10.5005/jp-journals-10019-1171

REVIEW ARTICLE

Implants for Auricular Prosthesis

[1]K Ramkumar, [2]C Sabarigirinathan, [3]K Vinayagavel, [4]C Gunasekar, [5]M Dhanaraj

ABSTRACT

Implants are wonderful treatment option for auricular defects as it provides a retentive auricular prosthesis. Auricular defects can be rehabilitated by autogenous and prosthodontic methods. Implants provide retention of auricular prosthesis by bar and clip method and magnets. Implant used in craniofacial region differs from the one which is used in the oral cavity. The implants are shorter with flange on the top, which is a unique feature for implants used in craniofacial region. The major challenge in placing the implant is the proximity of various anatomical structures. The implants should be placed 20 mm distance to the center of the external auditory meatus in 8 and 11 o'clock positions for right side of the face and the 1 and 4 o'clock position for left side. Two implants with distance of 15 mm will be sufficient to satisfy the biomechanics. Proper planning and use of implants with retentive aids like magnet, bar, and clip will provide a satisfactory prosthesis.

Keywords: Auricular defects, Craniofacial implants, Ear prosthesis, Implant-supported auricular prosthesis.

How to cite this article: Ramkumar K, Sabarigirinathan C, Vinayagavel K, Gunasekar C, Dhanaraj M. Implants for Auricular Prosthesis. Int J Prosthodont Restor Dent 2017;7(1):25-29.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

The loss of facial structure, such as eye, nose, ear, in an individual influences psychology to a greater level. The cause for the loss of facial structure is due to severe congenital anomalies, accidental trauma, surgical intervention of destructive tumor, or malignancies. The rehabilitation of maxillofacial defect can be done in two ways, such as autogenous and prosthodontic reconstruction. The major problem with artificial prosthesis is by the method of retention it can be achieved – soft tissue undercut, adhesives, and implants to support the prosthesis. This article will focus on implants as a treatment option to retain auricular prosthesis.

[1]Associate Professor, [2]Professor and Head, [3-5]Professor

[1]Department of Dental Surgery, Stanley Medical College Chennai, Tamil Nadu, India

[2,3]Department of Prosthodontics, Tamil Nadu Government Dental College and Hospital, Chennai, Tamil Nadu, India

[4]Department of Dentistry, ESI Hospital and Postgraduate Institute of Medical Sciences and Research, Chennai, Tamil Nadu, India

[5]Department of Prosthodontics, Saveetha Dental College Chennai, Tamil Nadu, India

Corresponding Author: K Ramkumar, Associate Professor Department of Dental Surgery, Stanley Medical College Chennai, Tamil Nadu, India, Phone: +914425281348, e-mail: ram.kamala@gmail.com

HISTORY

In 1977, implants were placed in the mastoid bone to attach bone-anchored hearing aids (BAHAs).[1] In 1979, implants were placed in the mastoid bone to retain an ear prosthesis; this pioneering work was done in Goteborg University Sweden. From late 1970 to 1990, groups from Sweden, the United States, and Canada were working on implant-supported facial prosthesis. In 1980, Tjellstrom published a report on BAHA; in 1981, Tjellstrom described two papers of which one specifically described about implants to retain ear prosthesis, later in 1983 Tjellstrom published 1- to 5-year follow-up on implants used in BAHA and to retain facial prosthesis of which 14 implants were used for BAHA and 44 implants were used to retain facial prosthesis. In 1985, Tjellstrom published 5-year experience on BAHA and implant-retained auricular prosthesis; out of 159 implants placed, 38 were used to retain ear prosthesis. In 1987 Goteborg research group reported implant as a more reliable option to retain auricular prosthesis; the details were total number of patients treated 174 by placing 389 implants of which 103 for BAHA, 49 for ear prosthesis, 18 for orbital prosthesis, 2 nasal prosthesis, 2 for other facial deformity, and overall success rate was 98% out of which 99.7% success in nonirradiated bone and 85.3% in therapeutically irradiated bone.[2]

