Chapter 153: Reconstructive Surgery for Congenital and Acquired Malformations of the Auricle

John K. Niparko, David E. Schuller

Restorative surgery for the absent and defective auricle posses significant challenges. The surgeon is faced with the task of reconstructing a complex structure with multiple contours that lie in relief from the cranium. An optimal result requires duplication of the exquisite detail and delicacy of the normal auricle in the face of the tendency for soft tissue to blunt with the healing process. It is hoped that the end result will be cosmetically pleasing, allowing the patient complete flexibility in activities and hairstyle. Moreover, the reconstructed auricle should be properly coupled with the external ear canal in order to fully restore the conductive hearing mechanism.

Congenital and acquired malformations of the auricle also carry a heavy psychologic impact. Because the ear is a readily apparent component of craniofacial visage, its deformity is not easily ignored.

Before initiating rehabilitation, preoperative education and counseling are critical. Because a perfect reconstructive result is rarely attained, the patient with an auricular defect should have a full appreciation of potential outcomes and realistic expectations.

Anatomy

The auricle is a cartilage-framed appendage, the proper shape and position of which are defined in relationship to neighboring craniofacial features. Because the skin of the lateral surface of the ear is thin and tightly adherent to its contours, the cartilaginous frame determines the visibly apparent features. The central concavity of the lateral surface is formed by the cam-shaped concha, bounded by the antitragus, the anthelix, and its inferior crus (Fig. 153-1) (Schuknecht and Gulya, 1986). The helical crus divides the concha into a cymba concha superiorly and a cavum concha inferiorly. The deep recess of the cavum concha is continuous with the cartilaginous external ear canal forming the canal meatus. The convex surface that lies in relief of the concha is the anthelical fold. This fold terminates superiorly by dividing into anterior and posterior crura and terminates inferiorly at the antitragus. The helix originates as the crus of the helix in the central concha, encircles the auricular periphery, and terminates inferiorly in the lobule. The tragus is a cartilaginous protuberance juxtaposed opposite the concha on the anterior aspect of the external canal meatus. The anterior and intertragal incisura lie superior and inferior to the tragus, respectively.

The auricle is joined to the lateral skull by skin and the anterior, superior, and posterior auricularis muscles. Each of the muscles has a paired ligament. The plane at the auricle is normally angled at 40 degrees or less from the sagittal plane. The concha cavum lies parallel to the sagittal plane, and the laterally directed curvature of the concha is directed perpendicular to the mastoid cortex.

Geography

Numerous landmarks can be used to define the proper size, location, level, and inclination of the auricle. Although visual observations can help to determine "what looks right" in duplicating an ear, the quality of such determinations varies with visual judgment and experience, with high variability between observers (Farkas, 1990). The use of surface measurements (anthropometry) relative to landmarks of the craniofacial complex provides a more objective, reliable method for planning auricular reconstruction.

Size

On visual appearance alone, the proper size of the ear is heavily influenced by the height of the face. Normal ear height approximates one half that of the nasion to gnathion distance (Fig. 153-2). The proper length (sa-sba) and width (pra-pa) of the ear can be determined relative to established means for the normal population (Farkas, 1978). Size proportions determined in normal adult populations indicate that the width of the ear is slightly more than half its length. A harmonious appearance of the ear is also dictated by conchal height that is one third the total ear height and equal to the height of segments above and below the concha. Determining the proper length of the anterior attachment between upper (obs) to lower (obi) points is also useful in planning reconstructive surgery. Approximately seven eights of total auricular growth occurs by the age of 7 years (Bardach, 1974). This fact is critically important because it determines the time when auricular reconstruction can be started.

Vertical location

Vertical position of the ear appears normal when its upper margin is on level with the eyebrow and the lower margin of the lobule is on level with the subnasale or midpoint of the columellar base with the head in a resting position. Projected measurements that determine horizontal ((t-sn) or (obi-sn)) and vertical ((t-gn) or (obi-gn)) positions of the ear in normal populations are published (Davis, 1987; Farkas, 1990).

