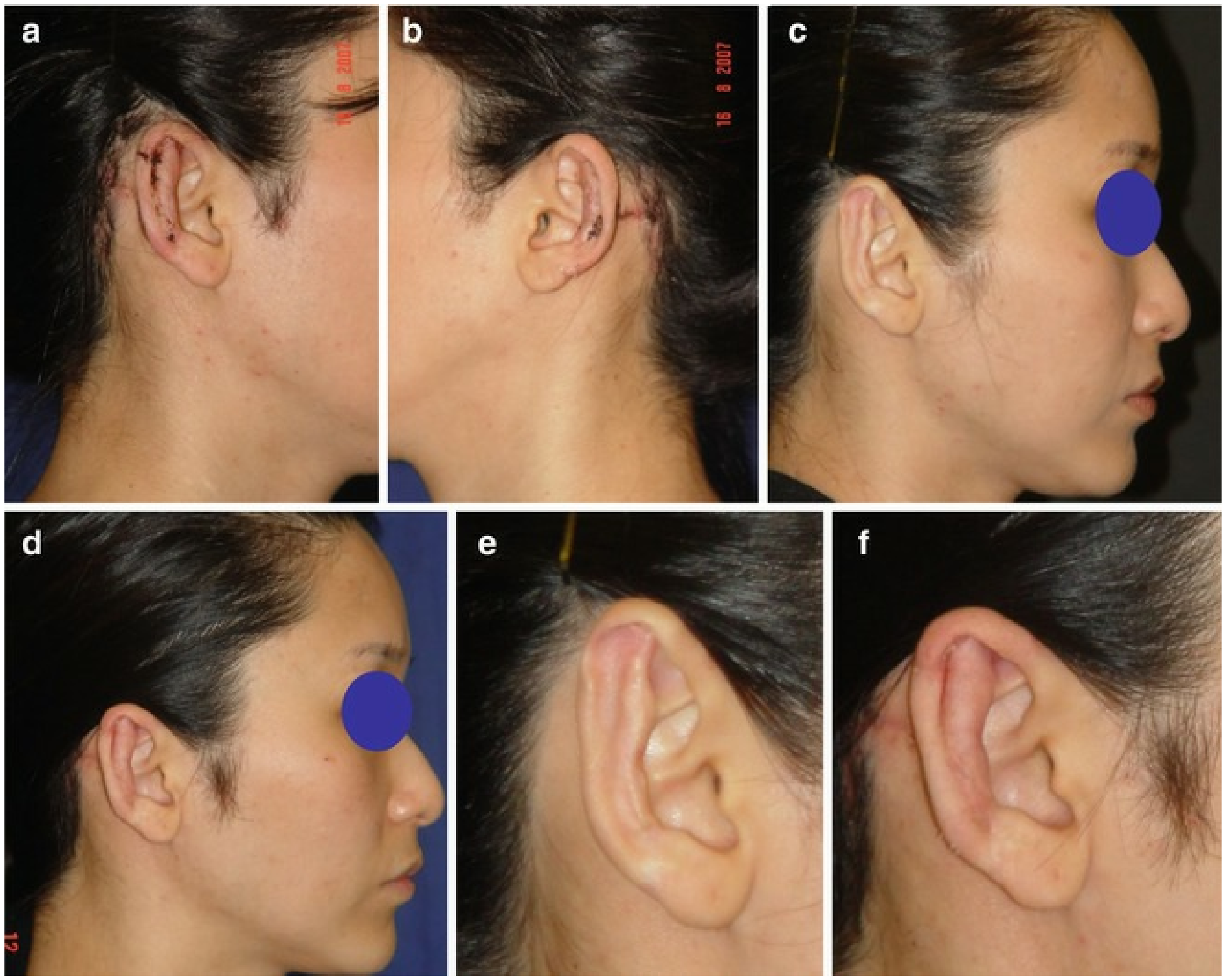


Fig. 15.12 A 23-year-old female presented with irregularities on the antihelix caused by prominent ear surgeries performed three times within 6 months by the same surgeon elsewhere. (**a**, **b**) Surgical planning was done following the same procedure performed on patient illustrated in Fig. 15.9. Drawing with *blue ink* shows the incision on the posterior wall of the ear and on the mastoid as well; (**c**, **e**) before correction of the deformities on the antihelix; (**d**, **f**) the final results, 1 year after surgery

15.5 Discussion

Prominent ear surgery seems like it is an easy procedure, but it is not, because each auricle can have a wide variety of abnormalities that must be thoroughly evaluated pre-operatively. Besides that, post-operative care requires a meticulous approach. Correcting unsatisfactory results after prominent ear surgeries is even more complex due to multiple deformities that may occur, all of which require proper treatment. After talking to the patient, the surgeon should examine each auricle and check all the alterations. The first step is to analyze the presence of scars due to previous surgeries.

Unsuccessful results after procedures for the esthetic treatment of prominent ear may occur due to surgical difficulties that give an unesthetic appearance to the auricles. Each patient must be treated according to his/her specific deformities, which require ability, imagination, and knowledge of anatomy as well the wide field of ear surgery.

Conclusion The correction of unsuccessful results after a procedure for the esthetic treatment of prominent ear may be necessary due to several situations. The operation is not as easy as it seems to be, and each patient presents a particular surgical difficulty that requires an adequate operation to correct the unesthetic appearance of the auricles. Each patient must be treated according to his/her particular deformities; to do so requires ability, imagination, and knowledge of anatomy as well the wide field of ear surgery.

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16. Complications After Ear Reconstruction: Treatment for and How to Avoid

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Keywords Complications on ear reconstruction – Complications during operation – Treatment of complications – Avoiding complications

16.1 Introduction

Undoubtedly, among the most feared problems regarding auricular reconstruction are pre-operative and post-operative complications. Besides the technical difficulties of creating the new auricular framework and being very careful during and after the surgery, there are several kinds of complications that may occur. There are not many scientific publications on the problem, and for this reason, I consider it very important to include this subject in order to point out some of the issues and to present my concepts and surgical solutions.

Depending on the complication, the success of the surgery may be jeopardized, leading to painful consequences and to even more complex procedures. The surgeon must bear in mind that the first operation in a non-operated patient is the best opportunity to perform an auricular reconstruction (Avelar 1986a, b, 1997a, b, 2011). Therefore it is mandatory to take into consideration the knowledge and personal experience acquired from previous operations when planning the surgery, but this does not mean that new ideas and innovations are not accepted in this field. These contributions are very important for the scientific and technical development of this specialty, but the basic surgical principles of the technique to be used must be strictly followed and must be the responsibility of the surgeon.

Didactically, I have divided all the complications in ear reconstruction into four groups:

(a) During surgery

(b) Immediate: those that may occur until the seventh day after surgery

(c) Medium-term: those complications that occur from the first week until the end of the second month

(d) Long-term: problems that may arise after 2 months

16.1.1 During Surgery

The most dangerous and frightening complication in this phase is pleural perforation. In my experience with over 1300 patients who underwent ear reconstruction with the removal of costal cartilage, I have never encountered this kind of complication. However, in Tanzer's publication (1971), he described five perforations of the pleura during the reconstruction of 44 ears in which he removed costal cartilage to excavate the new auricular framework. Considering that this kind of complication can occur, it is advisable that every surgeon warn the patients about what may possibly happen when ear reconstruction will be performed.

Also, in Spina's publication (1971), he described seven cases of pleural perforations in 48 auricular reconstructions. He mentioned one case of death, but without explaining whether the fatality was a consequence of complications during the operation or some other cause.

During the 43 years that I have been doing ear reconstructions, I have never had this complication. I admit that this statement is founded on the technical principles of my procedure, considering the circumstances under which the costal cartilage is removed on the sub-perichondrial level without damaging this layer (Avelar 1979, 1983, 1986a, b, 1997a, b, 1993, 2003). This way, the posterior level of the costal arch remains protected by the perichondrium and consequently is far from the pleura. Although I have never encountered this kind of complication, I carry out the following test during the surgery in order to verify a possible pleural perforation: I ask the anesthesiologist to apply pulmonary hyperventilation, and at the same time I add water to the cavity of the thoracic wall. In none of the cases have I seen a pulmonary air bubble through the water.

Tanzer (1959) Firmim et al. (1974) Fukuda (1974) advocated the importance of removing rib perichondrium attached to the cartilage; he believed that it avoids absorption. However, my preference is to preserve it. To the best of my knowledge, the cartilage grafted on a new bed requires adequate vascular conditions in order to create the new layer of perichondrium to surround itself. Furthermore, when the perichondrium is preserved in its natural location, it will regenerate a new costal structure that replaces the anatomy of the rib, offering very important protection to the chest wall. I have seen patients who were previously operated on elsewhere for ear reconstruction presenting with a deep depression located on the chest wall because of the removal of the rib cartilage. Two patients are described illustrating such severe complications. They he complained about the unpleasant aesthetics, but even more important is the danger of trauma to the chest wall and lungs.

16.1.2 Immediate (Up to 7 Days After Surgery)

Immediate complications that may occur during this period of time are hematoma, infection, dehiscence of the wound, and cutaneous necrosis.

1. *Hematoma* may occur in the donor area of the cartilage on the thoracic wall, as well as on the reconstructed region. Fortunately, I had only one case of this kind of complication. The hematoma of the wall can be completely avoided if the following measures are taken: rigorous hemostasis during the operation and keeping the patient in bed at total rest for 3 or 4 days after the surgery. To reach the costal cartilage during surgery, it is mandatory to cut the rectus abdominis muscle at the level of the 9th rib cartilage. Therefore, the lack of complete rest may lead to

bleeding in the first few days after the surgery; it is recommended for patients to rest for the next 3 days.

At the beginning of my career, I used drains in my first cases for 24 h after surgery. However, in the last 40 years, I have not used any drains on the chest wall or on the reconstructed ear, without any post-operative consequences.

Hematoma on the auricular region has merited a lot of attention from authors. Brent (1974) suggests the use of vacuum draining to prevent it. I consider this procedure unnecessary if the technical principles, as mentioned in the chapter dealing with my methodology, are followed. Using my technique, the level of cutaneous undermining does not bleed if one takes care that there are no profound lesions of the fascia superficialis or any superficial lesions of the cutaneous panniculus.

I have had one case of a small hematoma on the auricular area. Because the patient complained of pain in the auricular region, the first bandage was removed 48 h after surgery and a small hematoma was drained. It was given adequate treatment, and it did not lead to harmful consequences for the esthetic results. That particular case is not a reason for me to change my position regarding the technique because it is not necessary to use drainage on the ear region, especially since there is no room for it. I keep the first bandage applied immediately after the operation until 4 days post-operatively, and when it is removed, a new one is applied to cover the reconstructed auricle.

2. *Infection*. It is important to mention that this type of complication is not unusual in ear reconstruction, since it may come up in any kind of surgical procedure, even when strictly following the rules of asepsis and antisepsis in the operating room. I routinely prescribe antibiotics for my patients, whatever the intervention may be. The occurrence of infection after auricular reconstruction is quite rare; nevertheless, it is extremely important due to the serious consequences it can have. I have not had, as yet, any cases of complications in the donor area. I have three cases registered of little importance, which were solved without causing any trouble. I prescribe oral antibiotics (penicillin) for 15 days and change the first bandage 6 days after the operation.

Infection in the reconstructed ear occurs more frequently, probably because of the existence of cutaneous folds and due to the re-entrance and depressions of the reliefs of this region, making it difficult to use rigorous antiseptic measures. Nevertheless, the cases of secondary reconstruction appear to be much more subject to these complications. In two patients, there was loss of the whole fragment of grafted cartilage. In primary patients who had never had surgery before, I had two cases − one operated on at my clinic, and the other while demonstrating my surgery at another teaching unit.

