Analysis in Otoplasty

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The normal auricle has a well-recognized shape. Although there are many variations, significant deviation from "normal" is immediately evident. In particular, prominent ears are readily apparent and are a relatively frequent cause of patient concern.

Correction of the outstanding ear requires a careful understanding of the discrete elements that compose the normal ear. Careful anatomic analysis to determine the precise cause allows appropriate preoperative planning for the correction of a protruding ear.

Anatomy of the "normal" ear

The auricle is 85% of adult size by 3 years of age and is 90% to 95% of full size by 5 to 6 years of age, although it may elongate an addition 1 cm to 1.5 cm during life [1,2]. The long axis of the "normal" ear is approximately 20° from the vertical axis of the skull. The width should be approximately 55% of the length. "Idealized" dimensions are 63.5 mm × 35.3 mm for males and 59.0 mm × 32.5 mm for females [3]. The helical rim along its lateral edge is approximately 1 cm to 2 cm from the mastoid skin. The angle of protrusion of the auricle or the auriculomastoid angle is usually between 15° and 30°.

Among important surface features is the helix, the prominent rim of the auricle [Fig. 1]. Parallel and anterior to the helix is another prominence known as the antihelix or antihelical fold. Superiorly, the antihelix divides into a superior and inferior crus, which surround the fossa triangularis. The depression between the helix and antihelix is known as the scapha or scaphoid fossa. The antihelical fold surrounds the concha, a deep cavity posterior to the external auditory meatus. The crus helicis, which represents the beginning of the helix, divides the concha into a superior portion, the cymba conchae, and an inferior portion, the cavum conchae. The cavity formed by the concha on the anterior (lateral) surface of the ear corresponds to a bulge or convexity on the posterior (medial) surface of the ear that is known as the eminentia of the concha.

Anterior to the concha and partially covering the external auditory meatus is the tragus. The antitragus is posteroinferior to the tragus and is separated from it by the intertragic notch. Below the antitragus is the lobule that is composed of areolar tissue and fat [4].

Except for the lobule, the auricle is supported by thin, flexible elastic fibrocartilage. This cartilaginous framework is 0.5 mm to 1.0 mm thick and covered by a minimum of subcutaneous tissue [5].

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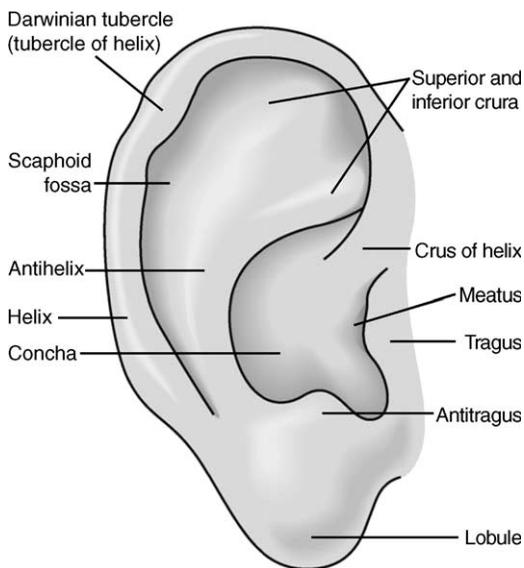
Fig. 1. Ear anatomy—surface features.

The skin is loosely adherent to the posterior surface and helix of the auricular cartilage. The close approximation of the skin to the anterior surface of the cartilage provides the auricle with its unique topographic features [Fig. 2].

The auricle has two groups of ligaments and musculature. The extrinsic ligaments connect the auricle with the side of the head and the intrinsic ligaments connect various parts of the cartilage to itself and to the external auditory meatus. The intrinsic group of muscles is rudimentary and serves no recognizable functional purpose. Certain individuals may have limited control of these muscles to "wiggle" the auricle.

The outstanding ear

Malformations of the auricle are not unusual and range from complete absence to macrotia. The incidence of abnormally protruding ears approaches 5% in white people [6]. Most ear deformations are inherited as an autosomal dominant trait with incomplete penetrance [7]. Understanding the pathogenesis of these deformities aids the facial plastic surgeon in developing an operative plan.