Tjellstrom after 11 years of his first report in 1980 presented 10 years follow-up; total number of patients in the report was 94 treated for ear prosthesis of which 30 were followed for more than 5 years and 52 followed up for more than 3 years. In earlier period, three to four implants were placed to support auricular prosthesis; this report by Tejellstrom recommends that two implants will be sufficient.[2] Pioneers, such as Parel, Roumanas et al reported their experience on craniofacial implant; the reports were similar to those of the previous authors.[3] The US Food and Drug Administration initiated a study on craniofacial implant conducted by Tolman and Taylor, which was also similar to the previous studies. Tolman and Taylor assessed the quality of life in the patients treated with craniofacial implant; the evaluation was done by a questionnaire survey. The study concludes craniofacial osseointegration provided an important

alternative to conventional reconstructive surgery and demonstrated a significant improvement in quality of life compared with previous retention system for facial prosthesis.[2] On January 13, 1995, the Food and Drug Administration provided clearance to Noble Biocare USA to market Branenmark craniofacial implant system after which many other companies manufacture and market implant for craniofacial prosthesis.

Auricular Defect Treatment Options

Reconstruction of auricular defect can be done in two ways: Autogenous reconstruction and prosthodontic rehabilitation. The indication, advantages, and disadvantages of autogenous ear reconstruction and osseointegrated ear reconstruction are given in Tables 1 to 4.[4] The treatment planning is usually decided by the surgeon to whom patient seeks the treatment; plastic surgery favors autogenous reconstruction, whereas otolaryngology and oral maxillofacial surgery will prefer osseointegrated prosthetic reconstruction. The success of the reconstruction depends on the final form and projection of the reconstructed ear. In situations which demand prosthodontics rehabilitation if attempted by surgical reconstruction, the compromise is on the final result and vice versa. Team work and good cooperation between the autogenous reconstruction group and osseointegrated group will result in pleasing final result, which will boost the confidence and psychology of the patient.

Table 1: Indications for autogenous ear reconstruction

Classic microtia
Lower third of ear intact
Patient preference
Less compliant patient

Table 2: Indications for osseointegrated alloplastic reconstruction

Major cancer resection
Radiotherapy
Absence of lower half of the ear
Severely compromised tissue
Patient preference
Failed autogenous reconstruction
Potential craniofacial anomaly
Poor operative risk
Microtia (controversial)

Implant in Auricular Prosthesis

Rehabilitation in craniofacial and intraoral situation differs in many aspects, the difference in oral and craniofacial rehabilitation is listed in Table 5.[5] The anatomical variation dictates the variation in the design of implant used in craniofacial reconstruction. The available craniofacial bone is between 3 and 4 mm, because of the close proximity to the anatomical structure, the length is lesser when compared with the intraoral implant. Another feature is that the implant will have

Table 3: Advantages and disadvantages of osseointegrated implant ear reconstruction

Advantages	*Disadvantages*
Surgical procedure is short and straightforward and can be done in outpatient basis	Daily care of the implant sites, regular maintenance visit, and replacement of the prosthesis make the osseointegration team and patient lifelong partners
Pain and potential morbidity are less	Alteration of lifestyle, limitation of body contact sport, and removal of prosthesis at night and in certain water sports
In older patients with calcified costal cartilage autogenous framework reconstruction is difficult	Unrealistic expectations may contraindicate an osseointegrated implant approach
The prosthesis will have similarity in the form and projection when compared with autogenous reconstruction	Maxillofacial prosthetic skills are necessary for planning and completing an osseointegrated approach
If the results are not satisfactory, new prosthesis can be made	Needs a team approach (surgeon + maxillofacial prosthodontist or anaplastologist)
Removal of ear remnant during osseointegrated surgery converts the area to anotia with superimposed scar. This severely compromise future autogenous reconstruction	

