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ORIGINAL ARTICLE

# The Use of Polysiloxane in Total Auricular Reconstruction with Autogenous Rib Cartilage Grafts

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**Objective;** Total ear reconstruction is multistage, complex and a difficult process requiring considerable experience and dedication to detail. In this study a simple new method were presented by using polysiloxane which is a highly malleable plastic material. The goal of our study was to use the techniques previously described by others in a more feasible manner as the material may represent a potential solution to some difficulties that may arise in the auricular reconstruction.

**Materials & Methods;** The polysiloxane was used as an adjunctive agent to obtain better auricular definition and projection. It was utilized for creating 3-D templates, as a bolster dressing, graft fixation and molding.

**Results;** There were no major complications related to the use of polysiloxane and the material that was used in the auricular reconstruction appears to be safe and satisfactorily.

**Conclusion;** Polysiloxane is highly malleable a plastic material that can be used as an adjunct to obtain better auricular definition and projection.

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Although the auricle represents only a minority of the total body surface area, it is one of the most complex tree-dimensional structures of the external body [1]. To perform a reconstruction of the ear, standard methods with acceptable results are well described in the literature However, it is a difficult process requiring considerable experience and dedication to details [2-4].

For the reconstruction of the microtic auricle, many techniques have been described up to date [1]. These techniques have been further refined by Brent over the last two decades [4-7]. Fortunately, knowledge of reconstructive techniques has continued to improve and benefit patients [1].

The basic steps in ear reconstruction, on average, three to four stages involving the use of the patient's rib cartilage to carve a framework which is implanted under the skin. Subsequent stages involve creating a lobule, separating the reconstructed auricle from the head and construction of the tragus [1-6]. For the less experienced surgeon, these excellent results are only obtainable after some considerable practice [7]. There are multiple limiting factors that include careful and meticulous carving and assembly of the cartilage framework, accurate assessment of skin pocked thickness, proper positioning of the framework, and diligent postoperative care [8].

Impression materials are used in the various phases of denture construction, and polysiloxane is one of the elastic impression materials, which is also known as 'condensation-cured (condensation-reaction) silicone'[9, 10].

The elastic and malleable structure of polysiloxane, allows this material to be used effectively for different purposes in practice regarding reconstructive surgery [11-13].

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In this study we revealed a new usage for polysiloxane and a few number of simple methods that may facilitate in all stages of the total auricular reconstruction.

## Materials & Methods

The present study investigated 24 patients of both sexes. 20 patients had unilateral and two patients had bilateral microtia while the remaining two patients had a traumatic amputation of the auricle. Twenty-two patients were males, three patients were females, and their ages ranged from 6 to 85 years (13±5.41 yrs). The follow-up period was 1 to 5 years (approximately 3.5 years). All patients were treated with Brent otoplastic technique and polysiloxane was used as an adjunctive material in every stage of total ear reconstructions.

Polysiloxane is a low-viscosity liquid and when mixed with a catalyzer (metallic organic ester) in a ratio of 1:1 portion, it solidifies within a few minutes and transforms into elastic form. Once polysiloxane is elastic, its consistency resembles a silicon gel sheet. This new form is available also for new shaping procedures. The malleable elastic structure of this material was used for three different objectives.

*1. Composing 3-dimensional (3-D) template:* All patients had three or four polysiloxane 3-D models of the normal ear made, and all were sterilized prior to surgery (Figure 1). At surgery, one of the templates was subdivided into two framework components. One of them was the helix and the other was the base plate of the framework. The reverse sides of them were placed on the costal cartilages and were used to directly measure the cartilages that will be harvested. Using basic cartilage carving and assembly techniques, the cartilage framework was created. This framework was matched to the templates appropriately for the result desired (Figure 2).

*2. As a bolster:* After the framework was placed in the skin pocked, suction was applied to the drain and the contours of the new auricle were created. Under sterile conditions, polysiloxane and the catalyzer were mixed at a ratio of 1:1 and then spread on the auricle by covering its entire surface. The material solidified within few minutes and then fixed to the skin by the aid of 4/0 monofilament nylon sutures, with just enough pressure to give the framework both stability and flexibility. Two weeks after the procedure, the material was removed (Figure 3).

