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Auricular Reconstruction of Congenital Microtia Using Autogenous Costal Cartilage: Report of 25 Cases

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Abstract:
Background: *Total auricular reconstruction in congenital microtia is one of the most challenging problems faced by a reconstructive surgeon as it demands precise surgical technique combined with artistic creativity. Ear reconstruction requires carefully planned procedures.The use of autogenous rib cartilage is the gold standard for microtia reconstruction. Alternatives for auricular reconstruction include autologous costal cartilage graft, prosthetic reconstruction with osseointegrated implants or the use of alloplastic frameworks (e.g. porous polyethylene)*
Material & Methods: *This is a prospective study. All the cases, which numbered about 25 cases, had been operated by the department of plastic surgery at Osmania General Hospital between August 2009 to May 2012.All our cases were underwent ear reconstruction using autogenous rib cartilage of contralateral side in three stages with 3-6 months of interval between each stage*
Stage I: *Auricular framework fabrication with contralateral rib cartilage and insertion of cartilage in the skin pocket*
Stage II: *Auricular framework elevation*
Stage III: *Lobule transposition*
Results: *The results of the reconstructed auricles in 25 patients were satisfactory in view of symmetry with opposite ear, lobule position, helical projection and creation of post-auricular sulcus with good aesthetic balance. The complications includes hair bearing are over the reconstructed pinna in 8 patients, infection with cartilage exposure in one patient, surgical emphysema of donor area in one patient.*
Conclusion: *Although various donor sites have been used for harvesting the cartilage, only costal cartilage provides a substantial source for fabricating total ear framework. The cosmetic outcome and least complication results in our series support this conclusion.This method of auricular reconstruction is a sound tested procedure that may be done optimally in three stages, using techniques that are within the competence of the trained plastic surgeon.*
Keywords: *Auricular Reconstruction, Autogenous Costal CartHage, Microtia.*

I. Introduction

Microtia is a birth deformity of one or both ears in which the outer ear is underdeveloped or absent.Microtia is a congenital malformation of variable severity of the external and middle ear. The microtic auricle consists of a disorganized remnant of cartilage attached to a variable amount of soft tissue lobule, which often is displaced from a position symmetrical with the opposite normal ear. The direction of displacement depends on the degree of associated facial hypoplasia. Depending on the severity of the anomaly, there may be evidence of external meatus formation. Microtia commonly involves the external canal and middle ear; hence, hearing can be affected.Its appearance also causes a lotof psychological impact on the affected children andtheir families.Microtia occurs once in about every 7,000 to 8,000 births in the general population. It occurs more often in right ears and males, especially in unilateral microtia. The cause of microtia is multifactorial. Fewer than 15% of the cases have a positive family history. Thalidomide and isotretinoin can cause congenital deformities such as microtia.Microtia may present as an independent anomaly or associate with other syndromes (Goldenhar syndrome and Treacher Collins syndrome).Among associated malformations, facial cleft and cardiac defects are the most common followed by anophthalmia or microphthalmia, limb reduction defects, severe renal malformation, and holoprosencephaly.

There are many classification systems for microtia. One widely adopted system assigns a grade from I to III based on the severity of the deformity. Grade I represents a pinna with all anatomic subunits present but misshapened. Grade II represents a pinna with some recognizable subunits but is rudimentary and malformed. Grade III includes the classic "peanut" ear, which is severely deformed with an inferior fibroadipose lobule and a nubbin of cartilage in the superior remnant.

