ISSN Print: 2394-7489
ISSN Online: 2394-7497
IJADS 2020; 6(3): 01-06

www.oraljournal.com
Received: 01-05-2020
Accepted: 03-06-2020

Dr. Anisha Rajani
Post-Graduate Student, Department of Prosthodontic, D Y Patil University School of Dentistry, Navi Mumbai, Maharashtra, India

Dr Gaurang Mistry
Head of Department, Department of Prosthodontic, D Y Patil University School of Dentistry, Navi Mumbai, Maharashtra, India

Dr Charushila Sardar
Professor, Department of Prosthodontic, D Y Patil University School of Dentistry, Navi Mumbai, Maharashtra, India

Dr Ashwini Kini
Reader/Associate Professor, Department of Prosthodontic, D Y Patil University School of Dentistry, Navi Mumbai, Maharashtra, India

Correspondence
Dr. Anisha Rajani
Post-Graduate Student, Department of Prosthodontic, D Y Patil University School of Dentistry, Navi Mumbai, Maharashtra, India

Rekindle maxillofacial prosthesis with extra oral implants as retention system

Dr. Anisha Rajani, Dr. Gaurang Mistry, Dr. Charushila Sardar and Dr. Ashwini Kini

Abstract
Maxillofacial defects have always lead to significant deterioration in a patient's quality of life leading to emotional burden requiring rehabilitation. The use of craniofacial implants is an effective treatment to offer the potential improvement in quality of life of patients with such deformities.
Brane mark succeeded in 1950s in discovering that titanium was made suitable for implants through the concept of Osseo integration. The rehabilitation of extra oral defects with implant retained prosthesis became important with the development of modern silicones and bone anchorage. With the evolution of Osseo integrated implants in maxillofacial prosthetic, rehabilitative procedures have greatly changed, as conventional methods are usually associated with patient's distress. These Implants have improved the Retention, stability and aesthetics and helped in reducing the problems by other retentive methods. Extra oral implants are currently used in oncology and trauma patients with intraoral soft and hard tissue defects with more pleasing aesthetics and more functional prosthesis. This article outlines the important features of extra-oral implant ology in maxillofacial prosthesis.

Keywords: Osseo integration, implant, maxillofacial prosthesis, extra-oral implantology

Introduction
Maxillofacial Prosthodontics is defined as, "The branch of Prosthodontics concerned with the restoration and replacement of the stomatognathic system and associated facial structures with prosthesis that may or may not be removed on a regular or elective basis [1]. Dr. Per Invar Branemark who coined the term Osseo integration has revolutionized the treatment of congenital, surgical, or traumatic soft tissue and bone defects. It has improved restoration in terms of retention and stability. End osseous titanium implants may be successfully placed in previously irradiated bone to secure maxillofacial prostheses. The most common retentive methods for maxillofacial defects include chemical method of retention using adhesives and surgical method of using implants.
Implants have reduced the need for adhesive use which helps in denigrating the disadvantages of adhesives simplifying cleaning procedures and thus extending the life of the prostheses. The use of craniofacial implants for retention of extra oral prostheses along with thorough evaluation and clinical judgement increases retentive abilities and improves a patient's appearance and quality of life. Implant-retained prostheses have provided patients the opportunity to participate in routine activities much better than other retentive methods of prosthesis leading to enhanced patient acceptance. The implants impact on patient has resulted in their ability to function in society with confidence as their defects will be less noticeable. The improvement of the possibilities of osseous anchorage of the epithesis by implants permit to reconstruct kind of complex facial wounds with restoration of oral function and with a good morphologic result.

Indications for bone-anchored prostheses [2].
- In case of high chances of recurrence of tumor where aftercare is necessary.
- In cases where skin is damaged after radiation
- Poor general condition.
- During individual stages in plastic reconstructive surgery (interim prosthesis).
- After failed reconstructive procedures.

