

Review of Auricular Reconstruction

Basnet SJ*

*Senior Registrar

ABSTRACT

INTRODUCTION: Auricular reconstruction is a challenging and demanding task faced by reconstructive surgeons because it is difficult to create tiny anatomical landmarks of the auricle. Various techniques described for centuries but it has still battled in this arena of reconstruction. In surgical progressing, autogenous costal cartilage ear framework and tissue coverage is being continued for the detail of ear. Periauricular tissue is one of the important factors so it can be solved by tissue expansion and improves the cartilage framework definitions.

KEY WORDS: Auricular Reconstruction; Autogenous Costal Cartilage; Ear Framework; Tissue Coverage

INTRODUCTION

Ear is an important organ in human beings and has complex anatomical structures. Auricular defects are relatively common usually resulting from congenital and acquired secondary to trauma, burn, auricular malignancy, infection and post-surgical problems.

Reconstruction of these auricular defects is a formidable task and contains structural framework support and tissue coverage. Quantity and quality of skin for covering the ear skeleton poses significant challenge because of its viability and effects of periauricular scar tissue that influences achieving a good ear result. The application of autogenous costal cartilage continues to be the gold standard material for auricular reconstruction. Various modifications in the Tanzer¹ technique have got different results in experienced clinical hands. However, ideal results are not always achieved, and there continue to be drawbacks with the standard approach to reconstruction with autogenous costal cartilage. To avoid these shortcomings, surgeons have developed alternative or adjuvant techniques to repair ear, including the use of tissue expansion with

autogenous costal cartilage, alloplastic implants, and osseointegrated prostheses. Review of the current literature describes advances with bioengineered cartilage, and review of the past years improves current status of the auricular reconstruction.

HISTORY OF AURICULAR RECONSTRUCTION

Ear reconstruction was first referred to in Susruta Samhita² where a cheek flap was suggested for repairing the earlobe. As early as 1597, the Italian surgeon Tagliacozzi³ described and illustrated repair of both upper and lower ear deformities with skin flaps from behind the auricular region. In Germany in 1845, Dieffenbach⁴ described repair of the ear's middle third with an advancement skin flap. At that time mainly focused on traumatic ear deformities. However, by the end of 19th century, surgeons began to tackle congenital deformities, especially prominent ears.

In 1920, Gillies⁵ originated microtic ear repair by buried carved homograft costal cartilage under the mastoid skin and then separating the ear from the underlying skin with a cervical flap. In 1937, he again used maternal cartilage for ear reconstruction in microtic patients.

Cronin^{6,7,8} et al in 1966, 1968 and 1974 were popularized in silicone as an implant material for the reconstruction of microtia, but later found high incidence of infection and extrusion.

Correspondence :

Dr Surendra Jung Basnet
Senior Registrar
Department of Plastic Surgery
Kathmandu Model Hospital, Kathmandu Nepal
email : surendrabasnet@yahoo.com

In 1964, Tanzer⁹ reemphasized the use of living autogenous costal cartilage as an implant material for auricular reconstruction. As described by Tanzer¹⁰ in 1967 and Brent¹¹ in 1981, because of its advantages on high viability, resistance to shrinkage, softening and extrusion, and also lower incidence of resorption than other type of implants except those constructed from inorganic materials. Living autogenous costal cartilage is still considered as the most successful material of choice in this time. But some disadvantages are also found with autogenous costal cartilage like donor site scar, risk of pneumothorax, initial postoperative pain.

CHOICE OF RECONSTRUCTIVE TECHNIQUE

MATERIALS

Autogenous Costal Cartilage Graft
Alloplastic Implant
Prosthetic/ Osseo-integrated

TISSUE COVERAGES

Temporoparietal Fascial Flap
Tissue Expansion
Tissue Engineering

AUTOGENOUS COSTAL CARTILAGE GRAFT

Traditionally, the use of autogenous costal cartilage as the material of choice for auricular support as advocated by Tanzer, is harvested en bloc from anterior rib in necessary quantity with suitable integrity, and less morbidity. In 1971 Tanzer¹² advocated total ear reconstruction required six stages to complete entire procedure using autogenous costal cartilage (6,7,8 costal cartilage harvested from contralateral) as implants. In the six-stage procedures, Tanzer transposed the lobular remnant in transversely in stage I. In stage II, he harvested autogenous costal cartilage, carved the framework and embedded it under the mastoid skin with a "V" shaped post lobule incision. In Stages III and IV, he elevated the framework and placement of retroauricular full-thickness skin graft. In Stages V and VI, tragus and the conchal cavity were created with composite contralateral skin/cartilage grafts.

