Review Article

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Remote Anchorage for the Rehabilitation of Posterior Maxilla: Zygomatic and Pterygoid Implants

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ABSTRACT

Background: Although there have been continuous advancements in the field of implantology, the rehabilitation of the posterior maxilla has proved too challenging because of the bone quality and quantity. The introduction of the long implants can be considered as a major milestone for the rehabilitation of the posterior maxillary region providing a less time-consuming option for the patient with successful results.

Keywords: Maxillary sinus, Zygomatic implant, Pterygoid implant.

INTRODUCTION

A successful replacement therapy aims at improving the function and aesthetics of the orofacial region and requires adequate anchorage. When residual dentition is utilized for support (extensive support, especially in cases of cantilevers), it gets traumatized easily to the point of premature failure if the off-axis load is not controlled. Due to increased occlusal load, the posterior edentulous areas are more difficult to replace. Therefore the entire extent of replacement therapy has shifted from tooth replacement to surgically placed implant reconstruction. Clinical applications of dental implant started in 1965, but presently it is considered as an excellent option for pre-prosthetic rehabilitation.[1,2] But according to clinical reports a minimum of 10 mm of bone height is essential for an acceptable success rate, but this becomes a challenge, especially in the posterior maxillary region.[3]Allthough various options have been proposed for the rehabilitation of the posterior maxilla of reduced bone height, but the use of long implants – Zygomatic and Pterygoid provides a non-graft surgical procedure with the provision of early loading which can provide remote bone anchorage.[1,4]

ZYGOMATIC IMPLANTS:

Zygomatic implants are commercially pure titanium screws that engage the zygoma.

- Per Ingvar Branemark in 1998 was the first to introduce Zygomatic implants[5]
- Malevezet al in 2000 described zygomatic implants as self-tapping screws in commercially pure titanium with a well-defined machined surface.[6]

Implant anatomy:

Zygomatic implants are made up of commercially pure titanium with a well defined machined surface. These implant a available in 8 different length ranging from 30 to 52.5 mm (30, 35, 40, 42.5, 45, 47.5, 50, and 52.5). and of 5mm diameter in the coronal third and 4mm in the apical two-third with

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the head angulated at 45 degrees. This angulation of the head compensates for the angle between zygoma and the maxilla. (Figure 1)

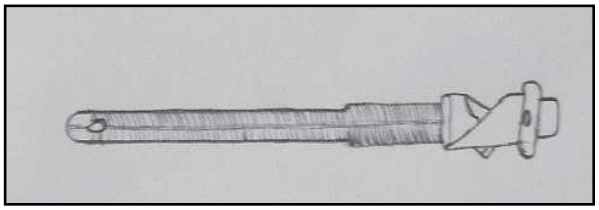

Fig 1: Zygomatic implant

The zygoma is similar to a pyramid that offers a solid anatomic structure for implant anchorage with the anterior-posterior length ranging from 14.1 to 25.4 mm and mediolateral thickness ranging from 7.6 to 9.5 mm. The trabecular bone density is poor with a strong cortex, that provides primary stability.[8] (Figure 2)

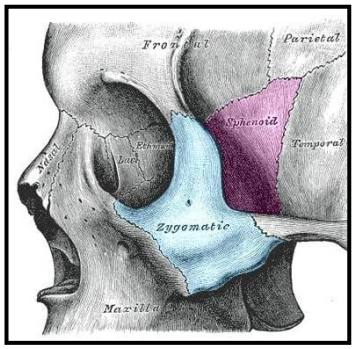

Fig 2: Zygoma Anatomy (Courtesy: Internet)

Patient selection:

The zygomatic implant is considered in the group of patients who demonstrate bone in zone 1 only. (Figure 3) In patients who also have limited horizontal alveolar width in zone 1, veneer grafting before placement of conventional implants for the anterior support is considered[9]

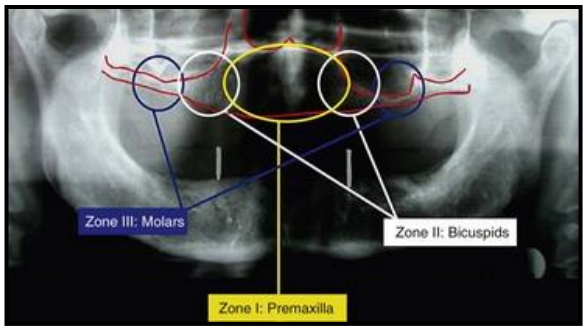

Fig 3: Zones of the maxilla

Courtesy: Bedrossian et al. Implant Restoration of Edentulous Maxilla. J Oral Maxillofacial Surg 2008.