The use of autogenous rib cartilage is the gold standard for microtiareconstruction.Alternatives for auricular reconstruction include autologous costal cartilage graft, prosthetic reconstruction with osseointegrated implants or the use of alloplastic frameworks (e.g. porous polyethylene)The origin of microtia repair had its significant beginnings in **1920**, when **Gillies** buried carved homograft rib cartilage under mastoid skin, then separated it from the head with a flap of neck skin.A major breakthrough came in **1959**, when **Tanzer** rekindled using autogenous rib cartilage, which he carved in a solid blockTo this date, autogenous cartilage remains the most reliable material that produces results with the least complications . Although various donor sites (including the knee!) have been used for harvesting the cartilage, only rib cartilage provides a substantial source for fabricating a total ear frameworkBuilding upon **Tanzer**'s sound principles, Brent continue refining and evolving the use of rib cartilage and have created frameworks for more than 1,700 patients during the years. He was the first to report the successful use of tissue expansion in reconstruction of the ear.Other dedicated proponents of rib cartilage from various parts of the globe include **Firmin** ,**Osorno** , **Nagata** ; **Weerda** and **Siegert**.

Recently, interest in the pre-fabrication concept has been rekindled via modern tissue engineering techniques in which bovine cartilage cells are grown in the labora- tory and seeded upon a synthetic ear from which is then implanted beneath the skin of a mouse. The early experimental results are interesting, but, it needs a long time of effort and work before it can be applied to humans.

II. Patients And Methods

This is a prospective study done among 25 patients with congenital microtia, which had been operated by the Department of Plastic Surgery at Osmania General Hospital between August 2009 to May 2012. Our study also includes the cases with associated anomalies along with congenital microtia.Patients with loss of external ear due to trauma and burns were excluded in our study. The age at cartilage harvesting ranged from 6 years to 20 years (mean age is 10) and the M/F ratio is 1.36:1.In our study,18 patients had unilateral involvement and bilateral involvement was seen in 7 patients.patients were evaluated clinically and radiologically. Otoscopic examination was carried out to see the depth of the external auditory canal and presence of the tympanic membrane. Tuning Fork tests and Pure Tone Audiometry were performed in all the cases. CT Scan of the temporal bone was undertaken for evaluation of status of middle and inner ear, to determine whether or not the child is a surgical candidate for atresia repair.

Age at Reconstruction:The surgical reconstruction of the external ear, especially unilateral microtia repair, is usually begun at about 6 years of age as at this age, there is sufficient rib cartilage to harvest for the framework and the ear has grown to approximately 85% of its adult size. So the child reporting earlier was called after 6 years of age. Cases with bilateral deformity were advised bone-conducting hearing aids till formal atresia repair was undertaken.

Associated Anomalies

Type of Associated Anomaly	No.Of Patients
Syndactyly	1
Facial Palsy	1
HemifacialMicrosomia	4

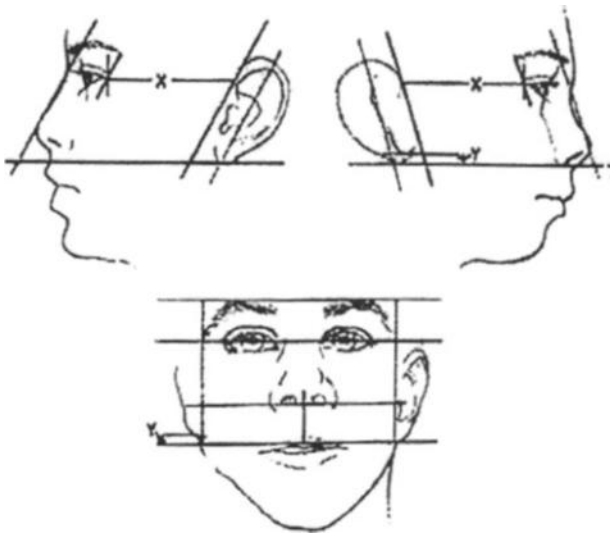
Pre-op

Planning

Planning of the placement of the new ear is essential to optimal aesthetic outcome. If the ear is misplaced with regard to the opposite ear or orbital and facial landmarks, the most exquisitely detailed auricle reconstruction appears abnormal.

The height of the ear is approximately equal to its distance from the lateral brow at the level of the helical root. Its width is approximately 55% of its height. Its top aligns with the brow, and the lobular tip aligns with the columella. The mature ear typically is 5-6 cm long. The helical rim protrudes approximately 2 cm from the skull at an angle of 21-25°. The long axis of the ear does not parallel the nasal dorsum but is approximately 15-20° posteriorly rotated from the perpendicular axis of the body.

