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Microtia Reconstruction

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Before the 1950s, very few systematic attempts to reconstruct the congenitally malformed or absent ear appear in the literature. In the 1950s, Radford Tanzer at Dartmouth Medical School was the first surgeon to devote a major intellectual effort toward the development of a series of operations to reconstruct microtia defects. Although he began his focus on microtia rather late in his career, and thus completed only 44 cases before his retirement, his work inspired the modern era of microtia reconstruction, most notably through his influence on Burt Brent, the pioneer of microtia reconstruction in the United States.[1-3]

Tanzer's repairs began with transposing the malpositioned lobule and then implanting an autologous costochondral framework in a later stage. In contrast, Brent developed and popularized a four-stage approach to auricular reconstruction, which began with the costochondral framework implantation, with lobule transposition occurring in a second operation several months later.[4-6] The third stage involved creating a postauricular sulcus by elevating the framework off the scalp and skin grafting the soft tissues, and the final stage employed a composite graft and skin graft from the opposite ear to create both a tragus and a conchal bowl. His results have had an incalculable impact; they are consistent and effective, and he and many of his disciples continue to employ this approach to microtia today (Fig. 25-1).

In the 1980s Satoru Nagata in Japan consolidated the steps involved in autologous auricular reconstruction and in the 1990s published a series of landmark articles that elegantly described the salient features of auricular reconstruction into two stages.[7-10] The first stage involved creating the costochondral framework with a tragal segment attached and transposing the lobule into correct position at the time of framework placement. Thus he performed the Brent first, second, and fourth stages all in the first operation, leaving only the postauricular sulcus creation for a later stage.

This latter operation was embellished by the interposition of a temporoparietal fascia flap (TPFF) between the medial surface of the framework and the skin graft, for better long-term preservation of the sulcus. His results were excellent and appealed to the reconstructive surgery community based on the improved detail, the long-term postauricular sulcus preservation, and the simplification of eliminating two operations. The major drawback of Nagata's approach was the requirement for significantly more cartilage, so operations were delayed until patients were approximately age 10 or older, when the thoracic cavity could provide adequate cartilage stock.

In the late 1990s Francoise Firmin, a French plastic surgeon, published her personal experience with microtia reconstruction, after performing the Brent technique serially for 7 years, followed by a 4-year experience with the Nagata technique.[11] She highlighted the pitfalls and advantages of each approach and recently produced a comprehensive treatise on the modern approach to microtia reconstruction that addresses precise pocket and framework modifications based on individual patient factors.[12]

Fig. 25-1 The Brent technique. **A,** Harvested carved framework with template. **B,** Native cartilage remnant removed. **C,** Framework inserted in subcutaneous pocket. **D,** Lobule incision for transfer *(dotted line)*. **E,** Dissection for lobular transfer. **F,** Lobular inset. **G,** Dissection for third-stage postauricular sulcus creation. **H,** Skin graft i set into the postauricular sulcus. **I,** J-shaped incision marked for fourth-stage tragal reconstruction. **J,** Inset of a composite graft and skin graft from the contralateral ear. **K,** Preoperative view. **L,** Final view after four surgical stages.

With superior results from several groups across continents, it became clear that nearly normal-looking auricles could be achieved using costochondral grafts, with pedicled flaps and skin grafts to complete the reconstruction.[13-17] Some surgeons described refi ements to the second-stage procedure to eliminate the need for any helical rim incision, though in general, the helical rim incision has not been considered a conspicuous aesthetic issue.[18] However, the results remain variable, at times unpredictable, and modern consensus supports that given the degree of nuance involved with microtia reconstruction, it is best performed in fewer centers around the globe, where both institutional and individual surgeon experience can maintain the breadth and depth required to optimize outcomes.[19]

Alternatives to costochondral reconstruction have also been variably popular across the decades. Silastic implants, popular in the 1970s and 1980s, are now universally recognized to extrude over the long term, and have been replaced by porous polyethylene (Medpor) constructs.[20-22] Initial descriptions of these implants reported placement in a subcutaneous pocket, similar to the method for implantation of a costochondral graft [23] Over the years, the need for vascularized tissue coverage to prevent extrusion has become widely recognized,[24,25] and modern approaches to total ear reconstruction with Medpor implants, popularized in the United States by Reinisch, now dictate the coverage of the implant with a pedicled TPFF based on the superfic al temporal vessels.[25]

EPIDEMIOLOGY AND CLASSIFICATION

The cause of microtia has not been elucidated. Among possible causes, maternal malnutrition, genetic defects, and high altitude have been implicated, although strong evidence does not currently exist to implicate a unifying cause.[26,27] The incidence is reported at between 0.4 and 5.5 of 10,000 births, approximately half in isolation and half with other associated abnormalities or syndromes.[27] In 82% of cases microtia occurs unilaterally, and there is a slight male predisposition for the condition.[28]

Microtia has been subject to myriad classifi ation schemas across the decades, although an original description by Weerda,[28] modifi d by Aguilar,[29] remains widely accepted today (Table 25-1).

Class III microtia, in which there is only a minor remnant present that may be utilized for the reconstruction, is the most common clinical presentation. Nagata further classifi d these class III deformities; lobular-type deformities are those in which a malpositioned lobule exists, but no conchal bowl, tragus, or antitragus.[8-10] When a concha, tragus, and antitragal elements are recognizable, the deformity is termed a *concha-type* deformity. A subtype, defi ed as the small concha-type, is a deformity in which the concha is signifi antly diminished in dimension, requiring modifi ation of the costochondral framework to address the conchal bowl (Fig. 25-2).