- Patient rejection for constructive procedures.
- When aesthetic demands are high

Bone Anchorage-Osseo integration

Branemark in 1950s succeeded in discovering that titanium possesses an exceedingly high bio-compatibility in bones. He coined the term "Osseo integration" [3]. This term was originally defined as direct contact between implant and bone [4]. It was unclear, however, whether 100% bone contact was necessary for successful Osseo integration [5]. In fact in the case of clinically successful implants a titanium-bone contact of on average only 70–80% was found [6]. It was found that there is a 20–500 nm wide amorphous gap between titanium and bone which is filled with collagens and calcified tissue under electron microscopic level.[7] Also the definition offered no guidance on deciding whether an implant was clinically Osseo integrated or not. Instead Zarb and Albrektsson [8] provided the following compact definition. "Osseo integration is a process whereby clinically asymptomatic rigid fixation of alloplastic materials is achieved, and maintained, in bone during functional loading." Osseo integration in previous times was contraindicated in irradiated bone leading to implant failures in such cases. However use of adjunctive hyperbaric oxygen therapy have shown to be effective in such cases.[9]

Albrektsson *et al*. named the following 6 important factors for the long-term stability of the implant to obtain Osseo integration [4].

- Biocompatibility of the material: for instance titanium is more commonly used as it integrates in the bone for many decades without causing any ill effects. Other material such as aluminium hydroxide, vanadium, certain ceramics, hydroxyapatite can also be used to certain extent.
- Implant design.
- Implant surface: the microstructure of implant affects Osseo integration as a rough surface implant will result in better Osseo integration than a smooth surface [10].
- Condition of the recipient area: if implant is installed in a child the bone might be immature and soft whereas in an elderly osteoporosis may affect the integration of implant in the bone [11].
- Surgical technique plays an important part too as it should be non traumatic. The surgical field should be protected from powders, fibres and other substances that may affect Osseo integration [12].

Biomechanical Considerations of Implants in Maxillofacial Prosthesis

a) Design of craniofacial implant

Intraoral implants have been designed in a vast array of different sizes, shapes and biomaterials. With craniofacial implant, one difference is that craniofacial bone site is thinner comparatively as in intra oral bone site. The effective implant length in craniofacial sites is often only 3-4 mm. Craniofacial implants are provided with a flange above the threaded portion to provide primary stability. The flange also helps in prevention of perforation through thin bone sites as well as prevents tilting of the implant due to lateral forces. (Fig. 1)

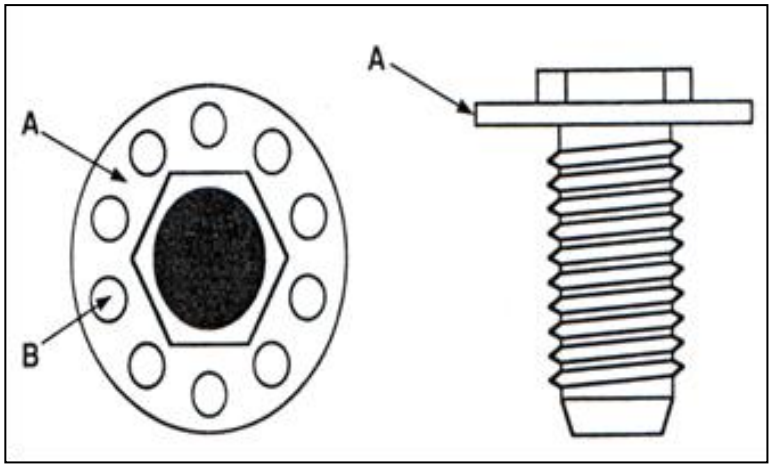

Fig 1: Craniofacial Implant: A – Peripheral flange, B- Perforations

b) Stress Transfer from implants to bone

A critical aspect affecting the success or failure of an implant is the manner in which mechanical stresses are transferred from implant to bone. It is essential that neither implant nor bone be stressed beyond the long term fatigue capacity. These requirements are met by Osseo integrated implants by virtue of the close apposition of the bone to the implant at angstrom level.

