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Implant-supported orbital prosthesis -A through and through review

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Abstract

Orbital defects can result from tumor resection, congenital malformations, and trauma. These defects lack hard or soft tissue undercuts, and prosthesis retention is obtained primarily by the use of skin adhesives. There are significant disadvantages to the use of skin adhesives. The margins of the facial prosthesis may be damaged by repeated application and removal of the adhesive, and occasionally a patient will have a toxic skin reaction. The retentive capacity of adhesives may be insufficient in mobile tissues or in moist environments. The presence of hair also complicates the use of skin adhesives. The use of craniofacial titanium implants for restoring orbital defects may provide many benefits. The aim of this paper is to present concept and principles of maxillofacial implants, history, literature review, considerations in treatment planning, finally the treatment phases of an implant-supported orbital prosthesis in particular and prospective developments for orbital prosthesis.

Keywords: Orbital prosthesis; Orbital implants; Osseo integration; Reconstruction

Introduction

The facial prostheses of Kazanjian's era were made of vulcanized rubber, characterized by the addition of celluloid paints for coloring facial features, but the vulcanized rubber presented a problem because of its rigidity. (3,4) Retention was a major obstacle to daily use and the design of these prosthetic artworks required a skillful blend of dental clasps, use of anatomic

undercuts, and, later, tissue adhesives. Latex rubber was introduced by Bulbulian (5) and Clarke (6) in 1939 and 1941, respectively. Acrylic resin later replaced vulcanized rubber for both intraoral and extraoral prosthetic use. Various modifications to acrylic resin helped overcome its rigidity and improved coloration techniques were developed. (7) Barnhart introduced the use of silicone elastomers in 1960. (8) Since then, improved materials have evolved, including polysiloxane, siphenylenes, RTV (room temperature vulcanization) silicones, HTV (high-temperature vulcanization) silicones, polyvinyl chloride (PVC), chlorinated polyethylene, and polyurethane. The most widely used materials today are the silicone elastomers, primarily the RTV silicone elastomers. Advances in polymer chemistry are being made continuously with regard to the potential for new silicones and other materials suitable for extraoral prostheses. A quantum leap in the design and comfort of facial prostheses occurred as a result of the introduction of titanium craniofacial implants for prosthetic reconstruction in the head and neck region. This arose in the late 1960s and early 1970s from the pioneering work of Bra° nemark, Briene, Adell, and Lindstro¨ m, who demonstrated the success of implant-retained dental prosthesis. (9–12)

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

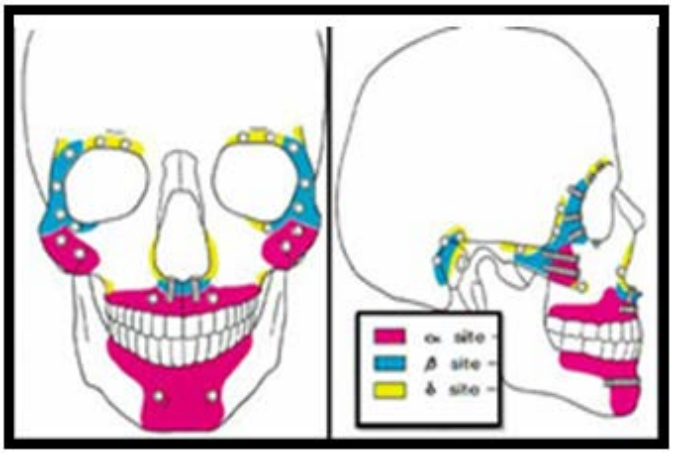

Figure : 1

Orbital prosthesis

A complex prosthesis that restores the exenterated orbit, including an immobile eye, eyelids, and periorbital structures. Currently most are endosseous implant supported.

Orbital implant

Endosseous implant that is Osseo integrated in the orbital/periorbital bony structures. This helps support and retains the orbital prosthesis.

