REVIEW ARTICLE

Different Reconstruction Splint for Post Operative Management of Ear Deformity – An Overview

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Abstract

Maintenance of ear projection and post auricular sulcus in staged ear reconstruction for patients having microtia is a trying problem. Helical keloids are difficult to treat as surgical excision requires effective compression of the operative scar to prevent recurrence while retaining the contour and elasticity of the helix. So, a proper dressing or a splint is required, which should be simple, reliable, inexpensive, readily available, easily and quickly fabricated that can be continuously applied to the complicated contours of the ear by controlling expansion, compression forces and prevent recurrence while retaining the contour and elasticity of the helix.

After ear reconstruction surgery, recurrence is high in case of keloids. Pressure therapy is used in the management of keloids, generally in combination with other therapies. Custom made pressure appliance made of methyl Methacrylate are also used. Thermoplastic splints are often used for post auricular sulcus or as ear guards. These splints are difficult to retain and some need to be harnessed around the head. Numerous splints and dressing techniques for the above-mentioned situations using different types of material has been described in the present table clinic presentation.The ear splint provides excellent compliance after reconstructive surgery. It's up to the individual interest, one can decide the type of splint require after surgery.

KEY WORDS

Ear elevation; splint; microtia; keloid; retentive loops; customized splints; pressure appliance

Introduction

The term **"microtia"** describes a variety of congenital auricular anomalies, from a tiny but otherwise healthy ear to an absence of any external ears at all (anotia). Microtia is usually unilateral (77% to 93%), more often right-sided (60%), and occurs more frequently in males (2.5:1). Globally, the incidence of microtia varies from 0.8 to 4.53 per 10 000 births.[1]

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Marx has classified microtia into four grades which is most widely accepted.

Grade I: Auricle is slightly smaller (at least 2 standard deviations below normal), but all subunits are present.

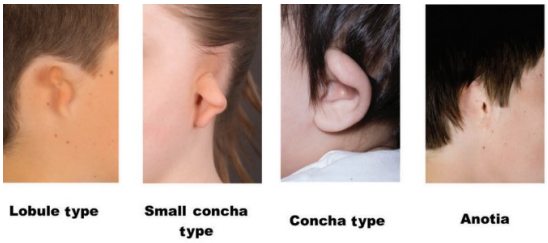
Grade II: The auricle is smaller, and subunits are severely underdeveloped or absent; the upper half of the ear is often less developed than the lower half.

Grade III: Only a small piece of cartilage is present in the superior remnant of the ear, and the lobule is rotated anterosuperiorly; this configuration is the most common and is often colloquially referred to as a "peanut ear."

Grade IV: Complete absence of the auricle and lobule (anotia).

Types of microtia according to Nagata Classification. [2]

- **Lobule type microtia -** Only the ear lobule is present along with the remnant of the ear
- **Small concha type microtia -** Ear lobule is present along with small conchal indentation and remnant of the ear
- **Concha type microtia –**Ear lobule, concha, external auditory meatus and tragus are present
- **Anotia-** All the features of ear are missing
- **Atypical -**Low hair line cases



Nagata Classification (a) Lobule type, (b) Small Concha type, (c) Concha type and (d) Anotia

There are two treatments available for microtia

- Silicon Removable Ear Prosthesis
- Rib Cartilage Reconstruction

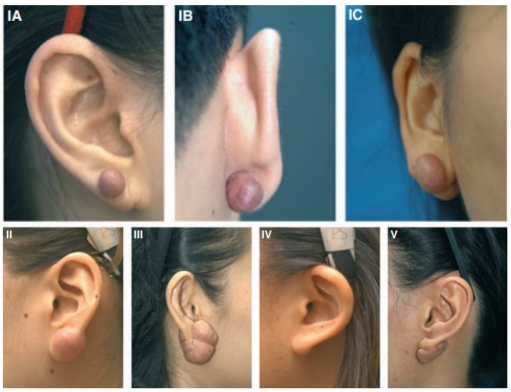
Treatment depends on the grade of microtia. For Grade I, II and III rib cartilage reconstruction are advocated. In case of Grade IV (Anotia) a prosthetic ear can be fabricated to look very similar to a patient's normal ear. There are two methods that are used to attach the ear prostheses. One uses a glue to adhere the ear to the skin. The second method uses titanium implants which are placed onto the bone around the ear. The prosthesis can then be "snapped" into place (called an osteo-integrated prosthesis).

