Avenues for rehabilitation of auricular defects

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ABSTRACT

Irrespective of the cause, abnormalities in shape, size, and position of body organs are often perceived as looking wrong. This perception can subject the individual to significant peer ridicule and social ostracism. Rehabilitation of patients with auricular defects can either be done by reconstructive surgery or by prosthetic means. The article draws a comparison between the implant-supported prosthesis and reconstructive surgery, listing the benefits, limitations, indications and contraindications of both the techniques. As both the available techniques give excellent results in appropriately selected situations, the restorative team must present all the alternatives to the patient and choose judiciously the better of the two.

Key words: Auricular defects, ear, implant, prosthesis, reconstruction

Tumor resection, congenital malformations, trauma, inflammation and burn injuries are the common causes of auricular defects.[1-6] Such abnormalities can subject the individual to social ostracism and ridicule, thus resulting in low self-esteem. Treatment options for such patients can be either surgical (autogenous reconstruction)[2,5,7,8] or prosthetic (acrylic or silicone retained by adhesives or mechanically) or combined (implant-supported prosthesis).[4,9]

Autogenous reconstruction can be performed by following either Brent’s four-staged surgery[10,11] or Nagata’s two-stage[12] or a single-stage surgery depending on the type of defect.[13,14] Autologous costal cartilage is the most reliable source for pinna reconstruction. For situations with insufficient skin, tissue expanders or temporoparietal fascia flap may be used.[10,15]

Criteria for a successful prosthesis include esthetic acceptability, functional performance, biocompatibility, retention longevity and lack of morbidity.[7,16] Retention of prosthesis can be achieved by mechanical means or by adhesives or implants. Mechanical retention may be by way of tissue undercuts or skin tunnels, attachment to spectacles or headband.[16-18] These are unwieldy methods. Use of adhesives was a popular method in the past. However, it has some shortcomings like failure of the adhesive system (e.g. during water sports, sweating), deleterious effects of solvent on the skin (especially if the patient has been subjected to chemotherapy), marginal deterioration and decreased longevity. Good dexterity is required for positioning and placement of prosthesis. Meticulous cleaning is required for long-term performance of the prosthesis. Lastly, many patients do not perceive the prosthesis as a part of their own body and possess a foreign body feeling toward it.[1,3,5,7,16-20]

ROLE OF OSSEOSTINTEGRATED IMPLANT-SUPPORTED PROSTHESIS

The conventional methods of retaining prosthesis have been surpassed in terms of stability and esthetics by the osseointegrated implant-supported prosthesis.[21,22] The history of osseointegrated implants with carefully documented animal experiments[23,24] and corresponding clinical studies[25-27] has documented favorable results using commercially pure titanium.

In early 1960s, Branemark, a Swedish surgeon, was involved in biocompatibility research and came up with the concept of osseointegration.[3,7,16,25] Osseointegration implies that there is no intervening connective tissue, but the bone is directly in contact with the implant.[25] The application of this biotechnology in maxillofacial region is an extension of intraoral implants.[16,17,25,27] Preliminary experience of the use of this technique in facial prosthesis restoration has been encouraging with long-term success being reported by several authors.[1,2,25,28-33] This method has thus been hailed...
as the most significant advancement in the field of facial prosthesis in the past 30 years.

While following the technique for implant-supported prosthesis, diagnosis and treatment planning must be done keeping in mind the position, size and orientation of the prosthesis. Prospective location of implants should be at 2 o’clock and 4 o’clock positions on the left-hand side and at 8 o’clock and 10 o’clock positions on the right-hand side, from a line joining the external auditory meatus and the outer canthus of the eyes. If external auditory meatus is not clearly located, then it is marked 10 mm posterior to the head of condyle in resting position. A distance of 10–12 mm must be between two fixtures. A wax prototype should then be made with the size and location as would be followed in final prosthesis. Also, this prototype must be such that the implant fixtures are located in its thickest portion (antihelix) so as to conceal the attachment apparatus and also to provide adequate space to the apparatus. Once the implant positions are finalized, a computed tomographic scan should be made with radioopaque markers at the prospective site, so as to determine the available bone and the vital structures in the vicinity.

