ELSEVIER
SAUNDERS

FACIAL PLASTIC
SURGERY CLINICS
OF NORTH AMERICA

Facial Plast Surg Clin N Am 14 (2006) 89–102

Nuances of Otoplasty: A Comprehensive Review of the Past 20 Years

Michael J. Nuara, MD, Steven Ross Mobley, MD*

The correction of the protruding ear was first described by Edward Ely in 1881 [1] and, over the last 125 years, has become one of the most debated procedures in the field. The primary goal is to construct or recontour the ear so that it does not draw attention to itself. Differing schools of thought have evolved in parallel to offer varying techniques to accomplish the global goal of the aesthetically pleasing ear. In this article, the authors broadly categorize these two schools as "cartilage reshaping and sparing" versus "cartilage incising and excising." The latter is typified by Ely's original description of the operation. Ely described the need to remove both cartilage and skin. This reduced the overall size of the ear, thus decreasing its protrusion, yet required very precise maneuvers that relied on optimal healing. Even small imperfections can give the appearance of an operated-on ear, thus negating the primary goal. Almost a century later, the second school of thought emerges with Mustarde's [1a] description of a cartilage-reshaping suture technique in 1963. Mustarde popularized the practice of cartilage-sparing techniques and relied more on reshaping the ear with horizontal mattress sutures. These techniques have also suffered some downsides, such as recurrent deformity, stimulating the 40 years of debate that followed. Today, evolved versions of both of these schools of thought continue to be presented in the literature. The goal of this work is to present the latest practices with a focus on some of the finer nuances of modern otoplasty. A literature review of the last 20 years was performed, and articles of particular interest are highlighted. The authors hope to provide a concise reference of the vast body of literature on the subject in an organized and thoughtful manner.

Pertinent anatomy

Appropriate surgical planning relies on a thorough understanding of the complex three-dimensional anatomy of ear. The auricle develops from the first branchial groove and has its rudimentary shape by the eighth week of gestation. The ultimate shape is essentially determined by 20 weeks gestation, and

Division of Otolaryngology–Head and Neck Surgery, Department of Surgery, University of Utah School of Medicine, 50 N. Medical Drive, 3C120, Salt Lake City, UT 84132, USA
* Corresponding author.
E-mail address: steven.mobley@hsc.utah.edu (S.R. Mobley).

doi:10.1016/j.fsc.2006.01.007
facialplastic.theclinics.com

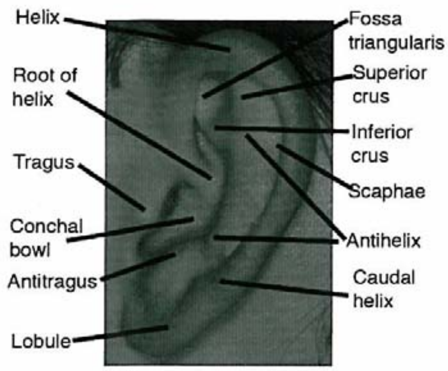

Fig. 1. External lateral anatomy of the auricle.

85% of growth occurs by age 5. The major visible and palpable landmarks of the ear are reviewed in Fig. 1. The longest dimension of the ear is tilted approximately 15° to 20° posteriorly to the vertical. The average width of the ear is 55% of its length [1b]. The lobule should rest in a straight line with the helical cartilage when viewed from the front.

The blood supply to the auricle is provided by branches from the external carotid artery. The superficial temporal artery supplies much of the anterior portion, including the lobule, whereas the posterior supply is derived from the posterior auricular artery. An extensive anastamosis between theses arteries provides a rich blood supply enabling diverse range of surgical manipulations. The venous drainage replicates the arterial supply in reverse. The parotid lymph nodes and posterior auricular nodes with further contribution from level 2 and level 5 cervical beds serve lymphatic drainage. Sensory innervation has contributions from the auriculotemporal branch of V3 and the great auricular nerve. Small areas are also served by distal branches of the lesser occipital and facial nerves [1b].

The most common indication for performing otoplasty is the prominent ear, a condition sometimes referred to as prominotia. Other indications for otoplasty include trauma, cupped ear deformity, or to correct a previous poor result. Primary surgery for repair of the prominent ear will be the focus of this discussion. Prominotia occurs as a result of one or more anatomic variants. Most often there is a lack of an adequate antihelix; the ear is less furled back on itself and thus protrudes from the skull. The defect itself may be associated genetically with a prominent antitragal muscle, based on cadaver studies [2]. This may contribute to recurrence if not addressed at the time of surgery. Another common anatomic finding in patients with prominent ears is a relative excess of conchal

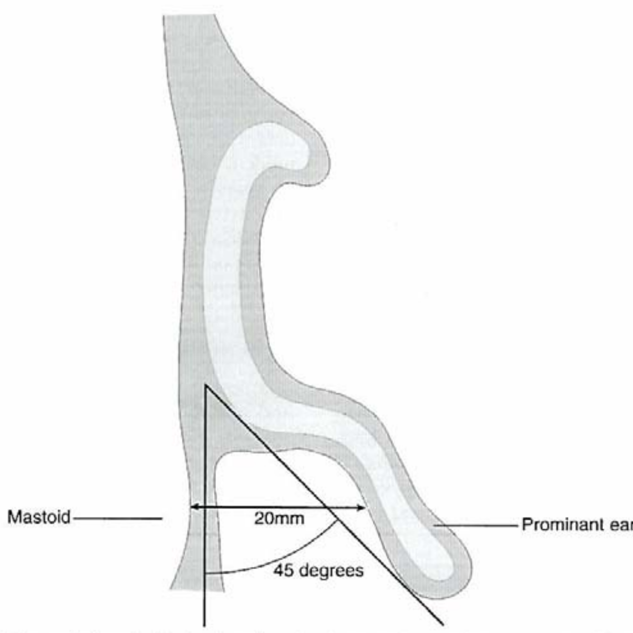

Fig. 2. Depiction of the cephaloauricular (CA) angle. Also shown is the CA distance. Normal distances are 12 mm to 15mm, whereas distances greater than 20 mm are considered prominent.

bowl cartilage. Guerra and colleagues [3] have also noted variation in the postauricular muscle complex and where it inserts on the conchal bowl, another factor contributing to auricular protrusion. A third component can be an ear lobule that is excessive in size or positioned laterally [1b].