Table 25-1 Aguilar's Classifi ation and Grading of Microtia

I	Normal ear
II	Deformities present
III	Anotia

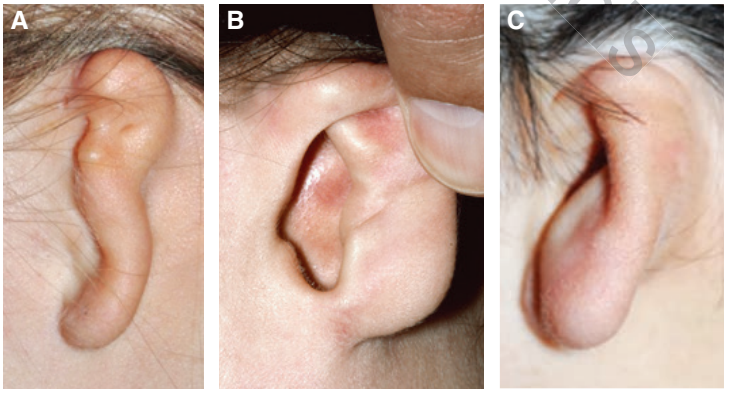

Fig. 25-2 Examples of the different types of class III microtia. **A,** Lobular type. **B,** Concha type. **C,** Small concha type.

The presence of microtia increases the likelihood of airway anomalies, and a well-defi ed association between microtia and difficulty visualizing the larynx has been established.[30] Middle ear anomalies are also associated with microtia, and the severity of the external deformity often predicts the severity of maldevelopment of the middle and inner ear structures[31] (see Chapter 26).

INDICATIONS AND LIMITATIONS

For two-stage autologous cartilage reconstruction of microtia, repair is indicated when patients reach adequate size (approximately age 10) and when both the patient and family are motivated to proceed, with an understanding of the risks, limitations, and potential drawbacks of the procedure. Because moderate discomfort at the site of rib harvest is expected, patients and families must be warned preoperatively about this likelihood, despite intraoperative treatment with long-acting local anesthetic intercostal blocks.

Signifi ant limitations to total auricular reconstruction exist when there is scarring at the site of the proposed reconstruction. Burns involving the skin and soft tissue of the area or traumatic auricular amputations complicate the reconstructive picture.[32] In such cases local healing is less predictable, the viability of the TPFF for primary or salvage use is less certain, and contractile forces may distort an otherwise well-crafted auricle. Some surgeons counsel against pursuing auricular reconstruction in these situations, because results are frequently suboptimal even in experienced hands.[12] Others describe good results, even in these complex situations.[32] When microtia accompanies hemifacial microsomia or another craniofacial anomaly, specific modifi ations to address reconstruction have been described, and the limitations are related more to the availability of rib cartilage than to other factors.[17]

PREOPERATIVE PLANNING

Preoperative planning includes size assessment of the patient, acknowledgment of any existing facial or mandibular asymmetries, and thorough assessment of the remnant elements and their position with respect to the planned placement of the neoauricle (see Chapter 12). Individual templates can be fashioned from radiographic film, transparency paper, or Silastic sheeting for intraoperative use (Fig. 25-3), though standardized templates are favored internationally. A large positioning template, fashioned from the contralateral ear, is used to locate the appropriate position of the neoauricle.

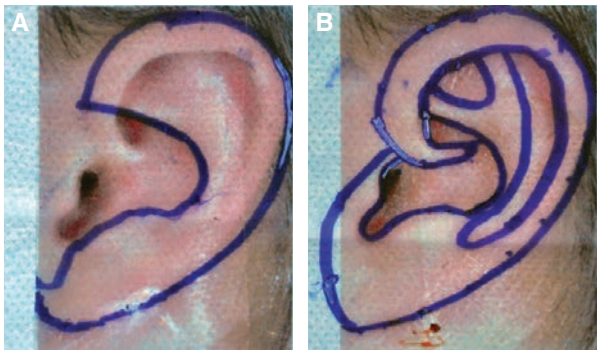

Fig. 25-3 Templates required for preoperative planning. **A,** Framework body template. **B,** Auricular design template.

TECHNIQUE

First Stage: Creation of the Costochondral Framework

The first stage involves creation of the costochondral framework, with onlay grafts for antihelix, antitragus, and tragus, and simultaneous lobular transposition, when necessary. The procedure is begun by using the positioning template to carefully outline the appropriate location of the neoauricle, based on transposing the template from the healthy side to the microtic side, and marking the corresponding appropriate location. Two additional maneuvers are performed to verify proper location and orientation of the planned reconstruction. First, a measurement is taken from the lateral canthus to the root of the helix on the healthy side, and is checked against the marked location of the planned reconstruction to verify that the distance is the same. Second, the rotation of the healthy ear is noted with respect to the plane of the nasal dorsum, and a line corresponding to the appropriate rotation for the planned reconstruction is drawn on the cheek for reference throughout the case[12] (Fig. 25-4). Finally, the proposed auricular position is outlined in detail in the appropriate location (Fig. 25-5).

Rib harvest proceeds on the ipsilateral chest wall, through a 5 cm incision, placed obliquely over the costal margin in male patients (Fig. 25-6). In female patients, a submammary approach can be used to further camouflage the scar.

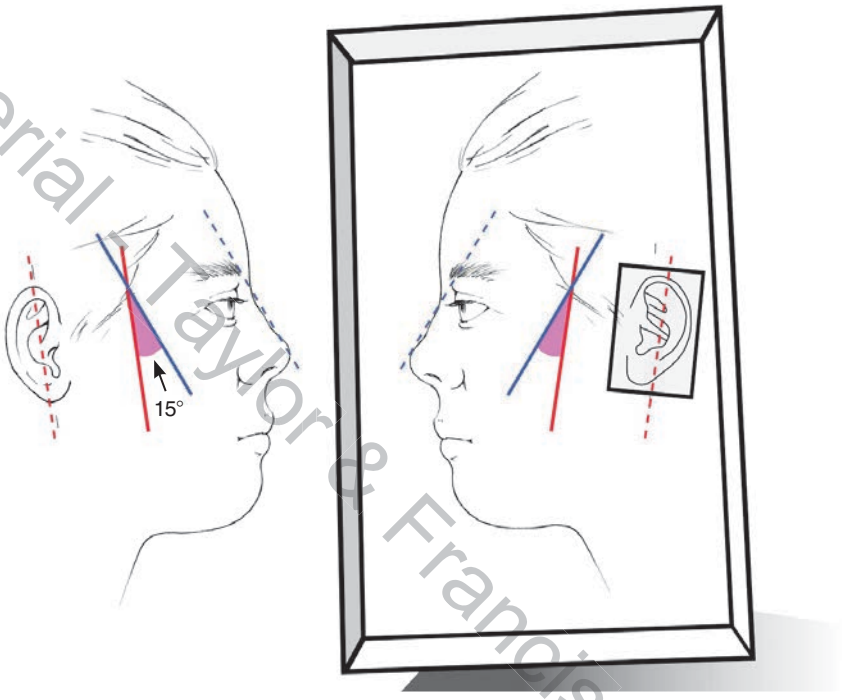

Fig. 25-4 Neoauricle orientation proceeds using the nasal dorsal plane as a reference, introducing the appropriate anterior rotation (10 to 15 degrees), according to the axis of the ear on the healthy side. (Modified from Firmin F. State-of-the-art autogenous ear reconstruction in cases of microtia. Adv Otorhinolaryngol 68:25-52, 2010.)

