Microtia Repair

David A. Staffenberg, MD

Bronx, New York

Construction of the congenitally absent ear is a particular challenge. It represents the true essence of plastic surgery in that it not only requires sound surgical principles but artistic skill. Although a solid familiarity with the stages is important, the surgeon's own experience will direct gradual modification.

Key Words: Microtia, hemifacial microsomia, ear reconstruction, cartilage graft, rib graft

Construction of a congenitally absent ear is a great challenge to the plastic surgeon. Factors contributing to this challenge include the thin skin and delicate framework. Autogenous costal cartilage is the most reliable material for construction of the framework.[1] The relative deficiency of thin skin for coverage of the framework remains a limiting factor, and a staged approach is choreographed.[2–6]

Embryology

The incidence of microtia varies with the severity of the deformity. More involved forms occur in approximately 1 of 7,500 newborns.[7] The right ear is affected twice as often as the left. Ten percent of cases are bilateral. Male newborns are involved two to three times more often than female newborns.

Complete absence of the ear occurs when there is a lack of mesenchymal proliferation.[8] Significant degrees of microtia result from some arrest in development during the sixth to eighth week of fetal development, whereas less significant degrees of deformity probably result from embryonic insults around the end of the first trimester. Microtia includes varying degrees of atresia of the external canal. Microtia may be seen as the mildest phenotypical expression of craniofacial microsomia.

From the Department of Plastic Surgery, Children's Hospital at Montefiore, and Department of Plastic Surgery and Pediatrics, Albert Einstein College of Medicine, Bronx, New York.

Address correspondence to Dr Staffenberg, 3353 Bainbridge Avenue, Bronx, NY 10467; e-mail: dstaffen@montefiore.org

Anatomy

To restore or create an ear that looks like an ear, familiarity with the anatomical components of the normal auricle is imperative. The anatomy of the external ear seems complex at first. The delicate structure of the auricle is defined by the convolutions of the underlying cartilaginous framework. The framework may be thought of in three components: the conchal complex, the antihelix-antitragus complex, and the helix-lobule complex. The meatus opens into the cavum concha, which is surrounded in its posterior perimeter by the antihelix and inferiorly by the antitragus. As the antihelix extends cephalad, it bifurcates into the superior crus and inferior crus, which, along with the helical rim, define the fossa triangularis. The crus helicis begins in the concha and ascends anteriorly and cephalad and becomes the helical rim, which defines the perimeter of the ear until its junction with the lobule. Finally, the meatus is shielded anteriorly by the tragus. The arterial supply of the auricle is derived from the superficial temporal artery as well as from the posterior auricular artery.[9]

Middle Ear Considerations

Because the external ear forms embryologically earlier than the middle ear, an abnormal middle ear must be suspected in each case of microtia. Computed tomography scans of the temporal bone, usually obtained at 4 to 6 years of age, are used to assess a patient's potential for middle ear reconstruction. If the microtia exists in a child with craniofacial microsomia, a craniofacial computed tomography scan with three-dimensional reconstruction can be obtained at the same time and used to plan ahead for possible distraction osteogenesis of the mandible, unless needed sooner.

The development of normal verbal communication requires hearing. Children with unilateral microtia and normal hearing on the contralateral side would be expected to develop speech. Children who have bilateral microtia with aural atresia, however, must be fitted with bone conduction hearing aids shortly after birth. Scars on the mastoid area must be avoided so that bone conduction aids can work. Osseointegrated implants should be considered for bi-

lateral aids. The decision to correct atresia is a complex one. Ultimately, the decision must take into account the risks of facial nerve injury, chronic drainage from the surgical site, and stenosis of the reconstructed canal.[10]

Surgical Considerations

One of the most difficult issues concerning surgical correction of microtia for the plastic surgeon is timing. The plastic surgeon must plan this along with the otologist. Hearing as well as the psychosocial aspects must be taken into consideration. Issues affecting the timing of the reconstruction of the external ear include the risk of ridicule for the child and rate of growth for the costochondral cartilage in situ as well as compared with the normal ear when transferred.[4,6]