Davis and Kittowski [8] point out that during development, the ear protrudes from the head because the crura of the antihelix are not formed. The margins of the auricle curl in the sixth fetal month to form the helix, followed by the folding of the antihelix and the development of the superior and inferior crura. The formation of the antihelix and its crura brings the auricle closer to the head.

The most common cause of outstanding ears is the lack of development of the antihelical fold [Fig. 3]. This malformation of the antihelix is present in approximately two thirds of all cases of protruding ears. However, other pathologic features may also contribute to the outstanding ear. A wide, protruding conchal wall is present in approximately one third of all cases. Additionally, the prominent concha is often accompanied by a thickened antitragus [9].

The outstanding ear is a single entity within a wide spectrum of auricular malformation. Depending on the degree of severity, the protruding ear may also have structural abnormalities seen in the classically described "lop ear" or "cup ear." The term "lop ear" is used to describe a deformity of the helix characterized by a thin, flat ear that is acutely folded downward at the superior pole. In the "cup ear" deformity, weak cartilage with resulting limpness of the auricle results in cupping or deepening of the conchal bowl. The "cup ear" is often smaller than normal and folded on itself. Poor development of the superior portion of the ear results in a short, thickened helix and a deformed antihelix. The surgical techniques used to correct the outstanding ear may be applied to the "lop ear" and to the "cup ear" [6–9].

Preoperative evaluation and analysis

Patients with outstanding ears typically present early in childhood, although some present in adulthood. The optimal age for surgical correction is between 4 and 6 years of age. At this age the auricle is near or at full adult size, and the child is capable of participating in the postoperative care of the ear. Also, the child is typically about to enter school, and unfortunately children with protruding ears are commonly subjected to severe ridicule by their young peers [10–12].

A comprehensive and quantitative approach for complete evaluation of the patient's ears is essential [11]. The auricles are compared with each other, both in overall symmetry and projection from the head. The proportion of the auricles to facial features and the head must be appreciated. The appearance of the auricles is judged by the symmetry from the front along the lateral helical rim. The superior aspect of the auricles should be level with the eyebrows. Additionally, development of the surface landmarks should be noted, along with additional features such as preauricular tags. The
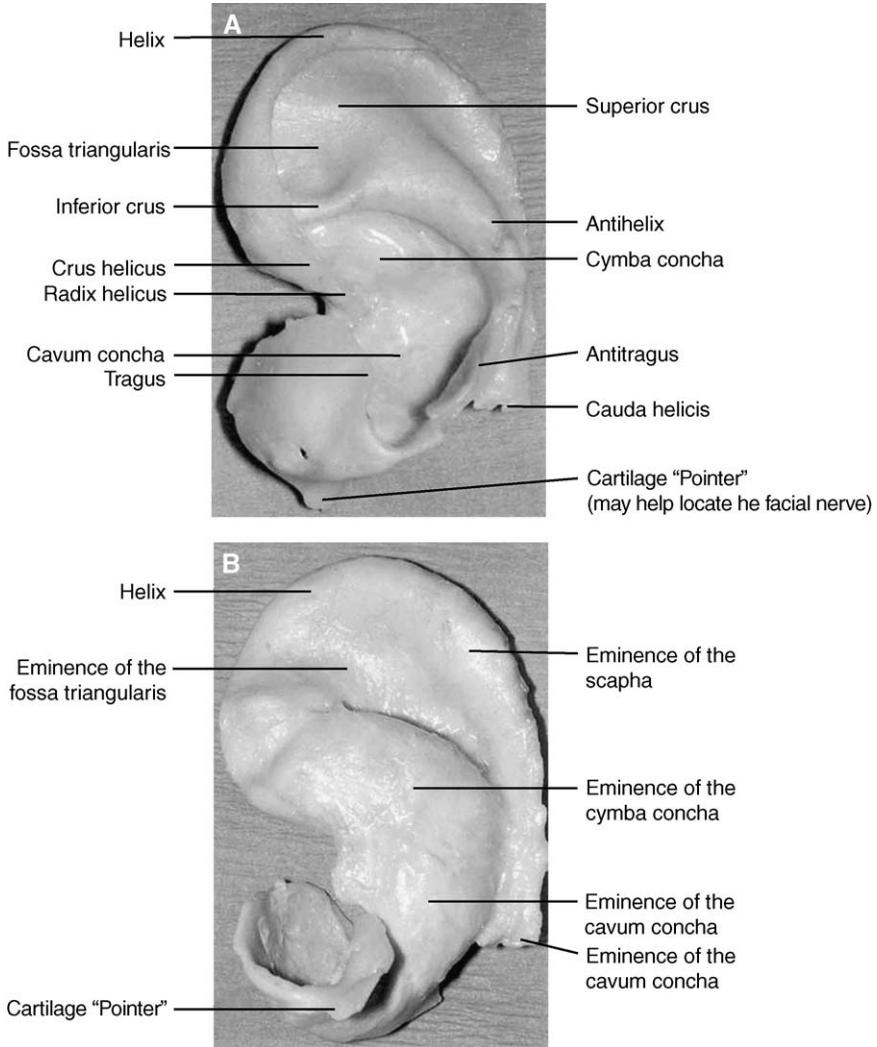
Fig. 2. Ear anatomy—cartilaginous topography. (*A*) Lateral surface. (*B*) Medial surface.
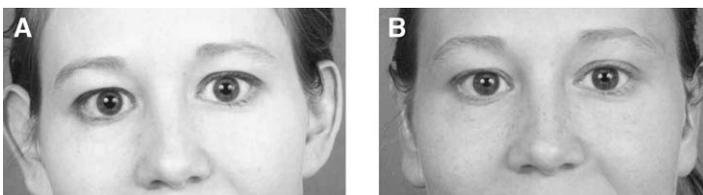
Fig. 3. Preoperative (*A*) and postoperative (*B*) otoplasty patient. Preoperative analysis reveals an undeveloped antihelical fold.