Fig. 25-5 Proposed auricular position, outlined in detail.

Five separate building blocks must be fashioned to create an adequate neoauricle and are crafted once the rib stock is removed, and the dimensions and lengths are appreciated. Several different approaches to crafting the blocks are illustrated in Fig. 25-7. Ordinarily, the seventh and eighth ribs and their synchondrotic area are used for the body of the framework, with the eighth rib used to fashion the helical rim segment. The ninth rib provides stock for the underlay segment, which is banked in the chest wound and used dur-

Fig. 25-6 Rib harvest, showing removed segments of ribs 6 to 9. Note the discrepancy between incision length and the length of the costal segments.

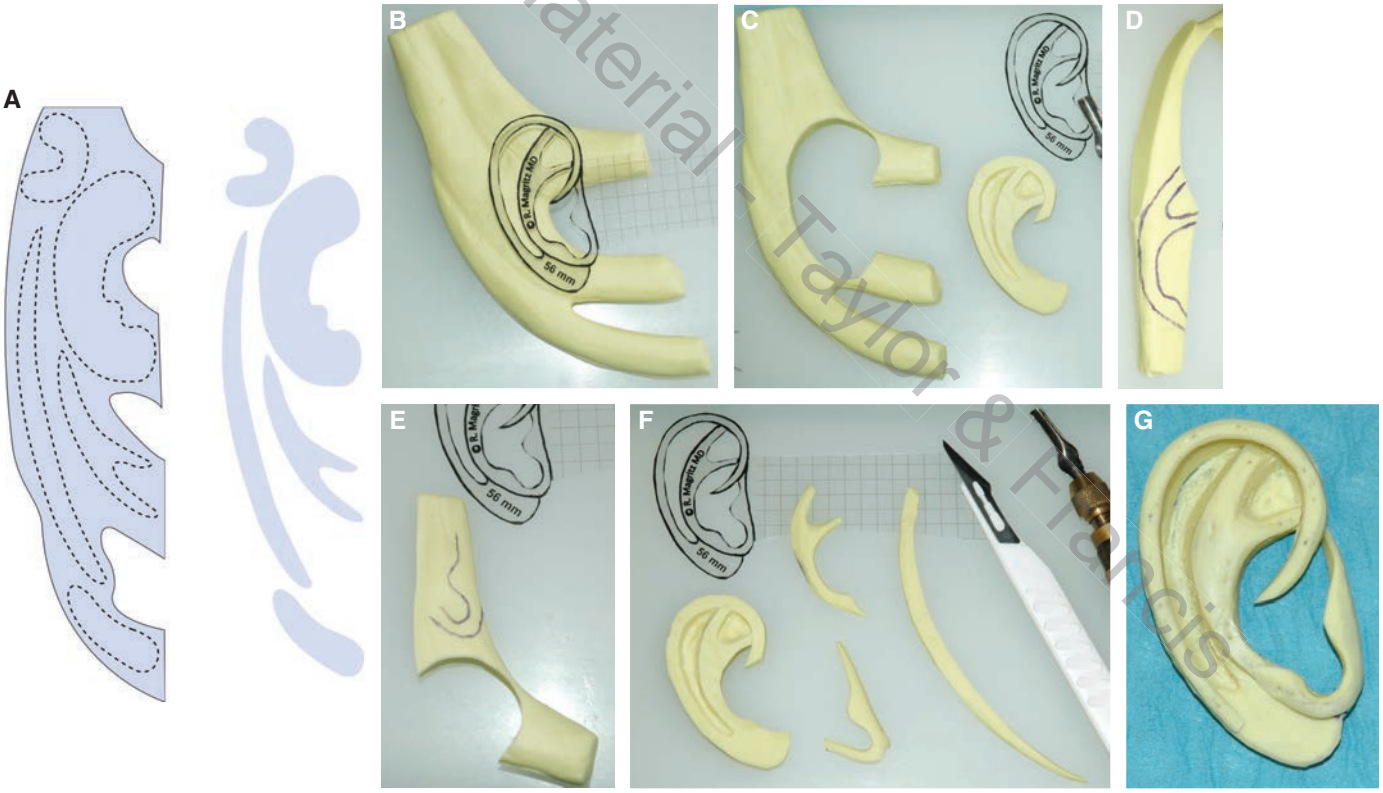

Fig. 25-7 Location of the five building blocks. **A,** Firmin approach to proposed areas for the components, dotted onto rib stock and then harvested. **B-F,** Silicone model of rib stock favored by Magritz, with proposed building blocks. **G,** Silicone segments integrated to form complete neoauricle. (**A** modifi d from Firmin F. State-of-the-art autogenous ear reconstruction in cases of microtia. Adv Otorhinolaryngol 68:25-52, 2010; **B-F** from Magritz R, Siegert R. Auricular reconstruction—surgical innovations, training methods and an attempt for a look forward. Facial Plast Surg 30:183-193, 2014. With permission.)

ing framework elevation to introduce appropriate auricular projection. Remaining segments of the seventh and eighth ribs, left over after the body and the helical rim are fashioned, are carved into the antihelical overlay and the antitragal and tragal complex. Pieces are then integrated in a systematic fashion, using 5-0 stainless steel on double-armed straight needles to produce the fi al three-dimensional construct (Fig. 25-8).

Creation of the pocket begins with incision placement, which is dictated by remnant location and features. Typically, the incision follows a W shape, extending onto the anterior surface of the lobular remnant and ending in a tight circle corresponding to the location of the tragal incisura (Fig. 25-9).