After diagnosis and planning (Figure 1), the implant fixtures are placed at the proposed sites at the first stage surgery (Figure 2). Some authors recommend three fixtures while others recommend two.[1] Two implants may produce a long cantilever of the bar substructure, which is detrimental to bone–implant interface. Hence, three fixtures are often recommended if there is greater than 12 mm distance between two fixtures. The fixtures osseointegrate for 3–6 months, during which time a prosthesis retained by conventional methods can be placed. Transmucosal abutments (Figure 3) are placed at the second stage surgery. Some authors have conducted this step at the first stage surgery itself.[16,17] A pressure dressing is placed for 2 weeks to avoid skin movement and resolution of edema.[7] Following this, the abutments are connected by a suprastructure (Figure 4) and prosthesis is fabricated either by hand sculpting or by computer associated designing/computer associated milling (CAD/CAM).[3,34]

The advantage of this procedure is the short duration and straightforward surgery which can be done on outpatient basis and under local anesthesia, thus being useful to patients
with poor operative and anesthetic risk. The suggested time of treatment for a non-irradiated patient is 3 months from first stage surgery and abutment connection followed by 3–6 weeks for peri-implant healing. The prosthesis can be fabricated within 1–2 weeks time. For an irradiated patient, time duration can be approximately 13 months depending on radiation and hyperbaric oxygen therapy. The prosthetic construction has a greater similarity of form, color and projection compared to autogenous reconstruction. A remake is also possible in case of unsatisfactory esthetics or damage, in order to overcome the shortcomings. The technique is less demanding of the surgeon, and so this procedure can become more widely available than autogenous reconstruction if there is suitable prosthetic laboratory support.\[16,34\]

The chief shortcomings of the procedure are the requirement of significant ongoing commitment from both the care provider and the patient.\[5,16,34\] Regular daily aftercare includes mechanical debridement with an interdental brush, irrigation with soap and water or hydrogen peroxide.\[1\] This reduces the soft tissue complications. This can further be augmented by removal of tissue tags and thinning of the flap during the surgical procedure of implant placement or at second stage surgery. As the region is converted to anotia with superimposed scar during surgery, the site is potentially a challenge for autogenous reconstruction, if planned at a later date.\[16\]

Regular follow-up for peri-implant skin assessment and evaluation of state of prosthesis is required by the caregiver.\[16,34\] Average life span of prosthesis is reported to be 1.5–2 years.\[3,33,36\] The most common cause of deterioration is discoloration due to bleaching by sun, sea, use of intrinsic colors and bacterial and fungal microflora.\[5\]

The attachment apparatus can be either paired magnets, bar and clip system or ball and stud system. The clip type of attachments provide excellent retention in region of bar but limited marginal stability for large restorations. They are also space occupying, hence provide less space for prosthesis. Cleaning around implants is difficult in case of bar and clip. The clips may be subjected to damage/deterioration, hence causing dislodgement of prosthesis.\[3,16,17,37\] Paired magnets are low-profile retentive units that minimize esthetic surface compromise and permit better peri-implant health and hygiene.

Alteration of lifestyle of the patients is recommended in some conditions like during contact sports (fear of damage to bar suprastructure or immense forces on implants during injuries) or removal of prosthesis during water sports (chances of deterioration due to discoloration).\[16\]

Technically, meticulous maxillofacial prosthetic skills are necessary for planning and subsequent prosthesis construction, making team approach mandatory, compared to autogenous reconstruction, where the surgeon can function independently.\[16\]

Immediate concerns with regard to the use of these implants in children are proximity to vital organs and interference with growth.\[16\] This is especially of concern in children with craniofacial anomaly due to an aberrant course of facial nerve, low middle cranial fossa and small mastoid process, thinner and softer temporal bone causing increased risk of disruptive injury.\[16,34\] Tjellström reported 12% contact with duramater and injury to sigmoid sinus in 12% of cases, and mastoid cells were seen in another 25% children.\[38,39\] With regard to growth, placement of implant in areas of bone resorption may decrease the functional life of implant during active growth. Long-term stability is further compromised at puberty when mastoid air cells undergo their maximum development.\[34\] The last concern of using implants in children is the psychological impact.\[40\] It is recommended to wait till the patient is mature enough to comprehend the pros and cons of all treatment options prior to undergoing any treatment.