Due to operative morbidity, secondary reconstruction and costs, different authors have described modifications of this concept. Over the past two decades, Brent and Nagata who have reviewed it thoroughly and have offered the most significant technical advances.

Ear reconstruction with autogenous costal cartilage is a staged process credited to Tanzer and later refined by Brent, Nagata. Brent^{13,14,15,16,17,18} reduces the Tanzer six-stage procedure to three or four stages, which has similar but slightly different in sequence. The first stage of the Brent technique consists of carving and placement of auricular framework (6th, 7th and 8th costal cartilage harvested from contralateral side) under a virgin skin envelope by high-profile construct. This technique will minimize the risk of vascular compromise of the skin flap. The lobule is not repositioned in this stage. This advantage sets Brent's technique apart from Tanzer's, which transposes the lobule in the first stage.

The second stage of Brent technique consists of lobule transposition and he occasionally combines with third stage. The construct framework is elevated in the third stage to achieve projection of the helical rim. Tragus construction, conchal excavation, and symmetry adjustment are performed in the fourth stage. In the case of bilateral microtia of Brent fourth stage reconstruction, he recommends the use of an anteriorly based conchal flap, but adds a cartilage to the framework to create a tragus. The aesthetic result using this method of tragus construction has been criticized. Brent has subsequently developed an alternative method to create a tragus whereby a small piece of costal cartilage is trimmed and attached to the auricular framework in two places during first stage.

Proponents of the Nagata technique have emphasized dissatisfaction with the appearance of Brent tragal reconstructions such as lack of definition of the conchal bowl, the intertragic notch, and the contour of the antitragus.

Nagata^{19,20,21,22} and Firmin²³ technique involves two stages and has undergone several possible technical refinements, depending on the type of microtia present. The first stage of his technique involves fabrication and placement of auricular framework, tragus construction, and lobule transposition. Thus this stage roughly corresponds to that of Brent's first three stages. In contrast to the three contralateral costal cartilage segments used in the Brent technique, Nagata has harvested the ipsilateral costal cartilages of the sixth, seventh, eighth, and ninth costal cartilages. The posterior lobule V-shaped incision used by Tanzer is converted to a "W" shaped incision, it allows to

lobule transposition and obviating the need for a conchal skin graft or a switchback procedure for lobular transposition as necessitated in Tanzer's technique. A 2-mm circular portion of skin is removed from the inferior portion of the anterior lobule/tragal incision to create the incisura intertragica.

During Nagata's second stage of auricular reconstruction, the auricular framework is elevated with a crescent shaped piece of cartilage taken from the fifth costal cartilage through the previous chest incision. Although the amount of costal cartilage harvested by Nagata is considerable, it may result in chest wall donor site morbidity in a second time. Nagata emphasizes that degree of the anterior chest wall deformity can be minimized if perichondrium is left in situ by stimulating cartilage regeneration. Finally, it has been argued that frontal symmetry is neglected with Nagata's technique. With Brent's technique, frontal symmetry is addressed during harvest of the composite conchal graft for tragus construction.

Walton and Beahm²⁴ are reported to discuss issues of relative vascular compromise, particularly with the more aggressive initial stage of the Nagata technique. They raised issue with the degree of chest wall deformity that is created with any harvest of costal cartilage. They go on to discuss adaptations in technique for the patient who has a low hairline in the temporal scalp.



Figure 1: (1) Harvested autogenous costal cartilage 7th and 8th; (2) Ear framework; (3) Template

ALLOPLASTIC IMPLANT

The use of an alloplastic implant for auricular reconstruction has been advocated to improve aesthetic result and avoid donor site morbidity and multiple difficulties with harvesting, sculpting, and placing of auricular framework. Initially silicone implants were used frequently, but failure rate was high in follow up study resulting from implant

exposure, infection and trauma. Recently, auricular reconstruction with a porous polyethylene (Medpore, Porex Surgical, Inc., Newnan, GA) framework is most widely used. It has minimal tissue reaction, soft-tissue ingrowth in its porosity and providing more stability. Now Porous polyethylene is not favor in auricular reconstruction because cost problem and complications like silicone in early period of time. In the past years, Romo²⁵ advocated the use of a temporoparietal fascia flap (could be used also from contralateral side) that completely surrounds the exposure of the implant then covered flap with full thickness skin graft. They found uncommon complications and can be treated conservatively with local skin flaps or healing by secondary intention.