A subcutaneous pedicle is ordinarily preserved at a location corresponding to the concha cavum, immediately anterior to the antitragus. The pocket is raised subcutaneously; it is thin, with dimensions approximately 1 cm larger than the planned auricular framework and the framework introduced in corkscrew fashion around the subcutaneous pedicle until the proper orientation is achieved. Skin closure is then performed, including lobular transposition into the appropriate location, covering the inferiormost aspect of the cartilage framework. Two suction drains are placed to promote apposition of the overlying skin to the framework (Fig. 25-10), although some surgeons have eliminated the use of drains and simply evacuate the air over a sealed dressing before emergence from anesthesia.

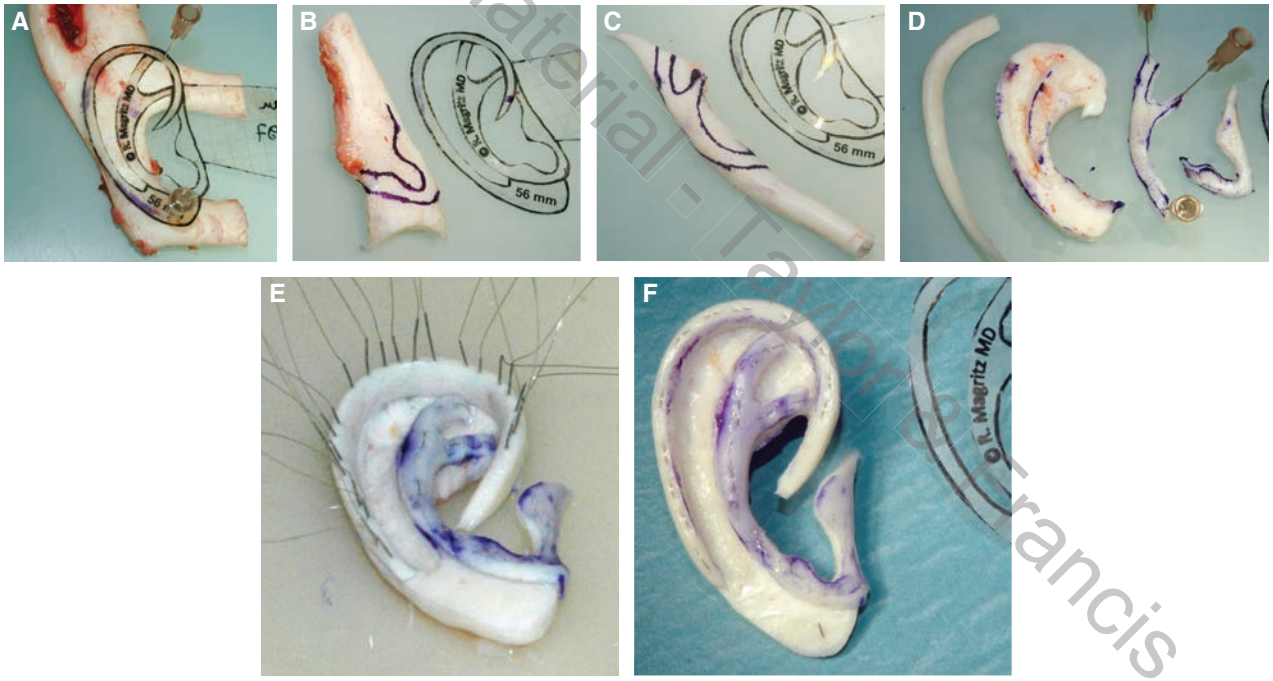

Fig. 25-8 Framework construction. **A,** Planning the base plate. **B,** Marked tragus-antitragus complex. **C,** Marked antihelix, including crura. **D,** Carved framework pieces. **E,** All components integrated using wire sutures. **F,** Completed framework. (Magritz R, Siegert R. Auricular reconstruction—surgical innovations, training methods and an attempt for a look forward. Facial Plast Surg 30:183-193, 2014. With permission.)

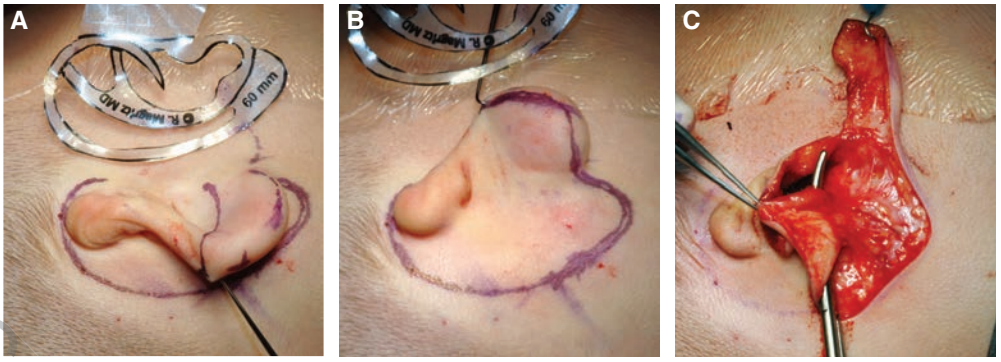

Fig. 25-9 Typical incision placement. **A,** View with remnant overlying proposed neoauricle position, exposing what will become the superfic al lobular surface. **B,** View with remnant displaced in the opposite direction, exposing remaining surface. **C,** Subcutaneous pedicle visible after flap elevation. (From Magritz R, Siegert R. Auricular reconstruction—surgical innovations, training methods and an attempt for a look forward. Facial Plast Surg 30:183-193, 2014. With permission.)

