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Review Article

Extra oral implants as retentive aids for maxillofacial prosthesis: A review

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ABSTRACT

Defects or deformities in the head and facial area almost always lead to a severe emotional disturbance. So the restoration of these defects play a vital role in function and cosmetic outcome. Maxillofacial prosthesis has gained importance in the fields of dentistry particularly in the fields of prosthodontic speciality. Although it involves many specialities the prosthetic outcome depends on the cosmetic reconstruction and method of retention. Different retention mechanisms are available, out of which implants have been evolved as the best method of retention with greater level of patient acceptability.

Introduction

Any defect of the face or associated structures may be congenital or acquired. Congenital defects are the defects or malformations present from birth whereas the acquired defects may be due to accidents, gunshot injuries, cancer treatment, ablative surgery and animal bite.[1] These malformations affect the well-being of the individual affecting them psychologically depriving the confidence levels. So the reconstruction of these lost or malformed structures is essential. Maxillofacial defect reconstruction can be made by three ways 1. Surgical reconstruction by alloplastic or autogenous grafts, 2. Maxillofacial or craniofacial prosthesis rehabilitation, 3. Combination of the above two.[2]

Reconstruction of facial defects is a complex modality either surgically or prosthetically driven depending on the site, size, etiology, severity, age and the expectation of the patient.[3] Whenever surgical reconstruction is not possible or failure of the alloplastic or autogenous graft occurs, maxillofacial or craniofacial prosthesis becomes an alternative method.[1] Maxillofacial prosthetics defined by the current Glossary of Prosthodontic Terms – GPT 8 " **as the branch of Prosthodontics concerned with the restoration and/or replacement of the stomatognathic (jaws) and craniofacial (facial) structures with prostheses that may or may not be removed on a regular or elective basis".**[4]

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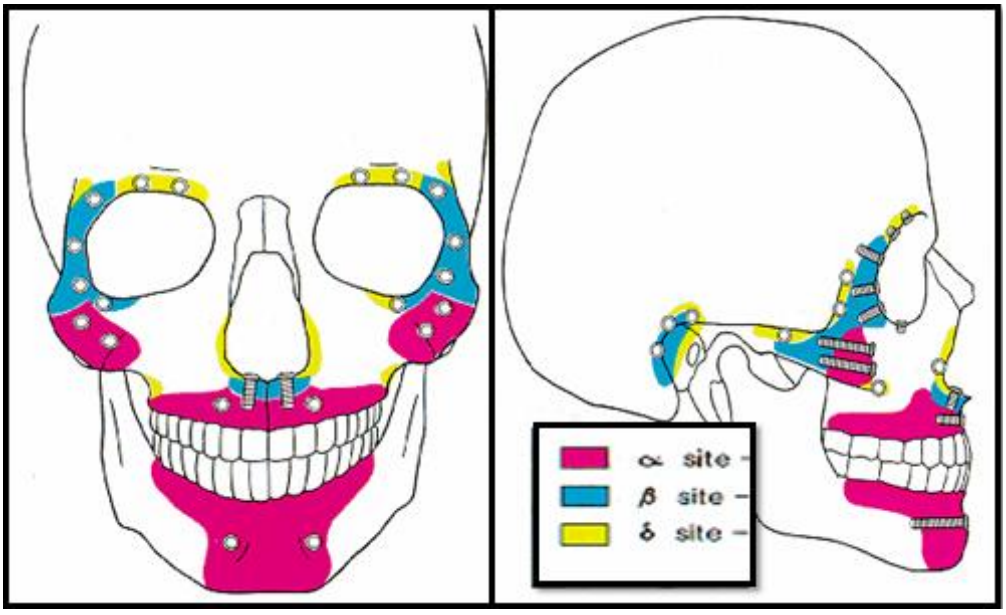
Figure 1: craniofacial implant classification based on bone availability:-



Historically maxillofacial prosthesis was defined as the restoration of hard and soft tissues of the stomatognathic system and surrounding maxillofacial structures that are lost or missing due to congenital anomalies or acquired defects. More recently, the term craniofacial prosthesis has been employed to describe the restoration of extraoral defects of head and neck, whereas maxillofacial prosthesis term is more related to defects that are closely associated with intraoral and adjacent structures.[1]