Anatomic norms for human ears have been established, thus it is possible to more objectively quantify patients who have irregular, prominent ears. The cephaloauricular (CA) angle, defined as the angle of projection from the mastoid to the helix, should normally be less than 45° [Fig. 2]. This CA angle is postulated by Richards and colleagues [4] to be a measure of successful surgical outcome. Also, norms of auricular protrusion from the skull have been quantified, with protrusions greater than 20 mm being excessive. There may also be a poorly defined helix.

Preoperative evaluation

The preoperative evaluation should focus on four key areas:

1. Analysis of the physical attributes of the ear(s)
2. Emotional and mental preparation of the patient and family
3. Selection of appropriate surgical technique to address the deformity
4. Selection of optimal anesthetic technique and positioning

Analysis begins with a meticulous evaluation of the anatomy, including the CA angle, protrusion, the extent of caudal helices, and any other deformities. These features can be subtle or quite exaggerated. It is common for patients to have different combinations of these abnormalities on either ear. Often, a single patient will have a rather different deformity on one side compared with the other. It may be equally severe, but awareness of the potentially different contributions of deformities on either side is crucial if symmetry is to be attained. Often, photographs are helpful. A basic series should include full facial frontals and laterals of both ears. Frontal close-ups, obliques, and posterior images of each ear are also helpful.

Just as important as the anatomic irregularities of the auricle are the expectations of the patient and family. It is important to discuss the potential outcomes and complications, and to ensure the patient has realistic expectations. For children it is important to remember that the parents may have very rigid views of what they are expecting from the surgery, and these expectations need to be openly discussed. The importance of diligent postoperative care to avoid unwanted complications must be established before surgery. When counseling younger patients and their families, the ability of the younger otoplasty patient to appropriately participate in postoperative care and protection of the dressings should be addressed.

In considering the proper surgical technique, there is room for surgeon preference and vision, yet one must consider the anatomy. The anatomic factors that lead to prominotia were discussed previously. The discussion later addresses many of these points individually. The surgeon should develop a complete surgical plan that is a conglomerate of the individual techniques necessary to correct each observed anatomic irregularity. For example, a cartilage-sparing technique can address the antihelix, excising cartilage can be used simultaneously to reduce the concha, and skin incision modification may be used to address the lobule. Sometimes a single technique may simultaneously correct more than a single irregularity, such as a modification of a postauricular skin incision that will provide access to cartilage as well as medialization of the lobule. It is important in surgical planning to remember that the cartilage becomes more calcified and brittle with age.

Anesthesia and positioning are integral in the surgical planning. Although anesthesia is discussed in more detail later in the article, the preoperative evaluation is the time to discuss this issue with the patient or family. For children it is also important to determine any complications or contraindications for receiving general anesthesia. In adults, otoplasty is often performed under local or local with intravenous sedation, yet co-morbidities may still be important. As with all surgical patients, a full history and basic physical exam is warranted. As ear development occurs at the same gestational age as other organs such as the kidneys and heart, a thorough review of these organ systems should also be performed. With regard to positioning, the supine position has been the position of choice, simply out of convention. Manushakian and colleagues [5] in contrast, describes using prone positioning in more than100 cases and describes this method as advantageous in allowing constant comparison with the contralateral ear without the need for repositioning. Patients in this study were surveyed and reported the prone position as comfortable and noted overall excellent satisfaction with surgical results.

Operative technique

The basic goals of otoplasty were summarized by McDowell [6] in 1968 and are listed in Box 1. As symmetry is key, it is recommended to begin with the more challenging ear.

Box 1: McDowell's basic goals of otoplasty

1. All upper third ear protrusion must be corrected.
2. The helix of both ears should be seen beyond the antihelix from the front view.
3. The helix should have a smooth and regular line throughout.
4. The postauricular sulcus should not be markedly decreased or distorted.
5. The helix to mastoid distance should fall in the normal range of 10 mm to 12 mm in the upper third, 16 mm to 18 mm in the middle third, and 20 mm to 22 mm in the lower third.
6. The position of the lateral ear border to the head should match within 3 mm at any point between the two ears.

Skin incision

Generally, a postauricular skin incision is used to avoid a scar on the anterolateral surface of the auricle. Although most investigators have advocated an excision of skin, some have described a simple incision [7,8]. If skin is excised, care must be taken not to remove excessive skin from the middle third, as this can contribute to a "telephone ear" deformity. This occurs when the middle portion is reduced to a relatively greater degree than the superior helix and lobule. This overcorrection in the middle breaks the straight line of the caudal helix and leaves a relatively overprojected superior helix and lobule, giving the ear a convexity similar to the shape of a traditional telephone. Telephone ear deformities can also occur later on if portions of the correction fail whereas other portions persist. The reverse phenomenon can also occur if

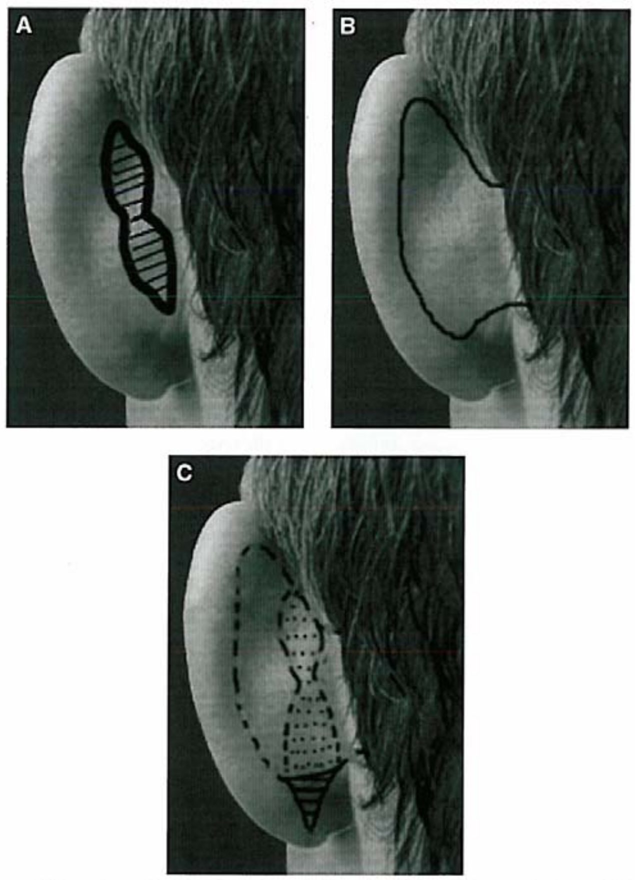

Fig. 3. Skin incisions: (*A*) Standard dumbbell incision with excised skin. (*B*) Medially based flap. (*C*) Including a lobule-correcting skin excision with either of the above (*dotted lines*).