The main characteristic of infection at the reconstructed ear site is the difficulty of efficient antibiotic therapy, either given orally, in the muscle or intravenously. I prescribe oral penicillin or chloramphenicol in order to stop the infection and prevent its diffusion into neighboring tissues. A more efficient procedure is daily local cleansing. I prepare a chloramphenicol solution (1 g) diluted in 10 ml of distilled water, to irrigate the canal and remove the fibrin and the purulent liquid; such a procedure for 4 to 7 consecutive days can eliminate the infection, without harming the cutaneous covering of the reconstructed ear.

(a) *Dehiscence of the wound*. This complication occurs only when there is local infection, assuming that all technical measures were properly followed. Evidently, a tense suture, intended to pull together the edges of a surgical wound having cartilaginous graft underneath the skin, is considered a mistake of a technical nature. It is a complication inherent to reconstruction.

(b) *Cutaneous necrosis*. The skin flaps made for the reconstruction deserve special attention from the surgeon and the entire surgical team. Undue manipulation may damage the cutaneous circulation, bringing about necrosis on the fourth to fifth day after surgery (Figs. 16.1, 16.2, 16.3, and 16.4).

Fig. 16.1 Small area of skin necrosis with reduced area of exposure of cartilage may heal without surgical procedure. (**a**) A left ear 1 month after second stage of reconstruction on anotia; (**b**) 2 weeks later the necrotic area became smaller; (**c**) in same patient 2 weeks later, the area was even smaller; (**d**) 1 month later; (**e**) the wound completely healed without any surgery

Fig. 16.2 Small area of skin necrosis was cured without surgery. (**a**) A patient with severe microtia on the right side before operation; (**b**) same patient 2 weeks after the second surgical stage of reconstruction presented with a small area of skin necrosis on the border of the helix; (**c**) patient came every week for post-operative care and showed great improvement; (**d**) same patient 1 month later, with

a completely healed wound

Fig. 16.3 Skin necrosis after first stage of reconstruction. (**a**) A 19-year-old male with microtia; (**b**) 3 weeks later a small area of necrosis on suture of the lobule with lower segment of the ear; (**c**) same patient 3 months later, without any surgical procedure; (**d**, **e**) same patient 3 months after the second surgical stage reconstruction

Fig. 16.4 Skin necrosis with exposure of a small area of cartilage graft on the left ear of a 7-year-old child 1 month after surgery. In photos (**a**, **b**) one can see the cartilage; (**c**) 1 month later with local care changing the dressing once a week; (**d**) same patient 6 months later without any permanent damage to the ear

The most frequent reason, however, is the existence of cutaneous scars produced by earlier surgeries. In secondary reconstructions, the surgical scars have to be observed and carefully evaluated, and not hinder the circulation of the skin flaps even more, since they constitute an obstruction to the skin's vascularization (Figs. 16.5, 16.6, and 16.7). So both the manipulation and the raising of skin flaps have to be done strictly in accordance with the respective technical principles.

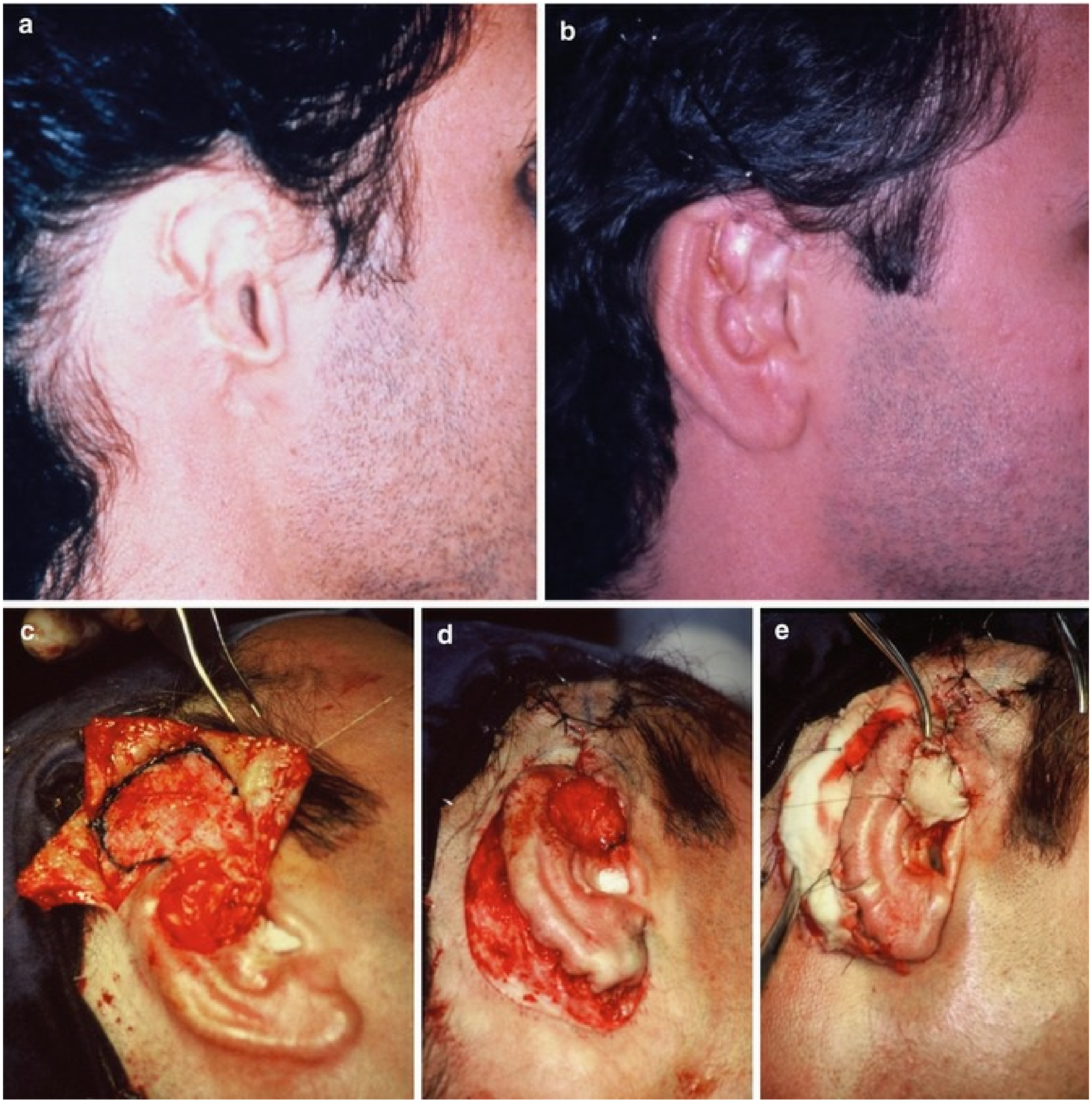

Fig. 16.5 Reparation of severe complication after first stage of total reconstruction of the right ear. The original auricular cartilage was erroneously embedded elsewhere underneath the skin of the mastoid region. (**a**) A 23-year-old male patient with total amputation caused by a car accident with only the tragus and external auditory meatus remaining; (**b**) same patient after two stages of reconstruction with

treatment of skin necrosis with cartilage exposed; (**c**) photo during the second stage showing creation of fascial flap on temporal region; (**d**) fascia is already rotated from up downwards, and the new auricle is lifted; (**e**) skin graft was performed on the fascial flap and on posterior aspect of the new ear

Fig. 16.6 Complex complication after a secondary ear reconstruction on severe microtia on the right side. (**a**) Pre-operative photo of a female patient showing the result of six surgical stages of reconstruction performed elsewhere; (**b**) 2 months after surgery, with new auricular cartilage framework that was introduced under the scars of previous surgeries. She came back with a small area of exposed cartilage graft. (**c**) As she did not have a fascial flap anymore, a flap of the temporal muscle was planned and raised (**d**) after rotation forward in order to cover the raw area with exposure of cartilage; (**e**, **f**) skin graft was performed on the segment of temporal muscle already rotated and sutured; (**g**) same patient 6 months after reparation without damaging the surgical result. One year later the patient will undergo another reconstructive procedure

Fig. 16.7 A secondary ear reconstruction on severe microtia on the right side presented a small area of skin necrosis. (**a**) The right ear after two stages of ear reconstruction presented a small area of skin necrosis on the superior border of the ear with small area of exposure of cartilage; (**b**) The patient who used to come once a week for postoperative care for 1 month presented and recovered well without any surgical procedure

I had 4 patients with cutaneous necrosis on the 4th day after surgery, due to scars from previous surgeries that obstructed the vascularization of the skin (Figs. 16.5, 16.6, and 16.7). In a 19-year-old male patient presenting with a severe cutaneous reaction that seemed to be a localized infection, I changed the bandaging in the beginning every 2 days and afterward every day. Even I had to remove a segment of the auricular cartilage (Fig. 16.8). In two other patients, I resected the segment of cartilage underlying the necrotic area, to provide for a skin graft on the raw bed in one, and in the other one, I performed rotation of the temporoparietal fascial flap, to again cover the whole cartilaginous framework with a skin graft (Fig. 16.5).