Design one template for the placement of the ear and another for the cartilage framework. Unexposed developed radiograph film, which can be "flash-sterilized," is convenient for use in the operating room.Fashion the templates from the normal side and transpose them to the affected side. The first template includes marks for the lateral orbit, brow, and the root of the helix.After transposing this information, mark the area for the pocket. Usually the pocket is under hair-bearing scalp in its posterosuperior aspect. Do not allow the hairline to guide the placement of the pocket, as that places the new ear inferior and anterior to the opposite side.



Surgical procedure

We, in Osmania General Hospital have been doing ear reconstruction using autogenous rib cartilage of contralateral side in three stages with 3-6 months of interval between each stage.

Stage I: Auricular framework fabrication with contralateral rib cartilage and insertion of cartilage in the skin pocket

Stage II: Auricular framework elevation

Stage III: Lobule transposition

Stage I: (Auricular framework fabrication with contralateral rib cartilage and insertion of cartilage in the skin pocket)

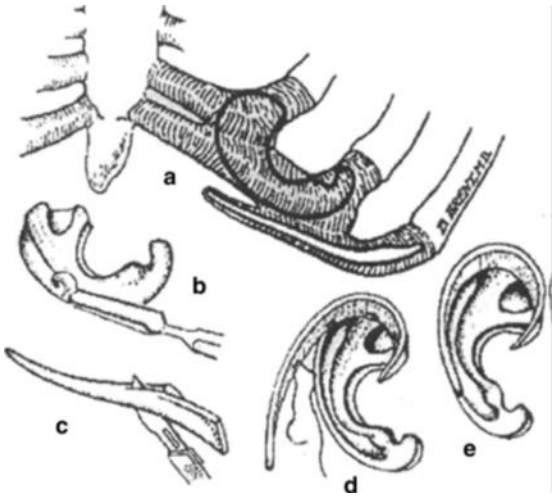
Obtaining Rib Cartilage:

Rib cartilages are obtained en bloc from the contralateral side synchondrosis of 6,7,8th ribs for natural rib configuration.The helical rim is fashioned separately with cartilage from the 8thrib.Excision of this cartilage facilitates access to the synchondrotic region of ribs 6 &7 which supplies a sufficient block to carve the framework body. By preserving even a minimal rim of upper margin of 6th rib cartilage we can decrease chest wall deformitiesCare taken to preserve the perichondrium on the lateral ,outer aspect of the framework to facilitate its adherence & subsequent nourishment from surrounding tissues.

The helical framework is bended acutely and sutured to the frame work base with the 3-0 or 4-0 prolene suture in order to exaggerate the helical rim.

Framework modifications in older patient:

Adult rib cartilage are often fused into a solid block, so sculpturing is done in one piece – not unlike doing a wood carving. It is difficult to create a separate helix that will bend without breaking. One can detach the helix and slide it up the framework body to augment the protusion of the rim.



Framework implantation:

Preop marking of site and location with precise upper, lower & outer limits of snug fit subdermal cavity in right axis was done. By small anterior incision on the auricular vestige with centrifugal skin relaxation, a thin flap is raised by sharp dissection by preserving subdermal plexus without making button holes. Native cartilage remnant is excised &discarded.Absolute hemostasis was done in the snug fit cavity and the cartilage framework implanted inside the skin pocket. Closure of the wound with negative suction without pressure dressing was done.

Intra operatively the donarsite as well as the reconstructed site were managed by negative suction drainage and removed later in post-operative period. This creates a continuous suction, which promotes adherence of the nourishing skin flap to the cartilage sculpture and prevents disastrous hematomas. The drains are removed on the fifth postoperative day, when drainage is minimal and the skin is well-adhered to the cartilage framework. Sutures are removed from the ear after 5-7 days

Stage II:(Auricular framework elevation)

Posterior auricular margin is defined by separating the ear from the head and covering its undersurface with a thick SSG. Incision is made several mm behind the rim ,so that the graft will not be seen anterior with care to preserve protective connective tissue layer on cartilage framework.The graft is harvested from thigh and usually partial thickness graft was used to cover the raw area and tie over dressing was done to maintain the proper cephaloauricular angle.