Surgical treatment of microtia is done in two stages, firstly the depth of cephaloauricular sulcus is attained to its appropriate position and secondly placement of reconstructive splint. During the initial phases of healing, maintaining the sulcus depth is essential to keep the projection of the auricle in its desired position. Secondly, the reconstructive splint is fabricated to counteract the contracting forces of the skin-graft and maintenance of ear elevation so that when the skin flap stabilizes, more rigid stent can be applied. Thus, main goal of splints is to stop the sulcus from being physically obliterated by re-epithelialization. As the contour if the ear is complicated and it protrudes from the head, it is very difficult to apply and maintain the splint in position.

Keloid is a wound healing complication occurs due to minor trauma, infection, burn, or inflammation. The term keloid was originally described in 1800s as "cheloid," derived from the Greek word "chele" means "crab claw". Usually appear as firm nodules, often pruritic and painful, and generally do not regress spontaneously. Most often occur on the chest, shoulders, upper back, back of the neck, and earlobes. It is characterised by continuous growing scar extending beyond the prior wound boundaries. Earlobes are common sites for keloid formation after ear piercing, with an incidence of approximately 2.5%.

Chang Park Classification of Earlobe Keloid [3]

1. Pedunculated
    a. Type IA
    b. Type IB
    c. Type IC
2. Sessile, single nodular pattern, Type II
3. Sessile, multinodular pattern, Type III
4. Buried, Type IV
5. Mixed, Type V



Chang-Park classification of earlobe keloids: Type IA (top, left). Type IB (top, center). Type IC (top, right). Type II (bottom, left). Type III (bottom, second from the left). Type IV (bottom, second from the right). Type V (bottom, right).

Larger keloids are treated by reconstructive surgery whereas smaller keloids are treated by compression therapy. Along with this, adjuvant therapy including, cryotherapy, intralesional corticosteroid injection, radiation treatment, laser treatment, topical silicone gel sheeting, verapamil, 5-fluorouracil, bleomycin, interferon alpha-2b, botulinum toxin type A, and colchicine have been proposed. Pressure therapy has been found to be successful in the management of keloid, in order to control the pressure and avoid soreness it is mandatory to fabricate custom-made splint. [4,5]

To stimulate patient compliance, the requirements of ideal long-term splint after ear reconstruction should be the following: [6]

1. Self-retaining, light weight, and easy to camouflage
2. Easy to apply and remove
3. Inexpensive and easily fabricated
4. Composed of a material that is:
    - Inert and nontoxic;
    - Soft to avoid pressure sores;
    - Nonadherent and non-absorbent;
    - Sufficiently elastic to allow application/removal; and
    - Sufficiently rigid to support the ear and to avoid rupture.

Several splints and ear protectors, each with benefits and drawbacks, have been described by a number of writers. There are several procedures that have been documented in the literature that can be employed following reconstructive surgery. This article will go through the different kinds of materials and procedures of using them that may be used as splints following ear reconstruction. These are,

- Impression Compound
- Silicone Foley's Catheter

- Polyvinyl Sheet
- Acrylic Resin

Splint with Impression Compound [7,8]

Impression compound is a thermoplastic material also called modelling plastic. It is hard at room temperature and softened by placing in water bath at temperature, ideally between 55-60^{0}C. A study was carried out where 211 patients of microtia treated over a period of 10 years was given ear reconstruction splint post-surgery resulted in maintaining ear elevation with no complications associated with the splint application or prolonged use. In dentistry impression compounds are used for making impression of edentulous ridge, bite registration and border moulding. Because of its favourable properties, it can be used to form splints after ear reconstruction.

Procedure

Splint can be fabricated soon after surgery or can be placed after a week once the graft had taken well. After the completion of ear reconstruction, the antibiotic cream is applied over the grafted skin. Impression compound is placed in a hot water bath, after it is removed from water bath it is kneaded with the finger in order to obtain uniform plasticity throughout the mass. Softened material is then placed against tissue on the posterior aspect to the anterio-superior aspect of reconstructed ear **(Fig-1)** before it cools to a rigid mass and removed after it hardens to check for appropriate adaptation. The patient is asked to use the splint continuously and remove only during bathing. The patient is recalled every month for periodic check-up

Advantages: -

- easily applied to the complicated contours
- can control expansion and contractile forces even if the growth of keloids, are progressing
- easily and quickly fabricated without requiring any prior impression
- light, inexpensive and easy to apply and remove
- colour can be painted to get a close match to patient's skin tone
- cost-effective as readily available materials
- Non allergenic
- reduce number of postoperative visits

Disadvantage

- falling may result in breakage of splint
- easily visible and may be less aesthetically acceptable.