individuals features within the auricle should be assessed in relationship to other surface landmarks. For example, there should be a balance between the size and prominence of the helix and antihelix or between the tragus and anti-tragus. Finally, the redundancy of the postauricular skin should be noted, and the thickness and stiffness of the cartilage should be assessed and compared between the ears.

Precise measurements can be made to document the height, width, and axis of the auricle. Additionally, the angular relationships of the auricle and concha to the mastoid can be documented. Symmetry between the two ears can also be compared by a standard set of measurements, which can provide standards for assessment preoperatively and intraoperatively [12].

Whereas the classic description of the outstanding ear attributes this deformity to the absence of the antihelical fold, overprojection of the concha or the lobule will also contribute to the appearance of the protruding ear. Consideration and correction of these elements will contribute to the ultimate goal of a normal-appearing auricle.

As with any cosmetic procedure, preoperative and postoperative photographs are absolutely critical for careful planning of the surgical procedure and to document changes to the auricle. Uniform lighting and views of the auricle should be used before and after the surgery. The photographs should include a full-face anterior and full-head posterior view, an oblique/lateral view of both sides of the head, and close-up views of the ears. For patients with long hair, a hair clip or headband can be useful to prevent the hair from obstructing accurate photodocumentation.

Goals of surgery for the outstanding ear

The primary goal of otoplasty is to re-establish a "natural" appearance to the auricle and relationship of the auricle with the head. Careful assessment of the outstanding ear, as described previously, will reveal those individual elements of the auricle that contribute to its abnormal appearance. McDowell [13] provided guidelines for consideration when undertaking correction of the protruding ear:

1. Symmetry of shape and protrusion of the ears should vary no more than 3 mm. Correction will often require bilateral alterations.
2. Maintain the normal appearance and curvature of the auricular components. The helix should arch backward naturally from its crus. It should be furled at its superior aspect and lead smoothly to the lobule. The antihelix should similarly curve forward into the superior crus.