An Osseo integrated implant in the form of a screw is able to transmit an axial tensile or compressive load to the surrounding bone, primarily by compression on the inclined faces of the screw.

Surface roughness of an implant can also have a beneficial interlocking effect similar to that of screw threads at a microscopic scale.

c) Load distribution to several screws

When prosthesis is supported by several screws, the resulting combined structure forms a unit in which the distribution of any applied load depends on the relative stiffness of the several members involved, as well as geometry of their arrangement.

d) Impact of implant stiffness on stress distribution

Implant should be as stiff as possible from the biomechanical standpoint. The stiffness increased by choosing an implant of greater diameter. If the diameter is increased by 30%, implant stiffness will be five times higher thereby reducing the stresses around implant neck.

e) Impact of the implant shape on stress distribution
Irrespective of the implant shape, implant Osseo integration in the entire bone region, will lead to stress concentrations in the cortical area during vertical and horizontal loading. Implants showing rational symmetry can be considered more favourable as it will lead to uniform stress distribution.

f) Impact of the implant surface on stress distribution
The implant surface should be enlarged by applying threads or by plasma flame spray coating or surface roughening and also by acid etching to reduce compressive forces.

Diagnosis and Treatment Planning
For each patient is proper prosthetic treatment plan is necessary as specific prosthetic interventions are good indicator of success of the prosthesis. A team approach is most conducive for a favourable outcome [13, 14]. Each team comprises of a surgeon, prosthodontist, anaplastologist, radiologist and often specialists like audiologist, pathologist, etc.
The preoperative planning in craniofacial implants requires assessment for each patient as it is a multifactorial process.

- A patient's general health status is to be evaluated prior to planning of surgery.
- Patient's consent and providing complete information to the patient is an essential part of treatment planning for patient motivation. If the patient can meet another patient with similar defect it is helpful in understanding of the planning.
- A CT scan or any other radiographic evaluation is important to look for bone quality and dimensions. Implant planning softwares are to be used for analyzing CT scan recordings to achieve information on ideal implant placement position, umber and angulations [15]. One of the techniques makes use of laser scanning of soft tissues overlying in an area along with the emergence profile. Watson 1993. Rapid prototyping along with stereo lithography has also been used in recent types in such defects. Acrylic model for implant positioning is also used [14].
- Various contraindications for the treatment are to be evaluated which involves patient's inability of aftercare.
- Facial moulage impressions are made for diagnostic purposes. Fabrication of diagnostic casts, wax trial prostheses are made after evaluation of presurgical photographs, presurgical casts, contralateral anatomy, and estimation of normal anatomic forms to assess potential areas for prosthesis retention.

Extra Oral Implant Systems
The classic Branemark systems are "solitary implants" and "grouped implants".

1) Extra oral system with solitary implants: Branemark System, ITI Systems and others systems with Solitary implants.
2) Extra oral grouped implants: Epitec system, epiplating system

Fig 2: Solitary and grouped implants

Surgical Implantation
The surgical technique follows the basic principles as from the Branemark technique involving two stage techniques. Surgery is performed under local anaesthesia except for children which is under General anaesthesia. The two stage technique involves bone drilling with placement of implant and secondly with a gap of 3 months consisting of soft tissue reduction as thick skin will result in adverse skin reaction [16] and achieving a hair free surrounding skin and insertion of percutaneous abutment. One stage approach is also described in mastoid area [17].
However, it is better to advocate two stage procedures in patients with orbit, midface applications and irradiated patients [18].
The drill speed is to be kept low along with profound irrigation at around 1500- 2000 r.p.m. after the implant site is drilled, the drilling speed can be reduced to 15 r.p.m for installing the fixture. Self-tapping can also be used whenever possible.

Craniofacial Prosthesis Attachment with Implant
Usually a metal bar and clip method is used in which a metal bar is screwed onto the percutaneous implant posts onto which the prosthesis can be clipped. Magnetic connections are now in use as they facilitate hygiene and insertion of prosthesis by the patient [2].

