Partial Auricular Reconstruction

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ABSTRACT

The authors summarize current methods for reconstructing partial auricular defects resulting from trauma, neoplasm, or congenital defects. They also review the anatomy and embryology of the ear as this is critical for proper reconstruction. Defects of the auricle are divided into upper-third, middle-third, and lower-third defects. Methods of total auricular reconstruction are also briefly discussed as these methods can provide more superior reconstruction than partial techniques in select cases.

KEYWORDS: Auricular reconstruction, auricular defects, helical reconstruction, lobule reconstruction

The projection of the auricle and its exposure to insults, such as solar injury, make the auricle a common site of malignancies and traumatic injuries. The topographic shape of the auricle, the convexities and concavities of the cartilage, and auricle's tenuous blood supply, present a surgical challenge in reconstructing partial auricular defects. Knowledge of auricular anatomy and embryology are essential. In reconstructing the auricle, specific attention must be paid to the contralateral ear if unaffected. The reconstructed ear must match the opposite ear in orientation, size, and shape. The goal is to recreate an ear that is symmetric to the opposite side and as normal as possible. The ear must be reconstructed in three dimensions. The location, size, and vascularity of the defect dictate the reconstructive plan. Defects involving skin and cartilage will similarly require composite grafts for reconstruction. Note must be made of any history of radiation therapy and the location of adjacent hair-bearing scalp.^{1,2}

Several different techniques for partial auricular reconstruction have been described. The decision as to which technique is used depends on the size, the injured soft tissue components, and the location of the defect. Patient preferences and the surgeons comfort level with

different techniques will also dictate the procedure chosen. Each case of auricular reconstruction is unique and all the above parameters must be taken into account.

In this article, we organize auricular defects based on the location and size of the defects. A brief review of the anatomy and embryology of the ear is provided, and we share some general principles to assist in the choice of a reconstructive method.

EMBRYOLOGY

The otic placode is the first sign of the future ear and presents during the third week of gestation. The auricle is derived from the mesoderm of the first and second branchial arches. Six mesenchymal proliferations of the first and second branchial arches surround the first branchial cleft and are called the six hillocks of His. The first branchial arch gives rise to hillocks 1 through 3 and the second arch to hillocks 4 through 6. The development of the auricle continues as these hillocks during the sixth week of gestation. There is some controversy as to the exact structures that each of the six hillocks correspond to. The lobule is the first component of the external ear to develop. The hillocks fuse at

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the 12th week of gestation. Failure to fuse can result in malformations such as sinus tracts.^{3,4} In general, malformations of the second-arch derivatives are more common as they develop later.

Cartilage formation begins at week seven with the concha derived from the ectoderm of the first branchial groove. The antihelix furls during weeks 12 to 16, and the helix furls during the sixth month. Malformations of the conchal bowl contribute to a protruding pinna, while failure of furling of the antihelix results in a protruding scapha.⁵

The auricle is initially located in the anterior neck of the embryo. As the mandible develops during weeks 8 to 12, the auricle migrates superiorly and dorsally. It reaches its adult location by week 20.⁴

ANATOMY

Anatomic knowledge of the contours, convexities, and concavities of the ear is fundamental in reconstructing the auricle. The skin over the lobule and the margin of the helix is fibrofatty and loose. The skin of the lateral surface is dense and attached to the perichondrium without any subcutaneous tissue. The skin on the medial surface on the other hand has subcutaneous tissue present. This allows greater mobility when excising skin on the medial surface as part of the resection or to serve as a donor graft.^{1,2}

The elastic cartilage of the ear provides a structural framework that is flexible yet resilient. Certain parts of this cartilaginous framework are critical for maintaining structural support and proper contour, whereas other parts, such as the concha and triangular fossa, can be excised without significant deformity.^{1,2}

Branches of the external carotid artery supply the auricle. The superficial temporal artery supplies the anterior and lateral portions of the auricle, and the postauricular artery supplies the medial and lateral surfaces of the auricle as well as the mastoid region. Branches of the occipital artery also contribute to the auricular blood supply.^{1,2,5}

The sensory innervation of the auricle is diverse and provided by several nerves, including the auriculo-temporal nerve, the lesser occipital nerve, the greater auricular nerve, auricular branch of the vagus nerve, and branches of the facial nerve.