3. The distance of the helical rim from the mastoid skin should be 10 mm to 12 mm at the superior pole, 16 mm to 18 mm at the middle third, and 20 mm to 22 mm at the level of the cauda helix. The proper auriculomastoid angle is 15° to 25°. Achieving these distances may require reduction of an overly large conchal bowl.
4. The helical rim should not be seen beyond the antihelix from the frontal view, at least down to the mid-ear.
5. The postauricular sulcus should be preserved.
6. Protrusion of the upper one third of the ear must be corrected. Protrusion of the lower ear may be tolerable, but only if the superior portion of the auricle has been corrected.
7. All visible surfaces should be smooth, without buckles, puckering, scars, or ridges that would reveal operative manipulation.

Although the physical dimensions and structural features are essential in the evaluation of the outstanding ear, the subjective assessment of the patient (and in the case of children) his/her parents is also important. The surgeon should understand precisely what a patient dislikes about his/her ears and what he/she hopes the operation will achieve. This will help the surgeon determine if surgery can achieve the patient's desires and whether or not the patient's goals are realistic. On occasion, unrealistic expectations for the surgery may exist. If this is the case, surgery should be deferred and referral for counseling may be appropriate.

Mattress-suture otoplasty

In the mid-1960s, Mustarde [14] described a corrective otoplasty technique that gained quick and ready acceptance and wide popularity, as it was a marked improvement over existing techniques. Horizontal-mattress sutures placed in the auricular cartilage along the scapha re-create the natural curve of the antihelix, blending gently into the scaphoid fossa. Dimensions of the horizontal mattress sutures have been described with outer cartilage bites of 1 cm separated by 2 mm. The distance between the outer and inner cartilage bites is 16 mm [12].

Advantages of this approach included that no through and through cartilage incisions are necessary, so the potential sharp edges of other techniques are avoided. Also, transperichondrial sutures may be positioned, test-tied, and then maintained or replaced as necessary to develop a natural antihelix. This was in contrast to the cartilage-splitting approach, in which the cartilage incision was irreversible and uncorrectable. Furthermore, the procedure has satisfactory long-term results and requires
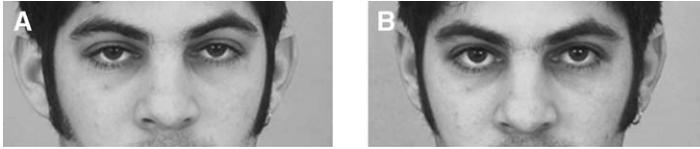
Fig. 4. Preoperative (*A*) and postoperative (*B*) otoplasty patient. Preoperative analysis reveals an overdeveloped conchal bowl as the primary cause of his deformity. Setback of his ears was achieved by "conchal setback" alone. Shave excision of this patient's thick, strong conchal eminence without through and through incision was undertaken to allow for proper setback.

less dissection of the ear and less surgical trauma than other approaches [see Fig. 3]. Surgeons also found this approach relatively easy to learn and to teach.

Whereas Mustarde's technique addressed the most common deformity of the protruding ear, the absent antihelix, Furnas [15] described a suture-fixation method to address the deep conchal bowl. Furnas described the placement of a permanent suture to adjust the apposition of the conchal bowl to the mastoid periosteum, decreasing the angle between the concha and the mastoid [Fig. 4]. Additionally, a suture from the fossa triangularis to the temporalis fascia may further correct conchal height or contour. Care must be taken when placing the suture to avoid rotation of the auricle anteriorly with resultant external auditory canal narrowing.

Although these cartilage-repositioning techniques have been used by surgeons to create a gently curved appearance to the antihelix and a pleasing appearance to the postoperative ear, other techniques exist that rely on incising the cartilage of the ear. These other techniques may be especially useful when large anatomic deformities must be corrected or when the auricular cartilage is especially inflexible or thick. However, these are technically difficult procedures that require substantial surgical experience. In general, techniques that reposition rather than resect cartilage may be safer and are therefore preferred.

Mattress-suture otoplasty: method of Tardy

Mattress-suture techniques with modifications are widely used today. One approach is reviewed in detail [2,4]. Suture-fixation techniques do not require incisions or excisions of the cartilage that permanently alter cartilage characteristics or leave permanent postoperative stigmata.