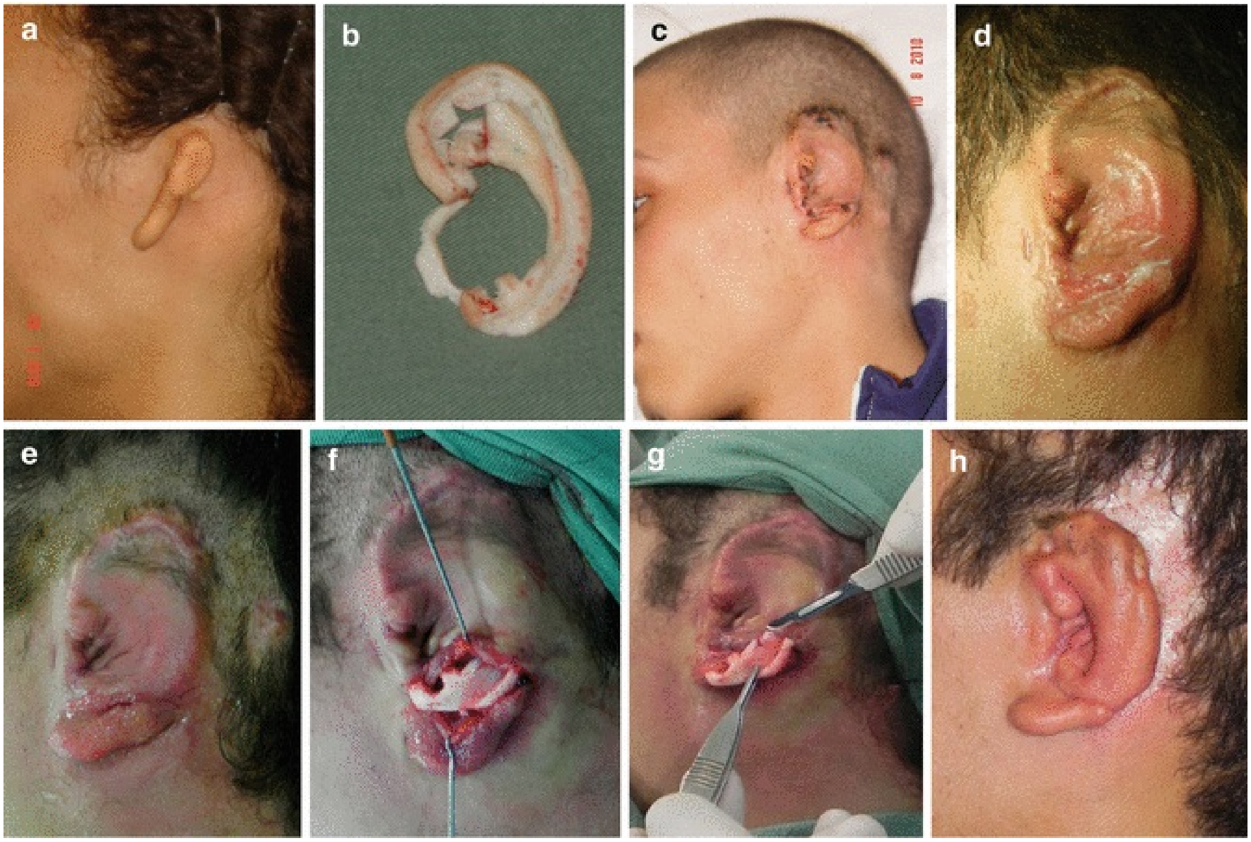

Fig. 16.8 Development of allergy 2 months after ear reconstruction. (**a**) A 19-year-old male presented with severe microtia on the left side; (**b**) the auricular framework was meticulously excavated and embedded following the surgical planning and the technique; (**c**) photo of the patient 2 months after surgery showing good results; (**d**) sent this photo one month later presenting some unknown allergic reaction in the operated ear; (**e**) he came back for medical care presenting local secretion with slough on the covering skin and on lobule; (**f**, **g**) the local reaction became more and more intensive. I decided to remove the inferior segment of the cartilaginous auricular framework embedded during reconstruction. After removing the segment and stopping an antibiotic cream , the local tissue was cured; (**h**) the second stage was performed 1 year later without using the previous local medicine and there were no more allergic reactions.

It is worth pointing out that the principal cause of cutaneous necrosis in the first few days after surgery is the use of mattress sutures tied over a gauze pledget, which is used to compress the skin over the grafted auricular framework (Fig. 16.9). This type of dressing was widely used in the 1960s and 1970s. I also used it several times with the intention of obtaining a good definition of the new ear’s reliefs. However, after two unsuccessful cases, I stopped using external stitches, eliminating this complication.

Fig. 16.9 The use of external stitches as a resource for the dressing may cause skin necrosis in several places after surgery. (**a**) A 19-year-old male with microtia on the left side; (**b**) same patient 4 days after ear reconstruction; (**c**) localized necrosis on triangular fossa. The treatment consisted of a resection of the necrotic area and a skin graft 1 week later; (**d**) the dressing I used was wet cotton instead of external stitches in order to avoid such complications

My procedure for repairing skin necrosis consists of raising fascial flaps to cover the exposed framework and proceeding with the cutaneous graft at the same surgical stage (Fig. 16.5).

16.1.3 Medium-term

I call “medium-term” those complications that appear from the end of the first week until 2 months after the operation. During this period, the patient is still under medical care, and complications occur less frequently.

In my practice, there was a case of infection that appeared 15 days after surgery, showing cutaneous distension due to the presence of purulent liquid. The patient did not show any signs of infection at the previous change and control of the dressings. The treatment is the same as described above. I have had 3 more cases of patients who showed cutaneous slough in the posterior wall of the reconstructed ear. One month after the surgery, I verified that the lower and upper extremities of the auricular block were exerting pressure on the skin, causing cutaneous suffering and exposure of the cartilage. In all these cases, I resected the exposed fragment of the framework, followed by rotation of the cutaneous covering. A simple suture on the edges of the wound was put in. In another example, after a secondary ear reconstruction a patient did not come regularly for post-operative care according to our schedule. After 3 weeks, he came, presenting a small area of skin necrosis on the superior border of the new ear with a small segment of exposed cartilage (Fig. 16.10). It was evident that such necrosis occurred because he did not take care of the dressing. As he came every week for 1 month, the problem was solved without any surgical intervention.

Fig. 16.10 Small area of necrosis 2 months after second stage of ear reconstruction, since patient did not come for regular post-operative care during the 3 weeks. (**a**) Patient with severe microtia on the

right side; (**b**) the new ear presents a small area of necrosis on its upper border; (**c**) the area recovered under careful dressing; (**d**) skin flap by advancement from back forward to cover the area

16.1.4 Long-term

I call “long-term” complications those that crop up 2 months or later after the surgery. They are classified as:

1 Reabsorption of the cartilaginous framework

1 Displacement of the framework

1 Fading of the auricular relief

16.2 Reabsorption of the Cartilaginous Framework

This complication occurs only in cases of technical failure and when there is post-operative infection. In the first case, it may be due to cartilage graft on an inadequate bed, as in secondary surgeries because of excessive pressure of the skin flap on the framework.

If the receptor bed does not offer adequate vascularization, it damages the integration of the cartilage. As a matter of fact, all esthetic and anatomical details of the reconstructed ear depend on the relief of the grafted framework. On the other hand, it is not difficult to understand that the infection process damages the local circulation, affecting the nutrition of the feeding tissue of the cartilage. If the problem is treated properly and quickly, the consequences can be lessened. I had a case of reabsorption of almost the entire framework due to severe local infection.

The second reconstruction should only be carried out 1 year after healing of the infection. The cicatricial tissue originating from the trauma has to recover totally in order to receive another cartilage graft.

16.2.1 Displacement of the Framework

Among my first cases were two disappointments due to deviation of the helix segment of the new ear. I concluded that the cartilage was very thin and was not in condition to keep itself in position. For this reason, I began to create the relief of the helix on a wide base. Nevertheless, the auricular block does not tottaly displace. Once grafted, the framework remains in place because of the cutaneous covering. This is why we have to do our best to find the right position and the correct place, so as to attain harmony with the other elements of the face. I had a case in which, although the ear had a good relief and esthetic aspect, I verified that the longitudinal axis of the ear was turned backward, without causing any displeasure to the patient.

16.2.2 Fading of the Auricular Relief

I have already stated that the esthetic result depends on the relief of the sculptured cartilaginous framework. A possible fading of the details of the ear is not a complication but a lack of skeleton. In any case, the aesthetic aspect will show up only 2 or 3 months after the reconstruction, when the cutaneous edema has already been eliminated. Nevertheless, infection or excessive pressure of the cutaneous covering may change the features of the reconstructed ear.

16.3 How to Avoid Complications During and After Ear Reconstruction

It is possible to avoid complications during and after ear reconstruction. Some rules and observations are very important during and after surgery. They are:

1. The technique. The surgeon must be familiar with the technique and have enough experience in using it.

2. During surgery, the surgeon must perform all stages of the operation carefully.

3. Hemostasis. There should be meticulous hemostasis during all phases of the operation, and in removing the rib cartilage and reconstruction as well.

4. Dressing after the first stage of reconstruction. The surgeon must use a

soft, but firm dressing with light compression over the reconstructed ear.

5. Dressing after the second stage of reconstruction. The surgeon must use a compressive dressing on the posterior aspect of the new ear in order to keep the skin graft in constant contact with the raw surface.

6. Removing the bandage. After the first stage of reconstruction, the bandage must be removed carefully after 4 days, and after 7 days after the second stage of reconstruction.

7. Changing the bandage. The bandage must be changed regularly every 7 or 10 days for at least 2 months, under the supervision of the surgeon and his or her team.

16.4 Discussion

One of the most frustrating and worrisome situations during and after ear reconstruction is a complication that requires immediate careful treatment. Although the surgeon may have devoted much effort and used all his knowledge and handiwork to create an important organ for his or her patient, unexpected complications may still occur. No matter when the complication happens, the surgeon must make immediate decisions about the proper treatment. Even when the surgeon follows all the appropriate steps in order to perform the operation, from the patient's first consultation through using a proper surgical plan to perform the surgery, complications may still occur, either during the surgery or afterwards. Nevertheless, there are some situations that are more vulnerable to those complications, such as patients who have been operated on previously (secondary reconstruction), and surgery after traumatic amputations. In both cases, the scar tissue formation on the auricles and neighboring regions is a constant challenge for surgical planning, as well as for performing the operation. It is very useful for the surgeon to carefully analyze all scars in the auricular region with meticulous evaluation of their location and position in order to plan the incisions during surgery. When a patient has undergone an ear operation, the surgical scars must be carefully evaluated because the subcutaneous scar tissue formation may create great difficulty during surgery because the blood supply may be jeopardized, and an additional surgical procedure can have an even more adverse effect on the proposed operation.

The most feared complication pre-operatively is pleural perforation during removal of the rib cartilage, which requires immediate treatment. Although such a situation up until now has not occurred in my practice, it is strongly advised that surgeons evaluate the wound in order to identify the perforation and take appropriate action.

When the bandage is removed after surgery, if local infection is detected, immediate management requires local and systemic treatment with antibiotics until the secretions are eliminated. If the skin covering is damaged and the auricular framework is partially exposed, the best option is rotation of the fascial flap combined with a skin graft on it. It is sometimes necessary to partially remove the cartilage, because after 48 h of exposure, it is not enough to cover it with local fascial flaps and skin grafts on top of it.

Complications after ear reconstruction may occur in 2–5% of cases. They are more frequent after secondary reconstruction as well as after traumatic amputation with complex laceration of soft tissues. Therefore, before performing a reconstruction, it is important to perform an adequate examination and to find out about previous operations. Primarily ear reconstruction on congenital anomalies, this kind of trouble is less frequent due to normal cutaneous covering without any scars as well as any fibrosis underneath the skin. Complications may be classified as occurring during the operation, immediate (up to 2 weeks after surgery), medium-term (from 2 weeks to 2 months), or long-term (2 months or more after surgery).

Conclusions

Since ear reconstruction is a very difficult procedure, complications during and after surgery may damage the results. I have never had perforation of the pleura during removal of the rib cartilage, since sub-perichondrial undermining is done, which will regenerate a new rib arch. The immediate complications with skin necrosis are the most frequent, and the treatment is to remove the exposed cartilage. Also, it is possible to re-cover the exposed cartilage with my temporoparietal fascial flap followed by a skin graft. Post-operative bandaging must be changed regularly every 7 to 10 days, and the surgeon must examine the reconstructed ear. It is more important to try to avoid complications during and after surgery.