Lastly, though the esthetics is superb with the prosthesis, the prosthesis construction may be a challenge because of a number of design factors, e.g. the tracking movement of condyle poses fitting discrepancy in anterior border of prosthesis for which a functional impression is recommended. Also, difference in reflectance between skin and the silicone makes photographic recording problematic.\[16\]

The major indication of osseointegrated implant-supported ear reconstruction is loss of the ear following major cancer resection, especially in cases with radiotherapy and compromised local tissue. This is due to the fact that the prosthesis can easily be removed and the site can be re-examined for early detection of recurrence. This is not possible in autogenous reconstruction where the tumor is covered by thick layer of soft tissue.\[9,16,24\] Also, lesser tissue undermining during implant placement surgery than during surgical reconstruction promises less risk in areas which are compromised by radiotherapy. Although radiotherapy decreases the success of individual fixture osseointegration, this is subject to radiation status and also to the hyperbaric oxygen therapy.\[3,16,31,34,41-43\] Patient preference, poor local tissue, failed autogenous reconstruction, extensive defects requiring complex external prosthesis, patients with significant craniofacial anomalies in whom site of ear placement (by autogenous reconstruction) would be difficult to predict on the basis of growth and potential surgical alteration of the area are the other indications for implant-supported prosthesis.\[16,20,29,34\]

The technique is less ideal if patients do not appear to have an understanding or commitment needed for this form of rehabilitation and in patients with poor manual dexterity or with unrealistic expectations.\[7,16\]
ALTERNATE TO PROSTHESIS: AUTOGENOUS RECONSTRUCTION

With the pioneering work by Tanzer,[16] Brent,[10,11] Kirkham[44] and others, [45-48] great advances in ear reconstruction with autogenous tissue reconstruction technique have been made. Though an improvement and consistency has been gained and reported by many over the time,[12,16,45,49,50] this is a technically demanding technique not easily applicable to all types of auricular defects and not readily available at all places.[16]

The major advantage of this technique is that patient perceives the ear as "self." Daily removal and replacement is also not required, thus demanding less commitment by the patient unlike implant-supported prosthesis.[16,34] Since patient’s own tissue is used, it is less prone to rejection of tissue. Also, this method has the likelihood of a stable, long-term success with little ongoing maintenance and less chance of complications. It has been reported that the framework may actually grow with age.[51] Elaborate laboratory support for fabrication like that needed for prosthesis is not required. No significant continued costs are incurred like that of prosthesis remake.[16,34]

The major disadvantage of this technique is the long duration of surgical procedure. This is especially associated with temporoparietal fascial flap[10] and soft tissue expanders.[48,52] There is also significantly greater surgical morbidity including rib resection, pain and scarring at several donor and recipient operating sites.[16,34] The final reconstructed ear is less similar to normal opposite ear than a sculpted prosthesis.[44] Unfavorable results include blunted convolution of the reconstructed ear (because of thick fibrous tissue), resorption of cartilage by infection, deformation of the constructed helix, less projection of the elevated ear, and hypertrophic scars.[16] The overall cost of surgery is greater than that in implant prosthesis, though no maintenance cost is required.

The relative deficiency of thin skin for coverage of the coastal cartilage framework remains a limiting factor. The use of tissue expander in the mastoid area solves the deficiency of the skin and improves cartilaginous framework by offering a non–hair-bearing, thin, well-vascularized skin to envelope an erect, contour-accentuated framework.[48]

Major indications are classical microtia with no prior surgery or in the presence of extensive cartilage and soft tissue.[7,16] Like when defect is such that lower one-third of ear is intact.[10] Some authors also recommend that if both treatment methods are available, this is the preferred treatment of choice.[16] It is also advised to carry out this procedure in a patient with poor compliance for prosthesis as less long-term co-operation is needed.[7,17]

NEWER AVENUES FOR MANAGEMENT OF AURICULAR DEFECTS

Among the newer avenues for rehabilitation of microtia is tissue engineering. This is the science in which a group of high density of functional dissociated cells are seeded onto synthetic biocompatible, biodegradable polymers, which are then transplanted into the animal model for generation of functional tissue.[53-55] The Harvard-MIT research group has brought significant attention in this area with their accomplishments.[56,57]

CONCLUSION

The success rate of osseointegrated titanium implants in mastoid region is reported to be between 98.4%[16,41] and 100%.[1,30-33] This can be attributed to the high density of bone in mastoid region making it easy to stabilize the implant at surgery. Also, the vasculature in this region ensures the maintenance of a bone–implant interface adequate to support functional loads.[1,38,58] However, osseointegrated implant-supported prosthesis is a viable reconstructive option which should complement and not threaten autogenous reconstruction.[16] Both the available techniques give excellent results in appropriately selected situations. Thus, it is the onus of the restorative team to present all the alternatives to the patient and choose judiciously the better of the two.

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