Fig 3: Prosthesis retention with implant- bar and clip, Magnets

Extra Oral Implants in Various Prosthesis

Orbital prosthesis: Replacement of the orbit and its contents may be a predictable procedure. The utilization of multiple acrylic resins custom trays and polyvinyl siloxane impression material allows the correct reproduction of all soft and hard tissue detail and hence the position of the implants. Implants are ideally placed superior and lateral aspect of the rim. In extensive orbital defects, it is placed in zygoma/maxilla. For an orbital defect, the superior, lateral and inferior orbital rims are considered as possible sites for 3 or 4 mm implants. 3 or 4 implants are needed with the long axes of the implants toward the centre of the orbit, to accommodate a one-piece retentive bar. In the periorbital area the lateral rim is more suitable than the superior rim for implantation. The cortical bone in the lateral border is generally thicker than in the superior border, which may determine the difference in success rates [12].

The orbital implant is either made from a nonporous material like silicone and polymethyl methacrylate or a porous material such as porous polyethylene, hydroxyapatite, and aluminium oxide [19]. Nonporous materials are best used for implants that are not to be integrated or pegged, and are well tolerated. Porous materials promote a fibro vascular ingrowth of host tissue, improving stability and lowering the risk of rejection [20]. These implants achieve 65 to 75% of the volume of the original ocular globe [21], and external prosthesis take up the remaining space.

An orbital or ocular prosthesis covers the cavity and underlying implant. Ocular prostheses could be either stock set of prefabricated eyes matched to the patient or custom made [22]. An impression is created from patient's eye socket to make custom made prosthesis which is hand painted to match the contralateral eye [20]. Retention of an orbital prosthesis is typically more successful after Osseo integration.

Nasal prosthesis: Nasal lesions may require a partial or total resection, and are commonly reconstructed with the use of regional flaps. Nasal prosthesis In some cases, may be the best alternative to match and restore the defect with a nose similar in colour, thickness, and texture to the surrounding anatomy. Osseo integration has significantly improved nasal implant retention on account of its tenacity and resilience in the face of dynamic environmental conditions. The implant retention for nasal prosthesis requires two implants, with one implant placed to the left and one to the right of the mid-line. Implants are to be placed in the maxillary & frontal bones. For nasal prosthesis, the anterior surface of the maxilla just inferior to the nasal cavity offers sufficient thickness of bone to place 4 mm implants. Longer implants, 6 mm or greater can also be used. This, however, is dependent on the quantity and quality of the available bone stock [23, 24].

Auricular prosthesis: Diagnostic wax patterns of the ear make it more valuable in determining implant position. Prosthetic replacement may produce anatomically correct and aesthetically pleasing prosthesis that's often difficult to position correctly and successfully retain in situ. Ideally placement of implants should make use of a surgical guide. The positioning of implants is usually related to the anti-helix of the external ear. 2-3 implants are sufficient for satisfactory retention. Ideal position of implants should be 18-20 mm from the middle of the external auditory meatus. The gap between the fixtures should be at least 15 mm. if possible depending on the anatomic situation. BAHA uses the principle of Osseo integration where the sound conduction is made through the bone directly to the internal ear by the position of Ti implant & abutment in mastoid cortex. Maintenance of hair free area around the abutment is imperative. Abutment is along with themechanoelectric transducer system after Osseo integration. Osseointegration for retention of auricular implants is favourable because of high success rate in bone anchoring, even in irradiated patients [25, 26]. Implants are placed in 2-3 locations to lend greater infrastructure support [27]. Placement of such type allows for a sufficiently high space for the abutment to support the prosthesis in correct anatomical position [28]. The bone must be vascularized and thick enough to support the load of the prosthesis [29, 30]. It is important to contemplate that portions of the normal anatomy, like the tragus, are often kept intact to hide the transition from skin to prosthesis.

An auricular prosthesis is easily implemented to provide significant functional and aesthetic benefits. Auricular prostheses help in a clinically relevant acoustic gain at certain head positions and frequencies that aid speech recognition in noise [31].