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17. Reduction Otoplasty to Improve Facial Contour

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Keywords Macrotia – Reduction of the auricle – Reduction otoplasty

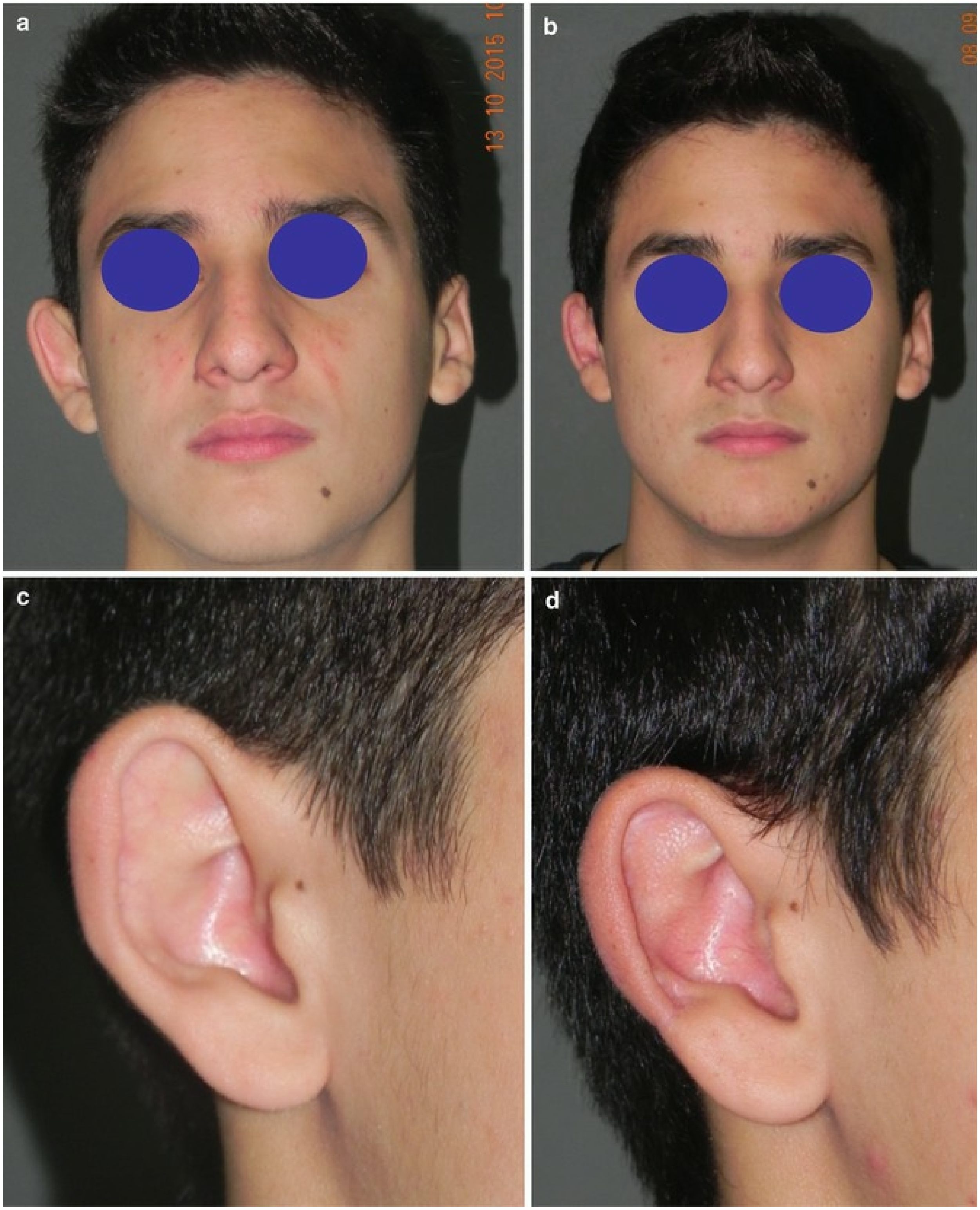
17.1 Introduction

It is well known that “prominent ear” is the most frequent congenital deformity of the auricle that requires otoplasty to achieve balance to the auricles as well as to the facial contour. On the other hand, when patients present with a missing partial segment or total absence of the ear, their corrections are made through reconstruction of the auricle. Nevertheless, when the auricles are too large, it may bring some physical discomfort to patients due to unesthetic unbalance of the facial contour. This kind of congenital abnormality, called “macrotia” has been encountered less frequently among my patients over my 43-year career, but it has many psychological ramifications for my patients and their parents as well. For these reasons, it is useful to describe such a deformity of the auricle, since its correction is a constant challenge. Although there are few patients who complain about large auricles, this imperfection affects the physical appearance and has psychological consequences as well.

Ever since I published my classification regarding abnormalities of the auricles (Avelar 1986a, b, 2011, 2013), I emphasized the clinical form of "macrotia" which describes those auricles that present regular auricular cartilage that is covered by normal skin on both sides. The skeleton, however, is larger than normal ears. This deformity is responsible for a peculiar appearance with an unbalance of the face itself, as well as between the face and the head. The auricles present a strange projection on each side of the face that are very evident when one looks at a person with this deformity.

Clinically, macrotia is quite different from the prominent ear, since the auricular cartilaginous skeleton is much larger than the normal size. However, prominent ears present several alterations of the anatomical and esthetic elements (which are not subject of this chapter).

Nevertheless, patients with macrotia may have prominent ears as well, which can be unilateral (Fig. 17.1) or bilateral (Fig. 17.2). One should also remember that the dimensions of the ear may increase due to hypertrophy of the lobule, which is a characteristic of old age. This clinical condition is quite different. The lengthening of the lobule is evident, but the auricular skeleton is normal-sized.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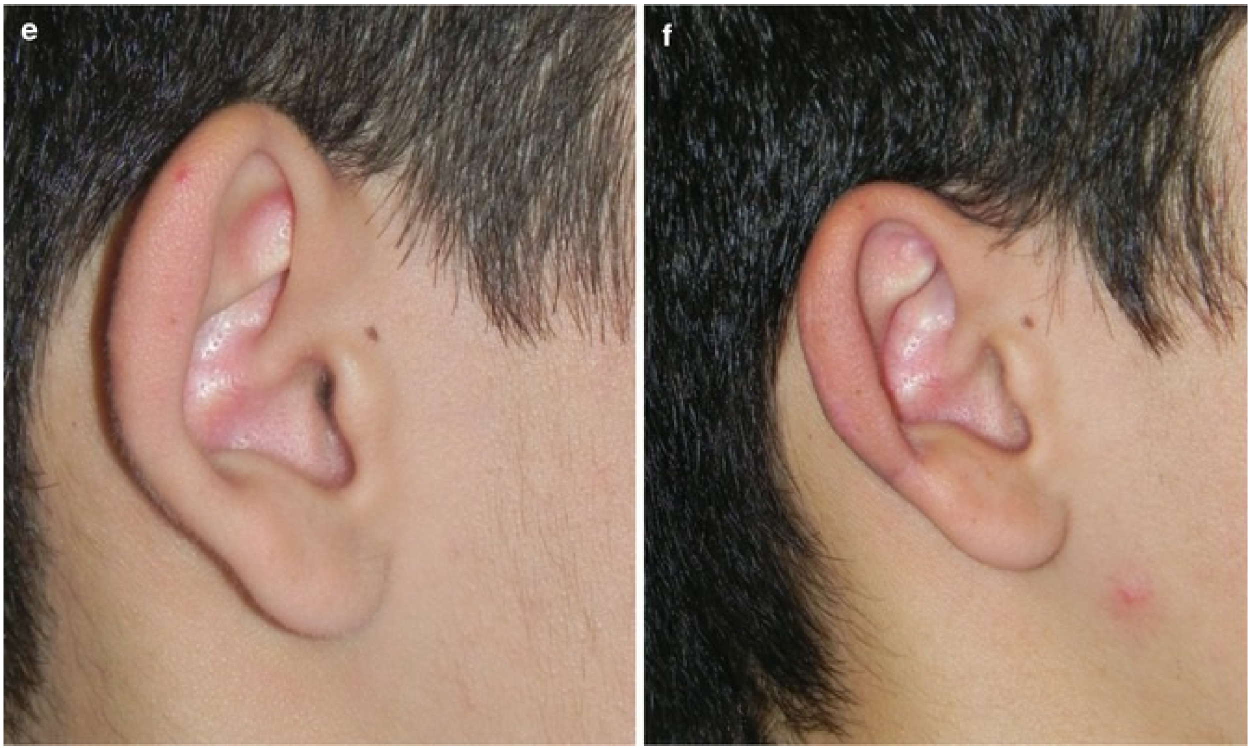
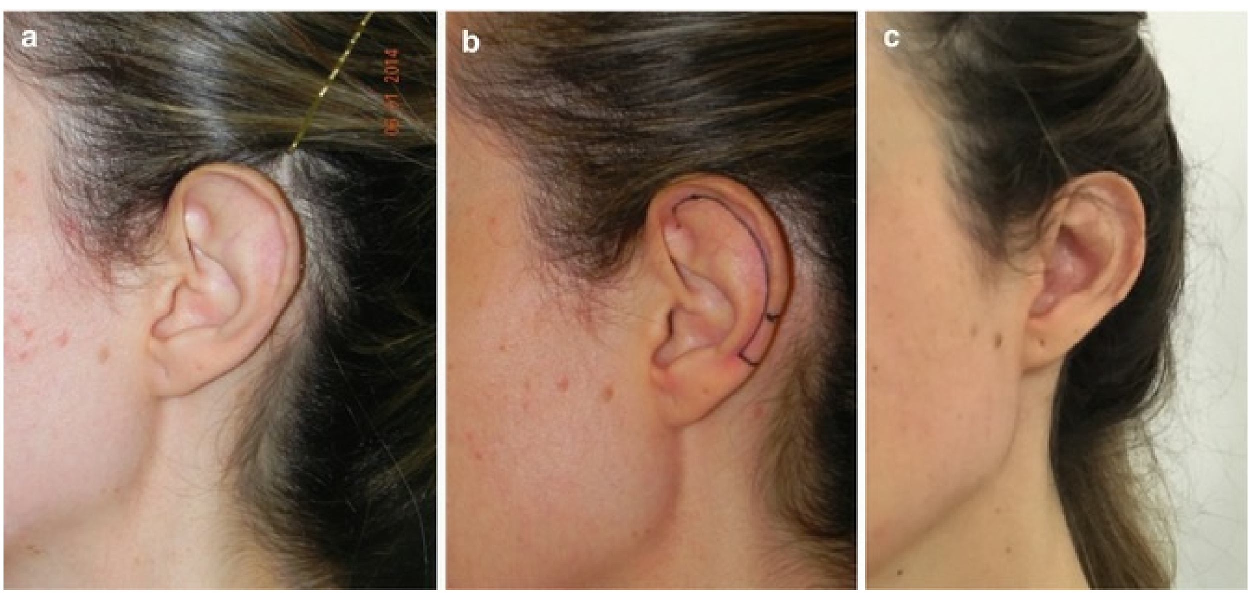


Fig. 17.1 Unilateral reduction otoplasty on a 17-year-old male patient. (**a**, **c**, **e**) Before operation showing macrotia on right side; (**b**, **d**, **f**) same patient 1 year after reduction otoplasty on right side using Avelar's technique



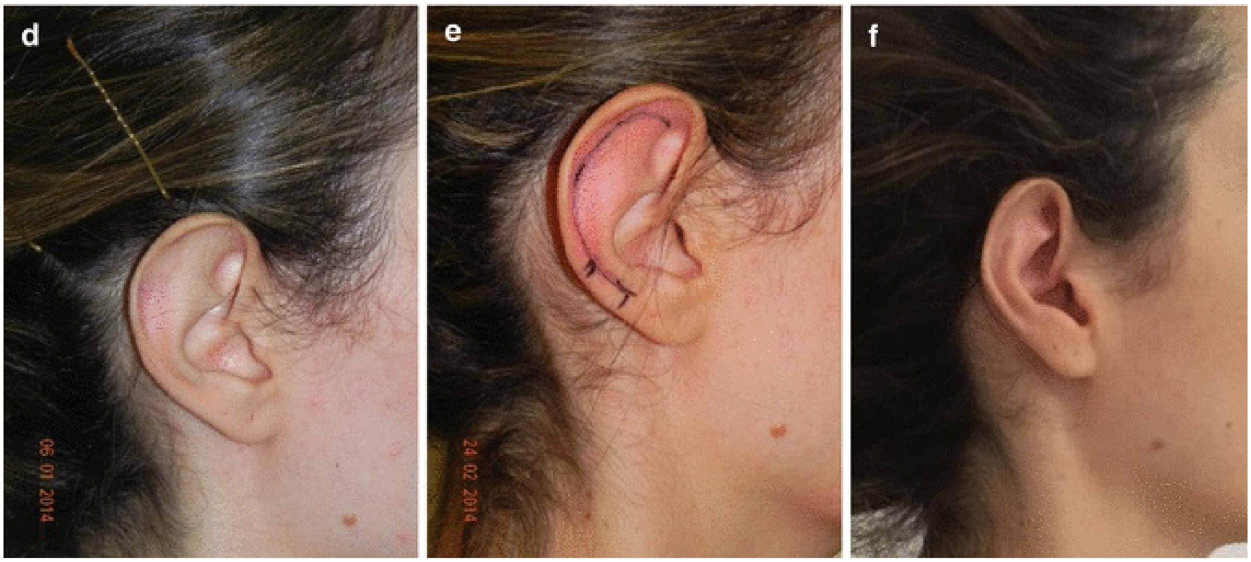


Fig. 17.2 Bilateral reduction otoplasty on a 19-year-old female patient. (**a**, **d**) Before operation showing macrotia on both sides; (**b**, **e**) surgical demarcation with blue ink according to Avelar's technique; (**c**, **f**) same patient 1 year after bilateral reduction otoplasty

According to Tanzer and Converse (1964), the first surgical correction of macrotia ever mentioned was published by Di Martino in 1856. The technique was basically performed by the excision of a combination of triangular segments of the scapha. Several other authors repeated Di Martino's method: Cocheril (1894), Cheyne and Burghard (1903), Binnie (1921), and Day (1921), who introduced some personal modifications of the basic technique.