Stage III:(Lobule transposition)

Safer and more accurate to transpose the lobule as secondary procedure.The rotation or reposition of this normal but displaced structure is essentially done by z-plasty transposition of narrow ,inferiorly based triangular flap.

III. Results

Inspection of Reconstructed Ear

The following grading scale was used for evaluation of the results;

Clinical assessment after ear reconstruction Grade
Good symmetry with opposite ear, Excellent
lobule position, helical projection and creation of post-auricular sulcus

Nice shape but deficient in one of the Good
above details

Patient pleased but surgeon unhappy Satisfactory

Grade	No. Of patients	percentage
Excellent Good Satisfactory	17 1 7	68% 4% 28%
Total	25	100%

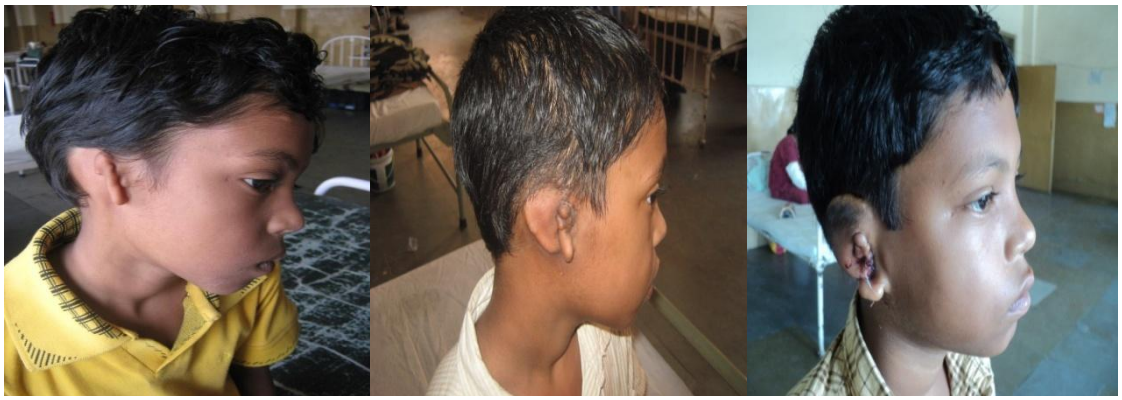
Complications
1)Post-operative infection and cartilage exposure: 1 Patient
2)Hair bearing skin over auricle: 8 Patients
In our study, 8 patients got hair bearing skin over the auricle due to low hairline pre-operatively,among them one patient got laser treatment for the hair removal in multiple sittings.

3)Donor site complications:
Surgical emphysema of donor site: 1 Patient

Summary of complications of auricular reconstruction using autogenous costal cartilage

Total no. of patients	Cartilage exposure	Donor site Surgical emphysema	Hair bearing skin over auricle
25	1	1	8

Pre-op **Post-op stage I** **post op after laser depilation**



Pre-op **Post-op stage I** **Post-op stage III**

Pre-op **Post-op stage I** **Cartilage framework**

IV. Discussion

Microtia can be defined as a malformation of the auricle, with varying severity, ranging from minimal structural abnormalities to total absence of the earlobe that can range from mild distortion of the anatomical landmarks to complete absence of the ear, which can have a great influence on a patient's quality of life.

The majority of microtia patients also have atresia or stenosis of the auditory canal, and there is a high correlation between the degree of microtia and the frequency of external and middle ear abnormalities.

Factors, which were studied in the patients, were

1. Age group.
2. Sex involved.
3. Side involved.
4. Classification.
5. Presence of hearing loss.
6. Associated deformities.
7. Complications.