Modification to improve the anchorage [5]

The compound can be wrapped around over a solid framework of thin stainless-steel wire attached to the band, spectacle frame **(Fig- 2)** or fancy bands **(Fig- 4)** for firm anchorage. In case of the earring-type splint it can be incorporated on the posterior link chain (*mattal*) **(Fig – 3)** of the jewellery.

Fig -1 *Splint in place on the posterior aspect of reconstructed ear*

Fig-2 *Splint with spectacle framework.*

Fig-3 *Splint with mattal earring framework application*

Fig-4 *Splint with fancy hairband framework*

Splint with Acrylic Resin [4,9]

Acrylates are a type of plastic material created by polymerizing monomers produced from acrylic or methacrylic acid. They have several uses in the printing sector, in paints, varnishes, and adhesives, as well as in the fields of medicine and dentistry, as well as in artificial nails. In dentistry it is used to make orthodontic retainers, dentures for repair, for relining dentures and for temporary or provisional crowns, obturators and in industry such as for fabrication of artificial teeth, occlusal splints, printed or milled cast, dies for treatment planning and embedding for tooth specimen for research purposes. Till now there is no other material found that have an ideal property. Acrylates can used to make active or passive pressure splints; it depends on the stage of treatment. Springs and magnets can be incorporated into the splint for additional retention and pressure. Active pressure splints are given presurgical to compress the keloids while to prevent recurrence passive pressure splint is given.

Procedure

Petroleum jelly is applied over the skin of ear and gauge pack is inserted into the ear canal. Beading around the auricle is done with wax or impression compound **(Fig-5)**. Alginate is mixed with water and a thin mix is poured within the confinement of the beading with patient's head tilted opposite to the side for which impression was being made. Thin mix of plaster of Paris was poured over the alginate as the backing material. Completed impression was retrieved after the impression materials were set. The impression was poured in dental stone with adequate land area to make the cast **(Fig-6)**. Using an 18 Gauge Stainless Steel wire, a coil with
retentive loop is made extending from the dorsal to the ventral surface of the reconstructed ear. Acrylic resin pads cover the retentive loops and a "C-shaped" resin tag and characterization was done to make the appliance more aesthetically acceptable and unnoticeable to others that is adapted along the surgical site which prevents reattachment until epithelization occurs. **(Fig-7)**. Magnets can be incorporated into acrylic resin for retention **(Fig- 8)**.

Advantages

- Esthetically acceptable as the extrinsic stains can be incorporated in acrylic to get a close match to patient's skin tone
- Loops can be adjusted for better retentiveness
- Small, compact and easy to clean and disinfect
- Reduced number of postoperative visits
- Light weight

Disadvantage

- Allergenic
- Polymerization shrinkage results in poor dimensional stability
- Difficult to retrieve from undercut
- May require frequent relining

Fig-5 *Impression compound beading around the right auricle with blocked meatus*

Fig-6 *Master cast of right auricle showing keloid on helix*

Fig -7 *Custom-made pressure appliance with spring on the right ear helix*

Fig -8 *Two-part prophylactic appliance incorporating magnets*

Splint with EVA Sheet [6,10]

EVA is one of the materials popularly known as expanded rubber or foam rubber. EVA foam may be produced similarly to other thermoplastics because of its fine, homogenous cell structure. It keeps its toughness and elasticity, and it rebounds from compressions rapidly. EVA foam may be found in a variety of appliances, cars, buildings, boats, electronics, medical equipment, packaging, sporting goods, leisure activities and footwear. To reduce impact stress, EVA is utilised in athletic footwear. Slippers and sandals are frequently made of this material because it conforms to the shape of the foot, is lightweight, does not retain smells, and has glossy finishes. EVA is a material that is significantly more affordable than natural rubber.

Procedure

After securing the ear canal with gauge and application of petroleum jelly over the skin, putty was adapted on the posterior half of the ear and notches were made (**Fig -9**). Similarly, anterior half is also made with putty and notches were made on the rim to orient both anterior and posterior half. Final impression was made using light body silicone impression material (**Fig – 10**). This negative replica of the ear was poured with dental stone. A two- four mm thick flexible transparent sheet of ethylene vinyl acetate film was pressed in a heat and vacuum press on the master die to obtain the final conforming splint (**Fig -11**).

Advantages

- Easy to apply and remove.
- Self-retaining, inexpensive, easily fabricated,
- Protects the ear from trauma
- Nontoxic
- Nonadherent
- Soft to avoid pressure sores.
- Excellent patient compliance

The benefit of this process is it can be made before the surgery by doing mock surgery of keloid area on the cast and fabricate it which can be placed immediately after the surgery.