Although the horizontal-mattress suture is the primary mode of repair in this technique, it is important to address thick and inflexible cartilage. The mattress-suture procedure is frequently augmented by thinning, weakening, and occasionally by limited incision of the cartilage to achieve natural and symmetric results. Thinning the cartilage by shave excision or with a burr and incisions through the cartilage to facilitate folding will reduce the tension on the horizontal-mattress sutures. Thus, every surgeon performing otoplasty must be comfortable addressing the protruding ear with more than one technique. Knowledge of one technique only is inadequate.

In the operating room, the ears are reassessed with regard to the causes of protrusion. Special attention is directed to the depth of the conchal bowl, the position of the lobule, and the strength and flexibility of the auricular cartilage. The peri-auricular areas are prepared with a sterile cleansing solution (hexachlorophene or Betadine) and draped with sterile towels. The postauricular skin and subcutaneous tissue are infiltrated with local anesthetic (example, 1% lidocaine with 1/100,000 epinephrine) for analgesia and hemostasis. The head is draped in a manner that permits comparison of both ears intraoperatively.

A fusiform or "elliptical dumbbell"–shaped incision is made posteriorly, exposing the portion of auricular cartilage in the area of the soon-to-be-formed antihelix [Fig. 5A]. Care is taken to avoid removal of skin in the postauricular sulcus, which would cause flattening of the ear against the head. The skin is excised leaving the posterior deep soft tissue and perichondriium which facilitates later scar formation, which is the strength of the repair. The remaining skin is undermined to the postau-
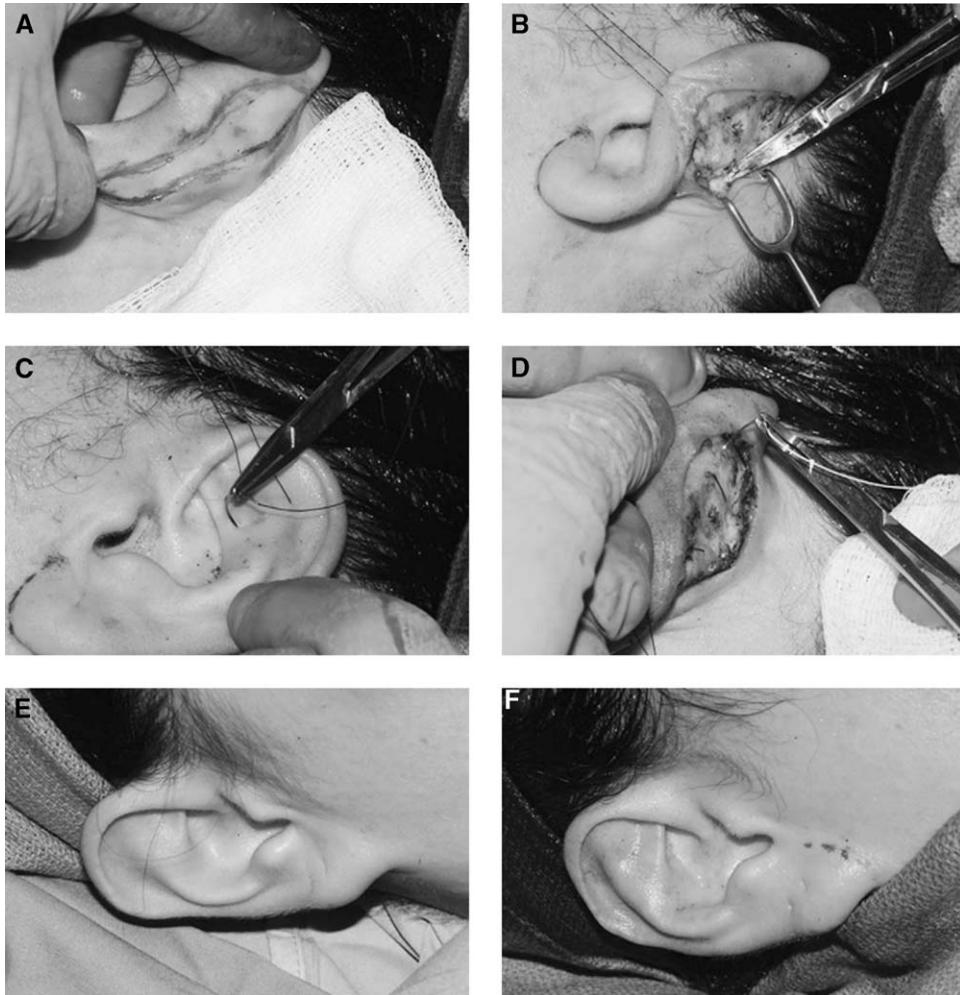
Fig. 5. (*A*) A fusiform or "elliptical dumbbell"–shaped incision is made posteriorly, exposing the portion of auricular cartilage in the area of the soon-to-be-formed antihelix. Surgery proceeds as outlined in the text. (*B*) The remaining skin is undermined to the postauricular sulcus and to the helical rim. (*C*) Temporary 4-0 silk marking sutures may be placed from anterior to posterior to mark the location of the horizontal-mattress sutures and thereby precisely guide their placement. (*D*) Once the new antihelix has been marked, 3-0 white braided nylon (Tevdek) horizontal mattress sutures are placed sequentially, from caudal to cephalic along the neoanti-helical fold. If the sutures are adequately placed, it is unnecessary to overcorrect the repositioning of the auricle. Intraoperative view before (*E*) and immediately after (*F*) placement of Mustarde sutures used to address a slightly underdeveloped antihelical fold.