Retentive mechanisms:-

Maxillofacial prosthesis is retained through various methods for their retention and support. Each retentive mechanism is having its own advantage and disadvantage. The various retentive aids available are 1) adhesive, 2) skin tapes/ straps/ suture material/ toupee tapes, 3) spectacle frames, 4) soft tissue or bony undercuts, anatomic projections using them as mechanical interlocks and 5) implants. These retentive aids are selected based on the various factors such as the extent of prosthesis, availability of bone, radiation therapy, patient's dexterity, location, amount of hard and soft tissue available and compliance of the patient.[5] In the past maxillofacial prostheses are retained by mechanical tools, undercuts and adhesives. Since 1979, there has been a shift towards the implant retained prostheses, which are preferred by most of the patients.[6] The most significant advance in craniofacial prosthesis over the last several decades has been the application of osseointegration to address the problem of retention of extraoral prosthesis.[2]

The treatment of maxillofacial or craniofacial defect is a multidisciplinary approach with a combination of both invasive and non-invasive treatment options. The maxillofacial team should consist of various members to plan the treatment including ablative surgeons, reconstructive surgeons, maxillofacial prosthodontists and maxillofacial technicians. Factors to be considered for the prosthodontic rehabilitation are as follows: 1) amount

of remaining supportive tissue; 2)number, position and condition of the remaining teeth; 3) age and medical condition of the patient; 4) pathologic findings; 5) patient preferences regarding surgical versus prosthetic reconstructions; 6) technical skills of the reconstructive surgeon and prosthodontist; 7) psychological status and manual dexterity of the patient to deal with maxillofacial prosthesis and 8) availability of adequate supportive care in case the patient is not able to take care of the prosthesis.[6]

Extraoral implants:-

Placement of implants for retaining prosthesis depends on a number of factors such as presence of bone, proximity of vital structures the dexterity of the patient, soft tissue conditions, prognosis, patient's health, radiation therapy and economic conditions.[5] The use of extraoral implants provide excellent support and retentive abilities to improve aesthetics as well as quality of life (QOL).[7]

Implants offer a high degree of stability and retention. Implants are used with different types of connections between the implants and the prosthesis. Different systems available with implants are 1) bar and clip system, 2) magnets, 3) mushroom and ball retention system.[5]

Biomechanical Considerations Of Implants In Maxillofacial Prosthesis

a) Design of craniofacial and intraoral implant:-

Craniofacial implants are less diverse than intraoral implants. They are available in smaller lengths of 3-4mm as the availability of bone is limited. It has a flange with perforations which increases surface area enhancing initial mechanical stability of implant design during healing period and also helps prevent tilting of the implant under the action of lateral forces and moments.[8,9]

b) Micromotion at the Bone-Implant Interface:-

Implants placed should be relatively immobile in order to have enhanced osseointegration. Any micromotion in such site causes formation of fibrous tissues leading to failure in osseointegration.[8]

c) Stress Transfer from implants to bone:-

Implants should never be stressed beyond their loading capacity. Unlike intraoral implants which are stressed 50 - 200 N craniofacial implants are stressed 0.1 – 1N.[10] The designing of implant screw transmit an axial tensile or compressive load to the surrounding bone, primarily by compression on the inclined faces of the screw.[8]

d) 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 is distributed evenly among all the members involved, which depends on the relative stiffness and geometry of their arrangement.[8]

e) Impact of implant stiffness on stress distribution:-

Stiffness of implant depends on the diameter of the implant. If the diameter is increased by 30%, implant stiffness will be five times higher, and the stresses around the implant neck are thus reduced dramatically.[8]

f) Impact of the implant shape on stress distribution:-

The stress conditions around an implant can also be improved by selecting an appropriate implant shape. Because force transfer into bone should be as even as possible, implants showing rational symmetry

can be considered more favourable for stress distribution.[8]

g) Impact of the implant surface on stress distribution:-

The implant surface used for force transfer should be as large as possible. To minimize the compressive forces, the implant surface can be enlarged by applying threads or by plasma flame spray coating or surface roughening and acid etching.[8]

h) Measurement of implant stability and Osseointegration:-

Methods to evaluate implant stability are histological analysis, percussion tests, reverse and vibration tests (perio test and radiofrequency analysis test).[11] In radiofrequency analysis technique evaluates bone quality at the time of implant placement and changes in stiffness at the implant tissue interface attributable to bone formation during healing.[8,11] There is decrease in resonance frequency and an increase in damping if an implant fails to integrate because of fibrous tissue formation at the interface.[8,11]

Extraoral implant systems:-

There are 2 systems available, solitary and grouped. In solitary systems single implants are available whereas in grouped implants, grid or plate systems are present which are secured by several screws.

Extraoral implants with solitary systems are Branemark systems, ITI systems, IMZ system, ankylose system, southern implants and epiplant system. Grouped implant systems are epitec and epiplating systems.[8]

Craniofacial Implant Classification:-

Based on the amount of bone available for the placement of implant fixtures craniofacial implants are classified as (1) alpha, (2) beta and (3) gamma sites (figure 1).