Visually, the upper margin of the tragus (tragion) and external meatus (porion) lie on level with the lowest point of the infraorbital margin (orbitale). The Frankfurt horizontal position is defined by horizontal orientation of the line connecting the orbitale, tragion, and porion. In the presence of complete canal atresia, the normal position of the meatus can be approximated in a posterosuperior relation to the glenoid fossa. More precise location can be identified using measurements relative to midfacial landmarks (Davis, 1987).

Horizontal location

In the presence of unilateral atresia, the proper horizontal position of the external meatus and auricle can be determined using spreading calipers that measure the distance between the external ear and facial midline (Farkas, 1990). These measurements ((t-sn) and (obi-sn)) in normal and atretic populations are also available (Farkas, 1978).

Inclination

The long axis of the ear is defined by the perpendicular dividing the line of its greatest width. The proper inclincation of the long axis of the ear appears harmonious when the long axis parallels the nasal dorsum. Normal population studies demonstrate that the mean inclination of the longitudinal axis of the ear is approximately 20 degrees (range of 6.3 to 35.6 degrees) (Farkas, 1978). There is some information suggesting that the long axis is even somewhat more vertically oriented rather than parallel to the nasal dorsum (Skiles and Randall, 1983).

Classification and Management Techniques for Congenital Deformities

Auricular deformities

Auricular deformities can be classified as either acquired or congenital. The acquired deformities are related usually to trauma or excisions for neoplasms. There are numerous expressions of congenital auricular deformities. They range from complete unilateral/bilateral anotia to subtle alterations in the external configuration. However, the most common configuration of a congenitally microtic auricle is a longitudinal fold of skin that contains a markedly disfigured auricular cartilaginous remnant that is usually anatomically located in the position of what one might anticipate as the external auditory meatus and ear canal (Fig. 153-3). Congenital auricular deformities are a manifestation of developmental problems of the first and second branchial arches, and often other manifestations of these arch deformities are evident, such as hypoplasia of the mandible, maxilla, and soft tissue on the side of the face of the atresia (Fig. 153-4). The rehabilitation of the patient with congenital or acquired auricular deformities can be achieved with multistage surgical reconstruction or with the use of a prosthesis. However, it is imperative that the patient, if an adult, or both the patient and the parent, if a child, clearly understand the expectations of surgical versus prosthetic rehabilitation.

Goals of auricular reconstruction

It is recommended that the patient or patient's parents clearly understand that there are alternatives for the rehabilitation of a congenital or acquired auricular deformity atresia. The alternatives basically involve a decision about whether multistage surgical reconstruction is undertaken or the patient is fitted with an auricular prosthesis. There are advantages and disadvantages of both. The goals of surgical or prosthetic auricular rehabilitation are the same: both are being undertaken to help restore facial symmetry. More specifically stated, the goal is to create a structure that has a comparable size to the normal auricle in the unilateral case or a comparable size to a reconstructed auricle in bilateral microtia with atresia and is also located in a similar position and at a similar distance away from the side of the head. The patient and family need to understand that surgical reconstruction cannot reliably create all of the folds of a normal auricle. That type of precise contouring sometimes occurs. But it is often more a function of the patient's innate healing capabilities rather than the skill of the reconstructive surgeon. In contrast, the duplication of the exact size and normal auricular folds can be achieved with an auricular prosthesis. However, the disadvantages of such a prosthesis are that it is not an integral part of the face and the interface between prosthesis and normal facial tissue is often noticeable. There appears also to be some negative psychologic reaction

to the reliance on a prosthesis rather than one's own tissue. Surgical auricular reconstruction is a multistage undertaking. Although the technique described in this chapter involves primarily four major stages, there is information in the literature to suggest that the completion of staged auricular reconstruction can involve 13 or more procedures (Farkas and Fara, 1958). It is only after the patient and family have been thoroughly informed of these alternatives that a decision can be made concerning surgical or prosthetic rehabilitation. The obvious advantage of surgical reconstruction is that an auricle is created that is an integral part of the patient's facial anatomy.

Surgical auricular reconstruction

This section discusses the operations needed to construct a total auricle in the case of microtia associated with congenital auricular atresia. However, these principles can be used to reconstruct an entire auricle in the case of an acquired deformity. The same principles can also be used for the reconstruction of partial deformities. Before discussing specifics, it is important to acknowledge and credit the work of Bardach and Brent in auricular reconstruction (Bardach, 1965, 1972, 1974; Bardach and Radziminski, 1962; Brent, 1980; Brent and Byrd, 1980, 1983). The technique to be described represents an amalgamation of approaches advocated by both authors.