PROSTHETIC/OSSEO-INTEGRATED

A prosthetic ear is an another alternative and can be used in poor periauricular tissues resulting from radiation, cancer, previous surgery (in failure of autogenous costal cartilage reconstruction), in elderly or high risk patients. In 1981 Tjellstrom²⁶ et al. reported on the technique of auricular prostheses. Ear prostheses were not tolerated well because of difficulty with retention, skin irritation and corrosion of the prosthesis caused by the chemical adhesive. These drawbacks have been overcome with the advent of osseointegrated anchoring system, which provides a direct bond to bone and a load-carrying implant. Although construction of the prosthesis is a time-consuming task requiring experience and expertise but requires lifelong attention and may be associated with late complications. Thorne²⁷ et al. described the use of auricular prosthesis and have outlined relative indications are: (1) failed autogenous reconstruction, (2) severe soft-tissue/skeletal hypoplasia, (3) a low or unfavorable hairline, (4) acquired total or subtotal auricular defect, most commonly traumatic or ablative in origin, which is usually encountered in adults.

Technically, a prosthetic ear is made with excellent shape by trained prosthodontist or other specialist. One of the greatest problems encountered with auricular prostheses is difficult to maintain its proper color. The prosthesis has tendency to fade when exposed to sunlight or seawater. However, prostheses will frequently need to recolorize and replacement after some years. Obviously, a prosthetic is insensate and feels like an unnatural or ornament rather than a part of own body.

TEMPOROPARIETAL FASCIAL FLAP

The temporoparietal fascial flap is one of the versatile tissue which can be used to cover the ear framework while local tissue is poor resulting from burn and trauma injuries. Placement of ear framework is one of the most important steps in ear reconstruction but it is basically quality and quantity of the skin available for framework coverage, which ultimately decides the final outcome in ear reconstruction. In 1977 Tegtmeier²⁸ stated that the use of temporoparietal fascial flap to cover the ear framework but later he found problem in the part of the ear framework due to contraction of flap, however it is better to use in the acquired auricular defect and poor local tissue.

Chun²⁹ et al. reported a single case in which the temporoparietal fascial flap was used successfully to cover a traumatically amputated ear that had failed an initial attempt at microvascular replantation. Alexander³⁰ et al. described the use of a posterior temporoparietal fascial flap, based on the posterior branch of the superficial temporal artery, with a more posterior and inferior extension ("galeal fascial flap") that is used to similarly cover the postauricular defect incurred with second-stage microtia repair. Tegtmeier and Gooding, Avelar, Brent³¹ et al. have successfully used the temporoparietal fascial flap for auricular reconstruction. Now, this fascial flap is used to provide a thin, pliable tissue to coverage the cartilaginous ear framework in difficult primary or secondary auricular reconstruction.