Nevertheless, the most important contribution in this field must be credited to Gersuny (1903), who introduced a new surgical concept, making elliptical resections of the scapha combined with shortening of the helix. Even nowadays his method is an important approach for reduction otoplasty. Later, Kolle (1909), following that basic procedure, suggested performing the shortening of the helix by resection of its anterior segment, adding a triangular resection of the antihelix.

The talented surgeon Malbec (1931, 1938a, b) published a "star-shaped" resection of the helix, scapha, and antihelix, without any cutaneous dissection. His operation was very similar to the one described by Cheyne and Burghard (1903), but with the intention of reducing the width of the upper third of the auricle. This procedure is very useful for resection of cutaneous tumors on the helix, antihelix, and scapha as well. However, for esthetic reparation it is not the most indicated method, because it leaves an ungainly scar that may greatly displease patients.

Other publications by Webster (1945), creating esthetic details on the new folds of the auricle, were described. Later, Peer and Walker (1957), Peer (1957) introduced some modifications in Gersuny's method. Recently, Hinderer et al. (1987) mentioned his personal technique for the correction of severe and moderate macrotia, using cartilage and skin resections on different levels of the scapha to improve the esthetic results.

My personal contribution was presented at the International Congress of Plastic Surgery held in Madrid, in 1992 (Avelar 1992, 1997). It is a combination of several techniques described by Gersuny, Webster, and also Antia and Buch (1967). The basic principles of my procedure are performing resection of the scapha cartilage in order to reduce the width of the upper third of the auricle; preserving the cutaneous covering on the posterior wall, combining helix resection on another area of the ear; and finally promoting the rotation and advancement of a chondrocutaneous flap in order to hide the final suture on the helical fold.

17.2 Method

17.2.1 Surgical Planning

As in any field of plastic surgery, the planning of the operation is a fundamental step before surgery. Each patient must be well examined in detail, checking all the anatomical anomalies of the auricular cartilage. It is very useful to create two models on an X-ray film in order to help the projection of the future auricle. The first one, called "S," shows the size, shape, anatomy, and dimension of the ear before surgery (Fig. 17.3). The second one, called "T," represents the size and shape of the future organ, according to the imagination of the surgeon (Fig. 17.4).

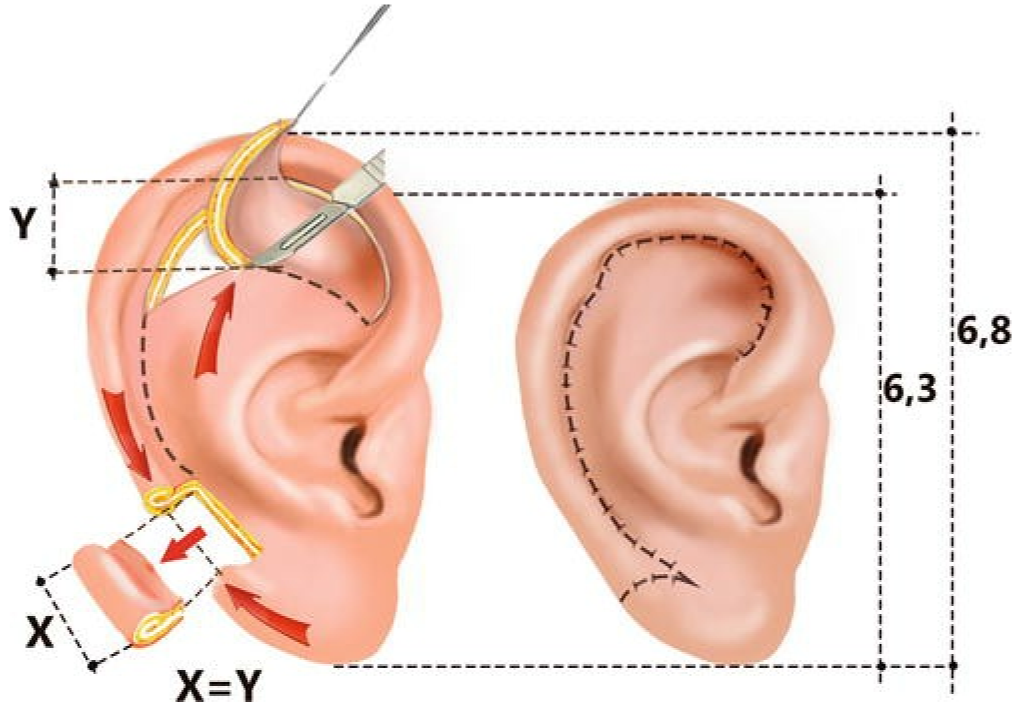


Fig. 17.3 Drawing showing the elliptical island for resection on the scapha and on the helix. The width "Y" is similar to "X" for reduction of only the vertical length

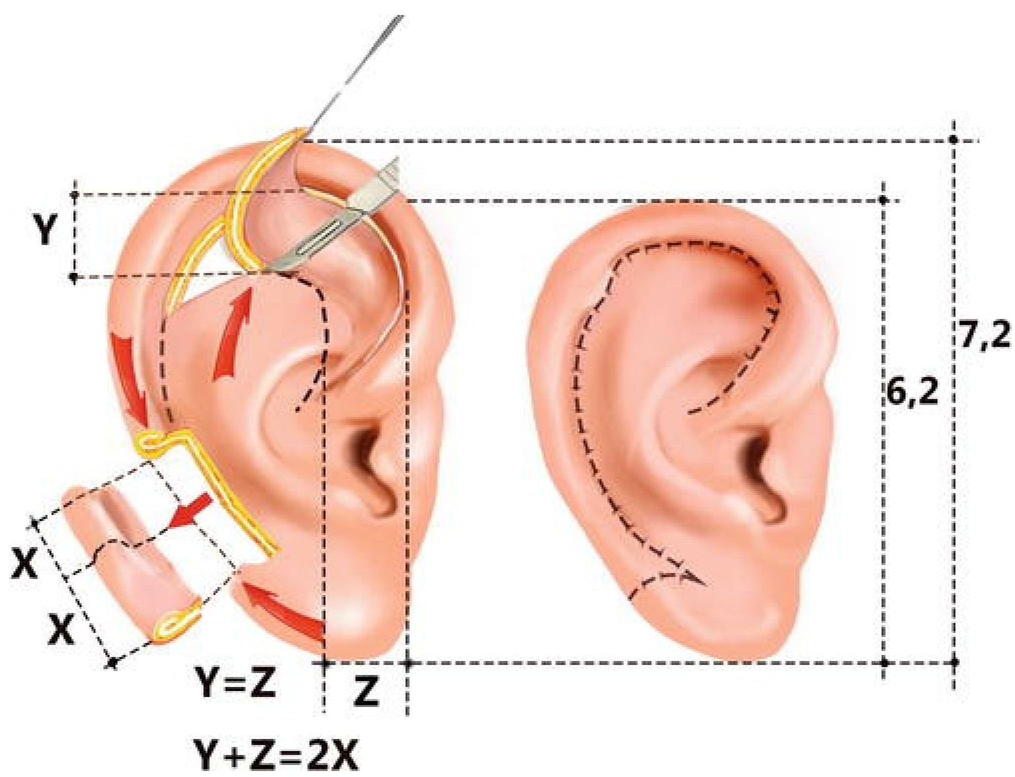


Fig. 17.4 Diagram showing the reduction of the auricle in the *vertical* and *horizontal* directions, which is the addition of both resections: "Y"+ "Z" = 2 "X"

Even while curving the X-ray film, the surgeon has enough time to think about the amount of tissue that will be resected and the rotation of the segments of the ear after resection. This is an exercise of imagination before surgery, which is very useful in order to save time during the surgery. It is possible to verify the reduced size of the auricle with a ruler.

17.2.2 The Operation

The surgery is performed under local anesthesia combined with intravenous sedation. It is important to emphasize that the infiltration should be done after the demarcation, following the surgical planning.

17.2.3 Demarcation

According to the surgical planning, the demarcation is another important step before starting the operation. In this procedure, it is mandatory to draw all incisions to follow the technique. An elliptical "island" is drawn on the scapha (Fig. 17.3). However, when the auricle is too long in the vertical direction, the "island" is horizontally located on the upper part of the ear, combined with resection of the lower part of the helix. Therefore, the reduction of the ear will only be vertical. The width of the elliptical resection "Y" is similar to that on the helix "X" (Fig. 17.3).

Yet when macrotia is vertical and lateral, the demarcation must be done in order to reduce it laterally. A "C-shaped" drawing is done, including a part of the triangular fossa to resect an anterior segment, in order to reduce the width of the auricle (Fig. 17.4). Another incision along the sulcus of the helix is drawn from the upper part downward until it reaches the lobule (Fig. 17.5). A segment of resection is drawn between the body of the ear and the lobule, for compensation, by sliding the superior segment over the inferior one. The width of the resection of "Y" + "Z" = "X" + "X" (Fig. 17.4).

Fig. 17.5 Avelar's technique for reduction otoplasty. (**a**) Surgical demarcations on the right ear. The lobule is also demarcated for reduction; (**b**) two segments of both ears after resection: above, skin and cartilage removed from the scapha; below, two segments of the lobule after resection. Perioperative photos showing reduction of the auricle. (**c**, **e**) Before cutaneous and cartilage resection; (**d**, **f**) same patient immediately after reduction of the auricle and lobule. The amount of reduction can be seen on the ruler. Photos of (**g**) the right ear before surgery; (**h**) after surgery; (**i**) left ear before surgery; (**j**) after surgery; (**k**) profile view of left side before surgery; (**l**) after reduction otoplasty

17.2.4 Incisions, Resection, and Rotation of the Flaps

Local infiltration should be carried out prior to the resection on the base of the conchal wall of the auricle, in order to avoid any damage to the drawings of the demarcation. A cutaneous incision is made following the previous drawings (Fig. 17.5). The incision reaches only the skin and the cartilage on the anterior side of the auricle. The posterior cutaneous wall is not incised, in order to provide good vascularization to the composite flaps.

The posterior aspect of the conchal perichondrium is undermined, attached to the posterior cutaneous flap (Fig. 17.5). For this reason, the thickness and the blood supply of the cutaneous flap give enough support to the new ear. A perichondrium cutaneous flap is created on the posterior side with the helix attached to its border (Fig. 17.5), and the chondrocutaneous "island" is resected, leaving the perichondrium in its natural place (Fig. 17.5).