There are four primary operations involved with total auricular reconstruction. The first involves the use of existing tissue to form a portion of the reconstructed auricle. That operation is followed by another that is intended to insert a rigid framework of the reconstructed auricle. The third operation involves the transfer of tissue that will ultimately be used to create the medial epithelial surface of the reconstructed auricle. The final operation involves the transferring of the reconstructed auricle into the normal auricular position. After the four primary procedures have been completed, it is not unusual to require additional lesser "touch-up" procedures to attempt to improve minor deformities.

Stage 2

As mentioned earlier in this chapter, most adult auricular growth has been achieved by the time a child reaches 7 years of age. This is the time when auricular reconstruction usually begins. The first step is to develop a template, usually using sterile x-ray film, of the configuration of the normal auricle. If there is bilateral atresia, then a normal auricular configuration is designed using the landmarks described earlier in this chapter. After the normal template has been cut by using x-ray film tracing over the normal auricle, this template is used to draw the position of the auricle to be constructed using methylene blue in the optimal anatomic position. It is usually possible to use the lower one third or less of the vertical fold of skin in repositioning this using Z-plasty to create the lobule of the reconstructed auricle. During this lobular repositioning procedure the underlying deformed auricular cartilage is excised. It is advisable to dissect the auricular cartilage away from surrounding soft tissue by freeing the soft tissue attachments as close as possible to the auricle in an effort to minimize the possibility of injury to an abnormally positioned facial nerve. It is imperative to always consider the remote possibility that the facial nerve may have an extratemporal course in a congenital deformity. Fig. 153-5 shows the new position of the lower portion of the longitudinal fold following the first operation in the child originally shown in Fig. 153-3.

Stage 2

The second operation occurs after healing is completed and the surgical scars have softened and become pale from the first operation. This procedure involves the insertion of a rigid auricular framework. The rigid framework primarily attempts to achieve the contouring of the helix and anthelix. In addition, it is intended to provide rigid support and aid the correct positioning of the auricular lobule. A variety of autologous and synthetic materials have been used in the past to provide this rigid framework. Although there is obviously less morbidity with alloplasts, there continues to be a problem with poor tolerance manifested by wound breakdown and infection as a result of the insertion of the alloplast in a relatively superficial subcutaneous pocket. Autologous materials seem to be better tolerated. The author (DES) continues to use autologous costal cartilage fashioned according to Fig. 153-6. The template of the normal auricle on the right side of Fig. 153-6 is used to develop the template of the helix and anthelix shown on the left side of Fig. 153-6. The costal cartilage is carved into the configuration of that template, and then the helical counterpart is wired to the anthelix to create the configuration demonstrated by Fig. 153-6. Finer contouring can be achieved by using a mastoid burr around the edges and thinning the rigid framework (Fig. 153-7).

Stage 3

The third operation involves the preparation of tissue that will eventually become the skin of the medial surface of the reconstructed auricle. Other techniques have used skin grafts placed on the medial surface of the auricle immediately after it has been transposed into its normal anatomic position. The disadvantages of that approach include the medial displacement of the reconstructed auricle toward the side of the head as the skin graft contracts. In an effort to avoid the negative impact of graft contraction, the graft is placed in the postauricular area after creating a recipient bed by the retrodisplacement of scalp tissue into a tubed scalp flap (Figs. 153-8 and 153-9).

Stage 4

The fourth operation is not performed until several weeks after stage 3. This time interval permits the normal dynamics of wound contraction and neovascularity to occur to the skin graft so that it eventually can be used as a skin flap based on the reconstructed auricle. This postauricular skin flap is incised so that it is based on the auricle and detached from the tubed scalp flap. The undermining of this postauricular flap continues medial to the rigid auricular framework so that the rigid framework is transposed the desired distance away from the side of the head. The medial surface of the transposed auricle is resurfaced with the postauricular flap. An auriculocephalic crease is created by using mattress sutures to suture the postauricular flap to the soft tissue in the desired position of the auriculocephalic crease. These stitches are left in place for 2 to 3 weeks to accentuate an auriculocephalic crease and to help maintain the laterally displaced position of the reconstructed auricle. The tubed scalp flap is undermined and freed from the underlying scar tissue so that the scalp and hairline are restored to their normal anatomic position. The final results after these four operations (Fig. 153-10) achieve the goals of establishing facial symmetry by creating a structure that is of comparable size to the normal auricle and comparable distance away from the side of the head. The fine contouring of the auricle as mentioned earlier, is often more the result of the

patient's healing rather than specific surgical technique. However, the thinning of the rigid auricular framework does increase the potential for achieving finer contouring of the auricular folds.