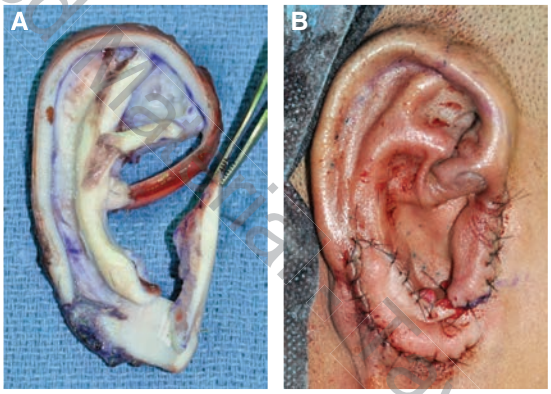

Fig. 25-10 The completed neoauricle. **A,** The assembled cartilage framework. **B,** Typical appearance of the neoauricle in the subcutaneous pocket, with test tube drains in place to create tight apposition of the overlying skin to the framework.

Sec ond St a ge: Cr ea tio n of a P ost a ur icul ar Sul cus

The creation of a postauricular sulcus is undertaken 3 to 6 months after the fi st stage. If the Nagata method is used, after a segment of scalp is shaved, harvest of a split-thickness skin graft s planned immediately behind the reconstructed ear, with suffici t dimensions so that when it is elevated and pedicled on the helical rim, it will reach the anteriormost aspect of the conchal bowl[18] (Fig. 25-11). The graft s elevated sharply, with meticulous care to remain intradermal, so as not to cause any long-term alopecia in the postauricular scalp. When the framework has been nearly reached, the dissection abruptly changes planes and continues in the subcutaneous tissue underneath the framework, thus elevating the neoauricle away from the skull. Care is taken to preserve soft tissue on the deep surface of the framework; the cartilage is not exposed. The underlay segment, previously banked in the chest wall incision, is harvested and secured

to the deep aspect of the framework to increase projection. A TPFF is raised through either a linear or a zigzag incision and tunneled into the wound to cover the fresh cartilage segment. The skin graft s then wrapped around the newly projected ear and secured to the underlying SMAS flap. The skin graft harvest site is protected with a Tegaderm bandage and the scalp site is drained. Reepithelialization of the skin graft harvest site, with new hair growth, is readily apparent within 7 days of the operation.

A simpler approach to sulcus creation, which avoids the elevation of a TPFF, involves incising the skin approximately 1 cm outside the helical rim, all the way from the root to the lobule (Fig. 25-12). A thin skin flap is elevated until the framework is reached, and the framework is elevated with care to preserve vascularized tissue on the medial surface of the neoauricle. Next, a flap of vascularized tissue is elevated from posterior to anterior in the plane just superfic al to the periosteum, based anteriorly, and the previously banked wedge of cartilage from the chest wall is wrapped in this deeper flap to provide auricular projection. The exposed areas are then covered with either a split- or full-thickness skin graft

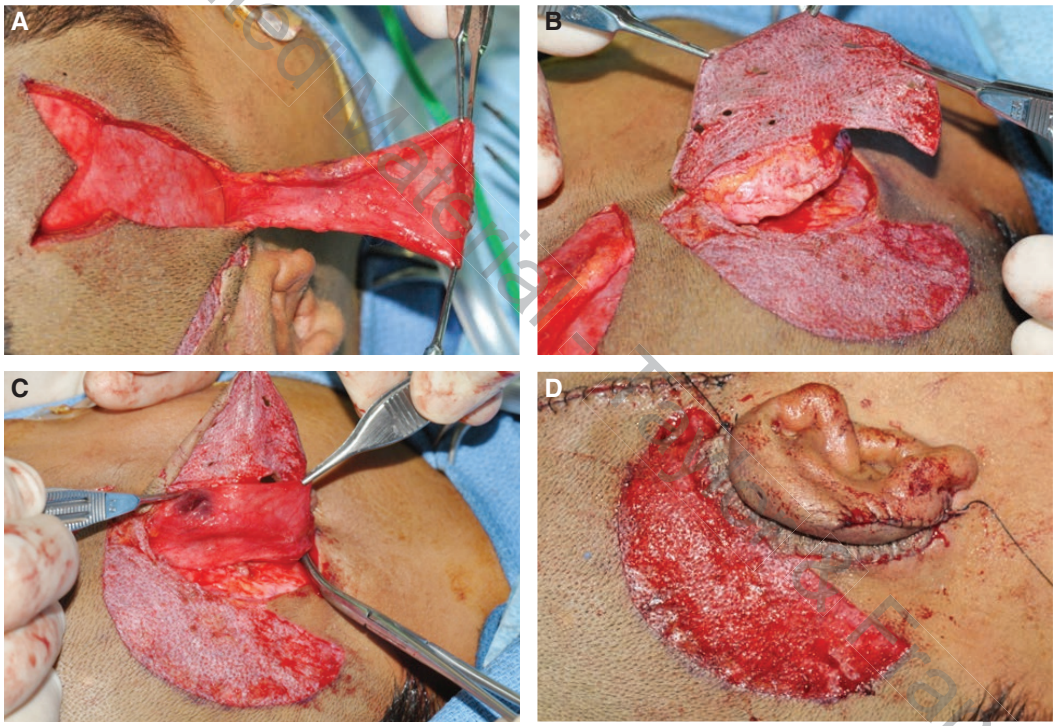

Fig. 25-11 The Nagata approach to second-stage microtia reconstruction. **A,** Elevation of the temporoparietal fascia flap. **B,** Elevation of the pedicled skin graft **C,** Fascia flap rolled into the postauricular sulcus. **D,** Skin graft secured over the fascia flap, with donor site left o reepithelialize.