For practical purposes, we agree with others who advocate auricular reconstruction around 6 years of age. At this age, a child is motivated to cooperate with the surgeon and the contralateral ear is almost fully grown. We generally design our framework to match the size of the opposite ear at the time of surgery, regardless of the age of the patient. Middle ear surgery is generally deferred until soft tissue reconstruction is completed in bilateral cases if hearing aids support speech development. Middle ear surgery preceding auricular reconstruction may lead to scarring of the soft tissue, which can compromise the construction.[6]

Although silicone frameworks were used at one time, their high exposure rate makes them an unattractive option. When an alloplastic framework is indicated, porous polyethylene (Medpor) may be considered.[11] Wellisz[11] reviewed 41 porous polyethylene frameworks, of which 5 were exposed. Each healed with local wound care, and none had to be removed. The porous nature of the implant allows ingrowth of healthy tissue. It is recommended that a primary temporoparietal fascia flap cover the implant. A skin graft is then placed over the flap.

Ultimately, the choices for ear reconstruction include a completely autologous reconstruction or a prosthetic reconstruction. We reserve prostheses for reconstruction of the ear after major cancer resection. Relative indications include poor quality of local tissues, absence of the lower third of the ear, and salvage after unsuccessful autologous reconstruction. When a prosthetic reconstruction is performed, osseointegrated implants obviate the need for unreliable adhesives. An implant is placed into the mastoid bone and covered with skin to allow osseointegration. During a second procedure, an abutment that protrudes through the skin is placed into the implant. This must be planned in close cooperation with a maxillofacial prosthetist.

In 1971, Tanzer[3] described his four-stage reconstruction consisting of 1) lobule transposition, 2) framework placement, 3) elevation of the ear, and 4) tragus construction with conchal excavation. In 1992, Brent[6] published his experience with 600 cases over 20 years, with a median follow-up of 5 years. Brent describes his four-stage technique consisting of: 1) framework placement, 2) lobule transposition, 3) tragus construction and conchal excavation, and (4) elevation of the ear framework. With experience, sequencing the stages of reconstruction is flexible depending on the degree of deformity and the surgeon's preference.

It is important to maintain as much unscarred skin as possible for the placement of the framework. This is the reason why Brent reversed Tanzer's first two stages, and he does not transpose the lobule before framework placement. The pervasive problem in microtia repair is inadequate skin coverage for a three-dimensional framework. We generally elevate the framework as a third stage. This allows an aggressive elevation without the excavated concha in the way and less scarring in this area to restrict elevation.

Each stage may be separated by as little as 6 weeks, yielding a total of 6 months for the four-stage procedure, but because of school schedules, this usually approaches 1 year for completion. A more detailed discussion of our typical reconstructive strategy follows.

Stage 1: Skin Pocket and Framework Fabrication

A piece of unexposed X-ray film is used to trace the normal ear, including an extension to the lateral canthus of the eye, and the normal ear's orientation is ascertained. We make this template a few millimeters smaller in all dimensions. The film is then used on the operative field, where it can be reversed and used at the donor site for planning. Although carving the framework usually attracts attention, the soft tissue coverage is also fundamentally important. Prophylactic antibiotics are administered and maintained for 5 days.

Although some prefer a preauricular incision, we make our approach through a sinusoidal incision above the planned framework within the temporal hairline as shown to me by Dr. Henry Kawamoto (Fig 1). This keeps any unnecessary scars off the face, keeps the scarring farther away from the framework, lends its use to the temporoparietal fascia flap if that