Lop-eared deformity

The lop-eared deformity is another congenital manifestation that is often familiar. The basic deformity involves the lack of development of the anthelix with the resultant protrusion of the auricle. This deformity has no negative impact on the patient's hearing capabilities. However, it can have a profound impact on the psychologic health of the person with this deformity. Accordingly, it is strongly advisable to recommend surgical correction before the child begins school. It is recommended that surgical correction be undertaken when the child is about 5 years of age before starting kindergarten.

The literature contains descriptions of several techniques for correction of the lop-eared deformity (Converse, 1958a, 1958b, 1963, 1967; Erich, 1958; Luckett, 1910). These techniques often incorporated a step that involved cutting the auricular cartilage with the creation of an abnormally sharp bend in the position of the anthelix. However, Mustarde (1963, 1967) describes a technique that primarily involves suturing the auricular cartilage with horizontal mattress sutures that create a gentle and more normal-appearing anthelical fold. The Mustarde approach has been the basis for most currently used surgical reconstructions of the lop-eared deformity.

This procedure is performed using general anesthesia in children and local anesthesia in adults. The adhesive otologic clear plastic drapes are applied to both ears in order to provide visual access to the rest of the facial landmarks so that the surgeon can determine the ideal auricular contour and position during the procedure. The medial surface of both auricles is infiltrated with 0.5% lidocaine (Xylocaine) with 1:100.000 or 1:200.000 epinephrine concentration for purposes of vasoconstriction. After waiting a suitable time for maximal vasoconstriction and for dissipation of the solution, the procedure is begun by outlining the desired position for the anthelix. This position is outlined on the lateral auricular surface. An incision then is made on the medial surface, and skin is elevated away from the auricular cartilage. A needle directed from the lateral surface perforates the auricular cartilage, and then the tip is touched with methylene blue so that it stains the tissue as the needle is retracted. The series of needle points then mark the anthelical position on the medial auricular cartilage surface. Horizontal mattress sutures are then placed using 5-0 clear nylon that traverses the entire thickness of the auricular cartilage including the perichondrium on the lateral surface. Reprotrusion of the corrected lop-eared deformity is the most common complication of suture otoplasty. This complication can be minimized by assuring that the sutures have passed through all auricular cartilage layers. Approximately five sutures in children and six sutures in adults are placed. All of the sutures are placed before tightening them. The tightening of the sutures begins with the middle suture, and the tightening is done while the surgeon assesses the medial displacement of the auricle. It is important to again remember the normal anatomic position as described in the earlier part of this chapter. The superior helical rim is approximately 2 cm from the side of the head, and the lobule is about 1 cm from the side of the head. The temptation is to tighten the suture excessively, which medially displaces the auricle against the side of the head and is as aesthetically unappealing as excessive protrusion. After the medial suture is locked into position, the other sutures are tightened to support the

auricular position that has been achieved with the first suture tightening. The excessive skin created by this medial displacement on the medial surface of the auricle is then excised in a fusiform fashion, and the postauricular skin incision is closed. This skin closure provides no strength to the medial displacement of the auricle. It is important that this closure be done under no tension so as to avoid obliteration of the normal auriculocephalic crease (Fig. 153-11).

However, the lop-eared deformity is frequently a function of not only lack of an anthelix but also a deep conchal bowl. The deep conchal bowl can be modified by placing a 5-0 clear nylon suture through the conchal cartilage and the mastoid periosteum near the external auditory meatus using a horizontal mattress suture. The tightening of this suture will displace the conchal cartilage toward the external auditory meatus and will decrease the depth of the bowl and the protrusion of the auricle that is created as a result of this abnormal concha. It is theoretically possible to dangerously narrow the external auditory meatus with this maneuver, and the surgeon should be aware of that possibility.