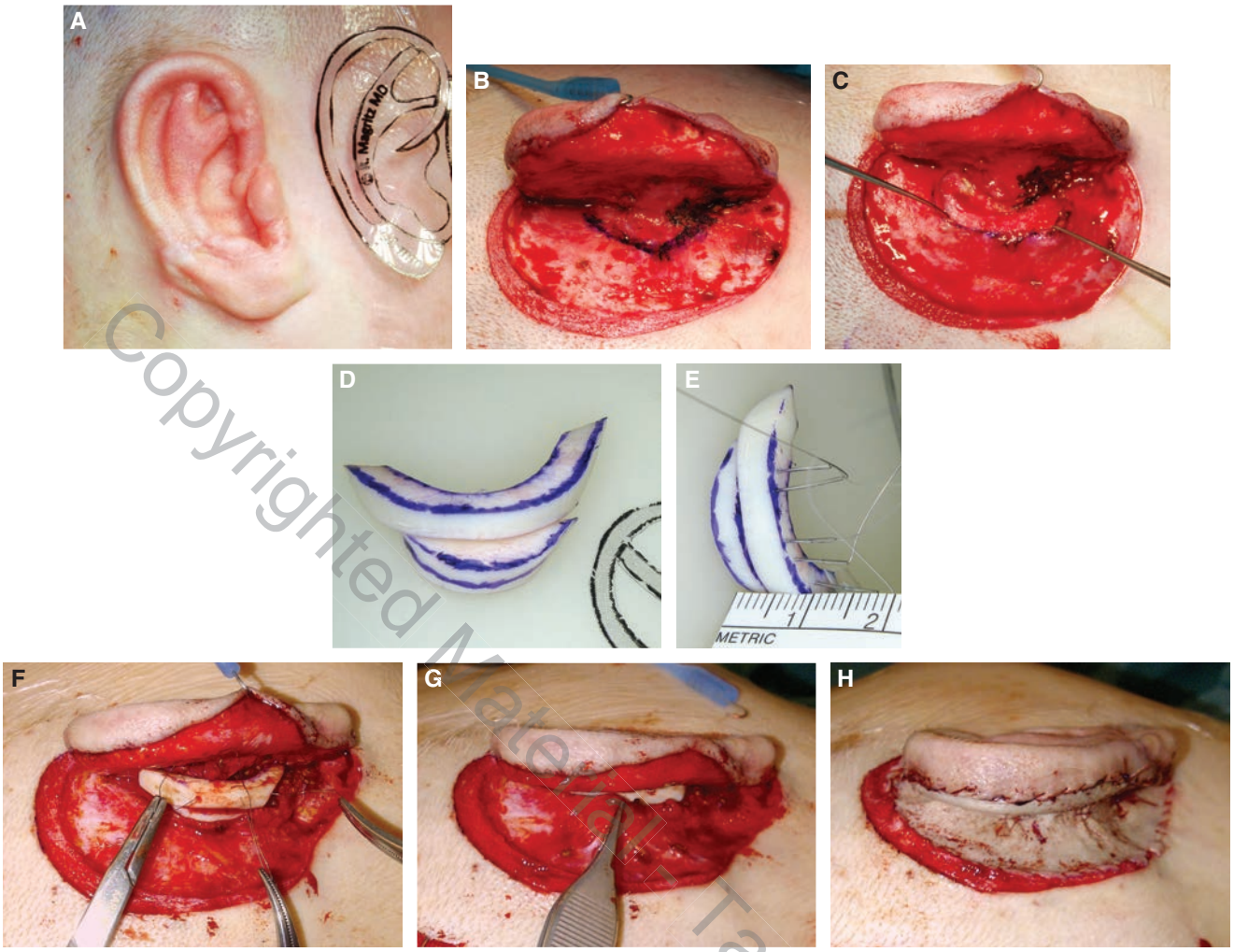

Fig. 25-12 Magritz approach to sulcus creation. **A,** Preoperative view after costal graft as healed. **B,** View after framework elevation, maintaining vascularized tissue on the deep surface of the framework. Note the markings for SMAS elevation. **C,** Elevated SMAS flap. **D,** Cartilage wedge harvested from a subcutaneous pocket in the chest wall. **E,** Integration of the two costal segments to create proper projection. **F,** Securing the costal graft to the deep surface of the neoauricle. **G,** SMAS flap covering the costal wedge. **H,** Placement of skin graft over the sulcus. (From Magritz R, Siegert R. Auricular reconstruction—surgical innovations, training methods and an attempt for a look forward. Facial Plast Surg 30:183-193, 2014. With permission.)

ADJUNCTIVE PROCEDURES

After complete healing, the lobule can be safely pierced with standard piercing methods if desired. Small irregularities can be addressed with minor surgical interventions, and hair removal, if required, is performed with laser techniques (see Chapter 41). It is preferable to place the neoauricle under non-hair-bearing skin to avoid the need for such treatments.[17] Similar principles to those described earlier may be used in cases of total or subtotal auricular loss, such as loss from traumatic auricular avulsion, burns, and auriculectomy defects for cutaneous malignancy. However, when significant skin scarring is present, the framework may be covered by a TPFF during the first reconstructive stage[32-34] and a split-thickness skin graft is placed (Fig. 25-13)or expanded local skin. Alternatively, free tissue transfer techniques may be used[32] (Fig. 25-14).

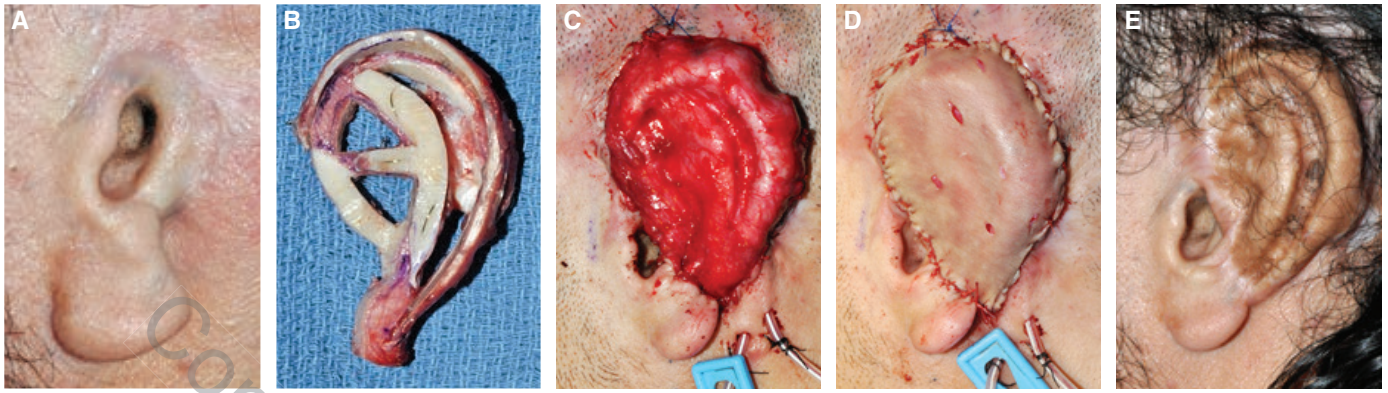

Fig. 25-13 Example of subtotal auricular reconstruction after trauma illustrating the utility of the temporoparietal fascia flap. **A,** Subtotal auricular avulsion. **B,** Carved framework. **C,** Temporoparietal fascia flap draped over the framework. **D,** Skin graft applied to the superfic al surface of the flap. **E,** Result 1 year postoperatively.

