The ear is a defining feature of the human face. It is considered one of the most important landmarks for a harmonious and aesthetically pleasing countenance. For any facial plastic surgeon, total auricular reconstruction is a formidable challenge because of the unique architectural topography of the ear. Any reconstructive surgical procedure aims for precise duplication of the missing portion. The ability of the facial plastic surgeon to reconstruct characteristics of the normal ear, including size, location, orientation, and anatomic landmarks, is important. If 1 or more of these features are missing, the ear will appear abnormal.1 One of the goals of treatment of microtia is to create a well-defined postauricular sulcus.

Many techniques for elevation of the pinna in cases of microtia have been described. These techniques range from simple elevation of the pinna using split-thickness skin grafts to transplanting cartilage and covering it with a temporal parietal fascia flap. This study presents our experience with a novel periosteal flap for elevation of the pinna in patients with microtia.

Methods

In total, 158 patients with microtia were operated on using the retroauricular, posteriorly based periosteal flap technique between February 3, 2005, and August 27, 2012. All patients underwent total ear reconstruction using a previously described technique.2 The first stage involves creation of the pinna with cartilage from the sixth to ninth ribs, reconstruction of the chest wall, and fabrication of the tympanic membrane and meatus. The second stage entails elevating the pinna and reconstructing the middle ear2 using the fabricated tympanic membrane and meatus in indicated cases according to the score by Siegert et al4, opening the meatus, and deepening the concha. The third stage further refines the shape of the pinna.

Report of Cases

Case 1
A 39-year-old man with right-sided grade III microtia and congenital auricular atresia had undergone more than 15 operations at other institutions for correction of the microtia and congenital auricular atresia (Figure 1). The result was unsatisfactory for the patient and his family, with multiple scars in the reconstructed auricle and the temple. Our surgical plan was to insert a tissue expander (350-mL crescent-shaped implant; Mentor) under the skin of the previously...
reconstructed auricle after excision of the old cartilage. Three months later, the pinna was constructed with autogenous rib cartilage, and the tympanic membrane and meatus were prefabricated.

Six months later, elevation of the new auricle was performed. Because of the severe scarring and multiple previous operations, no functioning temporal vessels could be detected by Doppler sonography. Relying on a random-pattern supply of the superficial temporalis fascia would have been unacceptably risky because of the numerous deep scars. Therefore, we decided to harvest a periosteal flap instead.

The surgical procedure began by typical positioning of the patient and injection of local anesthetic and epinephrine around the reconstructed pinna in the mastoid area. A 1-cm-wide superthin skin flap surrounding the new helical rim was prepared (Figure 2A).

At the helical rim, the plane of preparation extended deeper around the cartilaginous framework, including elevating its surrounding connective tissue (Figure 2B). At this stage, it is of utmost importance not to expose the bare cartilage. Next, we incised the periosteum of the mastoid plane in a C-shaped pattern with a broad posterior pedicle (Figure 2C).

To achieve sufficient length of the flap, it is important to extend the incision far anteriorly. The middle part of the C-shaped flap has to be adjacent to the posterior end of the temporomandibular joint capsule.

At this point, the surgical technique changes from delicate plastic surgery performed with loupe magnification to middle ear surgery using a microscope. The tympanoplasty (or so-called atresia operation) was performed as described elsewhere2 (Figure 2D and Figure 3A).

While the first team of surgeons (R.S. and R.M.) worked at the auricle, a second team (S.M.S.I. and others) removed the autogenous cartilage, which had been harvested in the first step and stored in a subcutaneous pocket of the thorax. It was

---

**Figure 1. Case 1**

A, A man with right-sided grade III microtia and congenital auricular atresia had undergone more than 15 corrective operations at other institutions. B, A close-up view is shown.

---

**Figure 2. Surgical Technique of the First Team**

A, A 1-cm-wide superthin skin flap surrounding the new helical rim is prepared. B, Wide undermining is performed without exposure of the cartilage of the framework. C, Incision of the periosteum of the mastoid plane in a C-shaped pattern with a broad posterior pedicle is shown. D, Marking for the tympanoplasty (or so-called atresia operation) is completed.

---

**Figure 3. Surgical Technique of the Second Team**

A, Drilling of the petrous portion of the temporal bone for the tympanoplasty is performed. B, Stabilization of the elevated auricle with a cartilage buttress as described by Nagata5 is shown. C, Coverage of the periosteal flap with a full-thickness skin graft is presented.
carved into a crescent shape, adjusted to provide optimal protrusion of the pinna, and fixed to the baseplate of the auricular framework to stabilize the elevated position of the auricle and function like a buttress as described by Nagata5 (Figure 3B).