The creation of the anthelix and the repositioning of the concha can also be further refined by placing a stitch in the lobular soft tissue to reposition the lobule into a more medial position. The combination of suture otoplasty creating an anthelix and conchal stitch to medially displace the concha, as well as lobular repositioning, creates an aesthetically pleasing refinement in the position of the auricle (Fig. 153-12).

Auricular Keloids

Keloids of the auricle usually occur following ear piercing and occur predominantly in blacks. Numerous approaches have been advocated for the treatment of keloids. Some have even advocated the use of radiation therapy, which is not recommended for benign disease because of the small possibility of the development of a radiation-induced neoplasm. Surgical excision followed by serial steroid injections dramatically reduces the chances for keloid recurrence as long as the patient complies with the steroid injections. Compliance is not always good, however, because of the pain created with the injections. It is also important for the surgeon to recognize the potential for the steroids to cause atrophy of the skin and subcutaneous tissues. Accordingly, a scant amount is used. It appears that regular injection over an extended period of time is more important than the volume or strength of the solution that is injected. If the patient is not able or willing to comply with the serial injections, it is likely that there will be a recurrence of the keloid.

Surgical excision of auricular keloids arising from the lobule can be a special challenge because of the paucity of normal remaining tissue. If the keloid is small enough, a full-thickness excision of the involved lobule can be performed without creating noticeable asymmetry. However, sometimes a keloid involves both the lateral and medial surfaces of the lobule (Fig. 153-13). In these extensive keloids the carbon dioxide laser is an effective tool to help to contour the tissue to be excised. Total excision sometimes cannot be achieved without creating a dramatic distortion that would require staged reconstruction. If the patient is not willing to undergo such a multioperational effort, a partial excision minimizing the deformity can be achieved using the contouring and hemostatic capabilities of the laser followed by serial steroid injections to dissolve or at least control the residual keloid (Fig. 153-14). However, it should be emphasized that serial steroid injections are the most

important key to minimizing the possibility of recurrence.

Prosthetic Rehabilitation

Satisfactory replication of the auricle when there is little or no remnant of the auricle presents a significant challenge for the reasons mentioned above. Some patients, particularly those predisposed to abnormal scar formation, are not ideal candidates for reconstruction via subcutaneous grafting techniques. For patients with auricular defects that are not amenable to conventional reconstructive surgery, the use of an auricular prosthesis as a viable rehabilitative alternative has gained acceptance.

Satisfactory substitution of a missing auricle with a prosthesis is possible because of the ability to cast and sculpt a prosthesis that bears both the appearance and the skull projection of the contralateral or a substitute model ear. Further development of elastomer technology and prosthesis artistry has provided the ability to fabricate a highly natural-appearing prosthesis. However, the retention of a prosthesis has in the past proved to be problematic (Jahrsdorfer, 1978).

A variety of techniques have been used to anchor the prosthesis. The most popular of these methods has been the use of adhesives, either double-sided tape or glues. These materials, however, have limitations in that they can produce contact dermatitis with long-term use and progressive discoloration and degradation of the prosthetic material. Auricular prostheses have also been coupled with eyeglass frames. The approach is, however, associated with practical problems when the frames are removed or dislodged (Tjellstrom et al, 1983, 1985). Other approaches use skin bridges or pouches on which the prosthesis is based.

All of the above methods fail to provide rigid fixation of the prosthesis. This can result in the prosthesis becoming dislodged, particularly when the site of fixation overlies the condylar region and is susceptible to jaw motion.

A significant breakthrough occurred with the application of osseointegrated fixtures for retaining auricular prostheses. The capacity of nonalloyed titanium to integrate directly with bone in the absence of fibrous tissue ingrowth was first described by Branemark (1983). The concept of "osseointegration", advanced by Branemark, is based on histologic evidence of viable bone ingrowth into the oxide surface of titanium implants that were placed with an atraumatic surgical technique. This method of attachment demonstrated excellent success rates when used to anchor dental prostheses and subsequently found application in the mastoid cortex.

The use of osseointegrated implants for auricular prosthesis retention offers distinct advantages over adhesives. In addition to reducing the likelihood of prosthesis dislodgement, skin reactions commonly associated with liquid aromatic cements are avoided (Parel et al, 1986). Prosthesis longevity is extended because shredding of the surface by adhesive does not occur.