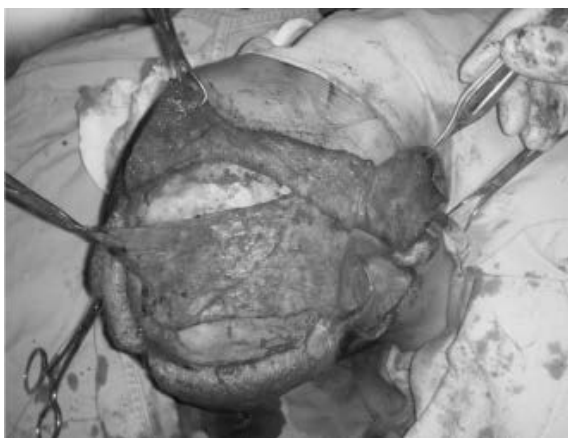


Figure 2: Temporoparietal fascial flap for auricular reconstruction

TISSUE EXPANSION

Tissue expander is another option to create soft tissue pocket during auricular reconstruction, it uses even in the presence of scarred skin and also minimizes skin grafting. Neumann³² first introduced the concept of tissue expansion in auricular reconstruction. Hata and Umeda³³ have reconstructed the auricle in a single stage without a skin graft. They have also reported matching of skin color and recovery of sensation is satisfied in their technique. Opponents of tissue expansion argue that formation of the fibrous capsular contracture prevents the adequate skin for draping cartilage framework, thereby influencing the outcome of the reconstruction. Brent³⁴ has advocated "intraoperative" tissue expansion, using a large Foley catheter to solve "marginal" skin tension problem, but this technique has limited in application. Although use of tissue expansion does not in favor in auricular reconstruction, but Park^{35,36,37,38} used expanded skin and fascia has been successfully in 146 microtia reconstructions with excellent results and relatively less complications, thus giving a new reconsideration of this technique.

The application of expanded retroauricular mastoid skin is relatively common in patients with insufficient skin and low hairline especially in adult aged with thick and taut skin on mastoid region, because it resists to being constructed ear conformation due to a problem create by skin during draping the framework. Expanding skin can increase the volume and provide thin and pliable of the skin, and fascial flap cover the different sizes and projection of ear framework, though it can achieve a result with good projection and fine anatomical details of auricle. Although some reconstructive surgeons are continue to use this technique in auricular reconstruction but some problems are encounter with injury of skin flap. Zhang³⁹ et al reported a high profile auricle and stability of surgical effect were achieved in 426 microtia patients using this method.

However, an inadequate amount of skin in the auricular region for draping the framework still remains a limiting factor. Various surgeons are inserted the tissue expander in the postauricular mastoid region and expands the skin by using water injection into a valve on the inflating tube. The auricular reconstruction with autogenous costal cartilage will be done after a lapse

of 30-60 days with completing inflation. This technique can be solved the deficiency of skin and improve framework definition.

Retroauricular fascial flap is not only envelope the ear framework but it is also appropriate for covering the different height and size of the contour accentuated ear framework. It also supplies nutrition to the ear framework. In addition, there is minimum jeopardize to extrusion of framework at the site where maximum tension has occurred by retroauricular fascial flap that covers the helical rim of framework and managed with conservatively.



Figure 3: (1)Expanded thin and well vascularised skin flap; (2) Post operative 1year

Tissue Engineering (Future Approaches for Auricular Reconstruction) Tissue engineering is blooming field in auricular reconstruction, in which autologous neocartilage auricular grafts are being constructed from cultures of native chondrocytes or stem cells. However, it would be a great advantage over the morbidity associated with harvesting costal cartilage and prolonged surgery, and artistic ability required to sculpt a framework from costal cartilage. Chondrocytes are taken and seeded it onto a bioresorbable three-dimensional scaffold, which is replaced by neocartilage that seems to native cartilage.

In 2004, Shieh⁴⁰ et al. reported the issues for auricular tissue engineering consist of optimal cell culture environment, choice of polymers, behavior of chondrocytes, study of cell-polymer constructs in an acceptable animal model, and long-term structural integrity by using polymer scaffolds of Polyglycolic Acid, Poly E-Caprolactone, and Poly 4-Hydroxybutyrate in vitro and in vivo.

Fussenegger⁴¹ et al. evaluated suspension of autologous chondrocytes in fibrin, stabilized with the

fibrinolytic inhibitors aprotinin and tranexamic acid. They found formation of neocartilage in vivo and used to fill a simple auricular defect. Naumann⁴² et al. demonstrated how a three-dimensional, computer aided design and stereolithography could help to create highly precise neocartilage grafts.

Cao⁴³ Y. et al. demonstrated bovine chondrocytes transplanted on trunk of immunocompetent mice onto a synthetic biodegradable scaffold, produce shape of the auricle. The scaffolding therefore, seems to be a critical component in the engineering of for all types of reconstructions, especially auricular reconstructions.

CONCLUSION

In the review of auricular reconstruction remains very complicated. The use of autogenous costal cartilage graft is still a material of choice in current clinical application, although there is use of alloplastic implants. Prosthetic osseointegrated auricular reconstruction is not favored by most surgeons, but remains an alternative option for auricular reconstruction. Various surgeon are employed the postauricular tissue expansion technique to solve the problem of inadequate skin to drape and improve the framework definitions and also achieve good outcome by this method. The technology of cartilage engineering continues to advance and hope it will be use in clinically.

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