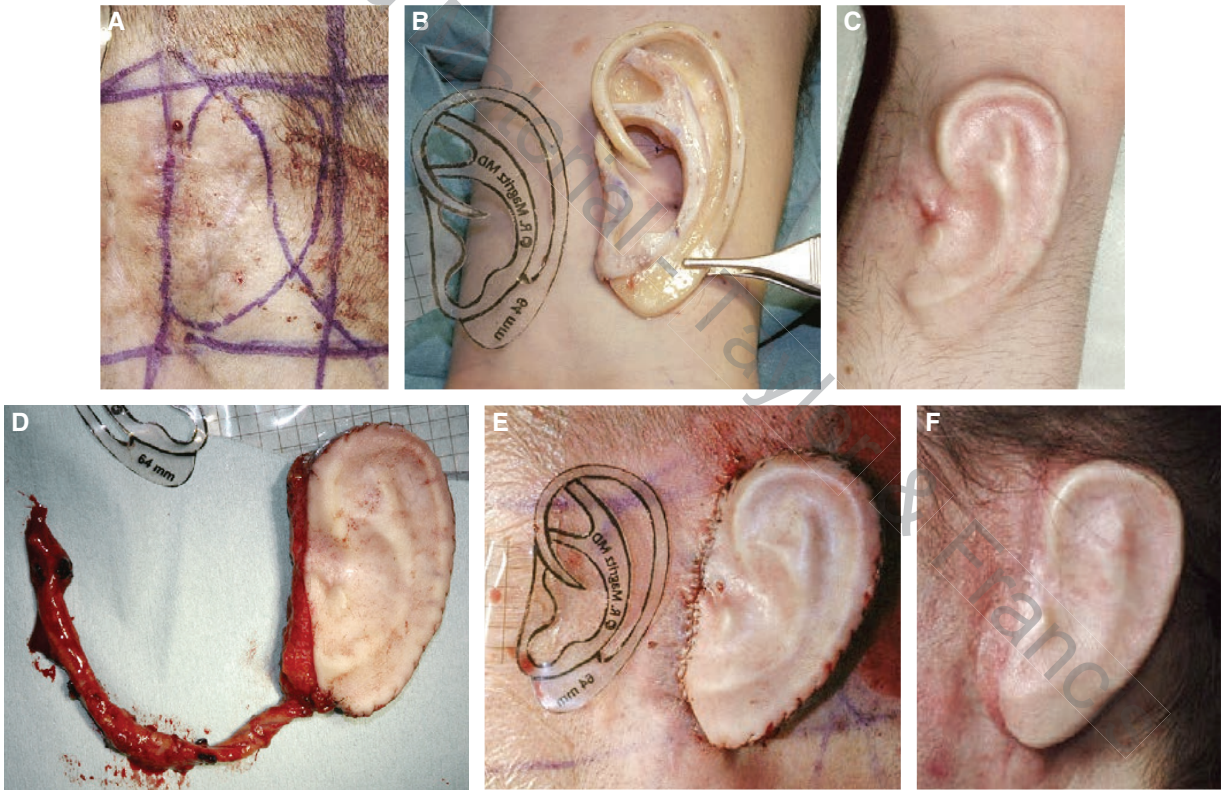

Fig. 25-14 Auricular reconstruction using a prelaminated radial forearm flap and costal graft **A,** Extensive scarring in the recipient bed. **B,** Carved framework before implantation into the forearm. **C,** Six-month view of the framework well integrated into forearm skin, demonstrating favorable defin tion. **D,** Harvested flap with vascular pedicle. **E,** Immediately after revascularization. **F,** Result 6 months postoperatively. (From Magritz R, Siegert R. Reconstruction of the avulsed auricle after trauma. Otolaryngol Clin North Am 46:841-855, 2013. With permission.)

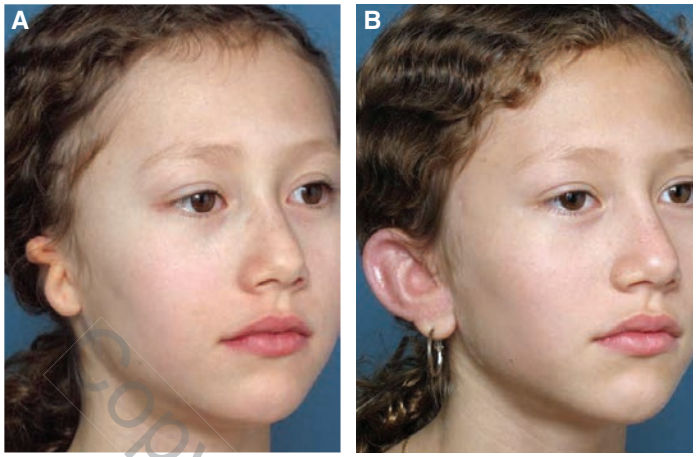

Fig. 25-15 Porous polyethylene auricular reconstruction. **A,** Preoperative view. **B,** Four months after one-stage auricular reconstruction with a porous polyethylene prosthesis. (Courtesy of John Reinisch, MD.)

Fig. 25-16 Auricular prosthesis in an older adult patient after total auriculectomy for malignancy. Note that the patient is able to support eyeglasses while wearing the prosthesis.

In cases in which autologous reconstruction fails, is not desired, or is not technically feasible, porous polyethylene implants offer an excellent alternative (Fig. 25-15).

In experienced hands, when a polyethylene reconstruction is properly covered by vascularized tissue, the aesthetic results may match or exceed those of autologous cartilage reconstruction. However, the long-term (lifetime) risk of framework fracture and extrusion is not currently known, and must be factored into the overall reconstructive plan.