Methods of retention of craniofacial prostheses

The anchorage of prostheses can be achieved in four ways [6]:

- anatomical anchorage (to already existing anatomical structures such as undercut areas in the cavities of an orbital defect),
- mechanical anchorage (for example to spectacle frames),

- chemical anchorage (using adhesives [7])
- surgical anchorage (e.g., using surgically created retention elements [8])

Today, surgical anchorage is carried out using skin penetrating Osseo integrated titanium implants on the bone. It has superseded surgical procedures such as various flaps for the creation of skin pockets for securing prostheses. Due to the secure retention, bone anchorage has contributed to a breakthrough in prosthetic rehabilitation.

Typically, a metal bar is screwed onto the percutaneous posts onto which the prosthesis can then be clipped This procedure has the advantage that the retention strength can be individually adjusted and altered by bending the clips. The bar construction, however, requires substantially parallel aligned percutaneous posts so that the least possible strain occurs. This parallelism of the posts is never achieved in the orbital area, and not always in the mastoid. For this reason, with very few exceptions, bar construction in the nasal and orbital areas can be regarded as obsolete

The advancement in magnetic connections thus represents huge progress. They facilitate the cleaning and insertion of the prosthesis by the patient. For this reason in the nasal and orbital areas magnets are used almost exclusively today

Orbital prosthesis:

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. The implant should not be angled facially as it may interfere in the prosthesis contour. Classic implant regions are found in the laterocranial and laterocaudal orbital rim. The mediocranial area is too close to the frontal sinus and the bone in the mediocaudal area is usually too thin. No magnets should be placed laterally as here there is not enough height for the prosthesis. In the standard situation, an orbital plate of the Epiplating system can be implanted laterocranially for 2 magnets, and a universal plate laterocaudally for one further magnet. In the case of a small orbital cavity, 2 magnets distributed laterocranially and laterocaudally on one universal plate respectively are sufficient. Alternatively an orbital plate can also be divided and one half each distributed on the same positions. In the case of a flat orbital cavity, the Epitec or Epiplating system can be placed through the orbital cavity like a ladder in the sagittal plane. Alternatively, the flat orbital cavity must be secondarily deepened in order to achieve the necessary height for the prosthesis of around 1cm. The free transplantation of a non-vascularised bone from the iliac crest with the insertion of 2 solitary implants has also been reported. Alternatively, alongside the extraoral solitary implants, the longer dental implants may also be used. Thus Wächter et al. report on the use of 8, 10 and 12 mm long ITI titanium screws in the orbital region.FIG 2

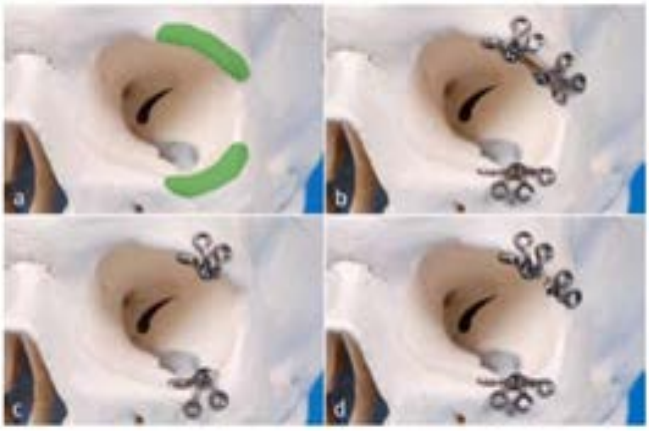

Figure: 2

The Presurgical planning must include a prosthodontist as part of the team since the implants must be carefully planned to be within the confines of the prosthesis and the retentive components and implants must not limit the esthetics of the final facial prosthesis. The presurgical

planning should also include a CT radiographic image of the orbit, a diagnostic waxing, and a surgical template. The frontal sinus can be the limiting factor for placement of implants in the 1 and 2 o'clock positions for the right orbit and at the 10 and 11 o'clock positions for the left orbit. The supraorbital rim is the most common site for orbital implant placement.