The resection of a segment of the helix "2X" is done on the inferior part of the helix, in accordance with the chondrocutaneous "island" resection performed on the scapha and the anterior, vertical segment "Y"+"Z". This means that the horizontal resection, combined with the vertical one, is an addition of both dimensions. Therefore, the more the auricle is reduced, the larger the "island" resection, including the vertical segment (Fig. 17.6).

Fig. 17.6 Reduction otoplasty on the right side of a 51-year-old male patient. Photos (**a**, **c**) before surgery; (**b**, **d**) same patient 1 year after reduction otoplasty using Avelar's technique. Patient used to have too much hair on his ear; it was removed during the operation since the skin with hair was resected

The suturing is done after rotation of the helix from the upper part downward and the excess skin is resected on the posterior side between the auricle and the lobule. It is not necessary to suture the cartilage. After the skin suture, the cartilage follows naturally (Fig. 17.6).

Sometimes the lobe is too long, as is the size of the auricle, giving the patient reason to complain. Reduction of the lobule may be performed by cutaneous incision on the anterior and posterior aspects of the lobule. It may occur unilaterally (Fig. 17.7), but more frequently it is bilateral macrotia that requires reduction of both lobules (Fig. 17.8).

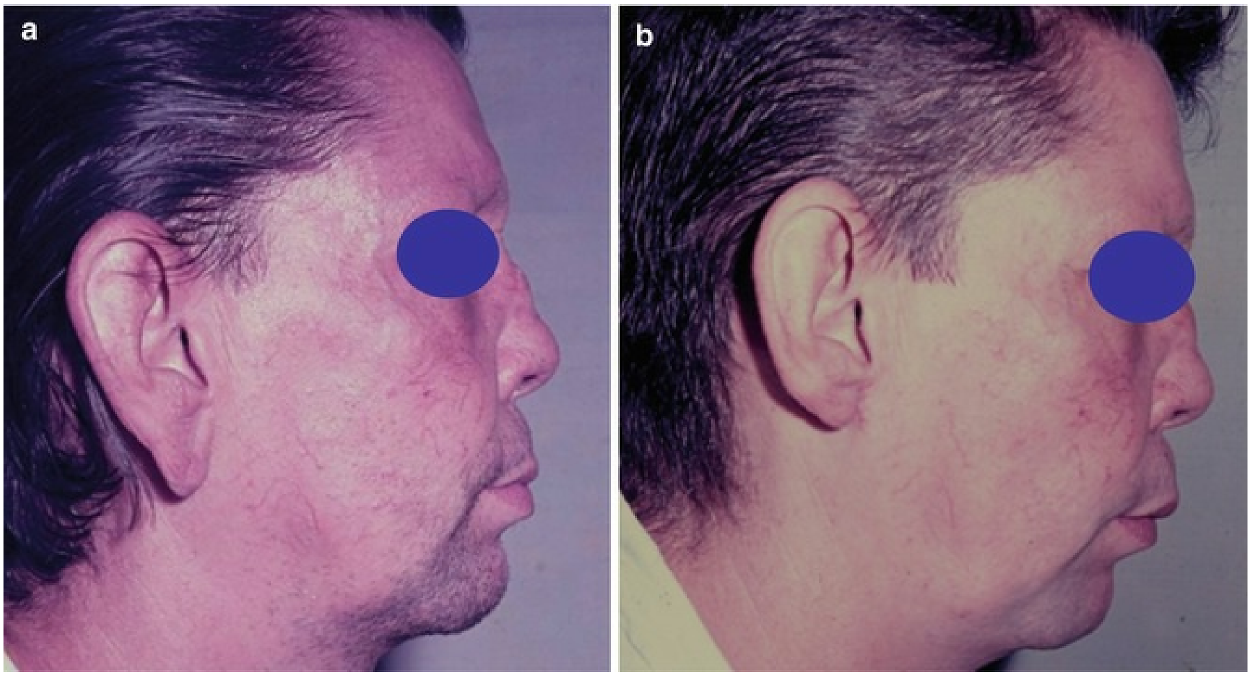


Fig. 17.7 Reduction of the lobule on right ear. Photo (**a**) before operation showing a very long lobule; (**b**) Same patient after lobe reduction through the technique demonstrated in this chapter

Fig. 17.8 Bilateral reduction of the lobule. Photos (**a**, **f**) before operation showing the imbalance of the ears due to length of the lobule; (**b**, **g**) same patient after bilateral reduction of the lobule; (**c**, **e**) surgical demarcations of the technique; (**d**) Close-up photo of right ear after lobe reduction

17.2.5 Dressing

A wet cotton bandage is applied to the anterior and posterior aspects of the auricle. Any stitches from one side to the other of the ear are forbidden because they may damage the vascularization, with serious consequences. I keep the bandage on for 5 or 6 days; after its removal, another one is applied for 6 or 7 more days before removing the stitches.

17.3 Discussion

It is important to emphasize that any alteration of size, shape, position, and location of the auricles gives an ungainly and unbalanced appearance to the face, with psychological repercussions for patients. When the auricles are larger than normal size, their reduction is required since patients − as well as their parents − complain about unesthetic aspects. Surgical planning is a fundamental step before the operation. Surgical demarcations must be done while the patient is awake in front of a mirror to show him or her the whole procedure. An elliptical “island” is drawn on the scapha, and an incision is done all the way down between the helix and antihelix. When the auricle is too long vertically, the “island” is horizontally located on the upper part of the ear. However, when the auricle is too long and too wide, a “C-shaped” drawing is done that includes a part of the triangular fossa. Another incision along the sulcus of the helix is drawn from the top downward until it reaches the lobule. A segment is drawn between the body of the ear and the lobule, for compensation. The surgery is performed under local anesthesia combined with intravenous sedation. An incision is made following the drawing. This incision reaches only the skin and cartilage on the anterior side of the auricle. The posterior cutaneous wall is not incised. The posterior aspect of the conchal perichondrium is undermined, and so a perichondrium cutaneous flap is created posteriorly with the helix attached on its border. The chondrocutaneous “island” is resected, and the suturing is done after rotation and advancement of the helix from the top downward. The excess skin is resected on the posterior flap between the auricle and lobule, and a wet cotton bandage is applied for 1 week. Also, hypertrophies of the lobule may occur unilaterally, but they are more frequently bilateral; this may be done by resection of the anterior and posterior aspect of the cutaneous covering of the lobule.

Conclusions

I have had very natural results with this method. The posterior flap slides easily from the upper part downward, giving the auricle a natural configuration. The anterior segment of the helix shows excellent rotation, giving a natural shape to the final esthetic results. The final scars are inconspicuous and very natural on the folds of the ear. When the lobule is too long, it may be resected, combined with the resection of the inferior segment of the helix.

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18. Ear Reconstruction After Destruction Caused by Piercing

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Keywords Ear reconstruction – Ear deformity – Destruction caused by piercing – Severeinfection caused by piercing

18.1 Introduction

Piercing is a voluntary adornment intended to achieve personal desires of beauty through perforation of some segments of the human body in order to introduce a foreign body made of metal elements. For teenagers, piercing is a way of expressing emotions, anxieties and other mental states, always aiming at beauty, since there are no rules in this case (Pitanguy 1986). The interpretation of beauty does not obey the predetermined aspects, because they change over time, because they depend on ethnic, social, moral and cultural aspects. On the other hand, the beauty is influenced by the media, because it says what are the best physical approaches by society to achieve harmonious balance points. (Avelar 2000; Rees 1973). Piercing has become a very common practice that may cause serious complications − especially in auricles − due to local infection, and sometimes with systemic repercussions.

Thus, piercing into one's own body is a personal action that fills a specific void in patients' self-assessment to achieve beauty. The skin is the largest organ of the human body; indeed, this form of body adornment may be done in many areas: orbital regions and eyelids but more commonly on the nose and ears and their various areas that often have more of an implanted element and several segments of the mouth, lips, gums, and tongue as well. Also, many models do navel piercing; the nipples to the genital areas are places for the young, and even adults have piercings in other areas that can be seen in primitive and contemporary societies, from Asia to South America.

One cannot estimate the incidence of piercings in the general population, but it is known that each feature is most common especially in adolescents (Pérez-Potapos and Cossio 2006) and as in adults. It is rare for a person to have only one piercing.

The main motivations vary from religion, rebellion, esthetics, mysticism, and rituals of initiation or passage from adolescence to adulthood. The use of piercing is considered by its carriers to be adornments of great esthetic significance but it can result in serious health risks for adolescents as well as adults. The most serious problems can occur immediately after perforation of the ear and introducing the piercing. Severe complications can arise due to local infection followed by destruction of the area (Fig. 18.1). As the ears are quite often chosen for such procedures, the consequences may partially or totally destroy the organ. My patients have presented with complex deformities as a result of perforation of the ear only on one side.

Fig. 18.1 Severe infection of the right ear Due to traumatic damage caused by the hair clip, placed in the hairdressing salon. (**a**) Anterior oblique view showing swelling of the ear and two foreign bodies

attached to the ear in order to avoid retraction; (**b**) after treatment of the infection, showing the complex retraction and contraction of the ear

18.2 Complications Resulting from Piercing

The ears are external appendages with more than 95% exposure and therefore they are preferred for piercing and rarely receive proper attention during personal hygiene. (Avelar 1984, 2011). The subtle architecture is formed by a cartilaginous structure in all segments that are responsible for capricious and peculiar folds and ridges, except in the lobe, which is formed only by two layers of skin. The cartilages are anatomical elements devoid of vascularization and therefore do not offer resistance to bacterial agents that penetrate the skin holes when drilling to insert piercings. Due to the wide exposure of the ears, they are the organs preferred for piercing (Fig. 18.2). Thus, by introducing foreign elements into the skin, piercing can offer disastrous possibilities for the penetration of bacteria that inhabit the skin and can develop into local infection with serious and irreversible consequences, as described by Cicchetti et al. (2002). Besides the absence of vascularization in the cartilage, the skin circulation offers little protection to the offending agent. I have had some patients with complex local infections who had to be referred to the intensive care unit (ICU) for several days and even weeks (Fig. 18.3). Due to the aggressiveness of the infection and restriction, sometimes innocuous action of antibiotic ear cartilage does not resist the effect of microorganisms emerging complex episodes of suppurative chondrite, which evolves into complex process of frame absorption. As a result, the skin coating folds over itself with retractions and distorting of the ear’s architecture. Such situations are some of the more complex cases in auricular reconstruction as the skin becomes inelastic and does not lend itself to surgery because rib cartilage must be used to replace the missing framework (Avelar et al. 1984, 1987,and 2013).