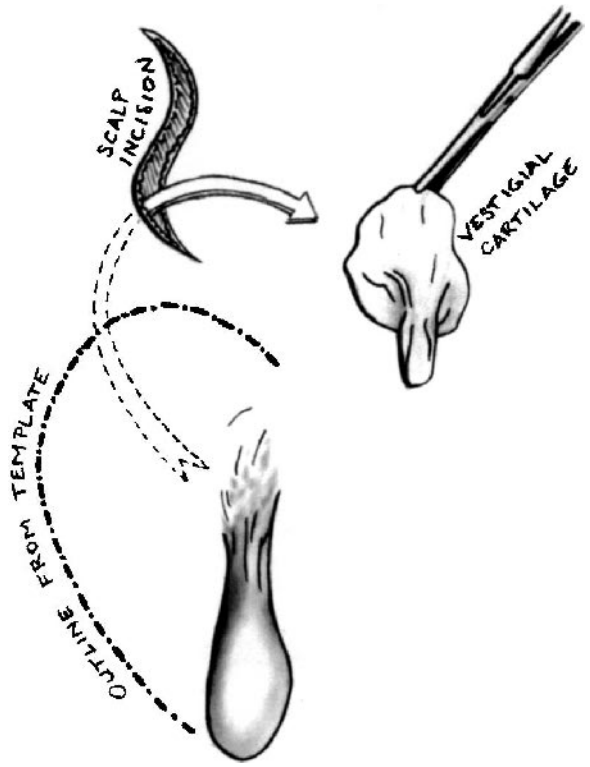

Fig 1 The vestigial cartilage is removed via a curvilinear incision in the temporal hairline. The pocket is dissected beyond the dimensions of the framework.

becomes necessary, and allows for easy "banking" of additional costal cartilage. This "banked" cartilage can be used to give additional ear elevation at the third or fourth stage.

It is important that the delicate overlying skin be meticulously preserved when removing the vestigial cartilage. Any perforation of the skin must be carefully repaired so that the suction drains will function properly at the end of the case. Peripheral to the vestigial ear remnant, the skin must be dissected as thin as possible while maintaining the subdermal plexus. If the skin flap is too thick, the detail of the framework may be lost; if too thin, skin necrosis and exposure may result. We prefer to deal with the recipient site before harvesting the cartilage because we can pack the site with gauze in an effort to gain any possible intraoperative expansion of this skin, and we are able to assess its vascularity. Before implanting the framework, this area is irrigated thoroughly.

In harvesting autologous costal cartilage, Tanzer[2,3] preferred contralateral cartilage, but he notes that ipsilateral cartilage is acceptable as well. Fukuda and Yamada[12] favor ipsilateral costal cartilage. When possible, we use the right costal cartilage for either ear. A short incision is made over the seventh rib, extending medially almost to the costal margin. In girls, the developing breast bud is avoided. The dissection maintains perichondrium on the lateral surface of the cartilage and leaves perichondrium on the visceral surface to allow for any possible cartilage regeneration. Although perichondrium on the lateral surface of the graft would lend itself to skin adherence, little is actually left after carving the framework.

The cartilaginous framework is sculpted at a sterile side table. A "base-plate" is carved, including the antihelix, antitragus, and fossa triangularis. A separate floating rib is used for the helical rim. The rim is attached to the base-plate using 4-0 stainless steel wire. Permanent suture may be used, but the wire is easy to tighten with one hand while the construct is held with the other, and tension can easily be adjusted. The twisted wire is kept on the undersurface of the framework. The caudal end of the helical rim usually tapers. In an effort to maximize lateral projection inferiorly, we attach it to the base-plate more laterally (Fig 2).

While harvesting cartilage, the parietal pleura may inadvertently be violated. If this is obvious, a red rubber catheter is placed through the rent and the site is closed in layers. The catheter is then removed as positive pressure is applied to the airway by the anesthesiologist. If no rent is seen before closure, the wound is filled with saline and the anesthesiologist applies 40 mm Hg pressure to the airway. If sustained bubbling is noted, a red rubber

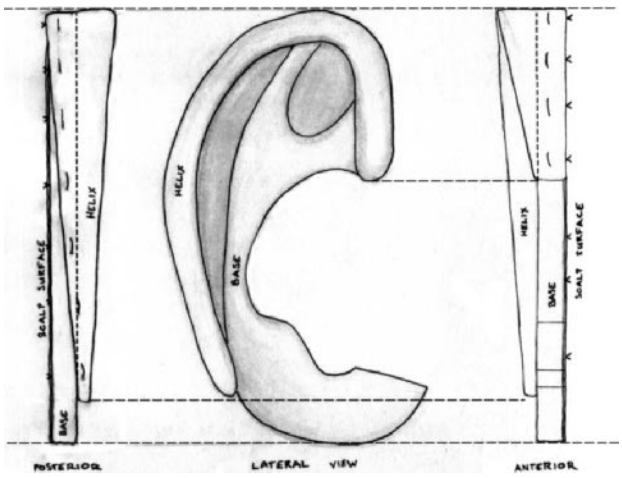

Fig 2 A "blueprint" for the proposed cartilage framework. The caudal aspect of the helical rim is advanced laterally to improve its projection.