Other anatomic key aspects include^{1,6}:

- Normal adult ear height ranges from 5.5 to 6.5 cm.
- The width of the auricle is ~55% of its length.
- The vertical height of the auricle is approximately equal the distance from the lateral orbital rim to the root of the helix.
- The helix protrudes 1 to 2.5 cm from the skull with an angle of 25 to 30 degrees (1.5 to 2 cm and 15 to 20 degrees³).

- The superior aspect of the ear is at the level of the tail of the eyebrow or upper eyelid.
- The auricle is tilted posteriorly 20 degrees and is parallel to the dorsum of the nose.

GENERAL PRINCIPLES

The general principles to be considered prior to undertaking auricular reconstruction are as follows.

- Successful reconstruction of auricular deformities requires appropriate restoration of the cartilaginous deformity as well as providing soft tissue support.
- Small defects of the medial surface can be closed given the mobility of the subcutaneous tissue.
- Defects of the lateral skin, however, can rarely be closed given the lack of subcutaneous tissue. For such defects:
 - o If the perichondrium is intact, the defect can be repaired with a skin graft.
 - o If the perichondrium is absent or compromised, then the cartilage should also be removed. If this involves a portion of the cartilage that is not structurally necessary (the concha, triangular fossa, or scapha), the cartilage can be removed and the defect repaired with a skin graft.^{1,2}
- Small defects (<1.5 cm) of the helix and antihelix can be repaired by conversion to wedge-shaped full-thickness excision with primary anastomosis. This will lead to a shortening of the ear. To avoid ear distortion and to allow tension-free closure, a portion of the concha needs to be included in the wedge resection in certain cases.^{1,2}
- Medium defects (1.5 to 2 cm) can be repaired by composite grafts from the contralateral ear. The graft should be half the size of the defect to allow for symmetry between the ears.^{1,2}
- For small- to medium-sized helical defects, helical advancement flaps can be used to repair the defect. For larger defects, a tube flap or postauricular advancement flap can be used.
- Large defects can be repaired by using a temporoparietal fascial graft (TPFG) to cover autologous cartilage and serve as bedding for a second-stage skin graft.
- In cases of large defects, prior failed reconstructive efforts, and patient preference, a total auriculectomy can be performed followed by total auricular reconstruction or prosthetic rehabilitation with excellent results.

Conchal Bowl Defects

The conchal bowl is a portion of the auricle that is not structurally essential for support; therefore, it allows for greater flexibility in the choice of techniques used for the repair of such defects. In fact, the concha typically serves as a common cartilage donor site for composite grafts.

For defects of the skin with intact perichondrium, the defect can be skin grafted. If the perichondrium is compromised, the cartilage should be excised and a full-thickness skin graft placed. The skin graft receives its blood supply from the medial subcutaneous tissue. Acceptable skin graft donor sites include the pre- and postauricular areas and the supraclavicular site. The skin grafts must be bolstered or secured with tacking sutures centrally. Healing by secondary intention is another viable option for such defects; however, in situations where the defect also involves the external auditory canal, the skin in this region requires coverage to prevent stenosis.^{1,2}

For full-thickness defects, a postauricular subcutaneous pedicled advancement flap can be utilized to repair the defect. The flap is elevated off the mastoid bone and mobilized in a posterior to anterior direction. The flap incorporates branches of the postauricular artery. The flap is then tunneled under the medial auricular skin and used to repair the lateral conchal skin defect. The medial skin can be skin grafted or closed depending on the defect. If sufficient flap is mobilized, the skin can be bivalved and used to repair both the lateral and medial skin surfaces. This flap can be used to repair lateral composite conchal defects as well, if a skin graft must be avoided.^{1,2,7-9}

Upper One-Third Defects

The extent of visibility of the superior portion of the ear depends greatly on a patient's hairline and hairstyle. This portion is also essential structurally for the support of glasses. In certain cases, a defect in this location can be camouflaged by hair and extensive reconstruction avoided if the patient so desires. For patients wearing glasses, it is essential to restore the structural framework even if the patient is not cosmetically concerned.