A final alternative to address microtia and total auricular defects is the auricular prosthesis. Fashioned from Silastic or other polymers and secured in position by either glues or osteointegrated implants, auricular prostheses offer a straightforward approach that provides the illusion of an ear in the appropriate location (Fig. 25-16). For poor surgical candidates, patients for whom surgery has failed, and patients in resource-constrained environments, this approach offers a reasonable aesthetic alternative.

POSTOPERATIVE CARE

Prophylactic antibiotic therapy is employed to prevent infection for the first postoperative week, and a mastoid type of dressing is maintained. Thereafter, topical antibacterial ointments are applied to the incision lines to prevent desiccation and avoid breakdown. In the early weeks after the first stage of reconstruction, meticulous wound care and regular inspection of the skin overlying the framework are critical. Even minor breakdown can lead to cartilage exposure and ultimately to a contour deformity in the reconstructed ear (Fig. 25-17). If there is an at-risk area along the helical rim, it should be followed very closely. A low

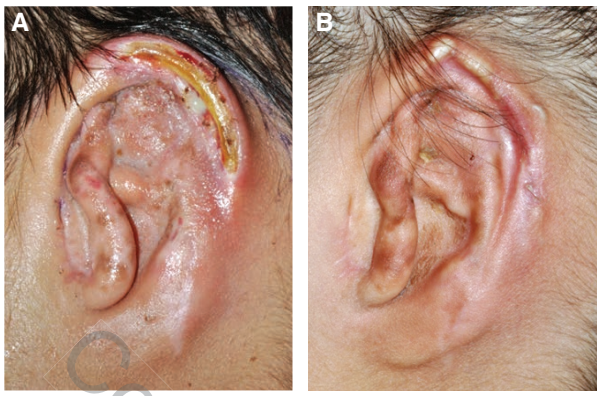

Fig. 25-17 Example of loss of helical rim defin tion after wound breakdown. **A,** Untreated exposed helical rim cartilage. **B,** Resulting long-term helical rim defic t.

Fig. 25-18 Salvaging an exposed auricular rim with a randomly based temporoparietal fascia flap, covered with a skin graft **A,** In this 10-year-old girl, the helical rim was exposed 2 weeks after primary microtia reconstruction. **B,** A segment of fascia was elevated through a Y-shaped incision. **C,** The fascia flap was inset, with a skin graft arvested from the remaining auricular remnant. **D,** Final appearance after 4 months, before elevation.

threshold is appropriate for return to the operating room to place a small randomly based TPFF over the area of breakdown with a skin graft (Fig. 25-18).

After the second-stage sulcus creation, a sponge is secured to the postauricular sulcus to wick away any moisture and to apply gentle overlying pressure that promotes skin graft take to the underlying TPFF. For the scalp skin donor site, a Tegaderm is stapled in place for the fi st 10 postoperative days. Thereafter, a petrolatum-impregnated gauze is placed over the reepithelializing skin and changed as needed.

COMPLICATIONS

Complications may arise at any stage during microtia reconstruction. Unlike other operations, even a minor wound issue may dramatically compromise the long-term result; thus a level of vigilance in avoiding complications reaps signifi ant rewards. A pneumothorax may arise from rib harvest and may be treated conservatively with supplemental oxygen or require chest tube placement for resolution. Wound infections are treated with judicious debridement and parenteral culture-directed antibiotic therapy; wound breakdown is treated with TPFF coverage of the exposed areas of framework with skin grafting.[33,34] We have found that hyperbaric oxygen therapy has improved overlying skin survival. Sulcus obliteration may be treated with revision elevation and skin grafting, and when the TPFF has already been used, a posteriorly based flap based on the occipital artery may be pedicled into the sulcus or otherwise used to improve the result.[34,35]

Tissue expansion has been advocated by some to increase the available soft tissue coverage and decrease the ischemic stress of the soft tissue pocket during framework placement, although the extra steps involved—including the lengthy filling process and the development of a thick capsule that requires thinning—have proved to be a deterrent to mainstream adoption of this approach.[36]

RESULTS

Using the four-stage Brent technique, reasonable results have been achieved consistently (Fig. 25-19). However, with the employment of more cartilage segments to introduce greater detail (such as in the Nagata technique and modifi ations by Firmin, Magritz, and others), overall attainment of pleasing results has increased (Fig. 25-20).

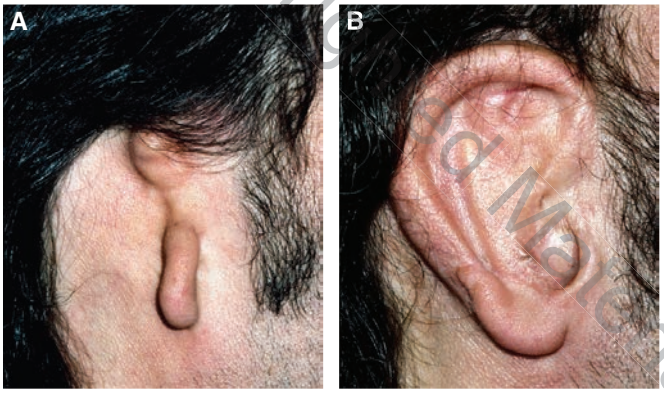

Fig. 25-19 Typical results from the four-stage technique. **A,** Preoperative. **B,** After four stages of auricular reconstruction.

Fig. 25-20 Th s patient is shown before and after two stages of auricular reconstruction. (From Magritz R, Siegert R. Auricular reconstruction—surgical innovations, training methods and an attempt for a look forward. Facial Plast Surg 30:183-193, 2014. With permission.)

Key Points

- Microtia has been a surgical problem of interest in the United States since 1959, when Tanzer first described its surgical treatment in earnest.
- Brent popularized the classic four-stage approach to auricular reconstruction.
- Japanese and European surgeons have popularized the two-stage auricular reconstruction, performing detailed repair using larger costochondral grafts
- Porous polyethylene reconstruction is an alternative to the use of autologous tissues for ear reconstruction.
- Wound problems can lead to unsatisfactory outcomes and must be avoided, monitored for, and aggressively managed by coverage with vascularized tissue to avoid loss of ultimate auricular definition.

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