- ***Alpha sites:*** In these sites amount of bone available is more ranging from 6mm or greater. Bone can withstand greater loads and regular fixtures. These may be used to retain complex facial prosthesis or dental prosthesis. Zygoma, anterior maxilla and mandible are the alpha sites in craniofacial region.
- ***Beta sites:*** These are found in the periorbital but also in the temporal, zygomatic, and anterior nasal fossa locations. These use short dental fixtures (5mm) or phalanged fixtures (4mm).
- ***Delta sites:*** include the buttress, pyriform, zygomatic arch, medial orbit, temporal and frontal bones, and zygomatico frontal process. Implant fixtures used are 3mm or less.[12]

Surgical procedures for placement of extraoral implants and their abutments are similar to those for intraoral implants. Two additional procedures, however, are employed.

The first occurs during implant placement, when the bone around the threaded implant hole is countersunk to accommodate the peripheral flange. The second occurs during abutment placement when surrounding subcutaneous tissues are reduced in thickness, in an attempt to limit the mobility of the skin around the implant. If the skin around the implant is hair bearing, it may be excised and replaced with a split-thickness skin graft. The lack of hair follicles around the implant enhances the patient's ability to keep the implant clean. Restoration of the implants may begin after adequate healing of peri-implant tissues.[10]

Features of extraoral implants:-

Generally four types of thread forms are suggested for implants - V-form, square, buttress and reverse buttress. Out of these, V- form is most commonly used as endosseous intraoral implant. Though square thread is able to transmit high compressive and low shear forces to bone, it is unsuitable for small implant length. Buttress thread form are considered as more suitable for supporting maxillofacial prosthesis. During routine removal and reinsertion of the prosthesis, tensile and compressive forces acts on the implant. Compressive stresses are effectively resisted by bone whereas the tensile forces may prove detrimental to the implant survival. Reverse buttress thread form can take care of the pull out force to a greater extent because the outward thread face is flat. So reverse buttress thread forms can also be used in supporting the maxillofacial prosthesis.[10]

In contrast to intraoral implants which are available in market with wide range of shapes, designs and surface modifications extraoral implants are less diverse.[13] These are comparatively shorter in length and have a dual structure with an endosseous part and a thread in abutment. Generally a perforated flange is provided to increase the implant surface area to have more bone to implant contact (BIC) to facilitate initial immobilization and prevent undue intracranial pressure.[8]

Various maxillofacial or craniofacial prosthesis retained by extraoral implants are ear prosthesis, auricular prosthesis, orbital prosthesis and finger prosthesis. To place an extraoral implant, fabrication of a surgical template is necessary or prerequisite.[14] It helps in pre-treatment planning by determining the oriental position and location of the implant. These surgical templates can be designed and fabricated either manually or digitally.[15]

Surgical template:-

Fabrication of a surgical template manually requires less armamentarium and is less cost effective. Digital surgical template is advantageous over the manual surgical guide as it helps in pre and post-operative implant placement comparison. Recent advances in computer technology have allowed maxillofacial prosthesis to be designed digitally various tools have been developed that help the surgeon with digital planning of extraoral implants, eg:-robot- assisted placement of craniofacial implants, placement of implants with image guidance.[16] The software used with digital surgical guide fabrication are computed tomography and cone beam computed tomography with the use of CAD- CAM and rapid prototyping technology.[15,16]

Extraoral implants in craniofacial reconstruction:-

Auricular prosthesis:-

Auricular defect generally occurs due to congenital abnormalities trauma (burns, accidents, animal attacks and human bites) or surgical removal of cutaneous malignancies. Simplest methods- spectacles, hair bands or adhesives.

- *Indications of auricular prosthesis* are major cancer resection, radiation therapy, severely compromised local tissue, failed autogenous reconstruction, patient preference and poor operative risk.Relative indications are microtia, absence of lower half of ear and calcified coastal cartilage

- *Location and number of implant for auricular prosthesis:*- As per the accepted protocol, the implants are to be placed in the mastoid area 15mm apart keeping a distance of 20mm from auditory canal opening. Usually 2 implants are sufficient for supporting auricular prosthesis and they should be placed at 8 and 11 'o clock position for the left side and 1 and 4 'o clock position on left side.[3,8] The retentive mechanisms used are bar and clip, ball clips and magnetic retentive cap systems.[3]
- *Healing period* is usually 3-4 months.[3,17]
- *Advantages* of affixing auricular prosthesis on implants are easier maintenance of prosthesis, easier positioning of prosthesis and improved retention compared to other mechanical aids.[2]