*3. Graft fixation and molding of elevated auricle:* At the second stage, after the split-thickness skin graft was applied to the post-auricular area, the material was

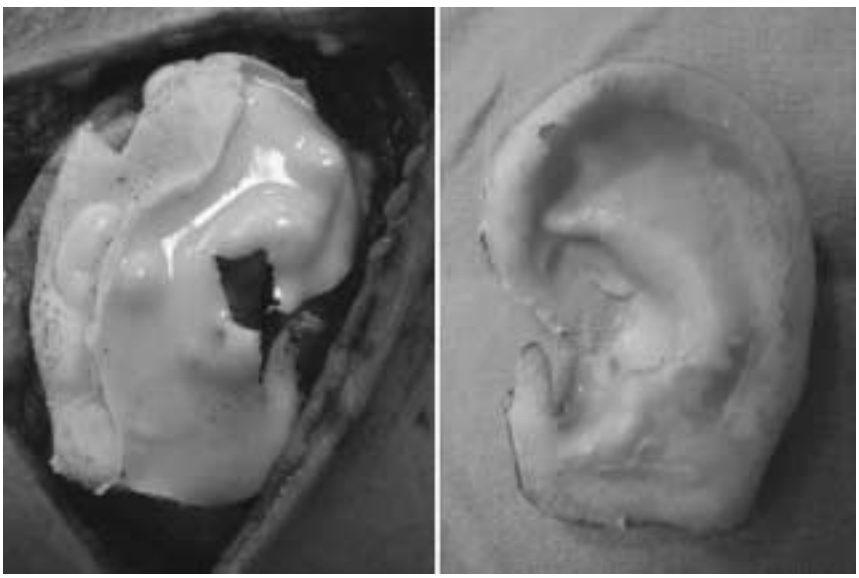

**Figure 1.** A polysiloxane model of the normal ear (right). Reverse side of the model was used to measure the cartilages that will be harvested (left).

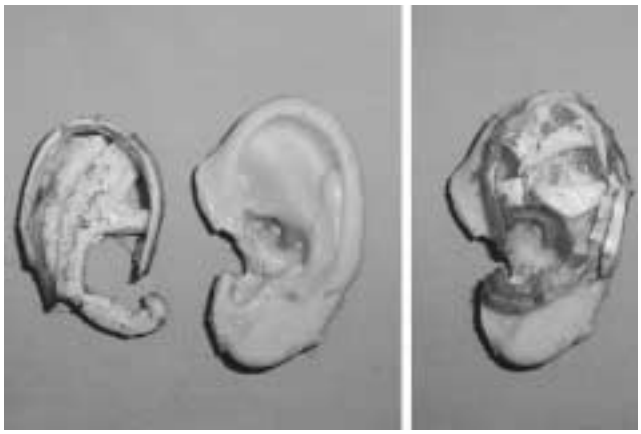

**Figure 2.** The model used as a guide for the assembly of a cartilage framework (left). Comparison of a polysiloxane model with the assembled cartilage framework (right).

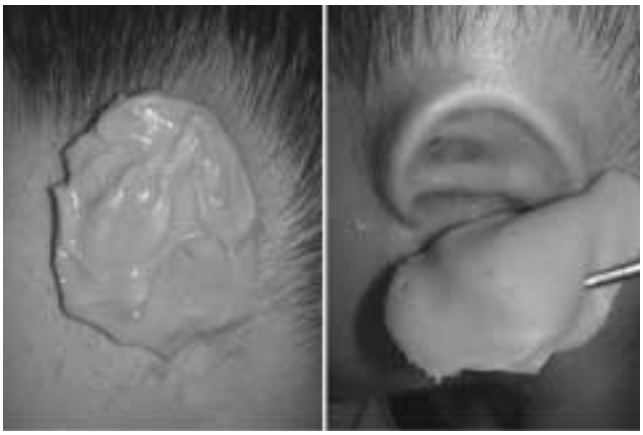

**Figure 3.** Appearance two weeks after the first-stage operation (left). Skin coaptation to the framework was maintained with polysiloxane. Removal of the material from the superior portion of the auricle is demonstrated (right).

spread on the graft surface. Once the material cured, it was fixed to the graft with four or five sutures. Five days after the procedure, dressings were removed.
Polysiloxane was also used for molding process of the post-auricular area to maintain a projection of the auricle during the late post-operative period. It was prepared in the same manner as discussed above and then filled into the post-auricular sulcus. The molds were left in place up to 2 months.