Fig. 4. Bending the helix toward the mastoid will reveal a natural place for placement of the neo-antihelix.

relatively less mid-portion correction is performed. This is termed a reverse telephone deformity. For these reasons, most surgeons will perform a dumbbell-shaped incision [Fig. 3]. Nolst Trenite [9] recommends leaving at least 1 cm on either side to avoid the ear appearing "glued-on," with the scar falling too close to the crease.

In contrast to the dumbbell excision of skin, an alternative approach is to start with a simple incision and excise skin as needed after correction of the cartilage and at the end of the procedure. Others describe creating a medial-based skin flap that is re-draped over the posterior auricle at the end of the case and excising the distal portion of the skin flap as needed to precisely fill the defect without tension or excess [10]. The advantage of this approach is that it is tailored to the end result rather than creating it. The skin flap technique along with simple incision technique benefits from tension-free closures, which may reduce the incidence of hypertrophic scars. The skin incision can be extended inferiorly to aide in lobule correction as well (see later discussion).

Shaping the cartilage: general principles

Many cases of prominotia will require reshaping of the antihelix. A practical and effective way to determine how much reshaping is needed is to bend the antihelix with digital pressure and then mark how the new anti-helix should look. This will serve to demonstrate how a natural-looking antihelical fold has a gentle anterior curve to it [Fig. 4].

As stated earlier, a review of the literature of the past two decades leads to the conclusion that there remain two major schools of thought in otoplasty. The first school of thought is that a cartilage incision is required and stems from Ely's original description [1]. This procedure is generally performed in one of two ways. The first is by making an incision in the cartilage along the neo-antihelix, scoring the cartilage to allow it to fold to create the antihelix curvature. A separate cartilage-cutting technique starts with a through-and-through cartilage incision to gain access for an aggressive scoring of the anterior surface of cartilage [Fig. 5]. This technique relies on the cartilage scoring alone to weaken the cartilage preferentially on the anterior surface, thus allowing it to fold on the undisturbed tighter matrix of the posterior surface.

The other school of thought, introduced by Mustarde [1a] in 1963, focuses on preserving the cartilage and relies more on reshaping the cartilage with precisely placed sutures [Fig. 6]. Mattress sutures are placed into the cartilage posteriorly between the new antihelix and the conchal bowl. They are then tightened to the extent required to appropriately reduce the defect and create an antihelix. To create the superior crus, the same type of stitch is secured

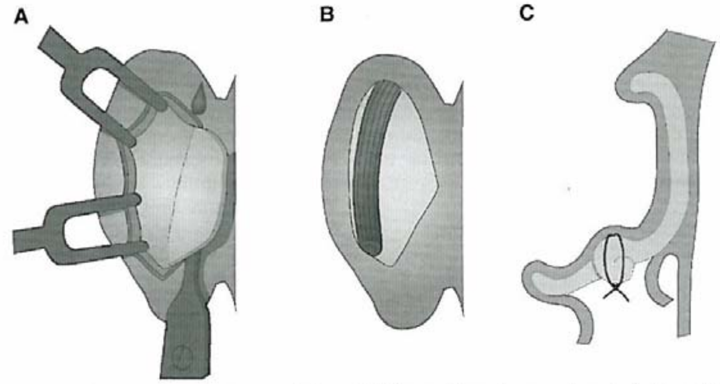

Fig. 5. An example of the cartilage-incising technique. (*A*) The cartilage is exposed posteriorly and incised along the neo-antihelix. (*B*) The cartilage is then scored on the anterior surface as it is rolled posteriorly. (*C*) The cartilage is then sutured in place.

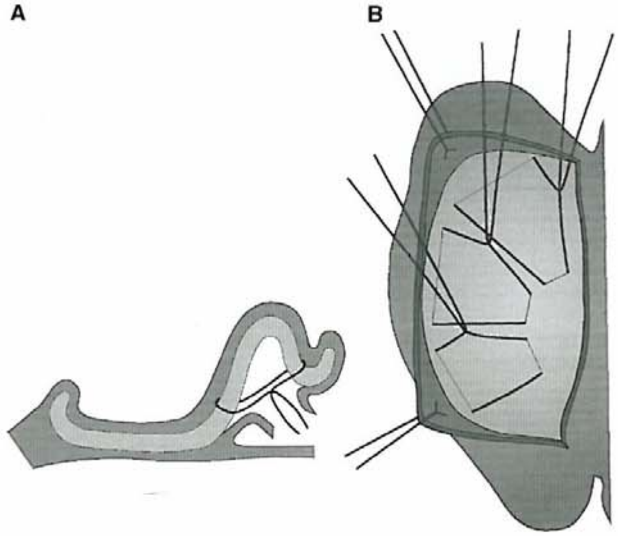

Fig. 6. Mustarde stitch. (*A*) Side view of a constructed antihelix by precise tension placed on mattress sutures between Helix and conchal cartilage. (*B*) Posterior view.

onto the fossa triangularis. Furnas [25] described an additional set of sutures to join the conchal bowl to the mastoid in a similar fashion to reduce this portion of the prominent ear.

The most recent advancements in otoplasty have been in fine-tuning these techniques with modifications directed at their weaknesses. For example, criticisms of the cartilage-sparing technique have focused on the relatively high rate of loss of correction from the Mustarde approach alone (up to 25%) or the possibility of stitch extrusion (up to 15%) [11]. In contrast, a cartilage-cutting approach where cartilage remodeling is performed has the risk of sharp edges and the appearance of an operated-on ear. These irregular edges are essentially not seen in cartilage-sparing techniques. See Table 1 for a comparison of recurrence and complication rates of cartilage-incising versus cartilage-sparing techniques. Many of the reviewed reports discuss combination approaches and modifications, using specific advantages of each while attempting to avoid the potential complications.

