

TOTAL EAR RECONSTRUCTION USING HOMOGRAFT COSTAL CARTILAGE

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INTRODUCTION

Microtia, a small or relatively absent ear, occurs in about 1 in 5,000¹ children. The external ear plays a functional role in wearing corrective lenses and protective masks, as well as offers an aesthetic focal point during socialization. Microtia can also be a source of embarrassment and teasing for children. Many school age children who present to our offices often have long haircuts to hide their small ear and may appear shy and withdrawn when talking about it. The role of the reconstructive surgeon in ear reconstruction is thus two-fold. Our goal is to create an ear that appears similar to the unaffected side and also serves a function. Ideally, the reconstructed ear should be able to last a lifetime, be able to withstand trauma and sports, and be resistant to infection or exposure.

The gold standard of ear reconstruction is autologous costal cartilage, popularized by Tanzer² in 1959, and later refined by Brent³ and Nagata⁴. Autologous ear reconstruction uses the patient's own rib cartilage to sculpt and create the ear construct. Cartilage is harvested from ribs 6,7,8, and 9 from the costal-chondral junction and used to craft the subunits of the ear. These parts are the base, helix, anti-helix, and tragus-antitragus components. These components are assembled using permanent sutures and placed under the skin envelope in the desired position of the new ear after removal of the vestigial remnants. The ear construct is then elevated and a postauricular sulcus created in a two or three stage procedure, depending on the desired technique. The result is a biologic and sensate ear that is resistant to trauma. However, there are downsides to autologous ear reconstruction, including psychological trauma of having to wait until the ribs are large enough (8-10 years old), pain and visible scars associated with rib harvesting requiring a hospital stay of 1-2 days, and risk of pneumothorax and chest wall deformity.

An alternative solution offering the benefits of an alloplastic, off-the-shelf product and single stage procedure was popularized by Reinisch⁵. Medpor is a surgical implant that is pre-carved and comes in two pieces which are soldered together using an ophthalmic cautery to create the desired size. Early results were met with high extrusion rates due to the thin overlying skin and rigid implant underneath. Adding an additional layer of tissue with a temporal parietal fascial (TPF) flap significantly reduced the extrusion rate and is now considered a critical component of Medpor-based ear reconstruction. The TPF flap additionally allows the ear to be completely covered on both sides and thus allows projection and only one necessary surgical operation to complete the reconstruction. TPF flaps also solve the problem of a limited tissue envelope and allow great details to be shown of the underlying construct. Because an implant is being used, alloplastic reconstruction can begin as early as age three, there is no significant post-operative pain, and the procedure can be safely performed as an outpatient procedure.

But alloplastic reconstruction is not without its downside as well, including risk of flap failure and extrusion, lack of sensation to the ear and potential for implant fracture and need for replacement. Poor or no sensation may create long term problems leading to extrusion due to pressure necrosis or burns.

Homograft costal cartilage may be the ideal solution for ear reconstruction, offering the benefits of both an alloplastic reconstruction (no donor site, minimal pain, no need to delay reconstruction) and a biologic solution (no need for TPF flap, allows for sensate skin, resists trauma).

Homograft costal cartilage has already been used safely for years in nasal reconstruction, plastic surgery,

and orthopedic cases. Using cartilage from younger age donors allows the cartilage to function similar to autologous with the same malleability. In addition, since the donors are older than age ten, the average age at which autologous ear reconstructions are usually performed, there is an abundance of cartilage, allowing the creation of complex Nagata/Firmin⁶ type constructs with no donor site morbidity. The constructs can be created before the patient even undergoes anesthesia, reducing OR time to 45 minutes and allowing ear reconstruction to become an outpatient procedure. Patients are sent home without opioids and have a fast recovery.

This paper outlines my technique for using Extearna™ Costal Cartilage homograft from MTF Biologics for total ear reconstruction in patients with unilateral microtia. Extearna is a fresh frozen, non-terminally sterilized allograft derived from ribs 5-8 on donors age 12-20. The synchondrosis between ribs 6 and 7 is maintained.