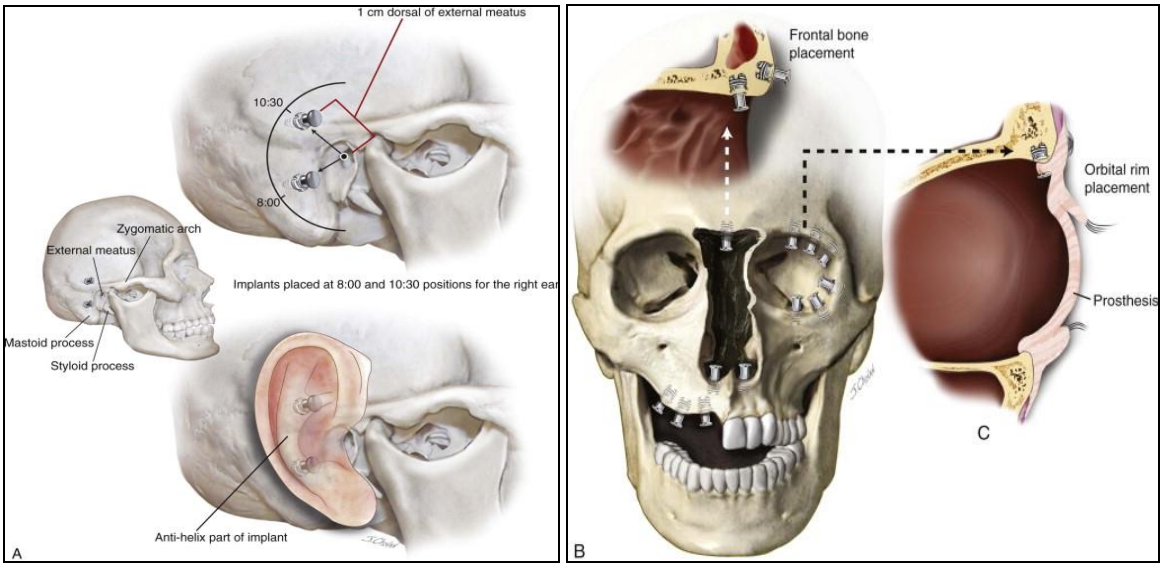

Fig 4: Assesment of implantation sites – A- auricular prosthesis, B- nasal prosthesis, C- orbital prosthesis

Recent Trends in Maxillofacial implants

There are several areas of development that appear important to the future of extra oral Osseo integration and its application to facial prosthetics. The challenge is that the soft tissues do not attach to the percutaneous abutment. Early work has been undertaken to understand how soft tissue attachment to the abutment may be promoted. Advanced manufacturing technologies will also become increasingly important in endeavour of this field. Conventional prototyping, rapid prototyping and image data acquisition systems are seen to likely play an increasingly important role in treatment planning and treatment. Colour matching of facial prosthetic elastomers to skin colour with portable spectrophotometry and computerized colour formulation have been developed and deployed clinically with reported success. Fascinating challenges to the field are provided by robotics in the development of active prostheses. Both blinking and moving eye orbital prostheses have been devised. Many other areas of innovation are under consideration or development but have not yet been brought to clinical application.