Shaping the cartilage: incisional technique modifications

In an attempt to reduce the sharp edges created from cartilage incising, cartilage scoring is often used to soften and weaken the cartilage. Many different tools have been used to score cartilage. With a posterior incision, access to the anterior surface of cartilage is via a full-thickness cartilage incision [Fig. 5]. The instrument used is limited by the degree of anterior dissection. Tan and colleagues [12] advocate the widely available Adson-Brown forceps as their scoring instrument of choice. Di Mascio and colleagues [13] report a cartilage-incising procedure that uses a dermabrader drill to score the anterior surface of the cartilage. A conchal-mastoid suture is added if needed to further reduce the angle. In a series of 75 treated ears, this dermabrader technique resulted in three hematomas (4%), four undercorrected ears (5%), and one asymmetry. Azuara [14] reports his experience using a no.15 multi-blade to make hemitransfixion incisions in a cartilage-cutting technique, where the cartilage incisions allow a tension-free rolling of the cartilage posteriorly. The folded cartilage is further secured with two posteriorly placed nylon sutures. Rubino and colleagues [15] have further modified this same technique by a more extensive dissection from the anterior surface of the antihelix up onto the anterior surface of the helix itself. Additional scoring of helix curvature is used to address the superior third and prevent a "telephone ear" deformity.

In the literature on cartilage incising, one study is particularly notable for its large study size of 500 patients with follow-up ranging from 0.5 to 62 months. In this series, Caouette-Laberge and colleagues [7] describe a unique method of avoiding a telephone ear deformity. This technique involves an extensive amount of auricular de-gloving and multiple cartilage incisions. Tension in the upper third is released by separating the cartilage at the root of the helix to create a "mobile handle." The freed nature disrupts the forces that often lead to the upper arch of the telephone ear deformity. This handle then does not necessarily require suture fixation; rather, it will freely follow the curvature obtained from remodeling of the antihelix. In this series, hematoma developed in only two patients (<1%), injury or scarring of anterior skin occurred in three cases (<1%), residual deformity in 22 cases (4%), and asymmetry in 28 (6%). Use of a separate surgeon for either ear independently led to an increase in asymmetry. A younger age of patient was also associated with greater occurrences of deformity or asymmetry after surgery.

Nolst Trenite [9] uses a scalpel to make multiple partial-thickness cartilage incisions, but stresses the importance of not incising the anterior surface perichondrium. In this approach, mattress sutures, similar to a cartilage-sparing technique, are added posteriorly to set the final position. This is a true combination technique that uses aspects of both cartilage incising and suture reshaping which, in theory, allows precise control of formation of an antihelical fold and the relation of the helix to this fold. He reports 2 of 65 cases where sharp edges were noticeable, and two "telephone-ear" deformities from poor suture placement.

Shaping the cartilage: cartilage-sparing modifications

Cartilage scoring has also been used in cartilage-sparing techniques, that is, techniques that do not involve a through-and-through incision of the cartilage. Recently, Epstein and colleagues [16] proposed using electrocautery on the posterior surface of the cartilage to weaken it along the neo-antihelix, superior, and inferior crus, thus augmenting mattress sutures by decreasing overall tension on the sutures. They reported 6 of 60 (10%) of patients requiring revision for return of protrusion in one ear and no cases of chondritis or necrosis. These numbers compare favorably to other published studies (see Table 1).

Alternatively, cartilage scoring on the anterior surface of the auricle can be performed without making full-thickness cartilage cuts. Bulstrode and colleagues [17] report on their experience using a precisely bent hypodermic needle to perform percutaneous cartilage scoring followed by posterior mattress suturing. They report no sharp edges or extruding stitches, and 6 patients of 114 (5%) with superior undercorrection. Fritsch [18] also describes an approach that is done using mattress sutures without ever making an incision. A 21-gauge needle is used to score the cartilage anteriorly through a puncture site, and Mustarde-type mattress sutures are placed percutaneously with the goal of the suture passing sub-perichondrially, with a common entrance and exit site. Yugueros and Friedland [19] also report on a combined approach with anterior scoring through a small anterior incision, Mustarde type mattress sutures, and conchal-mastoid sutures. They report undercorrection in 7 (4%) and stitch extrusion in 19 (10%) of the 193 ears in this series.

When a cartilage-sparing technique uses permanent mattress sutures placed under tension in the postauricular area, there is a very real concern for suture extrusion with possible loss of correction. Suture extrusion occurs with Mustarde or Furnas-type suturing, with as much as 15% reported [20]. Horlock and colleagues [11] have proposed a method for virtually eliminating problems with extrusion by raising a postauricular fascial flap. In this technique, rather than dissecting a single subperichondrial plane, a separate plane is dissected subdermally first and followed by the cartilage exposure to leave a mastoid-based fascial flap that can be repositioned over the sutures and provide a layer of protection to prevent extrusion. This technique did not significantly change the incidence of loss of correction when compared with other studies but did eliminate stitch extrusion.

Shaping the cartilage: putting it all together

By understanding the principles behind the various techniques outlined previously, individual surgeons can begin to form surgical strategies based on personal surgical philosophies. As one example, Foda [21] chooses to sequentially apply different techniques and modifications until the desired shape is obtained on the table. In this graduated approach, he describes correction of the antihelix as the initial step. If further correction of the ear is needed, then the concha or the lobule is addressed with respective techniques.

In contrast to this graduated approach, Spira [8] advocates a more aggressive approach with all cases to avoid the potential for loss of correction. In this method, a small anterior incision is made under the helix in the scapha to gain access for anterior cartilage scoring. Next, a posterior incision that also addresses the lobule is made, and mattress sutures are applied to address the antihelix with additional sutures for the conchal mastoid area. Spira advocates that every otoplasty case should include some degree of antihelix and conchal reduction with the addition of further adjustments for the root of the helix and the lobule as needed.