ricular sulcus and to the helical rim [Fig. 5B]. Meticulous hemostasis should be maintained at this juncture and throughout the procedure.

A deep conchal bowl, when it exists, may be addressed initially. Undermining along the posterior aspect of the cartilage reveals the posterior eminence of auricular cartilage underlying the conchal bowl. Excess cartilage in the posterior eminence frequently causes this area to impinge on the mastoid process, preventing the ear from resting closer to the head. Small disks of cartilage can be shaved with a scalpel from this region to allow retropositioning of the auricle. This cartilage sculpturing is often sufficient to retroposition the ear and makes

conchal setback sutures unnecessary. Excision of cartilage in this area will weaken the cartilage, reducing overall tension on the mattress sutures that will be placed in the antihelix region. Great care is taken to achieve partial thickness excision of cartilage, and through and through excision is avoided. Nevertheless, on occasion the auricle with a very deep cavum conchae may require conchal setback sutures or rarely the excision of a semilunar segment of cartilage within the cavum conchae to reconstruct the neoantihelix properly.

The new antihelix is created by manipulating the auricular cartilage and blending this fold into the superior crus. Temporary 4-0 silk marking sutures may be placed from anterior to posterior to mark the location of the horizontal-mattress sutures and thereby precisely guide their placement [Fig. 5C]. This method avoids the use of ink or sharp needles to guide placement of the permanent sutures.

Once the new antihelix has been marked, 3-0 white braided nylon (Tevdek) horizontal mattress sutures are placed sequentially, from caudal to cephalic along the neoantihelical fold [Fig. 5D]. These horizontal-mattress sutures are placed through the posterior perichondrium, the auricular cartilage and the anterior perichondrium. Careful palpation with the free hand along the anterior surface of the auricle ensures that the needle does not pass through the anterior skin. Incorporation of the anterior perichondrium in the horizontal-mattress suture is necessary to prevent the suture from tearing through the cartilage when it is tied down. Additionally, the sutures are not placed near the incision site to prevent future suture extrusion.

The horizontal-mattress sutures are generally placed from caudal to cephalad and test-tied. Sutures are removed and replaced as necessary to achieve the desired fold on the auricular cartilage and then held with a hemostat. The sutures are tied securely once the antihelix has been completely formed. Typically, four or more mattress sutures are necessary to distribute the tension evenly and to hold the repair until sufficient scar tissue forms, usually in 2 to 3 months. If the sutures are adequately placed, it is unnecessary to overcorrect the repositioning of the auricle, since the sutures will maintain their position without slippage [Fig. 5E, F]. The postauricular skin is closed with a fast-absorbing 5-0 chromic gut suture.