Different recent directions for reconstruction patients include

1) Computer design including CAD/CAM technique: The conventional method of making the auricular prosthesis includes impression making, master cast fabrication, wax model sculpting, dewaxing, silicone packing, and coloration. It requires artistic skills and is time consuming. Transformation of 3-dimensional image data to a CAD/CAM system for successive mathematical processing, design simulation, and model production can potentially minimize the time and skill required for sculpting ear prosthesis for patients with defects and provides new perspectives for future maxillofacial prosthodontics.
2) 3D virtual imaging- The goal of a multispectral data visualization system is to provide enhanced diagnosis capabilities for use by the medical practitioner. Several pioneer research groups have already demonstrated improved clinical performance using Virtual Reality imaging, planning and control techniques. Computed tomography (CT) and, more recently, cone-beam computed tomography (CBCT) provide volumetric images of the anatomic structure of a patient's face. These data can be converted into 3D images of a patient's craniofacial skeleton and the soft tissue covering it by using a sequence of computerized mathematical algorithms [32].
3) 3D printing and customized implants - the use of 3Dprinting to customize prosthetics and implants can provide great value for both patients and physicians and can associated with more precise results and less complication.
4) Navigation systems- to find the areas of interest for biopsies, staging, and especially restaging in the deep layers of tongue and floor of mouth, Real time with high accuracy to control resection margins, Documentation of resection margins for further diagnosis and therapy Measurements, planning, and template construction for bone and soft-tissue reconstruction, Assistance in search for suitable vessels, especially for microsurgical secondary reconstructions after primary tumor resection, neck dissection, and radiotherapy. Assistance in CAD/CAM reconstruction of tumour-associated defects [33].

Advantages of Implant Retained Craniofacial Prosthesis

It enhances camouflage.
Cosmetic results are excellent and predictable.
Tumour recurrence can be recognized early.
These are well suited for complex anatomic regions.
The retention is much secured.

Disadvantages of Implant Retained Craniofacial Prosthesis

It is not suited for replacement of anatomic parts which are mobile.
The procedure is expensive.
It must be removed at night.
Prosthesis has to me remade every 2 years.
Discolouration can occur due to smoking.
High after care is needed.

References

1. Anonymous. Glossary of Prosthodontic Terms. J Prosthet Dent. 1999; 81(1):42.
2. Federspil PA. Implant-retained craniofacial prostheses for facial defects. GMS Curr Top Otorhinolaryngol Head Neck Surg. 2009; 8:03.
3. Branemark PI, Hansson BO, Adell R, Breine U, Lindstrom J, Hallen O *et al*. Osseo integrated implants in the treatment of edentulous jaw. Experience from a 10-year period. Scand J Plast Reconstr Surg. 1977; 11:1-175.
4. Albrektsson T, Brånemark PI, Hansson HA, Lindström J. Osseointegrated titanium implants. Requirements for ensuring a long lasting, direct bone-to-implant anchorage in man. Acta Orthop Scand. 1981; 52:155-170.
5. Albrektsson T, Wennerberg A. The impact of oral implants – past and future, 1966-2042. J Can Dent Assoc. 2005; 71:327.
6. Albrektsson T, Eriksson AR, Friberg B, Lekholm U, Lindahl L, Nevins M *et al*. Histologic investigations on 33 retrieved Nobel pharma implants. Clin Mater. 1993; 12:1-9.
7. Albrektsson T, Brånemark PI, Hansson HA, Ivarsson B, Jönsson U. Ultrastructural analysis of the interface zone of titanium and gold implants. Adv Biomaterials. 1982; 4: 167-177.
8. Zarb GA, Albrektsson T. Osseointegation - a requiem for the periodontal ligament? Int J Periodontics Restorative Dent. 1991; 11:88-91.
9. Granstrom G. Hyperbaric oxygen therapy as a stimulator of osseointegration. In: Yanagita N, Nakashima T, eds. Advances in otorhinolaryngology, Karger Publishing Co, 1998, 33-49
10. Albrektsson T, Wennerberg. Oral implant surfaces: Part 1 - review focusing on topographic and chemical properties of different surfaces and *in vivo* responses to them. Int J Prosthodont, 2004, 544-564.
11. Drinias V, Granstrom G, Tjellstrom A. High age at the time of implant installation is correlated to increased loss of Osseo integrated implants in the temporal bone. Clin Oral Implants Rel Res, 2007.
12. Tjellstrom A, Rosenhall U, Lindstro¨m J, Halle´n O, Albrektsson A, Branemark PI *et al*. Five-year experience with skin penetrating bone-anchored implants in the temporal bone. Acta Otolaryngol (Stockh). 1983; 95:568-575.
13. Van Oort RP, Reintsema H, Dijk G, Raghoebar GM, Roodenburg JLN. Indications for extra-oral implantology. J Invest Surg. 1994; 7:275-281.
14. Wolfaardt J, Wilkes G, Granstrom G, Bergstrom K.