Surgical stages for osseointegrated fixtures

The surgical procedures developed for the placement of titanium implants are designed to accomplish reliable osseointegration of the fixture with reaction-free skin penetration. The surgery is performed in two stages separated by 3 to 4 months. Both stages are often performed with the patients under local anesthesia on an outpatient basis.

Stage 1 fixture placement (Fig. 153-15, A through G)

In the initial stages of surgery, fixture sites within the mastoid cortex are prepared with methods that preserve bone viability. This is accomplished by atraumatic and precise preparation of the implant sites.

Pilot holes are drilled in a radius of 18 to 20 mm from the external meatus in positions that correspond to the arch of the projected anthelix. Two implants are usually placed in positions 1:00 and 4:00 o'clock for the left mastoid and 11:00 and 8:00 o'clock for the right mastoid. Driling with depth-limited burrs to assess the adequacy of cortical thickness and to inspect for the presence of underlying dura and sigmoid sinus is used. When the pilot holes demonstrate at least 3 to 4 mm of cortical bone thickness, the hole is enlarged and countersunk with a spiral cutting burr rotated at speeds of 1500 to 3000 rpm. The countersink increases the area of surface contact with the implant flange.

Final preparation of the implant site is performed with liberal irrigation to promote cooling and low-revolution rotary drilling. The wall of the enlarged, countersunk hole is threaded with a titanium tap introduced at speeds of 8 to 15 rpm. Strict attention is paid to maintaining the tap surface free of nontitanium contaminants. Similar respect for the surface integrity of the screw-shaped titanium fixture is advocated. The fixture is driven into the tapped hole, again at low revolution with copious irrigation. Implanted fixtures are then covered with soft tissue as the exposing incision is closed.

Stage 2 abutment placement (Fig. 153-15, H through J)

In the second stage, performed 3 to 4 months after the first, the implants are exposed and fitted with 3 to 5.5 mm abutments that perforate the overlying soft tissue. In order to achieve reaction-free skin penetration, it is essential to thoroughly excise subcutaneous tissues surrounding the fixture abutment site. This permits direct seating of the dermis on the subjacent periosteum and obviates soft tissue movement on the surface of the abutment. Eventual fitting of the prosthesis is simplified by removing cartilaginous remnants in the second stage. In the absence of a tragus, cartilaginous remnants should be used to create one. The presence of a natural or reconstructed tragus is most helpful in further camouflaging the anterior margin of the prosthesis.

A gauze dressing is placed on the skin-penetrating abutment to compress the soft tissue on the mastoid cortex during a 2-week healing phase.

Stage 3 prosthesis fabrication (Fig. 153-15, K through M)

The anchoring bar and prosthesis are constructed using previously described methods (Tjellstrom et al, 1985). The prosthesis may be anchored to the implanted retention unit using either a bar-clip or magnet system (Parel et al, 1986). By avoiding the use of chemical adhesives, the auricular prosthesis can be fabricated with thin, translucent margins (Fig. 153-16, C). This produces a more natural skin-to-prosthesis color transition, thereby reducing prosthesis detectability.

Clinical results

A vast European experience (Parel, 1991; Tjellstrom, 1990) with the application of osseointegrating fixtures indicates that this method of auricular restoration is a reliable and safe alternative to conventional reconstructive surgery. Several criteria are available for assessing the success of such implanted systems, including implant longevity, patient morbidity, prosthesis function, and cosmesis (Parel et al, 1986).

Tjellstrom (1990) and Parel (1992) have demonstrated that th erate of successful integration of titanium fixtures *ad modem* Branemark (Nobelphrama Corporation, Gothenberg, Sweden) implanted in the mastoid cortex exceeds 98%. Although prior radiation would seem to reduce the success rate of integration, this does not appear to be the case for implants placed in the mastoid cortex.