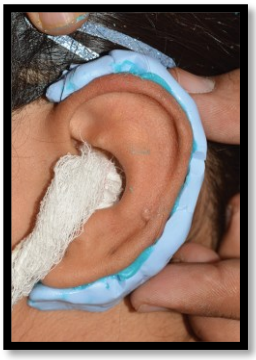


Fig -9 *Putty impression of ear*

Fig -10 *Master die*

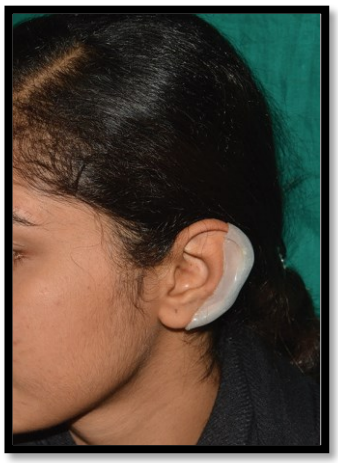


Fig -11 *Patient wearing splint immediate post-operative*

Splint with Folley's catheter [11]

Foley catheters are used for long-term drainage and are attached to a collection bag. They contain no latex, cheap and easily available, which makes them perfect for individuals with latex hypersensitivities or sensitivities. Silicone material has inert type chemical property and can be used for long terms. They are generally used after reconstruction of microtia for maintenance of ear elevation.

Procedure

The splint is fabricated using the catheter of 14 or 16 Fr size. The proximal end of a catheter of required length was retained and the distal part was cut off. The catheter was looped into a circle around the base of the reconstructed ear and secured in position with a suture. A similar construct was used in cases of external auditory meatus reconstruction or recanalization. The funnel-shaped distal drainage end was sutured to the circular frame near the region of the tragus. This funnel was inserted into the external auditory canal to maintain the patency. Construction was quick, easily made on-table and applied immediately. It is made of an inert, nontoxic, soft and pliant material. The catheter is inexpensive and easily afforded by most patients.

Fig -12 *A) Shows the splint made from the silicon Foley's catheter which was cut and sutured to itself. (B) Shows the splint in position in a case of microtia after ear elevation*

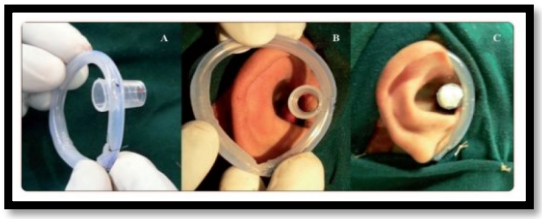


Fig -13 *(A) Shows the splint made from silicone Foley's catheter with the funnel-shaped drainage end sutured to the splint. (B) Shows the orientation of the splint while applying with the funnel-shaped attachment being placed near the tragus. (C) Shows the splint in position with a small pack in the lumen of the funnel*

Discussion

The most important step after microtia surgery and keloid treatment is maintaining of elevation of ear.[7] Numerous splints have been advocated by different author from dental impression compound, acrylic resin, silicone catheter and polyvinyl sheet each having its own merits and demerits. The popular traditional dressing, which consists of proflavine-soaked wool and a bandage, may be dislodged when bandaged loosely or may cause pressure necrosis when bandaged tightly.[8] The primary objective of such stents is to prevent the physical re-epithelization and thereby the obliteration of the sulcus.[9] Some splints are bulk and cumbersome making very difficult to retain and use socially. Nagata's technique uses cartilage block for ear elevation and a temporoparietal fascial flap cover.[12] Some authors have modified Dr. Nagata's technique, instead of using temporoparietal flap, people have used simple rotation flap from mastoid and neck to close the defect.[7] Radiation therapy has been accepted as a keloid treatment modality.[4] the long-term splint could protect the reconstructed ear from trauma and prevent prolonged edema.[6] Chalian et al. prepared shells of acrylic resin held together by nylon screws.[10] The splints can be fabricated by any commercial dental laboratory from impressions of the affected ear.

Conclusion

The various types of customized splints which are described in this article are self-retaining, easy to fabricate, concealable, inexpensive, lightweight and maintain the required auricular projection and definition. They also satisfy the patient's need for psychological and social acceptability. These splints have excellent patient compliance and help in minimizing adhesions. Since splints can be made by various materials, selection depends on the availability of the material and condition of the patient.

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