After creation of a neoantihelical fold, the position of the lobule is assessed. Ideally, the helix and antihelix should be in the same plane as the lobule. Commonly, simple skin excision and reattachment are sufficient to position the lobule in the appropriate plane, although more extensive intervention may be required at times.

The procedure is completed on the opposite ear. Frequent comparison between both ears assures as symmetric a repair as possible. Given the nature of auricular deformities, complete symmetry between both ears is nearly impossible [Fig. 6].

At the conclusion of the surgery, a conforming dressing is applied followed by a bulky head dressing, which is removed and replaced with a smaller dressing that the patient wears for an additional 36 to 72 hours.

Aesthetic complications arise from either incomplete or overly aggressive treatment of the original deformity. Although not considered a deformity in the nonoperated ear, a helical rim that is retropositioned relative to the antihelix is undesirable and is usually secondary to overcorrection of the neoantihelix. This deformity can be seen if Mustarde sutures are drawn too tightly or if overaggressive skin excision is undertaken.

In undertaking conchal repositioning, care must be taken in suture placement. Sutures placed too far posteriorly on the concha or too far anteriorly on

Fig. 6. Preoperative (*A*) and postoperative (*B*) otoplasty patient. Preoperative analysis reveals asymmetric ears. The left ear is larger and more prominent than the right ear. The patient opted to undergo unitlateral otoplasty only. Although some asymmetry persists (now the right ear is slightly more prominent), the patient is pleased.

the mastoid can result in stenosis of the external auditory canal.

Overcorrection of the middle portion of the ear leads to a "telephone ear" deformity due to relative prominence of the superior and inferior poles. One commonly described cause of the telephone ear deformity is overreduction of the hypertrophic concha. Alternatively, overcorrection of the upper and lower poles may result in the "reverse telephone ear" deformity.

As discussed in this article, otoplasty methods that incise rather than reposition cartilage run the risk of visible sharp edges or prominent creases.

With significant attention focused on the antihelical fold and addressing the cavum concha, the position of the lobule may be overlooked. The lobule and helix should lie in approximately the same plane. Although amputation of the cauda helices or cauda repositioning are sometimes necessary, most commonly excision of a soft tissue triangular segment from the posterior lobular surface is effective.

Antihelix plasty without modeling sutures

Rauning [16] has recently reviewed his technique of otoplasty, whereby the cartilage is neither sutured nor excised. In his review of 302 patients, he outlines his method of cartilage shaping by abrasion of the anterior surface of the antihelical cartilage, using a diamond-coated electric file. This technique takes advantage of the deformation that occurs when the elastic layer of one side of cartilage is weakened. Cartilage will bend away from the cut or weakened side, and controlled biochemical remodeling takes place.

To accomplish cartilage reshaping, Rauning favors the use of a small, diamond-coated file as it allows for uniform and predictable cartilage thinning through narrow skin tunnels. Tunnels are created through a skin incision about 10 mm in length in the region of the scapha above the superior crus. This incision is generally well concealed by the overhang of the helical rim. A subperichondrial tunnel is created inferiorly along the curve of the new antihelix to the antitragus. The file is then introduced and the cartilage is abraded until a desired contour is obtained. Further curvature of the anterior helical rim is made possible by the placement of a series of small radial incisions through the cartilage. A protruding lobule may be reduced by incising the cartilage in the caudal helix in two or three places.

At the completion of the procedure, Rauning places a cotton roll beneath the antihelix to allow for conformation to the new shape. Retroauricular fixation is achieved by taping the helix to the mastoid bone. A compressive head dressing is applied and removed at 1 week postoperatively. An elastic headband is worn only at night for a period of 6 weeks.

Advantages of the technique include the following: it is a minimally invasive approach that allows for decreased bruising and a reduction in the incidence of hematoma; all structures of the original ear are preserved; operating room time is reduced; and because sutures are not typically used, foreign body introduction is minimized. A disadvantage of this method is the requirement that the ears be taped for up to 6 weeks. Furthermore, in extreme cases of conchal excess, adequate conchal setback may necessitate the use of a posterior approach. At 4-year follow-up, patients experienced few complications and results have been promising in the achievement of durable, natural-appearing outcomes.

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