As discussed in the General Principles section, several techniques exist for reconstructing auricular defects depending on the size and location of the defect. Small defects (<1.5 cm) of the helix and antihelix are repaired by conversion to wedge-shaped full-thickness excision with primary closure. This will lead to a shortening of the ear. To avoid ear distortion and to allow tension-free closure, the apex of the wedge resection may need to extend into the concha and the apex should point to the root of the helix. The defect is closed in layers including reapproximation of cartilage edges.^{1,2} A variation of the wedge resection used for slightly larger lesions is a star excision. This method is similar to a wedge resection, but also includes two triangles of resection on each side of the antihelix to assist in distributing the tension in closure of the wound.²

Medium-sized defects and defects limited to the helical rim up to 2 cm can be closed with helical chondrocutaneous advancement flaps (Fig. 1). The lateral skin and cartilage are incised superiorly and inferiorly; the medial skin can be kept intact or incised depending on the degree of mobility needed. Burrow triangles are used if greater mobility is required.¹⁰⁻¹² Medium-sized defects can also be closed with composite grafts from the contralateral ear. The graft should be half the defect size to allow for symmetry between the two ears.¹

Helical rim defects greater than 2.5 cm can be closed using bipedicled tubed flaps. The bipedicled tubed flap can utilize pre- or postauricular skin. The procedure involves three steps. In the first step, a vertical strip of skin is tubed upon itself and pedicled superiorly and inferiorly. Three weeks later one end of the pedicle is taken down and attached to one end of the helical rim. If preauricular skin was used, the inferior pedicle is divided. If postauricular skin was used, the superior pedicle is divided. Three weeks later the other pedicle is divided

Figure 1 Helical chondrocutaneous advancement flap. (A) Superior helical defect following resection. (B) Elevation of lateral skin and mobilization of advancement flaps. (C) Reconstructed defect. Note the smaller size of the auricle.

and the flap sewn to the helical rim. The donor site is closed primarily (Fig. 2).^{1,13,14}

Reconstruction of larger defects requires the use of cartilage, TPF, and a skin graft (Fig. 3). For upper-third defects, the adjacent postauricular skin is thick and hair bearing, and therefore not ideal as a skin-coverage donor site. The TPF is based on the posterior branch of the superficial temporal artery. This flap is thin and serves to provide blood supply to the underlying cartilage graft and

overlying skin graft. Donor cartilage can be harvested from the septum, conchal bowl, or rib cartilage. The amount of dissection anteriorly and inferiorly should be limited as the temporal branch of the facial nerve lies immediately deep to the temporoparietal fascia in the region of the zygomatic arch. The cartilage graft is fashioned to provide structural support and is approximated to the existing cartilage. The TPF is draped over the cartilage and sutured in place. A full-thickness skin

Figure 2 Bipedicled tubed flap. (A) Vertical strip of skin is tubed upon itself. (B) Lower limb is divided and sutured to inferior helical defect. (C) The upper limb is divided and sutured to defect. (D) Postoperative result.

Figure 3 Temporoparietal fascial flap (TPFF). (A) Patient with upper two-third auricular defect. Rib cartilage graft has been harvested and fashioned accordingly. The TPFF has been elevated. (B) The TPFF is draped over the cartilage and sutured. (C) Skin graft is placed over the TPFF.

graft is placed over the flap. The skin graft is typically harvested from the contralateral postauricular skin, which is an excellent color match to the native ear.^{1,2,15,16}

Several other elaborate flaps and modifications of the above techniques have been devised.¹⁷ A series of sequential flaps can be used to reconstruct superior defects of the auricle with involvement of the helix. First, a chondrocutaneous flap from the ipsilateral pre-

auricular conchal surface is elevated and pedicled by the skin of helical crus.¹⁸ It is then transposed to the preauricular defect. Next, a postauricular skin flap is elevated, rotated from postauricular to preauricular, and used to close the anterior conchal donor site. For full-thickness defects, a postauricular transposition skin flap is then used to close the posterior superior skin defect. The defect from the postauricular skin flap is

closed primarily or skin grafted.¹⁹ A peninsular conchal axial flap is a modification of the above chondrocutaneous conchal flap with the pivot point based on the skin and subcutaneous tissue just superior to the auricle instead of the helical crus.²⁰ Other novel techniques include an ascending helix free flap from the opposite ear based on the superficial temporal vessels,²¹ and the use of

porous polyethylene (Medpor[®], Porex Surgical, College Park, GA) implant instead of autologous cartilage.²²

For defects not involving the helical rim, a postauricular subcutaneous pedicled advancement flap can be used. This flap is good for superior and central defects, and allows for incorporation of cartilage between the flap (see Conchal Bowl Defects section above).