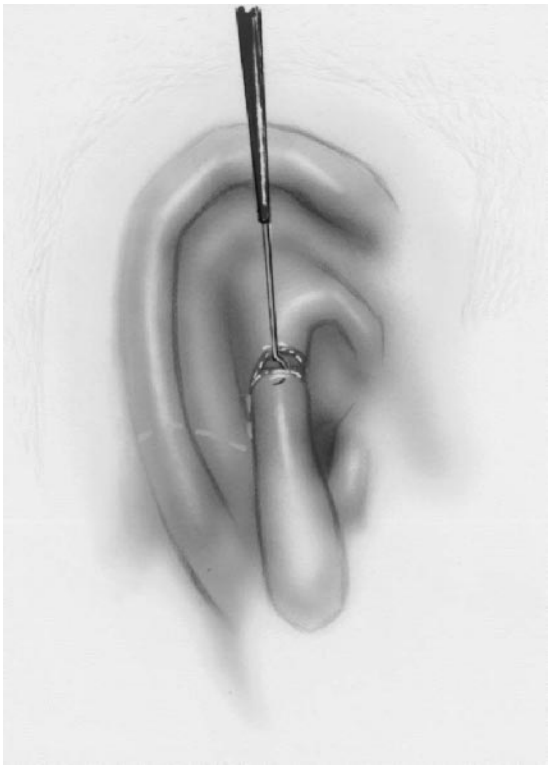

Fig 3 Transposition of the microtic remnant to construct the lobule. At this stage the meatus and tragus are not yet constructed while they are visible in this schematic.

catheter is inserted into the pleural space and the wound is closed as previously explained. A chest radiograph is routinely obtained before extubation.

The framework is placed into the pocket, and its orientation is confirmed. Two small suction drains are placed and maintained until the third postoperative day. Foam is placed around the periphery of the ear to serve as a bumper. Absolutely nothing is placed over the ear so that it can be observed easily. Any significant hematoma should be evacuated and irrigated. If skin necrosis occurs, the involved skin is debrided and the framework is covered with a temporoparietal fascia flap and skin graft.[13]

If there is significant skin shortage or an extremely low hairline, it is recommended that a primary temporoparietal flap be done and covered with a full-thickness graft from behind the normal ear,[6] although we have had some success with laser hair removal.

Stage 2: Lobule Transposition

The earlobe is transposed from its anterior position. Using the remnant of the microtic ear to build a lobule is more challenging than it may appear. This transposition takes the form of an asymmetric Z-plasty while "splicing" the lobule over the caudal tip of the framework (Fig 3).[14] By cheating on the anterior aspect of the lobule, the preauricular scar can be kept at the future site of the tragus (Fig 4).

Stage 3: Ear Elevation

The new ear is elevated from the scalp by first making an incision around the periphery of the helix. This incision is made a few millimeters beyond the border of the framework so that the skin flap can wrap around the edge of the helix. This places the long scar behind the helix. Next, the framework is elevated while maintaining a thin layer of soft tissue on the undersurface of the framework to support a skin graft (Fig 5). A scalp flap is advanced to the depth of the sulcus and held with permanent sutures. The medial aspect of the reconstructed ear is lined with a thin full-thickness skin graft from the groin. As opposed to a split-thickness skin graft, this

Fig 4 The new lobule in position. At this stage the meatus and tragus are not yet constructed while they are visible in this schematic.