Indications:	***Contraindications***:
1. Severely atrophied posterior maxilla with insufficient bony support. 2. Generalized severe atrophy of maxilla 3. Acquired and congenital maxillary bony defects 4. Previously failed dental implant and/or bony reconstructions	1. Medically compromised patient 2. Acute sinusitis 3. Adequate maxillary alveolar bone for conventional dental implants 4. Severe trismus 5. Previous history of head and neck radiation treatment

Implant placement:

Apart from the conventional zygomatic implant placement techniques there are other modified techniques for placement of zygomatic implants like modified zygomatic implant placement technique, sinus slot technique for simplification and improved orientation of zygomatic implants, extra-sinus zygomatic implant placement technique, quad zygomas, maxillary wall and sinus membrane preservation, zygoma anatomy guided approach (ZAGA):[10]

Conventional technique:

This technique suggests the placement of conventional implant anteriorly and zygomatic implant posteriorly. The conventional implant is placed in the usual manner for the placement of zygomatic implant the procedure is carried out under general anaesthesia, or deep intravenous sedation for the patients comfort although it can be done under local anaesthesia.

1. Firstly a 45^0palatal incision is given onto the soft tissue extending in between the two tuberosities with a vertical releasing incision is placed posteriorly along the maxillary buttress and one another anteriorly along the midline.[6]

2. The soft tissue is reflected up to the incisura (the point between the lateral and medial

surfaces of the frontal process). A zygoma retractor is placed at the incisura. A bony window is created in the supero-lateral portion of the maxillary sinus proving direct access to the roof of the sinus and the base of the zygoma.

3. A proper axis of the implant placement path is determined that extends from the premolar region through the maxillary sinus and enters the midportion of the zygomatic body. If the entry point is found to be anterior to this the risk of penetrating the orbit exists while if it is found to be posterior to it there is a risk of entering the infratemporal fossa causing soft tissue embedment and lack of osseointegration with a potential for unexpected hemorrhage.[9]

4. Osteotomy begins using a round bur followed by pilot drill along the trajectory of the implant. Osteotomy is made larger using the subsequent twist drills up to 3.5mm that provides primary stability of the implant. The implant is placed using a premounted implant carrier. This is done under copious irrigation, once the apical portion of the implant is engaged in the zygomatic bone for the remaining portion a manual driver is used.[1]

Modified zygomatic implant placement technique:

Incision and retraction are carried out in a similar manner. The bony window is created in the lateral sinus wall along the infrazygomatic crest and alveolar crest. Sinus lining is removed, and an entrance is created at the crest. A kit with extended drills which are 50mm longer is used. The implant placement is carried out in 3 possible locations. (Figure 4)

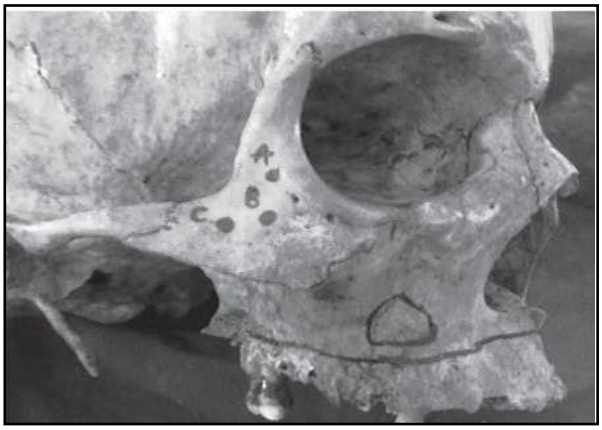

Fig 4: Possible locations for implant placement

1. The posterior most implant is placed first enters in the second molar region palatally. The implant runs posterior to the butteress perforating from the medial side.

2. The second implant which is placed in the premolar region runs along the infrazygomatic crest inside the sinus and perforates the middle aspect of the zygoma.

3. The 3rd implant is positioned in the lateral incisor region runs along the lateral nasal wall initially and perforates the zygoma close to the crestal bone.

Sinus slot technique for simplification and improved orientation of zygomatic implants:

Stella and Warner described this technique which makes the sinus window preparation unnecessary. A sinus slot is prepared through the buttress wall leaving a 5mm of residual maxillary bone on the inferior aspect.[13](Figure 5)

Fig 5: Slot preparation

Extra-sinus zygomatic implant placement technique:

This technique was suggested by Aparicio et al. in 2010, in which the implant bypasses the maxillary sinus to engage the lateral sinus wall as it penetrates the zygomatic arch to appear in the superior part of the zygomatic arch.[14]

***Quad zygomas*:**

Allows immediate loading of the implants by placing 4 zygomatic implants instead of 2 conventional implant.[2]

Maxillary wall and sinus membrane preservation:

The maxillary wall is preserved in order to protect the sinus membrane.[2]

Zygoma anatomy guided approach (ZAGA):

The zygomatic implant osteotomy is guided by the zygoma anatomy and the ideal site for implant placement.[15]

Prosthetic procedure:

The second stage of surgery is carried out after six months. Screw retained bridges and overdentures retained by bars are the different prosthetic options which can be carried out. However, screw-retained prosthesis allows better adjustability of the occlusion.

Complications:

The use of zygomatic implants can result in surgical complications like an invasion into the orbit or temporal fossa. Extra surgical complications that can exist are sinusitis, oroantral communication.