One major difficulty in trying to evaluate more objectively these two schools of thought or their modifications is a paucity of literature of actual head-to-head comparisons of the two surgical philosophies. To the contrary, most reports are introducing a new modification or combination technique without direct comparisons. Many are

Table 1: Complication rates reported in literature on otoplasty by author, year, and technique

Otoplasty	Author	Year	Patient number	Method	Recurrence or residual deformity (%)[a]	Suture extrusion (%)	Skin necrosis (%)	Hematoma (%)	Bleeding (%)
Cartilage Incising	Chongchet	1962	21	Cartilage incising and scoring	10	0		5	
	Tan	1985	101	Cartilage incising and scoring	9.9 + 4.4	0			8
	Calder and Nasaan	1994	562	Cartilage incising and scoring	8	0	1.4		2
	Jeffery	1999	118	Cartilage incising and scoring	12.7	0	1.7	3.4	
	Caouette Laberge et al.	2000	500	Cartilage incising and scoring	4.4	0	0.6	0.4	2.6
	Peker et al.	2002	178	Cartilage incising and scoring	0	0	0	2.2	5.6
	Kompatscher et al.	2004	14	Cartilage incising and scoring	50			7.1	
	Panettiere et al.	2004	33	Cartilage incising and scoring	4	0	0	0	
	Trenite	2004	65	Cartilage incising, scoring, and suturing	4.6			0.0	
	Di Mascio et al	2004	40	Cartilage incising and scoring +/– suturing	5.0			7.5	
	Rubino et al.	2005	10	Cartilage incising and scoring	0	0	0	0	10

Cartilage Sparing	Rigg	1979	101	Cartilage suturing	2	11			
	Minderjahn et al.	1980	135	Cartilage suturing	12.3				
	Attwood and Evans	1985	52	Cartilage suturing	0	4.6			2.2
	Tan	1986	45	Cartilage suturing	24.4	15			33
	Adamson et al.	1991	55	Cartilage suturing	6.6	8.4			0.8
	Foda	1999	39	Cartilage suturing	5.1	12.8	0	0	0
	Yugueros et al.	2001	100	Cartilage suturing with anterior scoring	5.0	10.0			
	Horlock et al.	2001	51	Cartilage suturing with fascial flap	11.8	0	0	0	2
	Bustrode et al.	2003	114	Cartilage suturing with anterior scoring	0.9 + 5.3	0	0	0	0.9
	Kompatscher et al.	2004	14	Cartilage suturing with anterior scoring	14			0	
	Panettiere et al.	2004	30	Cartilage suturing with posterior scoring	2	0	0	0	0

[a] Where reported, recurrence and residual deformity are reported, respectively, with a "+" sign. In regard to residual deformity, this was a subjective measure by either the author or the patients in the study and may differ in criteria.

presented in a "how I do it" style without an in-depth discussion of their experience with regard to outcomes measures and complication rates. Furthermore, using patient or surgeon satisfaction is often a subjective measure that is of questionable reliability for objective comparison. One European group compared a cartilage-cutting method of incising and folding the cartilage to reconstruct an antihelix with a modified mattress suture technique that included anterior scoring [22]. A matched-paired group of 28 patients was selected and compared by the length and breadth of the ear; the superior, medial, and inferior cephaloauricular distances; and the conchoscaphal angle as well as by using the Strasser evaluation system for appearance [23]. They observed a statistically significant greater amount of asymmetry and decreased patient satisfaction when cartilage is incised. A similar study reported by Panettiere et al. compared a cartilage-incising technique versus a cartilage-weakening and mattress suture technique, wherein weakening was performed by scoring along the posterior surface of the cartilage where the neo-antihelix was to be created. This study involved 33 patients in the cartilage-incising group and 30 patients in the weakening group in a follow-up of 12 months. Comparison was made by a blinded, independent plastic surgeon's review of follow-up photos [24]. Ninety-two percent of the ears in the cartilage-incising technique group had noticeably sharp edges, whereas none of the weakened and sutured ears displayed this irregularity in follow-up. Both methods were without recurrence in a 12-month follow-up. These studies reinforce the notion that the cartilage-cutting techniques potentiate more noticeable edges.

Conchal bowl

Addressing the conchal bowl follows a similar philosophy to addressing the antihelix. The majority of articles reviewed seem to confirm the practice of correcting the antihelix first and, if excess protrusion persists, addressing the conchal bowl as an adjuvant. Rarely is the conchal bowl the only element requiring repair to correct auricular prominence. There is a well described and broadly practiced cartilage-sparing technique popularized by Furnas [25]. This approach uses permanent conchal-mastoid sutures to medialize the conchal bowl to the mastoid periosteum, thus reducing auricular protrusion. As in antihelical reshaping, the risk of suture extrusion is present, but many of the articles reviewed do not distinguish between the extrusion of conchal mastoid sutures verus antihelical-reshaping sutures.

Other techniques to control conchal bowl prominence involve separating the cartilage where the concha meets the tail of the helix and removing an adequate portion along the conchal rim. The cartilage must then be reapproximated. Proponents of this technique claim that this cartilage incision hides well in the natural convexity of the junction of the conchal bowl and antihelical complex. At times the posterior surface of the conchal bowl may have a prominent convex protrusion of cartilage. This can usually be shaved flush without making a full-thickness cartilage incision.

Lobule

The lobule is the lower noncartilaginous third of the auricle. It can be an overlooked component of the prominent ear. Lobule protrusion is thought to occur either as a result of excess skin or positioning that is determined by the caudal end of the helical cartilage. As stated earlier, the lobule should rest in a straight vertical line followed along the caudal (inferior) portion of the helix. Furthermore, the resting position of the lobule depends on the relative position of the caudal helix to the conchal bowl. Some investigators advocate separating the helical cartilage from the conchal cartilage to enable a more medial repositioning of the caudal helix to the conchal cartilage, thus medializing the ear lobule as well [7].

Alternatively, Gosain and Recinos [26] advocate a single stitch approach. In this technique, a "point of control" is determined in the posteromedial aspect of the lobule, near the posterior sulcus, that can be used to manipulate the entire lobule as a unit. This "point" is secured to the mastoid region. The excess skin is then excised and the incision is closed [see Fig. 3C].

Helical rim

One further consideration in the prominent ear, not mentioned elsewhere, is the helical curl itself. Often this can be flattened and floppy, further contributing to the overly abnormal appearance. Few investigators have focused on this particular aspect. One study does describe a simple wedge excision along the helix alone without extending into the scaphae [27]. This shortens the outermost edge of the helix, enhancing its curl inward. This is used as an adjunct when the helix itself is noticeably flattened.