Figure 4 Postauricular advancement flap. (A) Large middle-third helical defect with flap margins outlined. (B) Postauricular flap is elevated and the cartilage graft is depicted overlying the flap. (C) Flap is taken down posteriorly. (D) Postoperative results.

Middle-Third Defects

Repair of defects of the middle third of the auricle follow the same principles as those discussed for superior third defects. In contrast to the thick, hair-bearing postauricular skin superiorly, however, the postauricular skin of the middle third of the auricle is non-hair-bearing and thinner. The middle third of the auricle is also not as critical for the structural support of glasses.

Small defects are repaired by conversion to a wedge resection with primary closure. Medium-sized defects of the helix are repaired with a helical chondrocutaneous advancement flap, and larger helical defects are repaired with a bipedicle tube flap. In contrast to superior third defects, which require temporoparietal fascial coverage of autologous cartilage grafts for large defects, large middle-third defects can be closed with postauricular advancement flaps to cover the autologous cartilage (Fig. 4). This difference is due to the thinner, non-hair-bearing postauricular skin in this area as compared with more superiorly.^{1,2}

Inferior-Third Defects

The preauricular and auricular skin inferiorly has greater laxity and therefore allows for greater ease of reconstruction as compared with more superior defects. For defects of the lobule, up to 50% of ear lobe can be excised with a wedge resection with minimal morbidity. Skin-only defects of the lobule, however, should not be repaired

by skin grafts as the lack of cartilaginous support and continued scar contracture will lead to lobule deformity. Instead, such defects should be repaired with a cartilage batten graft followed by a vascularized skin flap to maintain the lobule contour and prevent contracture.^{1,2}

Total lobule defects are repaired in two stages. Conchal cartilage is harvested and fashioned to the shape of the ear lobe (Fig. 5). The graft is buried in a subcutaneous pocket inferior to the auricle in the position of the desired new lobule. The inferior aspect of the auricle is sutured superiorly to this pocket. Six weeks later the cartilage and overlying skin are elevated as a unit and the medial surface is skin grafted. The donor site is closed primarily.¹

Total Auricular Reconstruction

Total auricular reconstruction is often necessary in select cases of partial auricular defects. These include certain large defects, prior failed reconstructive efforts with scarring of surrounding tissues, and patient preference. Although beyond the scope of this article, total auricular reconstruction techniques include prosthetic rehabilitation, costal cartilage grafts, or synthetic implants such as porous polyethylene (Medpor®). Such techniques, normally used in the repair of congenital microtias,^{23–25} can be utilized for acquired defects as well. In oncologic cases, such techniques also eliminate the need to limit surgical margins because reconstruction is now possible.

Figure 5 (A) Lobule defect. (B) Conchal cartilage is harvested and fashioned to the shape of the ear lobe. The graft is buried in a subcutaneous pocket inferior to the auricle in the position of the desired new lobule.

CONCLUSION

Reconstruction of partial auricular defects poses a challenge to the reconstructive surgeon. The goal is to recreate an ear symmetric to the opposite side, which restores form and function. Each defect is unique and should be approached systematically. In this article, we have presented general principles and surgical techniques to assist in the reconstruction of such defects.

