

**TITLE: Microtia Reconstruction**

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## **Introduction**

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 occurrence in general is more often in Hispanics and Asians than blacks and whites. The cause of microtia is multifactorial. Fewer than 15% of the cases have a positive family history. (1) And it is fairly common for microtia to be associated with other congenital abnormalities. 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. (2) And it has long been felt that microtia represents the mild end of the spectrum of hemifacial microsomia, with Goldenhar syndrome being the severe end of the spectrum. (2) 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. (6)

Microtia reconstruction is one of the most challenging surgeries faced by the reconstructive surgeon. Dr. Tanzer published a paper on the use of autogenous rib cartilage in reconstruction of the auricle in 1959 and brought in the new era of auricular reconstruction. Dr. Brent modified Dr. Tanzer's technique and has been treating patients with auricular malformation since the 1970s. He has treated over 1,000 patients with microtia in the last 25 years and has become the foremost expert in microtia reconstruction. Another popular technique based on a modification of Tanzer's technique was developed by Dr. Nagata from Japan. He has been using his technique treating microtia patient since the 1980s and has treated more than 800 patients. Currently the use of autogenous rib cartilage is still the gold standard for microtia reconstruction. However many new techniques are being developed, including alloplastic implants, osseo-integrated prostheses and tissue engineering.

## Surgical Planning

The timing of microtia reconstruction has been much debated in the literature. Factors used to determine the most appropriate timing for auricular reconstruction include the age of external ear maturity, the availability of adequate donor site rib cartilage, and psychological impact of the disease. (2) At birth, the auricle is 66% of its adult size. By age 3, it is 85% of its adult size. By age 6, it is 95% of its adult size. Rib cartilage is rarely of sufficient size until age 5 or 6 years. And per Dr. Brent's experience, the psychological effects of microtia are important once a child starts school. Therefore, Dr. Brent starts his auricular reconstruction at age 6 in general. About 60-70% of his reconstructions were done between age 6 and 10. (5) Dr. Nagata starts his reconstruction at age 10 and a chest circumference of at least 60cm, which can be confirmed with X-ray. (4) This may be related to the relative large volume of cartilage needed for using his technique for reconstruction.

A complete audiologic evaluation and radiographic study of the temporal bone is critical in all patients with microtia. The predominant hearing deficit in microtia is conductive hearing loss. However, sensorineural hearing loss has also been found in 10-15% of patients.(2) A normal middle ear is rarely found in conjunction with microtia. The status of the middle ear is not directly related to the external deformity. The severity of the external deformity appears to correlate with the severity of the temporal bone abnormality; but no association between the severity of the dysmorphic features and the degree of hearing loss has been found. Otologic surgery has traditionally not been performed for unilateral microtia with normal hearing in the other ear. This is because the patients often do not obtain true binaural hearing after otologic surgery. And also because of the belief that the auditory neural structures critical for binaural processing develop only if binaural hearing is present early in life. However, one recent study suggested that unilateral hearing loss increases the risk for speech and language delay, attention deficit disorder, and poor performance in school. And the plasticity in the developing auditory system may be greater than originally suggested. Therefore, there has been an increased interest in atresia correction. If otologic surgery is to be performed on the microtic ear, it is important to have careful coordination between the otologist and the reconstructive surgeon. Dr. Brent prefers to have the otologic surgery after the completion of the auricular reconstruction to avoid the disruption of the vascular supply. And this has been the standard approach to management in most patients.

### Brent Technique (3)

This is a 4- stage procedure.