Orbital prosthesis:-

These are indicated in patients with loss or absence of an eye caused by a congenital defect, irreparable trauma, tumour, painful blind eye, sympathetic ophthalmic.[14]

- *Location and placement of implant:*-outer canthus or inner canthus and superior orbital rim. Additional implant or two was often placed in the inferior orbital rim or zygoma.[2] The implant should not be angled facially as it may interfere in the prosthesis contour.[8]
- *Length of the implant* used is usually 3-4 mm.[2] There should be 10 – 12 mm space between the implants to allow access for hygiene.[8]The most commonly used retentive mechanisms with implants are magnets.[5]
- *Healing period* is usually 6-8 months.[8]

Implants used in orbital prosthesis are non-integrated (eg:- PMMA and Silicone implants), semi integrated (Allen implants), integrated (Cutler's implants) implants, bio integrated (Hydroxyapatite, structures with or without integration Porus polyethylene, with the prosthesis Aluminium oxide) and biogenic implants(Dermis-fat graft the prosthesis Cancellous bone).[18]

Nasal prosthesis:-

- *Mode of retention:*- adhesive, straps, spectacle frames and implants.[5]
- *Primary site for implant placement* are floor of the nose, piriform ridge or inferior orbital foramen. Other site suitable is glabella.[2]
- *Implant length:* - usually 4mm or longer fixtures are used.[8] 7-10 $mm^2$are used incase of supporting both intraoral and extraoral prosthesis. Such implants are called bifunctional implants as they support oral prosthesis at one end and extraoral prosthesis at the other end.[17] Implants should be placed 8- 10 mm apart in the anterior portion of the nasal floor so that it can be attached to immobile tissues.[8] Healing period is 6-8 months.[8]retentive mechanismsused are mini magnets (mostly) and rarely by bar and clip.[5]
- *Indications* for craniofacial osseointegrated nasal reconstruction are failed autogenous reconstruction, scarring at autogenous donor sites and following removal of adequate reconstruction due to tumour recurrence.[3]

Epiplating system (grouped implants) can be attached or combined with the hearing device abutment of the Bone Anchored Hearing Aid (BAHA) system.[8]

Surgical implant procedure and prosthetics:-

Implant placement procedures are of 2 types. They are (1) Single stage procedure and (2) two stage procedure.

In single stage surgical procedure, recovery screws are placed and the incision is closed in wire sutures followed by dressing with ointment soaked with gauze to protect the skin.[3] Two surgical procedures are carried out in two stage procedure. First surgery deals with the implant placement into the planned location of craniofacial defect. After sufficient healing period and osseointegration second stage surgery is carried out. This procedure included subcutaneous tissue reduction, placing healing caps were placed over the abutments and gauze soaked in ointment is used to prevent postoperative hematoma and swellings.[14]

Extraoral implant in irradiated patients:-

Individuals with diabetes mellitus, osteoporosis and especially irradiated patients are relatively contraindicated for implant placement. Radiotherapy was originally contraindicated to installing osseointegrated dental implants as per 1988 consensus. Implant placement causes minimal trauma during bony perforation leading to onset of osteoradionecrosis when the procedure is carried out near radiotherapy session. When a patient undergoing radiotherapy the cranial regions which were most affected are zygoma, mandible and frontal regions and lowest failure rates were found in maxilla. Hyperbaric oxygen therapy enables a better implant osseointegration in irradiated patients thus reducing surgical complication and increasing healing capacity.[1] The ideal time has not yet established for implant placement in irradiated patients. From the view point of tumour biology, it is advised to wait for 1-3 years for implant placement after radiotherapy; for radiobiological view point it is advised to wait for 2-4 months after radiotherapy. In order to reduce risk reduction by trauma on the irradiated tissue. It is advised to wait for a period of 6 months to 1.5 year after radiation therapy.[19]According to literature hyperbaric oxygen therapy can improve the implant success rate by 38%.[20]

Survival rate and Complications:-

From several studies conducted it is found that the implant survival rate is high for auricular prosthesis followed by nasal and orbital areas, the most common complication seen is peri-implantitis which is related to hygiene maintenance around the implant site.[2,7]

Conclusion:-.

Extra oral implants are safe, reliable and most effective method of retaining maxillofacial prosthesis with high survival rate thus providing enhanced comfort for the patient and ease of maintenance. This technology is remarkably adaptable to different situations and the technique used can be modified to meet the host challenges and also increases patient confidence.

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