Wound care/dressings

In this review, none of the studies particularly addressed the reasoning for the style of postsurgical dressing used or its duration. Furthermore, no investigations correlated a difference in surgical outcomes to the dressing type or duration. This point may have clinical implications and deserves further investigation. However, some investigators did provide detail about the choice of surgical dressings. Aygit [28] reports an anterior-scoring procedure combined with conchal mastoid sutures and placement of a custom-made mold for 2 weeks postoperative. Azuara [14] uses a moldable porous polyester splint in a similar fashion for 72 hours with a compression dressing fulltime for the first week postoperatively followed by 1 month of nighttime compression. Bulstrode and colleagues [17] pack the crevices of the ear with cotton wool and places elastic tape as a dressing for 1 week after the percutaneous scoring technique discussed earlier. Approaches to postoperative care vary greatly in style and duration, yet, without means for comparison, little can be drawn from these descriptions.

Anesthesia/positioning

Current trends in aesthetic surgery have moved toward local anesthesia combined with sedation, as opposed to general anesthesia, in an effort to reduce the potential surgical morbidity related to general anesthesia [29]. Remifentanil has gained specific popularity due to its rapid effect and high patient tolerance for such indications. Ferraro and colleagues [30] compared remifentanil with propofol and midazalom in otoplasty (and blepharoplasty) patients for intraoperative comfort, postoperative comfort, and neuroendocrine stress. Their findings suggest remifentanil is superior in patient tolerability and intraoperative pain management through these biochemical measures, thus illustrating its safety and efficacy in ambulatory surgery.

Regardless of whether general anesthesia or monitored sedation is used, the use of local anesthesia results in decreased postoperative narcotic use and decreased pain scores [31]. Kawamata and colleagues [32] investigated this idea in an experimental model. In this experiment, human volunteers received local infiltration with lidocaine either before a 4-mm incision in the forearm or 30 min after incision. In the pre-anesthetized group, the acute, most intense, phase of pain was nearly eliminated for up to 4 hours after the incision. Those that received anesthetic only after the incision had significantly higher pain readings at various postoperative time intervals up to 4r hours. From this experimental research, one could extrapolate the usefulness of pre-incision local anesthesia as an adjunct in managing postoperative pain. This translates into fewer admissions for pain management after ambulatory surgery [31].

Local anesthesia can be delivered in a number of ways. A peripheral nerve block can provide broad range analgesia with one injection, as opposed to local infiltration, which must be precisely placed to have the appropriate effects. When comparing a nerve block with bupivacaine versus surgical site infiltration of lidocaine with 1:200,000 epinephrine, Cregg and colleagues [29] found no significant difference in postoperative nausea or opioid use. Local infiltration, however, has the added benefit of hemostasis when low-dose epinephrine is included. Several studies have indicated that the concentrations of epinephrine greater than 1:200,000 do not provide greater vasoconstrictive benefits [33–36]. However, low concentrations of epinephrine have a dose-dependent effect on duration of analgesia from 1:3,200,000 to 1:200,000 [36]. In this study, the effect was a 200% increase in duration. The same effect, however, was seen between 1:50,000 and 1:200,000.

There are multiple choices of substances available as local anesthetics, including prilocaine, lidocaine, mepivicaine, bupivicaine, and ropivicaine. In one German study, Koeppe and colleagues [37] found that prilocaine and lidocaine were most commonly used while ropivicaine had the lowest side effect profile. Another study on ropivacaine found it to have comparable efficacy to bupivacaine specifically in otoplasty, but with a more desirable risk profile [38].

In children, general anesthesia has broadly been accepted a reasonable choice; however, at least one group is looking at the possibility of using local anesthesia with conscious sedation in children [39]. They note similar surgical results with less need for hospital stay and less postoperative nausea. Of 41 children aged 4 to17 who received only local anesthesia, none had to be admitted to the hospital and no child experienced postoperative vomiting. Nearly half of those who had received general anesthesia experienced vomiting, and 2 of the 44 were admitted. This proves that in appropriately selected children local anesthesia should at least remain an option.

Another issue of concern with regard to otoplasty in children is timing. Like many procedures involving the child's face, there is a concern about how the operative site will respond to pressures of normal growth. Given that children often start preschool at age 4, this is an important social landmark for parents of children with visual deformities. The concern for ridicule and its effect on social development has been clearly illustrated [10,40]. For this same reason, many children are not referred for otoplasty until teasing becomes an issue.

The misconceptions associated with congenital ear deformities dates back to the beginning of civilization [41]. These misconceptions are transferred from society to the child. In a study by Sheerin and colleagues [42], a cohort of 47 children with prominent ears was evaluated by a psychiatrist before undergoing surgical correction. The analysis was compared with 32 children with port-wine stains and 21 children without deformities, and matched by socioeconomic status. In contrast to the port-wine stain group, those with prominent ears rated themselves lower in physical appearance and athletic ability self-assessments and had difficulties with internalization, externalization, and concentration anxiety. In addition, the children with prominent ears reported significantly more teasing among their peers [42]. Teasing often occurs even within the family unit and can have a serious impact on psychosocial development and behavior [40]. With respect to ear reconstruction specifically, Horlock and colleagues [10] found 74% of adults and 91% of children reported an improvement in self-confidence resulting in improved quality of life.

Future directions

Until recently, few surgeons felt comfortable operating on the ear of a young child due to concerns about longevity and altered growth. In a cohort of 12 patients with prominent ears, Gosain and Recinos [43] demonstrate that otoplasty can be safely performed under age 4 without significant effect on ear growth. This was well demonstrated in three unilateral cases where comparison could be made with the contralateral ear. This study was limited in its small sample size but leaves optimism for future efforts.

Few basic science studies focus on otoplasty. Some recent research has been reported on cartilage reshaping in animal models. Preliminary studies using hyluronidase and elastase injected into rabbit ears show statistically significant cartilage remodeling compared with saline alone when splinting is applied [44]. Several investigators have applied splinting to prominent ears that were identified at birth with promising long-term results when applied within the first 3 days of life [45–50]. The Auri method is an example that uses a plastic clip device at night with a clear adhesive tape in the day to hold the auricle in a position that forces an antihelix. Treatment times were daily for 1 to 10 months. There is a substantial compliance-related drop-out. Good correction is reported as high as 34% with an additional 55% with fair correction [50]. The combination of this splinting technique with the use of injectable cartilage molding compounds may have promising applications in a broader range of age groups and potentially shorter treatment times.