Craniofacial reconstructions. In: Branemark P-I, ed. The osseointegration book. From calvarium to calcaneus. Quintessence Publishing Co.: Chicago, IL, 2004, 387-418.
15. Wolfaardt J, Gehl G, Farmand G, Wilkes G. Indications and methods of care for aspects of extra oral osseointegration. Int J Oral Maxillofac Surg. 2003; 32:124-131.
16. Reyes R, Tjellstrom A, Granstrom G. Evaluation of implant losses and skin reactions around extra-oral bone anchored implants: a 0 to 8 year follow-up. Otolaryngol Head Neck Surg. 2000; 122:272-276.
17. Tjellstrom A, Granstrom G. One stage procedure to establish Osseo integration. A zero to five years follow-up report. Am J Otolaryngol. 109:593-598.
18. Granstrom G. Osseointegration in irradiated cancer patients. An analysis with respect to implant failures. J Oral MaxillofacSurg. 2005; 63:579-585.
19. Begum Z, Kola MZ, Joshi P. Analysis of the properties of commercially available silicone elastomers for maxillofacial prostheses. J Dent. 2011; 31(01):67-74.
20. Cafiero-Chin M, Marques C, Danz H. Ocular prosthesis: indications to management. Canad J Optometr. 2015; 77(02):24-33.
21. Hughes MO. A pictorial anatomy of the human eye/anophthalmic socket: a review for ocularists. J Ophthal Prosthet. 2007; 12:51-63.
22. Gunaseelaraj R, Karthikeyan S, Kumar MN, Balamurugan T, Jagadeeshwaran AR. Custom-made ocular prosthesis. J Pharm Bioallied Sci. 2012; 4(02):177-179.
23. Ciocca L, Maremonti P, Bianchi B, Scotti R. Maxillofacial rehabilitation after rhinectomy using two different treatment options: clinical reports. J Oral Rehabil. 2007; 34(04):311-315.
24. Seçilmiş A, Oztürk AN. Nasal prosthesis rehabilitation after partial rhinectomy: a clinical report. Eur J Dent. 2007; 1(02):115-118.
25. Eriksson E, Branemark PI. Osseointegration from the perspective of the plastic surgeon. PlastReconstr Surg. 1994; 93(03):626-637.
26. Black B. Use of titanium in repair of external auditory canal defects. Otol Neurotol. 2009; 30(07):930-935.
27. Wright RF, Zemnick C, Wazen JJ, Asher E. Osseointegrated implants and auricular defects: a case series study. J Prosthodont. 2008; 17(06):468-475.
28. Federspil PA. Implant-retained craniofacial prostheses for facial defects. GMS Curr Top Otorhinolaryngol Head Neck Surg. 2009; 8:Doc03.
29. Giot JP, Labbe D, Soubeyrand E *et al*. Prosthetic reconstruction of the auricle: indications, techniques, and results. Semin Plast Surg. 2011; 25(04):265-272.
30. Mardani MA, Aminian G, Tabatabaian F, Arazpour M, Hutchins SW, Head JS *et al*. A novel technique for fabricating an ear prosthesis in a patient with congenital ear deformity. Prosthet Orthot Int. 2013; 37(04):340-343.
31. Walsh WE, Dougherty B, Reisberg DJ *et al*. The importance of auricular prostheses for speech recognition. Arch Facial Plast Surg. 2008; 10(05):321-328.
32. Marchetti C, Bianchi A, Bassi M, Gori R, Lamberti C *et al*. Mathematical modeling and numerical simulation in maxillofacial virtual surgery (VISU). J Craniofac Surg. 2007; 18:826-832.
33. Sailer HF, Haers PE, Zollikofer CPE *et al*. The value of stereolithographic models for preoperative diagnosis of craniofacial deformities and planning of surgical corrections. Int J Oral Maxillofac Surg. 1998; 27:327-333.