## Results

Polysiloxane was used for four purposes; composing 3-D models, as a bolster dressing, for graft fixation and splinting of the post-auricular sulcus. Overall there was no major complication related to the use of polysiloxane. There was also no sign of hematoma or skin necrosis.

The elasticity of polysiloxane resembles a silicone gel sheet and is highly malleable. As a template, polysiloxane can be easily separated into portions by the aid of a pair of scissors or a blade. The templates that were formed from polysiloxane had been detached into sub components which allowed a direct measurement for cartilage harvest. The advantage obtained in this method by the means of a 1:1 ratio of direct measurement can readily optimize the cartilage amount which shall be harvested. Thus, this method avoids the harvest of excessive amount of rib cartilage. It would also help to avoid wasting any of the valuable harvested costal cartilage, the major source of morbidity in these operations. The time required to fabricate the cartilage framework was less as well. Furthermore, technically fabrication of the framework was easier and more direct with the use of 3-D templates.

Polysiloxane was used as a bolster for close contact between the framework and skin flap. This creates a continuous optimal pressure that promote adherence of the nourishing skin flap to the cartilage sculpture and prevent hematoma or seroma formation.

The results of the total auricular reconstruction were satisfactory (Figures-4 and 5), with no signs of necrosis except in one case. In only one case, skin loss of about 0.50 cm in diameter resulted exposing fabricated costal cartilage on the helical portion. The wound was closed with a preauricular flap.

At the second stage of the reconstruction, polysiloxane was satisfactorily used for graft fixation. On the fifth day, the material was easily removed from the skin grafts. There was no absorbed blood or biologic liquid. Polysiloxane did not adhere to the tissues, so a correct, total and painless removal was performed. There was no graft loss in any of the patients.

Polysiloxane was used as a splint material in order to maintain a projection of the elevated ears up to one month. There was no allergic reaction observed due to

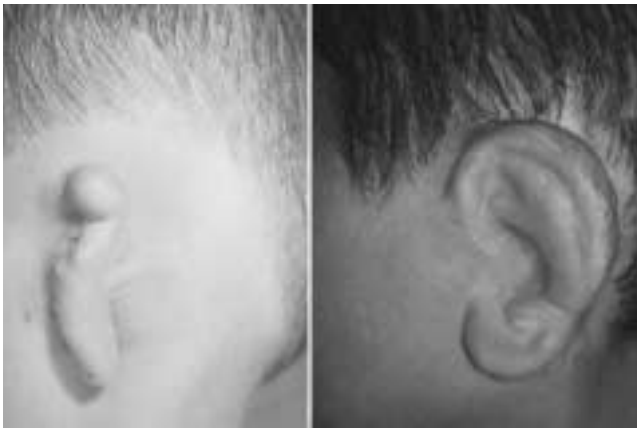

**Figure 4.** Preoperative condition of microtia in a 8-year old boy (unilaterally affected) and result after two stages.

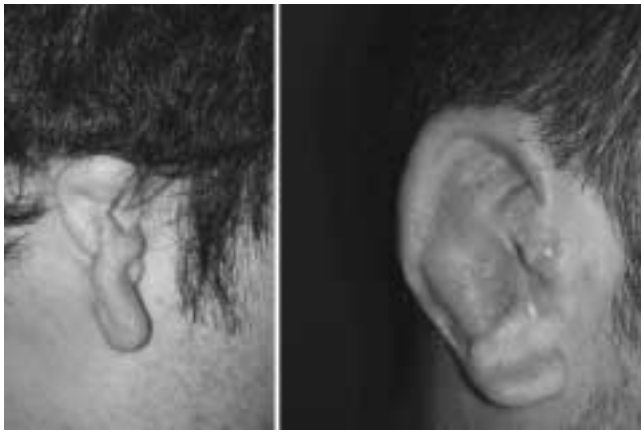

**Figure 5.** Preoperative condition of microtia in a 20-year old male (unilaterally affected) and result after three stages.

the use of polysiloxane. Because of the long-term compliance and elasticity of the mentioned materials, there was no noted sign of decubitus phenomena on splinted structures, whereas the splints kept the ears in the desired position or shapes with better patient tolerance.