PREOPERATIVE PROCEDURE: MEASURING THE CONTRALATERAL EAR

- Xray paper or clear film is used to trace the outline of the unaffected ear
- Measurements of the position of the ear, angular rotation, and height of the lobule are determined
- The mirror image of these measurements is reflected on the affected side and the outline of the ear is drawn with a skin marker (Figure 1, below)

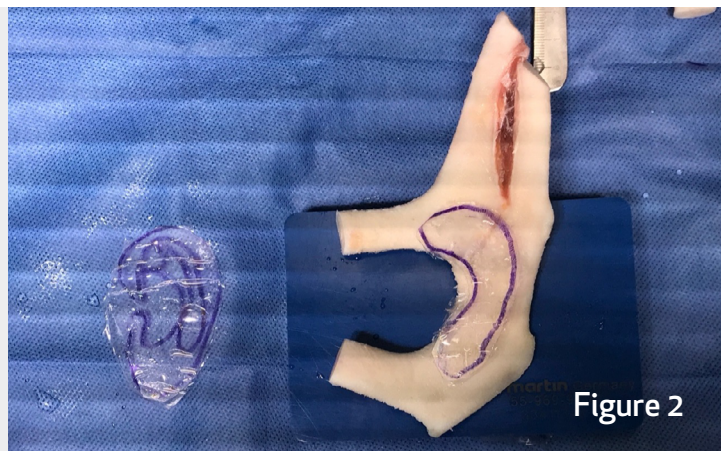


Figure 1

STAGE I: COSTAL CARTILAGE CARVING, EAR ASSEMBLY AND INSERTION

Prior to intubation, the ear construct can be fabricated on a sterile back table. The templates that were traced are cut out and then sandwiched between two sterile Tegaderm dressings.

The allograft costal cartilage is thawed in warm saline for 15 minutes. We prefer to use warm saline not only to speed up the thawing process but also to allow any on-table warping to occur prior to implantation. Warping is an intrinsic characteristic of costal cartilage not unique to homograft. Using the ipsilateral costochondral junction, the base piece is first traced on the synchondrosis and a scalpel is used to cut the cartilage to size (Figure 2, below).

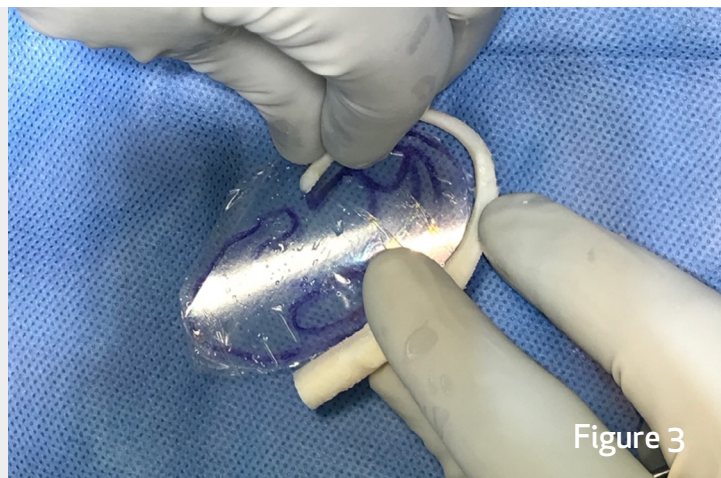


While contralateral cartilage was used in this patient, we often use ipsilateral cartilage so we can place the synchondrosis down and better sculpt and thin the ear without seeing the cartilage separation under the skin.

The thickness of the cartilage is reduced using the scalpel to about 3-5mm to create a less bulky ear, especially over the inferior part of the base, which will serve as the lobule.

The scapha (concave portion of the ear) is outlined on the base and then created (deepened) by using either a gouge or a diamond burr to a near full thickness (almost transparent).

The helix is created using part of rib 8 which is tapered along the root of the helix and the inferior portion (Figure 3, below).



Ear Assembly

The helix is fixated to the base using 4-0 clear nylon sutures. We use a silicone cutting block and Keith needles with an eyehole to thread the nylons and therefore place the knots on the underside of the base. Several sutures are placed to create a “rigid” fixation of the helix to the base (Figure 4).



Figure 4

The anti-helix and the tragus-antitragus are then fashioned using the remaining cartilage. Using the traced outlines, a segment of Extearna is used to create each piece independently. The superior and inferior crus of the antihelix should recess into the helix so as to appear less defined the closer they get. Similarly, the antitragus and the tip of the tragus should be most convex, while the junction should be thin and concave.

These pieces are fixated to the base similarly using the Keith needles and nylon sutures. If desired and as described by Firmin, a P1 (piece of cartilage linking the tragus to the root of the helix) and/or P2 projection piece (cartilage graft placed at the posterior conchal bone to increase the height), can be placed to stabilize the root/tragus or add height to the conchal bowl respectively (Figure 5).