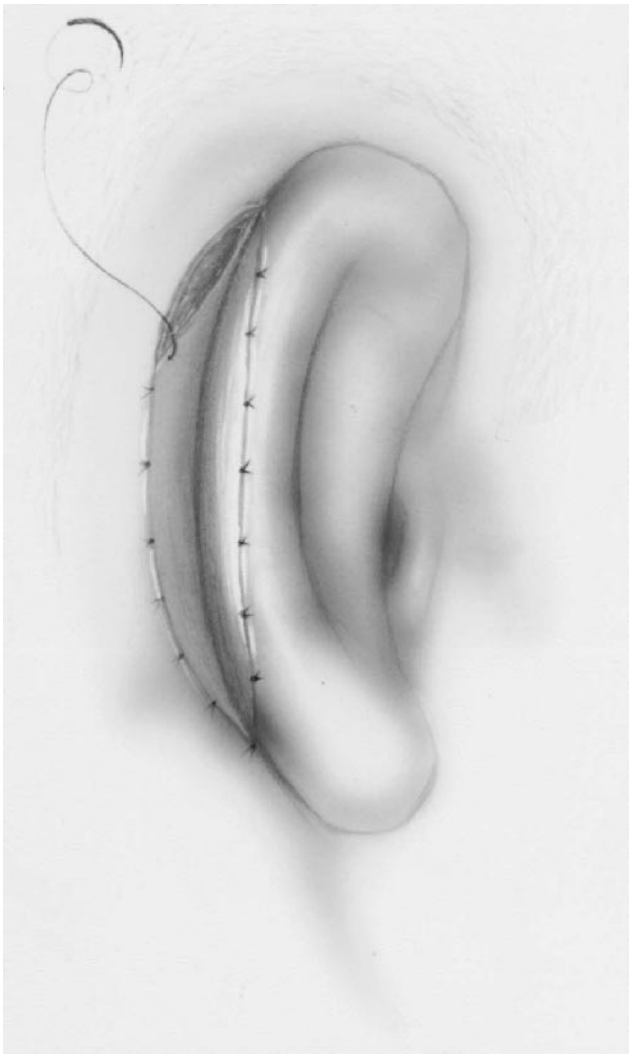

Fig 5 The framework is elevated from the scalp while preserving a thin layer of soft tissue on the medial surface of the ear. A thin full-thickness skin graft from the groin is used to line the medial surface. The scalp is advanced into the new sulcus. This flap lessens the size requirement for the skin graft and keeps it less visible on the medial aspect of the ear.

donor site can be closed primarily, leaving a linear scar in the groin crease. Furthermore, on the medial aspect of the ear, color match is not a consideration. A tie-over bolster is placed in the sulcus.

Stage 4: Tragus

The final stage includes excavation of the concha and creation of a tragus. We begin with a J-shaped incision, which defines the edge of the new tragus. The crook of the "J" simulates the intertragal notch. The concha is undermined posteriorly to allow deepening. The posterior or medial lining of the tragus as well as its support is derived from a composite graft from the concha of the normal ear (Fig 6). This graft is harvested from the anterolateral aspect of the concha. This approach facilitates a balancing otoplasty, which is often necessary.[6,14] A skin graft from the medial aspect of the contralateral ear is often needed to line the deepened concha. It is important that this be taken below the level of the composite so they are not coincident. The newly created tragus casts a shadow, which gives the illusion of a meatus.

Discussion

Carefully planned and executed autogenous construction of the ear is reliable. Particular emphasis must be placed on the initial consultation. The parents of the patient suffer significant anxiety from this deformity and are reassured during the initial consultation, which is frequently early in life. They are usually eager to have surgery "as soon as possible" and must be helped to understand the rationale for the staged approach and its timing. If pho-

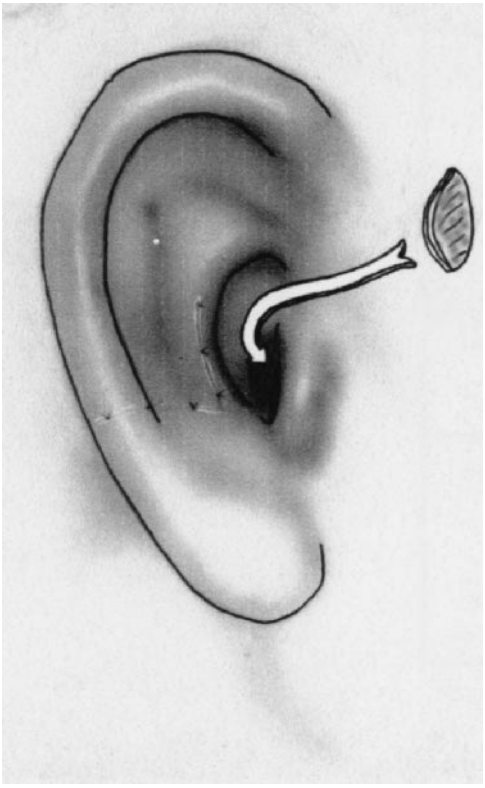

Fig 6 Composite graft from contralateral ear used to provide support and posteromedial lining for the tragus.

tographs are shown, they should represent the surgeon's average results.[15]

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