#### **First stage: Auricular framework fabrication with contralateral rib cartilage**

A template is made by placing a piece of X-ray film against the normal ear in the unilateral cases or the parent's ear in bilateral cases and tracing all anatomic landmarks. The template is then made several millimeters smaller to accommodate for the thickness of the skin cover and overgrow potential of the reconstructed ear. (5) The contralateral 6<sup>th</sup>, 7<sup>th</sup> and 8<sup>th</sup> costal cartilages are usually harvested. The base of the framework is carved from the synchondrosis of the 6<sup>th</sup> and 7<sup>th</sup> rib cartilage. The helix is carved from the "floating" 8<sup>th</sup> rib cartilage. The helix is then sutured to the base with clear nylon suture. The fabricated framework is then positioned in a subcutaneous pocket through an incision at the posterior and inferior border of the vestige. An

extra piece of cartilage is also banked either in a pocket posterior to where the framework is placed or underneath the chest incision to be used in the later stage for improved ear projection. Two small suction drains are placed and left for 5 days.

### **Second stage: Lobule transposition**

This is performed several months after the stage I procedure. The lobule is mobilized as an inferiorly based tissue flap and rotated to receive the end of the framework. Unused lobule tissue is excised.

### **Third stage: Auricular framework elevation**

An incision is made several millimeters from the margin of the rim. Dissection is carried over the capsule of the posterior surface of the construct until the correct amount of projection is achieved. The backed piece of cartilage is placed between the framework and the mastoid to stabilize the ear position. A split thickness skin graft is used to cover the back of the elevated cartilage framework.

### **Fourth stage: Tragus construction**

A composite skin/cartilage graft is taken from the anterolateral conchal surface of the normal ear. A J-shaped incision is made along the posterior tragal margin. The composite graft is placed through the incision and positioned so that it produces both projection of the tragus and cavitation of the retrotragal hollow. Soft tissue also is removed from the new concha to deepen the concha bowl. The shadow of the neotragus imitates an external auditory canal. Frontal symmetry is also addressed at this stage.

### **Recent modification:**

The most recent modification is to incorporate a small cartilage into the framework to create a tragus in stage 1. It is sutured to the inferior aspect of the framework to create an antitragus, then curved around and attached to the crus helix with a bridging mattress suture superiorly to create a tragus.

### **Major Criticism:**

- 1) Number of stages required to achieve the final result.
- 2) The aesthetic result from the tragus reconstruction
- 3) Effacement of the postauricular sulcus causing decreased projection of the reconstructed ear

## **Nagata Technique (3)**

This is a 2-stage procedure.

### **First stage: fabrication of auricular framework, tragus reconstruction and lobule transposition**

Ipsilateral costal cartilages of the 6<sup>th</sup>, 7<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> ribs are harvested. The base of the framework is carved from the synchondrosis of 6<sup>th</sup> and 7<sup>th</sup> ribs. The helix and crus helix are carved from the 8<sup>th</sup> rib. The 9<sup>th</sup> rib is used to construct the superior crus, the inferior crus, and the antihelix. The remaining structures are carved from residual cartilage pieces. The cartilage

framework is assembled with fine-gauge wire suture. Most of the posterior perichondrium is left intact to minimize the anterior chest wall deformity. An incision is made at anterior surface of the lobule. A 2mm circular portion of the skin is removed at the end of the incision. A W-shaped incision is also made at posterior lobule to divide the lobule into an anterior tragal flap and posteroanterior lobular skin flaps. A subcutaneous pocket is dissected through this incision. The central portion of the posterior skin flap is not elevated to augment blood supply to the skin flap. The framework is then placed in the pocket. The posterior flap is then advanced to suture to anterior tragal flap and the lobule is transposed by assembling the flaps in the Z-plasty fashion. The small circular skin defect gives rise to incisura intertragica. Bolsters are used to approximate skin flaps to the framework, and the bolsters are left in place for 2 weeks.

### **Second stage: framework elevation**

Six months after the first stage, a crescent-shaped piece of cartilage is harvested from the 5<sup>th</sup> rib through the previous chest incision. An incision is made 5mm posterior to the margin of the construct. The framework is elevated and held in place by wedging the newly harvested cartilage into position. A temporoparietal fascia flap is elevated through a new scalp incision and tunneled subcutaneously to cover the posterior surface of the cartilage graft and reconstructed auricle. The back of the framework is then covered with ultra-delicate split thickness skin graft harvested freehand from the occipital scalp.