The flap was long enough to completely cover the cartilaginous pillar. It was fixed to the connective tissue adjacent to the baseplate with 4-0 polyglactin 910 sutures and then covered with a full-thickness skin graft from the thorax, which was harvested adjacent to the incision for removal of the rib cartilage so that no additional scar was created (Figure 3C). The flap was secured with firm tapes to avoid any movement for 1 week.

Cases 2 Through 158
The remainder of the cases were patients with grade III microtia and congenital auricular atresia without prior treatment. Because of the good result in our first case, we used the same type of periosteal flap. This procedure avoids the much more time-consuming preparation of the temporalis fascia and reserves that flap as a rescue option in case of wound healing problems, which we fortunately have not needed so far.

Results
In total, 158 patients with grade III microtia were operated on using the retroauricular, posteriorly based periosteal flap technique and evaluated for periosteal flap and free skin graft survival in the early postoperative period. In all cases, the grafting was completely successful. Further evaluation of our technique was performed just before stage 3. We found that the aesthetic shape of the graft was excellent in all patients, with satisfactory frontal symmetry of the reconstructed ear. Figure 4 and Figure 5 show preoperative and postoperative views of a woman with right-sided grade III microtia and congenital auricular atresia.

Discussion
Over the past 50 years, many surgeons have contributed greatly to improvement in the results of microtia reconstruction.5-14

An important step in total ear reconstruction is elevation of the buried ear framework in stage 2. This step has undergone many changes in technique, ranging from the use of skin grafting to the use of flaps and cartilage blocks in the retroauricular sulcus.

Nagata15 used a galeal flap to cover a cartilage wedge graft in stage 2. Among a subsequent series of 144 patients using the technique by Nagata, Firmin16 reported 10 cases of partial failure of the graft and 1 total failure of the galeal flap. In 8 patients with microtia, Yoshimura et al17 described a 2-stage method for reconstruction of congenital microtia using an anteriorly based mastoid fascial flap covered with a skin graft in the second operation. The skin grafts demonstrated good survival, and an appropriate auriculocephalic angle was preserved in all cases. The authors noted that their method was easy to perform and left no scar in the temporal hair-bearing area. Ou and colleagues18 used a fascial flap based on the same principle as the method by Yoshimura et al. All the fascial flaps and overlying full-thickness skin grafts survived. Ou et al stated that their technique has multiple advantages, including firm elevation, good frontal projection, and a natural appearance of the posterior aspect of the ear. Furthermore, it is a fast and practical procedure, avoids additional scars on the scalp, and preserves the superficial temporoparietal fascia and superficial temporal vessels.

In other reconstruction variations, Park and colleagues19-21 described the use of a cranial-based retroauricular flap in addition to the mastoid fascia flap. Yotsuyanagi and coworkers22 used a local flap from the hairless mastoid region. They reported that the skin of the flap provides good texture and color match to the auricle. Furthermore, the flap skin has good elasticity for a subcutaneous pocket for subsequent cartilage grafting. With this technique, the suture line is placed anteriorly, resulting in a visible scar on the anterior surface of the reconstructed ear.

Alexander et al23 described a technique of elevating the buried ear framework in the second stage of microtia correction that combined a posterior temporal parietal and galeal fascial flap. The flap was robust, with a dependable blood supply based on the posterior branches of the superficial temporal artery, and all patients had satisfactory ear projection.
Conclusions

Based on our experience, we believe that the above-mentioned flaps in the Discussion section are unsuitable when middle ear reconstruction is indicated because they interfere with the atresia operation and might be at risk for necrosis. We also propose that the temporal parietal fascial flap should be reserved for secondary procedures and treatment of complications that may occur during or after the procedures performed for microtia reconstruction. The typical flap used for reconstruction of the retroauricular sulcus should be versatile and of sufficient length, have a wide base, lie adjacent to the ear (ie, the field of reconstruction), allow excellent exposure of the mastoid bone in cases of atresia operation without sacrificing important blood vessels (eg, the superficial temporal artery and vein), and provide a robust bed for the graft used to cover the posterior surface of the pinna after elevation. Our novel periosteal flap described herein meets all these conditions, with excellent survival of the graft and satisfactory frontal symmetry of the reconstructed ear.

ARTICLE INFORMATION
Accepted for Publication: April 14, 2015.
Published Online: July 16, 2015.

Author Contributions: Drs Saad Ibrahiem and Magritz had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Siegert, Magritz.
Acquisition, analysis, or interpretation of data: All authors.

Drafting of the manuscript: Saad Ibrahiem, Magritz.
Critical revision of the manuscript for important intellectual content: Siegert, Saad Ibrahiem.
Statistical analysis: Saad Ibrahiem.
Administrative, technical, or material support: All authors.

Study supervision: Siegert, Magritz.
Conflict of Interest Disclosures: None reported.

REFERENCES