Summary

Otoplasty is a century-old procedure that has undergone many modifications over the years. We continue to learn more about the advantages and disadvantages of various anesthetic techniques. There is room for further research in the areas of the role of postoperative dressings as well as the future possibilities of nonsurgical tissue engineering methods of auricular reshaping. A debate remains about the most appropriate surgical techniques. From review of the most recent practices among plastic and facial plastic surgeons around the globe, it appears that there remains a great deal of variability not only in techniques but also in the manner in which they are evaluated [51–67]. Objective measures include such items as recurrence of complication rates or anatomic measurements of angles and distances. More subjective measures dominate the literature and may include perceived asymmetry, surgeons' satisfaction, or patients' satisfaction. The choice of which procedure to use is up to the reader.

References

[1] Ely ET. An operation for prominence of the auricles. Arch Otolaryngol 1881;10:97.
[1a] Mustarde JC. The correction of prominent ears using simple mattress sutures. Brit J Plast Surg 1963;16:172–6.
[1b] Pham TV, Early SV, Park SS. Surgery of the auricle. Facial Plast Surg 2003;19(1):53–74.
[2] Bennett SP, Dagash H, McArthur PA. The role of the antitragicus muscle in plical folding of the pinna. Plast Reconstr Surg 2005;115(5):1266–8.
[3] Guerra AB, Metzinger SE, Metzinger RC, et al. Variability of the postauricular muscle complex: analysis of 40 hemicadaver dissections. Arch Facial Plast Surg 2004;6(5):342–7.
[4] Richards SD, Jebreel A, Capper R. Otoplasty: a review of the surgical techniques [review]. Clin Otolaryngol 2005;30(1):2–8.
[5] Manushakian HS, Wilson PA, De Souza BA, McGrouther DA. The prone position in otoplasty. Plast Reconstr Surg 2005;115(3):963–4.
[6] McDowell AJ. Goals in otoplasty for protruding ears. Plast Reconstr Surg 1968;41:17–27.
[7] Caouette-Laberge L, Guay N, Bortoluzzi P, Belleville C. Otoplasty: anterior scoring technique and results in 500 cases [review]. Plast Reconstr Surg 2000;105(2):504–15.
[8] Spira M. Otoplasty: what I do now–a 30-year perspective. Plast Reconstr Surg 1999;104(3): 834–40 [discussion 841].
[9] Nolst Trenite GJ. Otoplasty: a modified anterior scoring technique. Facial Plast Surg 2004;20(4): 277–85.
[10] Horlock N, Vogelin E, Bradbury ET, et al. Psychosocial outcome of patients after ear recon-

struction: a retrospective study of 62 patients. Ann Plast Surg 2005;54(5):517–24.

[11] Horlock N, Misra A, Gault DT. The postauricular fascial flap as an adjunct to Mustarde and Furnas type otoplasty. Plast Reconstr Surg 2001;108(6): 1487–90 [discussion 1491].

[12] Tan O, Atik B, Karaca C, Barutcu A. A new instrument as cartilage scorer for otoplasty and septoplasty: Adson-Brown forceps. Plast Reconstr Surg 2005;115(2):671–2.

[13] Di Mascio D, Castagnetti F, Baldassarre S. Otoplasty: anterior abrasion of ear cartilage with dermabrader. Aesthetic Plast Surg 2003;27(6): 466–71 [Epub March 4, 2004].

[14] Azuara E. Aesthetic otoplasty with remodeling of the antihelix for the correction of the prominent ear: criteria and personal technique. Arch Facial Plast Surg 2000;2(1):57–61.

[15] Rubino C, Farace F, Figus A, Masia DR. Anterior scoring of the upper helical cartilage as a refinement in aesthetic otoplasty. Aesthetic Plast Surg 2005;29(2):88–93 [discussion 94. Epub April 21, 2005].

[16] Epstein JS, Kabaker SS, Swerdloff J. The "electric" otoplasty. Arch Facial Plast Surg 1999;1(3): 204–7.

[17] Bulstrode NW, Huang S, Martin DL. Otoplasty by percutaneous anterior scoring. Another twist to the story: a long-term study of 114 patients. Br J Plast Surg 2003;56(2):145–9.

[18] Fritsch MH. Incisionless otoplasty. Facial Plast Surg 2004;20(4):267–70.

[19] Yugueros P, Friedland JA. Otoplasty: the experience of 100 consecutive patients. Plast Reconstr Surg 2001;108(4):1045–51 [discussion 1052–3].

[20] Tan KH. Long-term survey of prominent ear surgery: a comparison of two methods. Br J Plast Surg 1986;39:270–3.

[21] Foda HM. Otoplasty: A graduated approach. Aesthetic Plast Surg 1999;23(6):407–12.

[22] Kompatscher P, Schuler CH, Clemens S, et al. The cartilage-sparing versus the cartilage-cutting technique: a retrospective quality control comparison of the Francesconi and Converse otoplasties. Aesthetic Plast Surg 2003;27(6):446–53 [Epub March 4, 2004].

[23] Strasser E. An objective grading system for the evaluation of cosmetic surgical results. Plast Reconstr Surg 1999;104:2282–5.

[24] Panettiere P, Marchetti L, Accorsi D, Del Gaudio GA. Otoplasty: a comparison of techniques for antihelical defects treatment. Aesthetic Plast Surg 2003;27(6):462–5 [Epub March 22, 2004].

[25] Furnas DW. Correction of prominent ears with multiple sutures. Clin Plast Surg 1978;5:491–5.

[26] Gosain AK, Recinos RF. A novel approach to correction of the prominent lobule during otoplasty. Plast Reconstr Surg 2003;112(2):575–83.

[27] Maurice PF, Eisbach KJ. Aesthetic otoplasty: wedge excision of a flattened helix to create a helical curl. Arch Facial Plast Surg 2005;7(3): 195–7 [no abstract available].

[28] Aygit AC. Molding the ears after anterior scoring and concha repositioning: a combined approach for protruding ear correction. Aesthetic Plast Surg 2003;27(1):77–81 [Epub March 14, 2003].

[29] Cregg N, Conway F, Casey W. Analgesia after otoplasty: regional nerve blockade vs local anaesthetic infiltration of the ear. Can J Anaesth 1996;43(2):141–7.

[30] Ferraro GA, Corcione A, Nicoletti G, et al. Blepharoplasty and otoplasty: comparative sedation with remifentanil, propofol, and midazolam. Aesthetic Plast Surg 2005;29(3):181–3.

[31] Pavlin DJ, Chen C, Penaloza DA, et al. Pain as a factor complicating recovery and discharge after ambulatory surgery [table of contents]. Anesth Analg 2002;95(3):627–34.