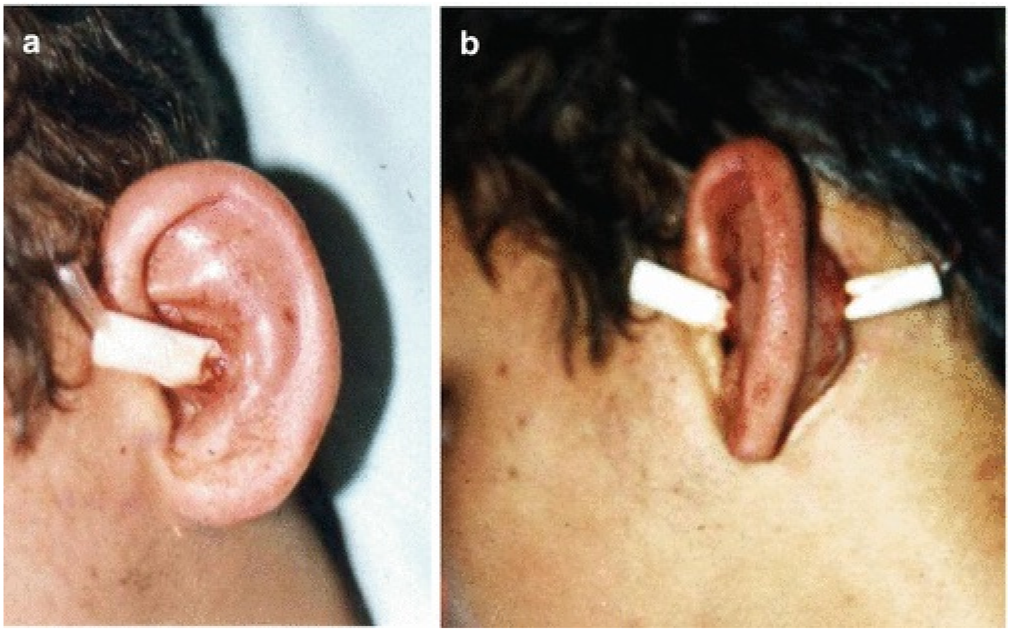

Fig. 18.2 Severe infection of left ear caused by piercing. (**a**) Anterior oblique view after drainage crossing the auricle was introduced; (**b**) profile view of the same patient

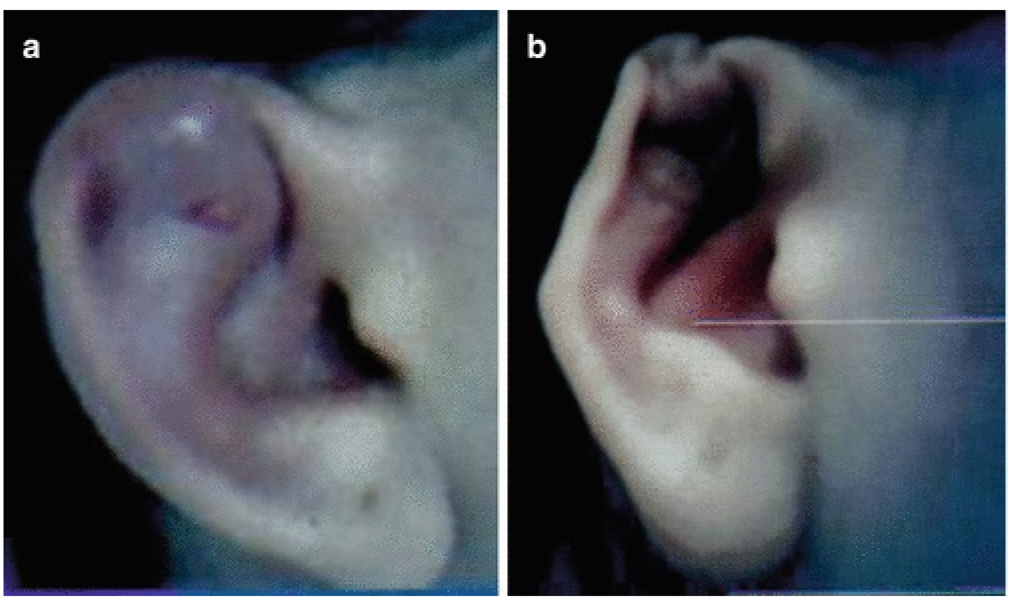

Fig. 18.3 Severe infection on the upper pole caused by piercing on the right ear of a 17-year-old girl. (**a**) The ear 3 days after the piercing; (**b**) same patient 2 weeks after intensive treatment, showing retraction of the skin due to infection

Once the deformity is established and when associated with sub-perichondral abscess and loss of cartilage, it becomes difficult to treat, due to unsightly deformities; this is known as an ear resembling a “cauliflower.”

Perichondritis is one of the more serious complications, and these days it is quite frequent, as described by Fernandez et al. (2008). The local symptoms are swelling, redness, and pain in the ear (excluding the lobule) due to the absence of cartilage (Figs. 18.1, 18.2, and 18.3). If there is a delay in treatment due to carelessness or no suspicion of infection, there can be generalized edema of the pavilion and the infection can spread to cause a subperichondral abscess with ischemic necrosis of the cartilage (Hanif et al. 2004). Due to the abscess with a floating point, surgical drainage with debridement of necrotic tissue associated with intravenous medication are recommended. (Figs. 18.1, 18.2, and 18.3). The destruction of the auricular cartilage in cases of unfavorable evolution, associated with the pleated and deforming scar, makes the success of plastic reconstruction extremely difficult to achieve (Avelar 1986, 1989).

18.3 Reconstruction of Ear Deformities

To correct ear deformities, the patient must undergo a complex cartilage graft procedure in one, two, or three surgical stages. Some deformities on the upper pole may be treated in a single stage (Figs. 18.4, 18.5, and 18.6), and two or three stages are necessary for more severe abnormalities. During the first operative stage, a new auricular skeleton is created, using rib cartilage removed from the 8th or 9th arch. In the same surgery, the new framework is carved to create the helix and antihelix, which is then carefully inserted subcutaneously to create the auricular structures (Figs. 18.7 and 18.8). It is often, necessary to use a tissue expander, since the cutaneous covering of the mastoid area is very thick and inelastic (Figs. 18.9 and 18.10). It is not ideal skin for ear reconstruction, but it is the best since it is in the area of the future auricle. After tunnelization of the skin of the mastoid area, the use of a tissue expander extends the subcutaneous tunnel created by dissection using a special instrument without damaging the vessels nearby. Thus, the skin maintains its full thickness, which is a satisfactory procedure before embedding the new auricular framework. My preference is to remove the 9th rib cartilage to excavate the new skeleton (Figs. 18.9 and 18.10).

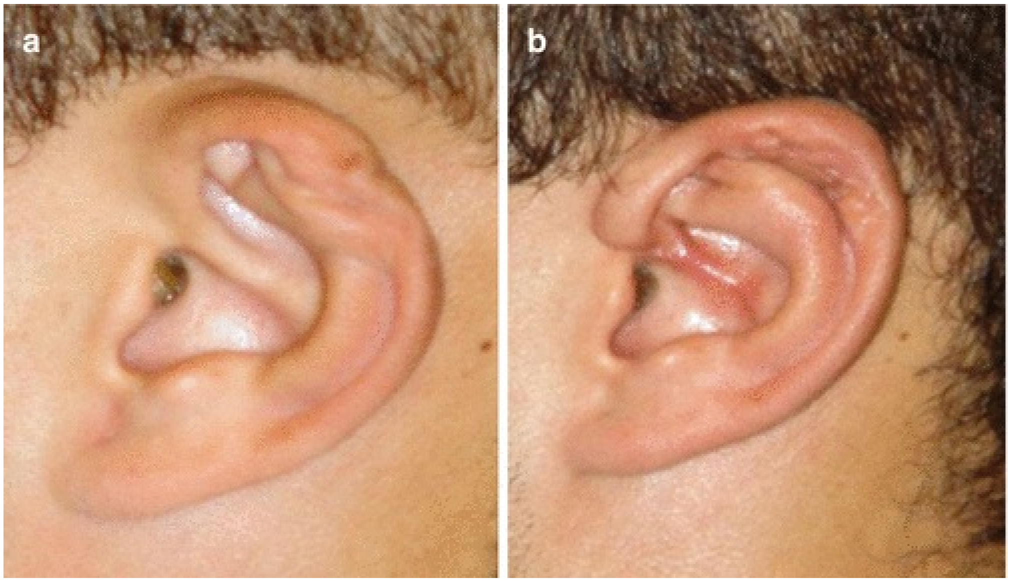

Fig. 18.4 Partial destruction of the upper pole of the ear caused by piercing followed by severe local infection. (**a**) A pre-op photo of the left ear of a 19-year-old male patient showing complex damage to the upper pole because of severe local infection; (**b**) post-op view of the same patient after reconstruction with a new “D-shaped” cartilage graft combined with forward advancement of an “island” skin flap from the retro-auricular sulcus to create the scapha

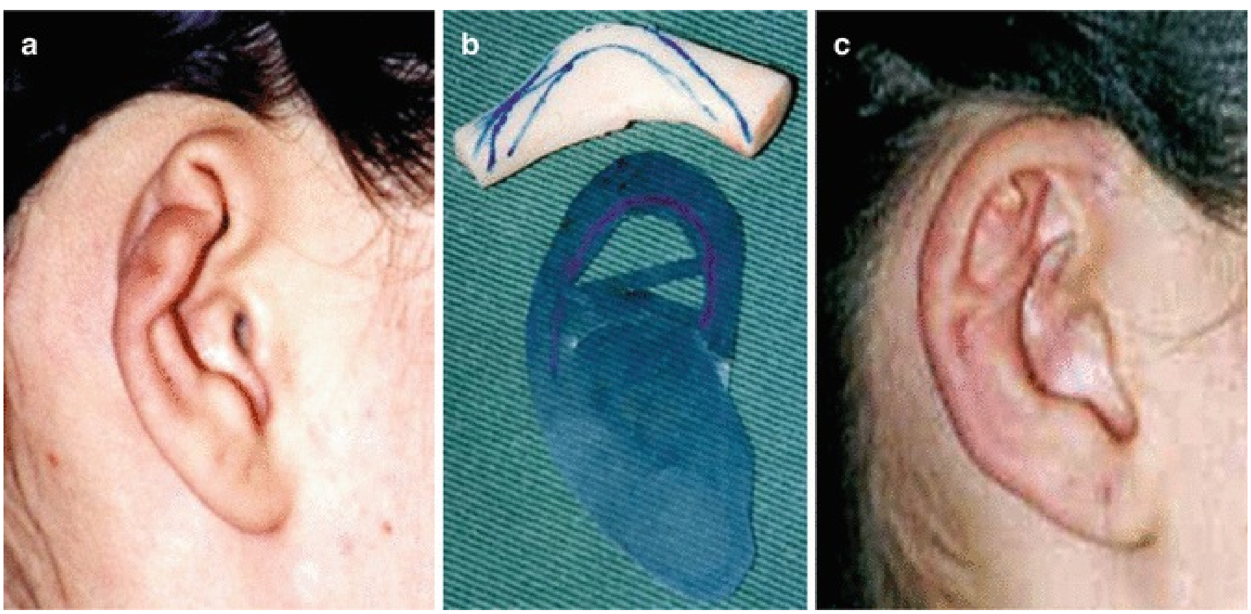

Fig. 18.5 Partial destruction of the ear caused by infection due to piercing. (**a**) Pre-op photo of the right ear of a 19-year-old girl showing unestheticc skin retraction with severe damage to the ear cartilage; (**b**) surgical planning on an X-ray of the new auricular framework on a rib cartilage to create the missing segment; (**c**) the same patient after a one-stage reconstruction with insertion of the missing framework

Fig. 18.6 Serious damage to the propeller caused by piercing the left ear of a 20-year-old man. Photographs (**a**, **d**) showing the appearance of the propeller in the preoperative period; (b) perioperative photo showing the projection of the new ear and the new helix already sculpted in the cartilage of the ribs; (**c**, **e**) same patient 1 year after reconstruction of the helix