Table 4: Advantages and disadvantages of autogenous reconstruction

Advantages	*Disadvantages*
Reconstruction by using patients' own tissue	Longer surgical procedure
It produces stable long-term result with no maintenance, little risk of late complication, and minimal alteration in lifestyle	Final reconstruction may be esthetically pleasing; it is anatomically less similar to normal opposite ear than sculpted prosthetic ear
Reconstruction becomes part of self and has been shown to grow with age	

Table 5: Differences between oral and craniofacial rehabilitation

Oral cavity jaw bone	*Craniofacial extraoral environment*
Saliva	Air exposure
Oral microflora	Skin microflora
Mucosal covering	Skin covering
Teeth, plaque	Keratin, sebum, sweat, hair
Increased bone volume	Typical reduced bone volume
More standardized anatomy	Highly variable local anatomy
Longer implant length	Shorter implant length
Higher loading force	Reduced load demands
Majority of patients nonirradiated	Higher incidence of radiation therapy
10 Varying esthetic demands of prosthesis with emphasis on function	Highly dependent on esthetics

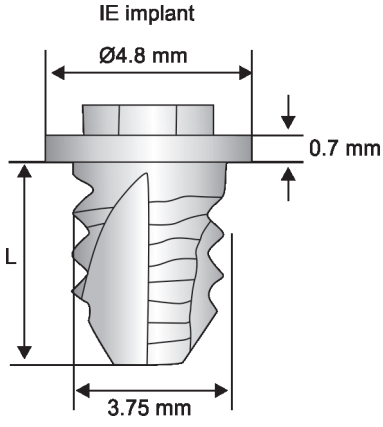

Fig. 1: Solitary implant (root form implant)

a flange at the top as shown in Figure 1, which prevents accidental perforation of implant through thin bone sites that may be encountered in the craniofacial anatomy.[6] The thread design for the shorter implant is reverse buttress because it can resist pull-out and push-out force in a better way.[7]

Location for Placing the Implant

The position of implant decides the final esthetic result. The implants should be placed 20 mm distance to the center of the external auditory meatus in 8 and 11 o'clock positions for right side of the face and the 1 and 4 o'clock position for left side.[8] With correct position of implant 20 mm from the ear canal and 15 mm between the implant, the prosthesis support bar will be underneath the helix. In certain situations like poor bone quality or insufficient bone volume, implants will be located less or more than 20 mm from the external ear canal.[8] Implants when located less than 20 mm, the final prosthetic ear will have shallow concha. When implants are located more than 25 mm, then the acrylic plate will have to be fabricated with an extension so that prosthetic ear can be positioned correctly.[8]

Number of Implants

In the early days of implant-retained auricular prosthesis, three implants were placed; finally, it was concluded that two implants will be sufficient. Tjellstrom et al recommended that two well-spaced implants 15 mm apart are adequate for an auricular prosthesis.[2]

Biomechanics of Two and Three Implants

Biomechanical loading in implant can be studied by numerical methods like seesaw model, Skalak model, Skalak, Brunski, Mendelson (SBM) model, Morgan and James model (MJ), Brunski and Harely model (BH), and by finite element analysis.[6] The details of the various model are given in Table 6.

Skalak or BH model for auricular cases with two implants connected by bar was made. Loads are applied on the bar, implant, and tested in numerical way. A test load of 10 N is applied in negative Y direction at a

Table 6: Details of various biomechanical model

Name of the model	*Author*	*Nature of load*	*Application*
Seesaw	Ranger et al	Only force, no moment	Simple to predict when two implants are used
Skalak	Skalak (1983)	Only force, no moment	Completely edentulous state, this model can be used
SBM model	1993	Force and moment in all directions	It allows for different axial stiffness among the abutments while still assuming ball and socket joints, not the bridge abutment connection
MJ model	1995	Moment as well as vertical and horizontal loads	
Brunski and Harely	1995	Features of SBM and MJ model	

particular point in the framework (10 N is used only as nominal test load because no data are available on actual forces on this type of prosthesis). Both the implants were loaded in X and Y component of force. The Y component of force on implant 2 is slightly more than on implant 1, whereas the X component is equal. The X component is kept equal because the force of 10 N will produce clockwise and counterclockwise moment, which will be easily nullified. Two implant when used for auricular prosthesis the moment, the moment of the implant could be large as 10 N × 1 cm = 10 N cm, which is about 25% of mean torque out failure for implant in mastoid bone as reported by Tjellstrom. However, 10 N direction shows that the sense of moment would actually tend to tighten the implant in bone.[6]