[32] Kawamata M, Takahashi T, Kozuka Y, et al. Experimental incision-induced pain in human skin: effects of systemic lidocaine on flare formation and hyperalgesia. Pain 2002;100(1–2): 77–89.

[33] O'Malley TP, Postma GN, Holtel M, et al. Effect of local epinephrine on cutaneous blood flow in the human neck. Laryngoscope 1995;105:140–3.

[34] Dunlevy TM, O'Malley TP, Postma GN. Optimal concentration of epinephrine for vasoconstriction in neck surgery. Laryngoscope 1996;106: 1412–4.

[35] Gessler EM, Hart AK, Dunlevy TM, Greinwald Jr JH. Optimal concentration of epinephrine for vasoconstriction in ear surgery. Laryngoscope 2001;111(10):1687–90.

[36] Liu S, Carpenter RL, Chiu AA, et al. Epinephrine prolongs duration of subcutaneous infiltration of local anesthesia in a dose-related manner. Correlation with magnitude of vasoconstriction. Reg Anesth 1995;20(5):378–84.

[37] Koeppe T, Constantinescu MA, Schneider J, Gubisch W. Current trends in local anesthesia in cosmetic plastic surgery of the head and neck: results of a German national survey and observations on the use of ropivacaine. Plast Reconstr Surg 2005;115(6):1723–30.

[38] Romo 3rd T, Sclafani AP, Shapiro AL. Otoplasty using the postauricular skin flap technique. Arch Otolaryngol Head Neck Surg 1994; 120(10):1146–50.

[39] Lancaster JL, Jones TM, Kay AR, McGeorge DD. Paediatric day-case otoplasty: local versus general anaesthetic. Surgeon 2003;1(2):96–8.

[40] Keery H, Boutelle K, van den Berg P, Thompson JK. The impact of appearance-related teasing by family members. J Adolesc Health 2005;37(2): 120–7.

[41] Gamatsi IE, Nikolopoulos TP, Lioumi DE. The ear and its malformations: strange beliefs and misconceptions. Br J Plast Surg 2003;56(4): 369–74.

[42] Sheerin D, MacLeod M, Kusumakar V. Psychosocial adjustment in children with port-wine stains and prominent ears. J Am Acad Child Adolesc Psychiatry 1995;34(12):1637–47.

[43] Gosain AK, Recinos RF. Otoplasty in children less than four years of age: surgical technique. J Craniofac Surg 2002;13(4):505–9.
[44] Massengill PL, Goco PE, Norlund LL, Muir-Padilla J. Enzymatic recontouring of auricular cartilage in a rabbit model. Arch Facial Plast Surg 2005;7(2):104–10.
[45] Furnas DW. Otoplasty for prominent ears. Clin Plast Surg 2002;29(2):273–88 [viii].
[46] Tan ST, Abramson DL, MacDonald DM, Mulliken JB. Molding therapy for infants with deformational auricular anomalies. Ann Plast Surg 1997;38:263.
[47] Tan ST, Shibu M, Gault DT. A splint for correction of congenital ear deformities. Br J Plast Surg 1994;47:575.
[48] Matsuo K, Hirose T, Tomono T, et al. Nonsurgical correction of congenital auricular deformities in the early neonate: a preliminary report. Plast Reconstr Surg 1984;73:38.
[49] Matsuo K, Hayashi R, Kiyono M, et al. Nonsurgical correction of congenital auricular deformities. Clin Plast Surg 1990;17:383.
[50] Sorribes MM, Tos M. Nonsurgical treatment of prominent ears with the Auri method. Arch Otolaryngol Head Neck Surg 2002;128(12):1369–76.
[51] Hoehn JG, Ashruf S. Otoplasty: sequencing the operation for improved results [review]. Plast Reconstr Surg 2005;115(1):5e–16e.
[52] Peker F, Celikoz B. Otoplasty: anterior scoring and posterior rolling technique in adults [review]. Aesthetic Plast Surg 2002;26(4):267–73.
[53] Erol OO. New modification in otoplasty: anterior approach. Plast Reconstr Surg 2001;107(1):193–202 [discussion 203–5].
[54] Lazaridis N, Tilaveridis I, Dimitrakopoulos I, Karakasis D. Correction of the protruding ear with a modified anterior scoring technique. J Oral Maxillofac Surg 1998;56(3):307–13.
[55] Weinzweig N, Chen L, Sullivan WG. Histomorphology of neochondrogenesis after antihelical fold creation: a comparison of three otoplasty techniques in the rabbit. Ann Plast Surg 1994;33(4):371–6.
[56] Siegert R. Synopsis of otoplasty. Facial Plast Surg 2004;20(4):299–300 [no abstract available].
[57] Siegert R. Correction of the lobule. Facial Plast Surg 2004;20(4):293–8.
[58] Crumley RL. Some pioneers in plastic surgery of the facial region. Arch Facial Plast Surg 2003;5(1):9–15.
[59] Lam SM. Edward Talbot Ely: father of aesthetic otoplasty. Arch Facial Plast Surg 2004;6(1):64.
[60] Emery BE. Otoplasty [review]. Facial Plast Surg Clin North Am 2001;9(1):147–57.
[61] Kakagia D, Fotiadis S, Tripsiannis G. Comparative efficacy of ropivacaine and bupivacaine infiltrative analgesia in otoplasty. Ann Plast Surg 2005;54(4):409–11.
[62] Honkavaara P, Pyykko I. Effects of atropine and scopolamine on bradycardia and emetic symptoms in otoplasty. Laryngoscope 1999;109(1):108–12.
[63] Horlock N, Vogelin E, Bradbury ET, et al. Psychosocial outcome of patients after ear reconstruction: a retrospective study of 62 patients. Ann Plast Surg 2005;54(5):517–24.
[64] Janis JE, Rohrich RJ, Gutowski KA. Otoplasty. Plast Reconstr Surg 2005;115(4):60e–72e.
[65] Gosain AK, Kumar A, Huang G. Prominent ears in children younger than 4 years of age: what is the appropriate timing for otoplasty? Plast Reconstr Surg 2004;114(5):1042–54.
[66] Chongchet V. A method of antihelix reconstruction. Br J Plast Surg 1963;16:268.
[67] Stenstrom SJA. "natural" technique for correction of congenitally prominent ears. Plast Reconstr Surg 1963;32:509.