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.8The most commonly used retentive mechanisms with implants are magnets. FIG 3

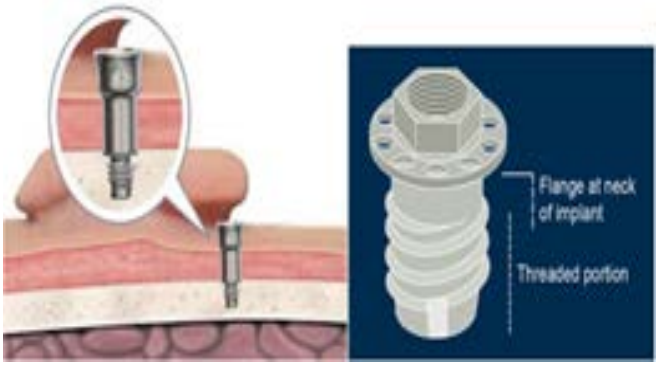

Figure: 3

Healing period is usually 6-8 months

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)

Soft tissue surgical preparation: debulking previous reconstructive flap

The principles of soft tissue management regarding intraoral dental implant placement apply to orbital and craniofacial implant placement. Ideally, the peri-implant soft tissues should be thin, to allow a shallow cuff around the emerging fixtures that simplifies lifelong peri-implant hygiene.

A prior soft tissue flap reconstruction may have left behind bulky tissue or a "closed cavity," with an excess volume of tissue within the orbital structure. In other patients, actual completion of the orbital exenteration may be necessary following the original partial resection or debridement.

Either scenario creates a problem for receiving a prosthesis and for maintaining implant cleanliness

A soft tissue debulking surgery may be required to:

1. Establish an adequate negative volume or "open cavity" to receive an esthetically acceptable prosthesis
2. Provide ease of peri-implant hygiene and to prevent peri-implantitis

The final goal is a healthy, well-adhered, keratinized soft tissue covering of approximately 5 mm thickness or less, which is ideal for long term implant health. Soft tissue reaction or "peri-implantitis" around percutaneous implants has been reported in between 3% and 7% of patients, with most being mild erythema or irritation.

Planning: role of ct and stereolithographic model

Computed tomography (CT) scanning provides an accurate representation of the orbital defect and a 3-dimensional (3D) reconstruction improves even better visualization and measurement of the defect. A stereolithographic (SLG) model made from a high-resolution 3D CT offers the surgeon a palpable model for surgical and prosthetic planning. It enables the surgeon prosthodontic team to identify sites around the orbital rim with adequate bone stock for placement of implants of adequate length and to plan optimal protection and avoidance of the adjacent frontal sinus and duramater. It also allows the

prosthodontist to create a 3-dimensionally accurate implant drilling guide. Clear communication between the maxillofacial prosthodontist and the maxillofacial surgeon is critical for treatment planning.

Implants for orbital prostheses are most commonly placed in the lateral and superior aspect of the orbital rim, into both the zygomaticand frontal bones. In the frontal bone, SLG model surgery helps determine how far medially implants can be placed before entering the frontal sinus. The thick bone of the zygomatic body inferolaterally provides excellent bone stock for larger implants. Rarely is adequate bone present in the inferior or medial orbital rims. A minimum of 3 implants is needed, but 4 are preferred, ideally spaced with at least 5 mm between adjacent implants. If the patient has an associated maxillary defect requiring an obturator prosthesis below the orbital prosthesis, additional retention and/or connectors may be required in the form of magnets or mechanical attachments. The implants are oriented in an arc to allow better stress distribution and retention of the prosthesis. If possible, the implants are placed slightly behind the orbital rim to allow adequate prosthetic thickness and to provide camouflage for implant fixtures. The implant placement also should allow proper emergence profile for magnet placement or bar 1 attachment FIG 4