In Skalak or BH model connected for auricular case with three implants and load of 10 N test load applied on the horizontal plane, there are no moments predicted about the axis of any implant. The two implants in the middle implant arrangement do not see any X component force; this is because implants at positions 1 and 3 together supply counterbalance couple moment of framework.[6]

Retention System in Implant-retained Auricular Prosthesis

Bergstrom description for making bar and clip superstructure states that 0.2 mm gold bar should be used and it should be positioned under the antihelix of the ear. The cantilever should not extend more than 8 to 10 mm beyond the abutment; when the distance is greater than 8 to 10 mm from the distal abutment greater bending moment applied to the implant can compromise the long-term success.[8] Bar and clip provide the highest retention than magnetic system; number of clips or magnet does influence initial retention and final retention capacity. Bar and clip system showed an increase in tensile strength after some insertion and removal cycles. This increase in retention occurs as a result of activation of elastic memory of the material used in manufacturing clips. Bar and clip attachment prostheses are more difficult to insert than magnet-retained prosthesis because of limited visual access. In patients with little manual skills, the magnetic attraction facilitates the correct positioning of auricular prosthesis. Physical activity and sports demand better retention for safety, thus bar and clip attachment may be better for active patient. The comparison is shown in Table 7.

Table 7: Comparison of bar and clip and magnetic retention

Bar and clip	*Magnet*
Difficult to insert and remove; need some training initially	Easy to insert and remove
Difficult for the patient to maintain the hygiene	Easy to maintain the hygiene because of easy access to the abutment
Retention is more	Retention is less
Long-term use of the prosthesis, retention decreases	Longer and more predictable level of retention
Difficult in fabrication	Easy fabrication
Longer appointment	Lesser appointment
Two implants will be sufficient when bar and clip is used	Three implants in tripod fashion needed for better stabilization
Patient in sports activity more retention which is possible in bar and clip	Patient with little manual skills or feel easy with magnet

Commercially Available Implants for Auricular Prosthesis

Implant used for retention of auricular prosthesis is classified into solitary implant and collective implant. The implant of solitary type is shown in Figure 1; it can be noted that the presence of flange at the top makes difference from the one used in intraoral situation. The drills used for the extraoral implant are shown in Figure 2,