## Discussion

The first step of the ear reconstruction is to carve the patient's rib cartilage as a framework which will be implanted under the skin [1-6]. The technical aspects of cartilage carving and fabrication are difficult to master [7]. Often, a template is used by the surgeon to aid in this complicated process. The traditional templates used in auricular reconstruction were 2 dimensional. As proposed by Tanzer, Brent, and others, a normal ear is traced on a sheet of unexposed x-ray paper [2-7]. The use of a 2-dimentional model only provides a rough estimate of the cartilage framework needed. Kelley and Kaneko did use 3-dimentional synthetic templates [7,14]. These models can be used intraoperatively to obtain more accurate cartilaginous auricular framework with utmost satisfaction but the generation of these templates need for complex instruments. Polysiloxane is one of the elastic impression materials, which are also known as ''condensation-cured (condensation-reaction) silicones.'' [9,10]. These products are manufactured in a wide spectrum by different companies and can be obtained easily. Polysiloxane is a low-viscosity liquid and when mixed with a catalyzer (metallic organic ester) it solidifies within a few minutes and transforms into elastic form [15]. In this study we have presented a 3- dimensional template to sidekick the creation of an accurate cartilage framework implant. Using a polysiloxane template as a guide, we found the nuances of cartilage framework fabrication easier and with a less of mystery. Further more, the material is very cost effective than the others.

At the first step of the ear reconstruction, as a bolster dressing polysiloxane minimizes the dead space and prevents the formation of hematoma. Adherence of the skin flap to the cartilage framework is one of the keys to successful auricular reconstruction [3, 4, 8, 16]. In the conventional methods, the bolsters are placed just outside the helical rim then tied with inner bolsters on the scapha and concha using mattress sutures 8. Nagata reported a series of his bolster techniques for total auricular reconstruction. In his method, the overlying skin is fitted to the framework by the conventional bolster suture methods. He takes great care of the compression bolster sutures and checks the bolsters daily over a two week period to prevent any vascular compromise to the overlying skin [17, 18]. The bolsters can cause tension on the skin, impending the blood flow to the overlying skin flap. Fukuda et al reported skin necroses on the helical rim or the conchal portion in 30 of 275 reconstructed auricles [19]. To obtain an accentuated contour, Cronin et al. and Brent

used a continuous suction drainage system instead of bolster sutures to prevent skin necrosis [6, 20]. Otherwise, suction catheters can be obstructed by the coagulation of blood so the system may fail to maintain a negative pressure and to form a secure tight contact between the skin flap and the framework, resulting in a nonetheless and undesirable auricular contour [8, 16]. At the beginning of the process, polysiloxane appears as a liquid with a low consistency. When poured on the new auricular surface, it will immediately take the shape of the surface and fill all the cavities and then will solidify. During the stiffening process, polysiloxane transforms into a three-dimensional shape on the wound surface and specifically allows the pressure to be distributed equally in all directions on the surface [11]. The most important advantage of this method is that the dressing material can be specifically shaped for all type of surfaces by this way, the bolster can be prepared at optimal dimensions and unnecessary bulkiness can be avoided.

At the second stage, polysiloxane was also used for graft fixation and molding of the elevated auricle. Recently, we have also reported that the usage of polysiloxane for the facial graft fixation could be extremely effective [11]. The smooth surface of the material prevents adherence to the underlying graft or eventually absorbs blood or other liquids, so correct, total and painless removal was performed without causing any harm to the graft.

After the newly reconstructed auricle was elevated, auricular projection tends to decrease over a period after several postoperative months. In this study, polysiloxane was also used for splinting of the post-auricular area to maintain to the projection of the auricle (mastoid-helical angle) during the late postoperative period. Ferraro et. al. used similar material for the correction of prominent ear with a new splinting technique [21]. They showed that, as a splinting material, polyvinylsiloxane can be used very effectively and with a better patient compliance. Polysiloxane and polyvinlysiloxane are current dental silicone-based impression materials and they resemble each other in many respect. The only difference between polysiloxane and polyvinlysiloxane is polymerization cascade. In this study, we preferred polysiloxane because it has some advantages such as better elastic properties, good setting time and low cost rate as compared the polyvinlysiloxane [22-24]. In our study we observed that polysiloxane can be used with confidence as a splint material in a long term postoperative period.

In conclusion, total ear reconstruction is multistage, complex and a difficult process requiring considerable experience and dedication to detail. The goal of our study was to use the techniques previously described by others in a more accessible manner. Polysiloxane is highly malleable a plastic material that can be used as an adjunct to obtain better auricular definition and projection.

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