The transcutaneous connection with implanted fixture has been evaluated by grading skin reactions at follow-up examinations. Of 2458 observations of 244 transcutaneous abutments placed over a 5-year period, approximately 90% of the observations failed to detect any adverse soft tissue reaction. In less than 1% of the observations was there evidence of granulation tissue. Adverse skin reactions are likely to occur when the soft tissue surrounding the abutment is thick and mobile or when hair-bearing skin surrounds the abutment. In many cases, however, skin reactions result from inadequate hygiene, and in many cases adverse reactions can be reversed by more frequent cleaning of the periimplant site.

The use of osseointegrating implants to anchor auricular prostheses averts the disadvantages inherent in the use of adhesives. In addition to improved prosthesis color transition and longevity, reliably secure anchoring of the prosthesis enhances patient security (Parel et al, 1986). This approach to rehabilitating major auricular defects provides a reliable alternative to traditional reconstructive surgery.

Hearing Rehabilitation and Auricular Reconstruction

Timing of microtia / canal reconstruction

Although the external ear and ear canal are traced to separate embryonic anlaga, their proximity, common blood supply, and the dependence of the lateral ear canal development on deepening of the concha cavum contribute to a high concurrence rate of auricular and ear canal maldevelopment.

The goal of reconstructive surgery for ear canal atresia is to provide a patent meatus and bony canal in continuity with a mobile tympanic membrane ossicular chain (Jahrsdorfer, 1978; Malony and De La Cruz, 1991). External canal malformations range from mild stenosis of a patent canal to complete atresia with a solid bony plate in the place of the tympanic membrane. Reconstruction requires removal of bone obstructing the normal path of the canal. This procedure entails a critical balance between adequate bone removal to enhance long-term patency and excessive opening of mastoid air cells that may drain postoperatively. Grafting of the newly formed canal and tympanic membrane, as well as reconstructing the ossicular chain when necessary, may also be required. The technical aspects of canal and middle ear reconstruction are detailed elsewhere in this text (see Chapter 151).

Microtia or canal atresia rarely requires repair before 4 years of age. Children of this age or older are generally able to cooperate with postoperative care in the clinic without resorting to general anesthetics. By waiting until the child is at least 4 years of age, pneumatization of the mastoid is nearly complete (Bullucci, 1960). If the use of autologous rib graft for microtia repair is anticipated, the procedure should be deferred until at least 6 or 7 years of age to allow for development of sufficient costal cartilage (Jahrsdorfer, 1978, 1990).

One of the critical management decisions involved in the rehabilitation of the atretic ear concerns the priority of reconstructing the external ear versus the ear canal. Although the ideal sequencing of reconstructive surgery should be determined on an individual basis and may depend on the severity of maldevelopment, repair of the auricle before canal reconstruction is frequently justified for several reasons:

1. Meatal Location

Of prime consideration in determining the sequencing of reconstructive surgery is the eventual location of the meatus. Although the otologic surgeon is somewhat restricted by anatomic landmarks such as the tegment tympani and glenoid fossa, there exists a significant degree of flexibility in locating the external meatus to conform with the location of the ear canal. With adequate enlargement of the newly created external auditory meatus and preparation of the soft tissues, the external opening can be satisfactorily aligned with the bony meatus and tympanic membrane.

2. Condition of Soft Tissue

Auricular reconstruction results are optimized by graft placement in a virginal subcutaneous bed. Fibrous tissue with relatively poor vascularity induced by a prior incision and elevation of the soft tissue may compromise the ultimate result of auricular reconstruction when a subcutaneous graft is used.

3. Utility of Reconstructed Concha in Grafting the Canal

The presence of a reconstructed concha can provide a scaffold to which a skin graft of the reconstructed canal may be anchored laterally. The likelihood of meatal stenosis is thereby reduced.

These arguments support the notion that auricular reconstruction should take precedence in most cases requiring both auricular and canal reconstruction. Equally important is the need for a coordinated approach by the reconstructive and otologic surgeon. In many cases the audiologist, speech pathologist, and educator should be included in formulating the rehabilitative plan.

In cases of bilateral atresia when bone-conducting aids fail to adequately restore impaired hearing, unilateral canal reconstruction may be required at a very early age to enable proper speech and language development. The evolution of semiimplantable hearing aids and osseointegrating implants to anchor auricular prostheses has provided alternative approaches that may be more appropriate in an individual case (Hough et al, 1986; Hakansson et al, 1985). These considerations further underscore the need for multifaceted management of the child with combined auricular and canal atresia.