REFERENCES

- Cheney ML, Hadlock TA, Quatela VC. Reconstruction of the auricle. In: Baker SR, ed. *Local Flaps in Facial Reconstruction*. Edinburgh: Elsevier Mosby; 2007:581–624
- Park SS, Hood RJ. Auricular reconstruction. *Otolaryngol Clin North Am* 2001;34(4):713–738; v–vi
- Murakami CS, Quatela VC. Reconstruction surgery of the ear: Microtia reconstruction. In: Cummings CW, Flint PW, Harker LA, Haughey BH, Richardson MA, eds. *Cummings Otolaryngology Head & Neck Surgery*. St. Louis: Mosby Inc; 2004:4422–4438
- Kelley PE, Scholes MA. Microtia and congenital aural atresia. *Otolaryngol Clin North Am* 2007;40(1):61–80; vi
- Adamson PA, Doud Galli SK. Otoplasty. In: Cummings CW, Flint PW, Harker LA, Haughey BH, Richardson MA, eds. *Cummings Otolaryngology Head & Neck Surgery*. Philadelphia: Mosby Inc; 2004:853–861
- Farkas LG. Anthropometry of the normal and defective ear. *Clin Plast Surg* 1990;17(2):213–221
- Stucker FJ, Sanders KW. A method to repair auricular defects after perichondrial cutaneous grafting. *Laryngoscope* 2002;112(8 Pt 1):1384–1386
- Patterson AR, Brady G, Walker PD, Telfer MR. The perichondrial cutaneous graft and “flip-flop” flap in facial reconstruction: a series of 41 cases. *Br J Oral Maxillofac Surg* 2008;46(2):114–118
- Dessy LA, Figus A, Fioramonti P, Mazzocchi M, Scuderi N. Reconstruction of anterior auricular conchal defect after malignancy excision: revolving-door flap versus full-thickness skin graft. *J Plast Reconstr Aesthet Surg* 2010;63(5):746–752
- Ferri M. Treatment of partial losses of the helix. *Plast Reconstr Surg* 1998;101(7):2011–2012
- Antia NH, Buch VI. Chondrocutaneous advancement flap for the marginal defect of the ear. *Plast Reconstr Surg* 1967;39(5):472–477
- Majumdar A, Townend J. Helix rim advancement for reconstruction of marginal defects of the pinna. *Br J Oral Maxillofac Surg* 2000;38(1):3–7
- Ellabban MG, Maamoun MI, Elsharkawi M. The bi-pedicle post-auricular tube flap for reconstruction of partial ear defects. *Br J Plast Surg* 2003;56(6):593–598
- Dujon DG, Bowditch M. The thin tube pedicle: a valuable technique in auricular reconstruction after trauma. *Br J Plast Surg* 1995;48(1):35–38
- Park C, Chung S. A single-stage two-flap method for reconstruction of partial auricular defect. *Plast Reconstr Surg* 1998;102(4):1175–1181
- Ruder RO. Injuries of the pinna. In: Gates GA, ed. *Current Therapy in Otolaryngology: Head and Neck Surgery*. Philadelphia: Mosby; 1994:127–131
- van der Lei B, Spronk CA. Reconstruction of non-marginal ear defect by a postauricular wedge transposition flap. *Br J Plast Surg* 1998;51(1):14–16
- Donelan MB. Conchal transposition flap for postburn ear deformities. *Plast Reconstr Surg* 1989;83(4):641–654
- Yotsuyanagi T, Nihei Y, Sawada Y. Reconstruction of defects involving the upper one-third of the auricle. *Plast Reconstr Surg* 1998;102(4):988–992
- Dagregorio G, Darsonval V. Peninsular conchal axial flap to reconstruct the upper or middle third of the auricle. *Dermatol Surg* 2005;31(3):350–355; discussion 355
- Maral T, Borman H. Reconstruction of the upper portion of the ear by using an ascending helix free flap from the opposite ear. *Plast Reconstr Surg* 2000;105(5):1754–1757
- Oztürk S, Sengezer M, Zor F. Reconstruction of acquired partial auricular defects by porous polyethylene implant and superficial temporoparietal fascia flap in adult patients. *Plast Reconstr Surg* 2006;118(6):1349–1357
- Ruder RO. Congenital auricular deformities. In: Papel J, Frodel J, Holt GR et al, eds. *Facial Plastic and Reconstructive Surgery*. 3rd ed. New York: Thieme Medical Publishing; 2009:1043–1047
- Ruder RO. Microtia reconstruction. In: Papel I, Nicholas N, eds. *Facial Plastic Surgery*. Philadelphia: Mosby; 1992
- Ruder RO. Congenital malformation of the auricle. In: Papel I, Frodel J, Holt GR et al, eds. *Facial Plastic and Reconstructive Surgery*. 2nd ed. New York: Thieme Medical Publishing; 2003