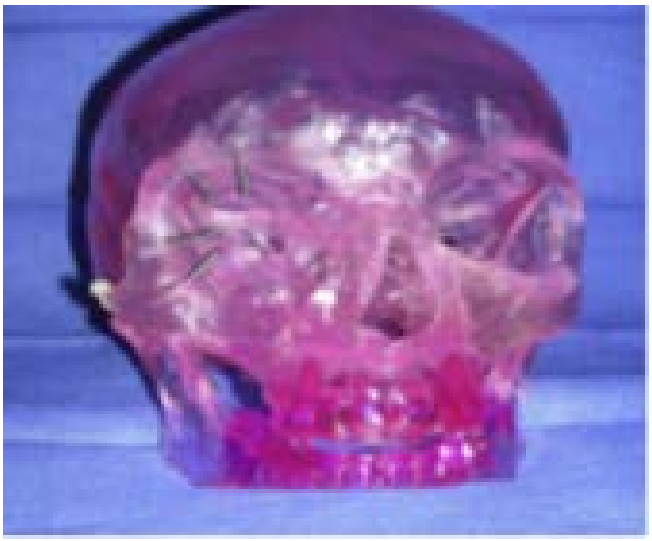

Figure: 4

Implant placement procedure

The implant preparation osteotomy is ideally done under general anesthesia within a sterile operating room environment. The surgical guide is used to mark the exact location of each implant site. To create an accurate transfer of the implant location from the surgical stent to the patient, methylene blue dye on a 1-mL tuberculin syringe on a small needle can be used to perforate the skin down to bone. The plunger is gently tapped to delivera tiny amount of dye into and under the periosteum. This will guide proper placement of the implants once reflection of the overlying skin is performed. Following exposure of the orbital rim, the drilling sequence to prepare the osteotomy site is the same as is used for conventional intraoral dental implants. Although not usually necessary, intraoperative navigation and/or intraoperative CT could be used as an adjunct to guide and assess the accuracy of implant position, angle, and depth.FIG 5

Implant placement can be done in either 1-stage or 2-stage fashion. The 1-stage method requires placement of temporary abutment and soft tissue adaptation around the exposed abutment, whereas the 2-stage technique allows initial soft tissue coverage of the cover screw and surgical exposure of implant is done later.

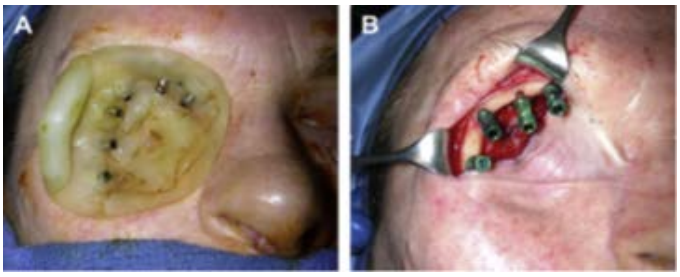

Figure: 5

Fabrication of orbital prostheses

The orbital prosthesis can be connected to the implants by 1 of 2 methods. The original method entailed the fabrication of a metal framework, which was screwed to

the implants and allowed either magnetic or mechanical connectors. This is similar to the design of an intraoral implant overdenture framework. Currently, most orbital prostheses are fabricated without a metal framework. This change evolved because of the use of longer implants, the hygiene problems associated with the framework, and the advent of much stronger magnets. The final abutment contains the titanium keeper and is torqued into the implant. Its length is such that it protrudes from the tissue at the desired level. Since the keeper abutments are not connected to other abutments, hygiene is greatly facilitated and the osseointegration of each implant can be readily rechecked should a question arise. If the orbital defect is large, the magnets can be connected to an acrylic resin or fiber-reinforced composite resin subframework,24 to which the eventual silicone orbital prosthesis is then bonded. This decreases the weight of the orbital prosthesis, strengthens it, and allows for more ideal processing of the silicone because the depth of the silicone can be controlled

Two-piece impression procedure for implant-retained orbital prosthesis.