All our cases were underwent ear reconstruction using autogenous rib cartilage of contralateral side in three stages with 3-6 months of interval between each stage.

Numerous Authors have proposed various modalities of treatment yet its management remains difficult. Initially Dr.Tanzer and Dr.Brent were started the ear reconstruction by using autogenous rib cartilage in 4 stages and later on Dr.Nagata and Dr.Firmin changed the trend of multiple stages of ear reconstruction to only 2 stages of surgery and now some surgeons(Dr.Park) are doing in single stage only.Currently the use of autogenous rib cartilage is still the gold standard for microtia reconstruction.

The use of alloplastic frameworks was attractive at the beginning and several materials were used as silicon rubber and polyethylene.This technique was thought to be less invasive and reliable method of total ear reconstruction in comparison to many other techniques. But, in the last few years many authors [3 ,4 , 12] reported high incidence of extrusion of all these alloplastic frames, regardless the material used inspite of the attempts to minimize this problem by covering the framework with extra tissue grafts and flaps.

The other obvious limitation of these alloplastic frames is the difficulty of a accommodating the great variation in size and shape that must be produced to match the opposite normal ear. When sculpting directly from rib cartilage these limitations do not exist because the surgeon creates the required specific size and shape each time. So, we discontinued using all these alloplastic frames in favor of costal cartilage frames. Serious attempts at tissue engineering began in the early 1980s. Cartilage, being avascular with modest nutritional requirement, was an ideal medium to begin work in this arena. This quickly lead to applications in microtia repair [13]. Bioabsorbable artificial polymers served as matrices for chondrocytes. Early results with culturing polyglycolytic/polylactic acid polymers with bovine chondrocytes demonstrated that lasting three dimensional structures were feasible. Chondrocytes multiplied and the biodegradable polymer was to some extent replaced by matrix, however, polymer replacement inevitably led to loss of prosthesis shape with time. Ongoing work with human chondrocytes and biodegradable matrices continues and 1 day might represent the standard of care in microtia repair. Maintenance of cartilage integrity with time and thus preserving a precise and delicate auricular architecture remains the most significant hurdle to overcome before this technology is clinically feasible. To this data, when tissue engineering can provide the ideal cartilage frames, sculpted autogenous rib cartilage remains the material of choice for surgical repair of lobule type microtia.

Although various donor sites have been used for harvesting the cartilage, only costal cartilage provides a substantial source for fabricating total ear framework. Many authors support this concept as Osomo [8] and Nagata [4]. So, we continue refining and evolving the use of costal cartilage frameworks. The cosmetic outcome and least complication results in our series support this conclusion. As regard the soft tissue cover of the frame work we found the use of a skin pocket carefully dissected without a temporoparietal facial flap is very useful in the first stage reconstruction, the facial flaps with a skin graft over it is risky and the aesthetic results are much less as it masks the contour and details of the framework. Also, in the second stage we elevate the ear with a skin graft only and appear to be satisfactory without a supporting block of cartilage. It was found that it was useful to perform ear lobule transposition in the second stage not at separate stage. Ear reconstruction from autogenous tissues withstand trauma remarkably well [5]. This observation is always found in all of the present cases.

In our series, all patients achieved satisfactory results in view of symmetry with opposite ear, lobule position, helical projection and creation of post-auricular sulcus. They accepted the ears for functional wearing glasses &wearing hearing aid and even ear ring in the girl.

V. Conclusion

Reconstruction of the auricle is one of the most challenging and rewarding aspects of facial plastic surgery. Each patient and each ear deformity are unique, thus making the management of these patients a humbling, challenging, and perpetually stimulating problem. Autogenous costal cartilaginous graft using two piece framework for pinna reconstruction can be attempted with good long term results Although various donor sites have been used for harvesting the cartilage, only costal cartilage provides a substantial source for fabricating total ear framework. The cosmetic outcome and least complication results in our series support this conclusionThis method of auricular reconstruction is a sound tested procedure that may be done optimally in three stages, using techniques that are within the competence of the trained plastic surgeon.

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