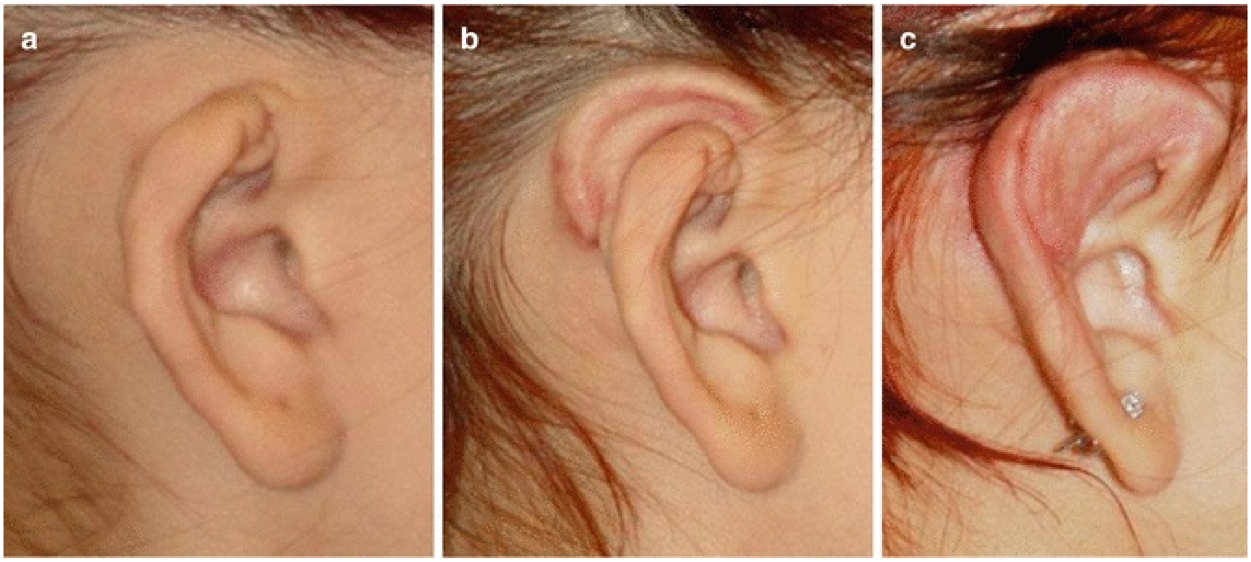

Fig. 18.7 Reconstruction of the upper pole of the ear caused by piercing followed by severe local infection with serious damage to the ear cartilage. (**a**) Pre-operative view of the right ear of a female patient after complex complication owing to the use of piercing with partial destruction of the auricular cartilage. The cutaneous covering of the upper pole was retracted and it was impossible to recreate the missing segment. (**b**) A new framework was carefully excavated on the rib cartilage to create a "D-shaped" graft that was inserted in the first stage of reconstruction according to the surgical plan; (**c**) final results after two-stage reconstruction of the upper pole of the pinna with grafting of a new auricle

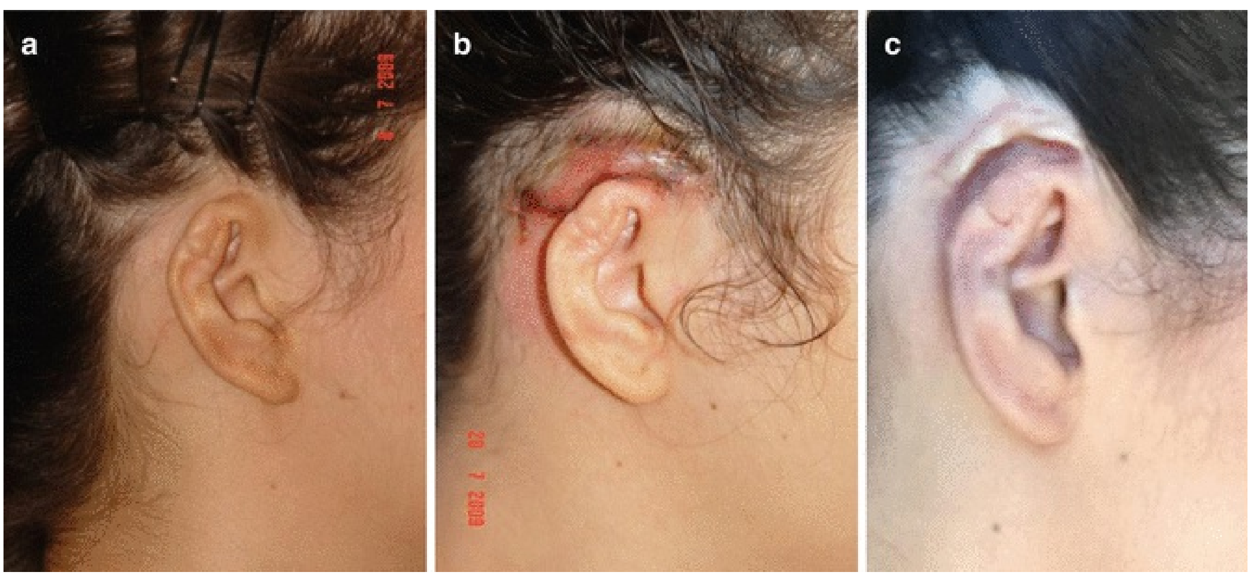

Fig. 18.8 Severe skin retraction of the superior segment of the ear caused by piercing followed by complex local infection. (**a**) Pre-operative view of the right ear of a 20-year-old female patient. The cutaneous covering of the upper pole was retracted, and recreating the missing covering was impossible. (**b**) A new framework was carefully excavated on a rib cartilage and embedded underneath the skin on the upper pole to complete the helix; (**c**)the same patient 7 years after first stage of reconstruction, since until now he could not undergo the second stage, according to the surgical plan. Skin flap of the helix

Fig. 18.9 Partial deformity of the ear caused by severe infection due to piercing. (**a**) Pre-op photo of the right ear of a 21-year-old male showing unesthetic damage with severe destruction of the ear; (**b**) same patient 1 year after insertion of the new auricular framework excavated on rib cartilage to create the missing segment; (**c**) same patient 2 years after the first stage of reconstruction; (**d**) close-up of the new auricle

Fig. 18.10 Sequential photos showing total ear reconstruction on a complex deformity on the right ear caused by severe infection due to piercing. (**a**) Pre-operative photo of the right ear of a 24-year-old male showing unesthetic damage with severe destruction on the ear; (**b**) surgical planning of the future ear; (**c**) spatial projection of the future ear; (**d**, **e**) photos showing skin distention of the future ear; (**f**) the new auricular framework excavated on the rib cartilage is being introduced through the subcutaneous tunnel created by cutaneous dissection; (**g**) the new skeleton had already been introduced through the subcutaneous tunnel auricle; (**h**, **i**) the ear was destroyed; (**j**, **k**) the same patient 6 months after the first surgical reconstruction

After surgery, special bandaging is applied in order to protect the future ear; the bandage is changed 4–5 days after the operation, and then a new one is applied and is changed every 10 days for at least 2 months. During the second surgical stage, an incision is made near the area that covers the new auricular framework in order to lift the new auricle, followed by skin grafting for closure of the raw area and maintaining its projection (Avelar 1986, 1987, 1990, 2011, 2013).

18.4 Enlargement of Ear Lobule

The use of a lobule expander of earlobes is an unusual mode of piercing application, because it promotes the creation of ample cavityfor fancydecorative objects. As described above, the earlobes are formed by only two non-cartilage skin surfaces. Due to these anatomical characteristics, adepts of piercing work usually create new features to adorn the ears. This is found in young men and women and adults, including Indians. Currently, however, some patients (men and women) who are not Indians use a similar procedure to stretch the earlobes as a body adornment and sign of beauty. Sometimes patients create unusual situations that lead to severe complications because these interventions are done by laymen, and then a surgical solution has to be sought

Regarding these kinds of body decorations, it is interesting to describe an exciting period in my life when upon graduating from medical school, I worked in the Brazilian Amazon jungle for a year, where I provided voluntary medical care. My job was to help poor people in very small towns as well as in primitive native villages. During that time, working far away from civilization, I recall that there was a tribe with peculiar customs regarding the subject matter of this chapter. An 11-year-old girl came asking for medical treatment because of bleeding from her auricular lobule. She informed me that she started to change the shape and size of her ear lobes in order to achieve the sense of beauty that was customary for her tribe. First, a small perforation was made in the center of both lobes, through which a small piece of metal or stone was hung. Afterwards, a heavier and larger piece was hung, and gradually the lobule lengthened smoothly, creating a wider circle that could progressively be long enough to turn upward and reach the upper pole of the ear. This distention of the lobule, in addition to being a decoration, gives a specific distinction among the entire population, making the girl an important female member of the tribe. However, because her lobe was destroyed by laceration, it meant that she would not be among the leading members of the tribe.

There are some non-native individuals who use the same method of elongation of the ear lobule as a matter of beauty as well as to hang objects of personal decoration. They used to come for medical care because the elongation procedure was unsuccessful, with laceration of the lobular tissue and even severe damage to the earlobe. Repair of the lobule can be carried out under local anesthesia. This condition is a unique phenomenon of tissue expansion, which is an important field in plastic surgery, particularly in ear reconstruction.

18.5 Discussion

The use of piercings is a resource seeking to use the body for adornments that can damage the organ’s structure with severe consequences from the moment it is done, as well as in the long term. It is a grisly procedure performed by laymen who do not obey the principles of hygiene and even use unacceptable principles of asepsis and antisepsis. The reasons that young people and adults permit this kind of assault against their own bodies are diverse; they include esthetics, religion, artificial identity, seeking superiority among other people, and peer pressure.

Regardless of the reasons that lead young people and adults to seek artificial identification to achieve such desires, they can only be realized by intervention procedures through the body. Such perforations are at risk for local and systemic infection from the lack of hygiene and antisepsis. There is a preference for placing objects in the ears, nose, eyebrows, lips, gums, navel, and other even the genitals. When piercing is done through the ear, it may cause severe infection with partial or total destruction of the organ. The skin has a concentration of bacteria that resides on all surfaces of it. However, after perforation and penetration of foreign bodies constituted by metallic elements, they can cause local and systemic infection, with harmful consequences for the patients..

I have had 38 patients with severe deformities in the ears caused by piercings that progressed to serious local infection that destroyed the ear cartilage (Avelar 1987, 1990, 1997, 2011, 2013). In all of my patients, the deformity is unilateral. The skin of the auricle after infection presents unesthetic retractions and folds due to severe fibrosis that developed underneath, which is similar to a “cauliflower,” and its successful reconstruction is one of the most difficult in the field of ear surgery (Fernandez 2008).

Repairing ear deformities caused by piercing requires partial or total reconstruction by creating a new auricular framework excavated from the rib cartilage. The complete treatment is performed in one, two, or three surgical stages, similar to any other traumatic ear deformity. In selected cases, it is possible to repair the upper pole in one single operation, but in most cases, two stages are necessary. During the first stage, the rib cartilage is removed and meticulously excavated in order to create all anatomical details of the missing skeleton. The new frame is embedded underneath the skin of the mastoid region after cutaneous undermining. During the post-op period, the patient must remain under the care of the surgeon and his/her team. The second stage is performed 6 months later, when a skin incision must be made that follows the rim margin of the new auricular framework previously introduced during the first stage. The raw area behind the new auricle is grafted with the skin removed from the posterior auricular surface of the opposite ear.

Conclusions

The correction of severe deformities caused by piercing is a constant challenge since there is fibrotic tissue retraction due to infection that began a few days after introducing the foreign body through the ear. In all cases, it is necessary to replace the missing segment of the auricular framework because the cartilage was destroyed by infection. Some of my patients were treated by inserting a partial segment of the frame through the remaining cutaneous covering the ear. Nevertheless, in most patients, two or three stages are necessary. The operation is performed only after complete recovery from the infection caused by the piercing. These problems are found in males as well as females.

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