Obtaining an accurate impression of facial tissues with undercuts and extraoral implants has always been a challenge for both clinicians and patients. This report describes a three-step, two-piece technique that enables an accurate and comfortable impression of undercut tissues and extraoral implants in an orbital defect. An impression of the basal tissue surface of the defect area was made using a medium-body polyether impression material followed by an impression of the entire face of the patient made with a polyvinyl siloxane (PVS) impression material. First, the PVS impression material was removed; second, the impression posts were removed from the magnets; and third, the polyether impression was removed from the defect. The impression posts were attached to the implant analogs and placed in the negative spaces in the polyether impression. The polyether impression, which carries the implant analogs and impression posts, was placed in the PVS impression through the negative spaces. This technique minimizes trauma to the soft tissues and implants during impression making and also does not require additional material FIG 6

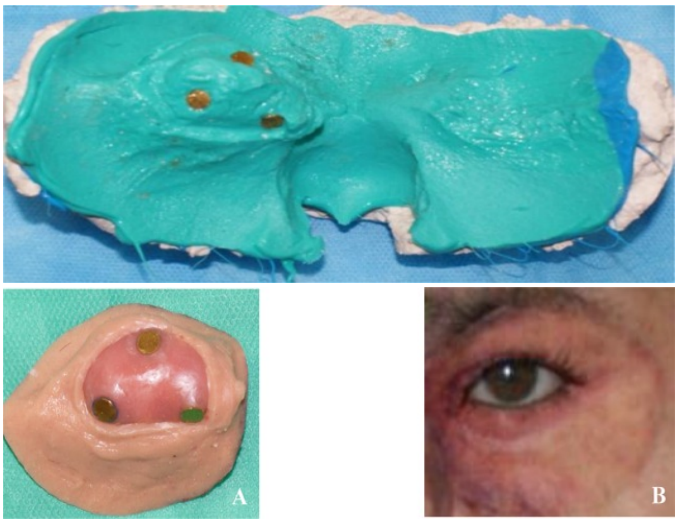

Figure: 6

Current development

An orbital prosthesis was presented by Klein et al. which can blink via myoelectric conduction from the opposite side. Up until now, however, such prostheses have been too heavy. A further field where exciting developments are awaited is that of robot-supported interventions. First steps have been taken in the area of implantology for bone-anchored prostheses.

Bioactive surfaces are on offer from a number of producers of dental implants which in the advertising are referred to as “osteo-attractive”. In this context, bioactivity is defined as a “characteristic of an implant material which allows it to cultivate a connection with living tissue”. With such bioactive surfaces it is hoped that a speedier osseointegration will be achieved. Calcium phosphate bonded implants are available from

several manufacturers. A fluoridated implant (Osseospeed) is produced by Astra Tech. With TiUnite, Nobel Biocare offers an implant with an oxidised surface, where in one study no bioactivity could be demonstrated, however. In the case of an oxidised magnesium implant, on the other hand, a speedier osseointegration could be observed. One further field is that of the pharmaceutical coating of implants with, for example, the bone morphogenetic protein (BMP), or other bone growth factors. In animal experiments, a nano-porous TiO_2 coating also proved to be more favourable than standard implants. Siegert and Stemmann treated patients with a subcutaneously implanted double magnet, where the auricular prosthesis attached magnetically can be worn on intact skin. To what extent these approaches will be successful and better than previous procedures in the future still has to be shown by clinical studies.

Conclusion

When faced with devastating loss of orbital structures owing to tumor, trauma, burns, or congenital reasons, an implant-supported prosthesis is a viable option to an extensive and multistaged tissue reconstruction. Careful planning between the oral and maxillofacial surgeon and/or oculoplastic surgeon and the maxillofacial prosthodontist will result in a secure and accurate esthetic reconstruction using an implant-supported prosthesis. Osseo integrated implants have eliminated the need for adhesives while delivering superior mechanical support, vastly broadened the application, and increased patient acceptance of orbital and other facial prostheses. Long-term maintenance of implant sites and prostheses is critical to success.

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