**Advantage: more natural and deeper conchal bowl.**

### **Major criticism:**

- 1) Vascular compromise of the peri-lobular flaps from manipulation, increasing the risk of flap necrosis
- 2) Considerable amount of cartilage required by this technique
- 3) High extrusion rate may be due to use of wire suture
- 4) Temporoparietal fascia used in every case with risks of scalp scarring, temporal hair thinning, and making it unavailable for future possible salvage of complications
- 5) Frontal symmetry not addressed

### **Complications:**

The immediate complications at the chest wall donor site include pneumothorax and atelectasis. The delayed complications include anterior chest wall deformity and scarring. The chest wall deformity was observed more often in younger children than in older children. Dr. Nagata has recommended keeping posterior perichondrium intact to help prevent this problem. (3)

The complications at the ear reconstruction site mainly consist of extrusion of the framework secondary to skin flap necrosis and resorption of the framework. If the framework is exposed, early intervention with local skin and fascial flaps is usually used to salvage the reconstruction. The temporal fascia is a potential salvage resource. Also, suture placed too tightly or placement of the framework in a scarred, ischemic bed may predispose the cartilage to resorption. (3)

## Alloplastic reconstruction

There has always been interest to find an alloplastic material to reconstruct the microtic ear and provide a more consistent aesthetic result while avoiding donor site morbidity. Also without the limitation of the size of the rib cartilage, the reconstruction may start at an earlier age.

Cronin and Ohmori have described the use of the Silastic framework for auricular reconstruction. (2) They had excellent initial results. But the long term follow up showed a high incidence of implant exposure. Also minor trauma or abrasions resulted in implant exposure and failure. Therefore the use of silicone for auricular reconstruction has been abandoned

More recently Reinisch has proposed to use porous polyethylene (Med pore) in microtia reconstruction. Good short-term (2 years) results were reported. Romo also reported that using temporoparietal fascia flap that completely surrounds the Med pore implant appears to have significantly reduced its failure rate. (1)

## Prosthetic reconstruction

The osseo-integrated anchoring device uses a titanium fixture to provide direct structural connection between living bone and a load carrying implant. It was approved by the FDA to be used extra-orally in 1995. It has been used more frequently in Europe than in the USA. Thorne and Brecht (7) outlined the relative indications for prosthetic microtia reconstruction, even though they believed that autogenous reconstruction is still the technique of choice for children with congenital auricular malformation. The three relative indications for prosthetic reconstruction are 1) failed autogenous reconstruction, 2) significant soft-tissue/skeleton hypoplasia, 3) low or unfavorable hairline. The usual indication for prosthetic reconstruction is acquired total or subtotal auricle defects in adults.

Even though prosthetic reconstruction usually involves less surgery, the prosthesis must be replaced every 2 to 5 years. In addition, the skin/implant interface is prone to irritation, therefore meticulous hygiene is necessary. Minor trauma may lead to infection. Lastly the prosthetic reconstruction precludes future autogenous reconstruction because all ear remnants and skin and soft tissue in the region are removed.

## Tissue Engineering

Tissue engineering offers the potential to grow autogenous cartilage in a precisely predetermined shape. This method can offer the advantage of autogenous reconstruction without the morbidity associated with rib harvest. Cao *et al.* (1) transplanted bovine chondrocytes onto a synthetic scaffold in the shape of the human ear and implanted this in mice. The specimens harvested at 12 weeks after implantation demonstrated new cartilage formation and gross shape of the complex structures of the human ear. The scaffold appears to be critical. It has to be strong enough to maintain its shape over time and also has to avoid extrusion. Furthermore, a significant amount of human chondrocytes must be replicated from a small amount of cartilage. Human chondrocytes have been extracted from a number of sources, including rib and ear. *In Vitro* they have demonstrated ability to multiply well and form new cartilage. (3) However, the

durability of this neocartilage remains unclear. Even though a tissue engineered framework is not yet a practical option in auricular reconstruction, the technology and concept are promising.

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