Figure 5

Insertion of Ear Construct

After the new ear construct is fabricated, the patient is then intubated and the entire head is prepped and draped. Local anesthesia with epinephrine is injected to the outlined area.

The access incision, typically a transfixion with a backcut, is created to rotate the lobule inferiorly and posterior to the desired location outlined.

The subcutaneous tissue of the lobule is incised to create a pocket for the base of the new ear construct. The vestigial ear cartilage is excised, and the skin laps elevated with 1mm of subcutaneous tissue slightly beyond the margins to allow skin recruitment.

The tissue over the new conchal bowl is excavated to deepen and accentuate this essential anatomic feature.

Thin round drains are placed into the pocket and placed on suction.

The ear construct is then placed into the pocket and the inferior portion into the lobule. The skin is closed with sutures and the outline of the ear should appear once a vacuum seal is obtained using suction drainage. We often use 2x7 French round drains with a bulb suction for this purpose.

Excess skin may be excised to help improve the aesthetic of the ear.

Cotton is placed into the valleys of the ear outline to help maintain these accentuating features. We use silicone putty (Azoft) to place a mold over the area to protect and maintain the bolster. Drains are then connected to self-suction canisters and the patient is extubated.

Drains remain in place for 5-7 days prior to removal. Bolsters are maintained for 2 weeks post procedure. The mold is changed after the first week and inspected for evidence of skin necrosis or infection. We typically use a 5-day course of antibiotics covering skin flora and only NSAIDs for pain control. Patients are instructed to use a protective ear dressing (Glascoc) particularly at night when sleeping.

STAGE II: EAR CONSTRUCT ELEVATION AND PROJECTION

Four to five months after the first stage of surgery, the ear construct can then be elevated and projected off of the base of the head. This time allows for vascular inflow into the surrounding tissues allowing the ear reconstruction to laminate and accept a skin graft on its elevated posterior surface.

The patient is taken to the operating room and undergoes general anesthesia.

The construct is outlined on the affected side and local anesthesia injected. An incision is made approximately 2mm posterior to the cartilage to recruit skin for the visible anterior surface of the helix (Figure 6).



The construct is elevated with soft tissue on its posterior surface so as not to expose the cartilage construct. The mastoid skin is elevated and advanced into the post auricular sulcus.

The skin on the helix is advanced and sutured posteriorly to line the helix with native skin.

The length and width of the residual defect is then determined for skin grafting. A full thickness skin graft is harvested from the thigh, thinned and pie crusted, and the donor site closed (Figure 7).



One of several methods can be used to project the ear construct, including a TPF flap with cartilage grafting to the posterior base or the author's preferred method of creating a tunnel between the ear construct and the vascularized soft tissue for placement of the new cartilage graft. After either method, the skin graft is then sutured to the tissue covering this new graft and a xeroform and cotton bolster is placed.

Patients are sent home with oral antibiotics and the bolster is removed on POD #7. A new xeroform dressing is placed and the ear is protected until the dressing is changed again in 4-5 days.

References

1. Stallings, E. et. al. Population-based birth defects data in the United States, 2011-2015: A focus on eye and ear defects. *Birth Defects Res.* 2018 November 15; 110(19): 1478-1486. doi:10.1002/bdr2.1413.
2. Tanzer, R. Total Reconstruction of the External Ear. *Plastic and Reconstructive Surgery and the Transplantation Bulletin*: January 1959 – Volume 23 – Issue 1 – p 1-15.
3. Brent B. Auricular repair with autogenous rib cartilage grafts: two decades of experience with 600 cases *Plast Reconstr Surg* 1992 Sep;90(3):355-74; discussion 375-6.
4. Nagata S. Modification of the stages in total reconstruction of the auricle: Part I. Grafting the three-dimensional costal cartilage framework for lobule-type microtia *Plast Reconstr Surg* 1994 Feb;93(2):221-30; discussion 267-8.
5. Stephan, S. Reinisch, J. Auricular Reconstruction Using Porous Polyethylene Implant Technique. *Facial Plast Surg Clin North Am.* 2018 Feb;26(1):69-85. doi: 10.1016/j.fsc.2017.09.009.
6. Firmin F. Ear reconstruction in cases of typical microtia. Personal experience based on 352 microtic ear corrections. *Scand J Plast Reconstr Surg Hand Surg.* 1998;32(01):35-47.



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