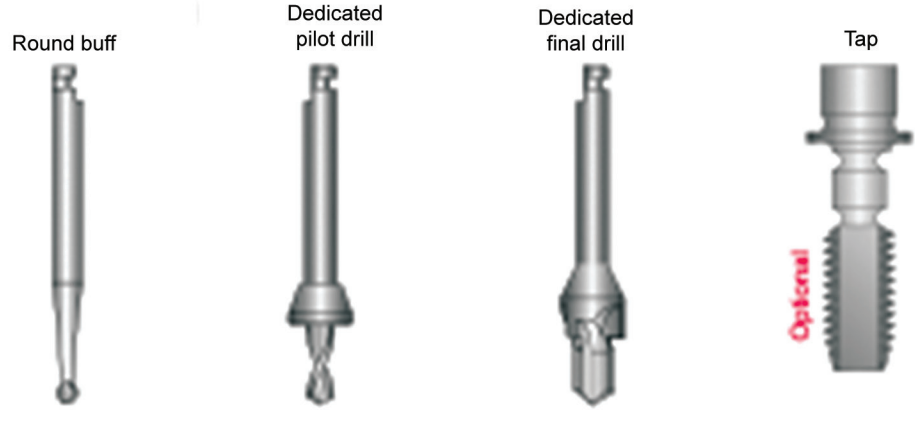

Fig. 2: Drills for extraoral implant

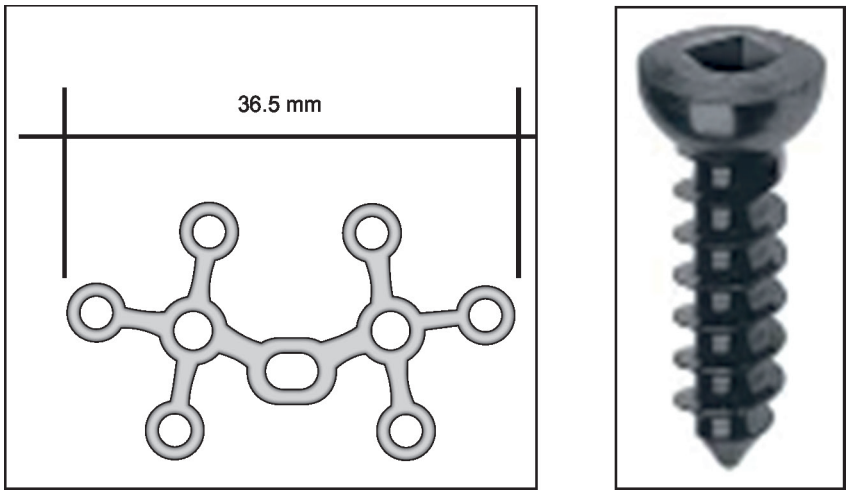

Fig. 3: Epiplates and screws for grouped implant

which has a initial round drill followed by countersink drill. There are various manufacturers, such as Nobel Biocare, Strauman, and Southern Implant who manufacture the root form of implant.

Collective implant is a plate form of implant shown in Figure 3; it is also known as epiplates. This type of implant is used for implant-retained nasal prosthesis, orbital prosthesis, and ear prosthesis. Epiplates differ from the root form of implant in the distribution of forces and are more suitable for the areas which have less quality of bone; prosthesis made from this will be mostly retained by magnet. Medicon is the company which manufactures titanium miniplate system for osseointegrated bone anchorage of craniofacial prosthesis.

CONCLUSION

Implant-retained auricular prosthesis is the best treatment option in the rehabilitation of auricular defects, and it restores the loss with better retention, without the use of adhesives and mechanical device like spectacles. Cases with ear defects generally approach plastic surgeons for the correction; surgeons should decide which can be taken for autogenous correction and alloplastic reconstruction. Referring the case to a maxillofacial prosthodontist which needs alloplastic reconstruction will provide more retentive and natural-looking artificial ear prosthesis to the patient.

REFERENCES

1. Granström G. Craniofacial osseointegration. Oral Dis 2007 May;13(3):261-269.
2. Wolfaordt, J.; Tjellstrom, A. International prospective on treatment outcome. In: Osseointegration in craniofacial reconstruction. Chicago (IL): Quintessence; 1998. p. 68-73.
3. Parel SM, Tjellström A. The United States and Swedish experience with osseointegration and facial prostheses. Int J Oral Maxillofac Implants 1991 Spring;6(1):75-79.
4. Wikes, GH.; Wolfaardt, J. Auricular defects treatment options. In: Osseointegration in craniofacial reconstruction. Chicago (IL): Quintessence; 1980. p. 144-149.
5. Eckert, SE.; Desjardins, RP. Prosthetic considerations. In: Osseointegration in craniofacial reconstruction. Chicago (IL): Quintessence; 1980. p. 113.
6. Brunski, JB.; Skalak, R. Biomechanical considerations for craniofacial implants. In: Osseointegration in craniofacial reconstruction. Chicago (IL): Quintessence; 1980. p. 15-34.
7. Lovely M. Desgin and development of an implant system for auricular prosthesis. Trends Biomater Artif Organs 2010;24(1):11-18.
8. De Oliveria, MF. Auricular prosthesis. In: Osseointegration in craniofacial reconstruction. Chicago (IL): Quintessence; 1980. p. 213-216.