PTERYGOID IMPLANTS:

The pterygoid implants are anchored to the pterygoid plates or in some cases a little anteriorly in the pterygomaxillary region posterior and parallel to the sinus. Tulasne in May 1985 placed the first pterygomaxillary implant when suggested by Paul Tessier. It was placed as a rescue implant in a patient who had lost previous implants when placed in a full iliac bone graft.[4]

Implant anatomy:

The length of pterygoid implants ranges from 7 to 20 mm. About 97% of the implants used are of 15mm in length. However, longer implants have higher survival rates as it engages the dense cortical bone of the pterygomaxillary region. The pterygoid implant width varies between 3.75mm to 4mm, and these implants are placed at an angle of 45^0 to the horizontal.

Anatomy of the pterygoid process:

The pterygoid and the pyramidal processes are made up of dense cortical bone with the average thickness between 6 and 6.7mm at the juncture. The pterygoid processes go down from the sphenoid bone to the lower areas. It is made up of three parts: upper base, wing and pterygoid groove. The distance between the second molar region on the alveolar crest to the medium region of the pterygoid process is 15mm. Hence, a 13mm of distance is required to reach the pterygomaxillary process. Pterygoid implants can be placed in 2 different anatomical locations: Pterygoid process and Pterygomaxillary region. (Figure 6)

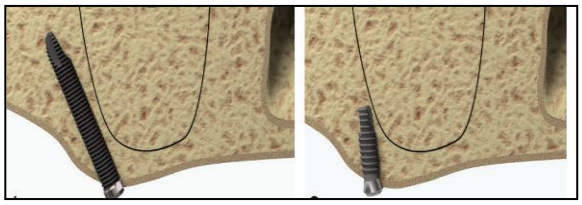

Fig 6: Pterygoid implants (a) In pterygoid process (b) In the pterygomaxillary region

Courtesy: Candel E et al. Rehabilitation of the atrophic posterior maxilla with pterygoid implants: A review. J Oral Implantol 2012.

Indications:	***Contraindications***:
1. Patients with partially edentulous arches. 2. Completely edentulous arches. They are especially helpful in maxillary complete arch fixed implant-supported prosthetic rehabilitation when four implants do not adequately provide distribution of forces and prosthetic support. 3. Rehabilitation of maxillectomy defects	1. Patients with trismus or reduced mouth opening. 2. When the maxillary tuberosity is absent 3. The presence of an impacted maxillary third molar obliterates access to the pterygomaxillary region.

Implant placement technique:

a. When the anchorage of the pterygoid implant is from the pterygoid plate of the sphenoid bone, it passes through the maxillary and the palatine bones with the distal angulation between 35^0 and 55^0. This angulation depends on the floor of the maxillary sinus and the height of the bone of the tuberosity.[15]In a study done by Yamakura verticalization of the implant to obtain a 70^0 angulation in the mesio-distal angulation. This is done to reduce the non-axial forces. Once the implant penetrates 10 mm, the resistance of the implant on reaching the high-density bone is appreciated, and hence pressure is required to reach the pterygoid process. As described by Valeron and Valeron, the implant site is prepared using straight osteotomes beginning with the smallest, followed by the pilot drill and consecutively increasing to the drills of increasing diameters. [16]

b. When the implant is anchored in the pterygomaxillary region within the maxillary tuberosity placing it near or parallel to the sinus wall posteriorly, the surgical procedure is similar to that of the implants placed in the pterygoid region except the osteotomes used are curved instead of straight with an angulation of 10^0 to 20^0.[18] In order to achieve good implant angulation Bahat et al. suggested that a minimum of 35mm of mouth opening is required to achieve a good implant angulation.[19]Valeron et al suggested the use of osteotomes in order to preserve more bone and reduce surgical risks.[17]Nocini et al. advised the use of anatomically modified osteotomes while Penarrocha et al combined burs and osteotomes.[20,21] The advantage of using the combination is that the burs create the bed in the dense cortical bone area while the osteotomes minimized surgical risks, increased preservation of the bone and allows more tactile control in the inaccessible areas.

A healing period of 2-3 months is required before loading the implant. In the second stage of surgery, 3-4 mm of the gingival tissue is removed, which decreases the risk of peri-implantitis.

Complications:

Owing to the proximity of the internal maxillary artery 1 cm above the pterygomaxillary suture bleeding is one of the major surgical risks during this period. Krekmanov and Vrielinck have reported poor anchorage of the implants[18].

DISCUSSION

The various techniques utilized to restore the posterior maxilla may be divided into the graft and graftless techniques. The sinus bone graft technique described by Boyne in 1980 is one of the most extended techniques. The non-graft techniques include the use of short implants, cantilevers, zygomatic implants and pterygoid implants. Use of short implant requires a minimum basal bone height of 7mm, which is not always present. Use of cantilevers creates non-axial forces making the prognosis worse.

Zygomatic and pterygoid implants are long screw-shaped titanium endosteal implants which are inserted in the posterior maxillary bone. (Figure 7)

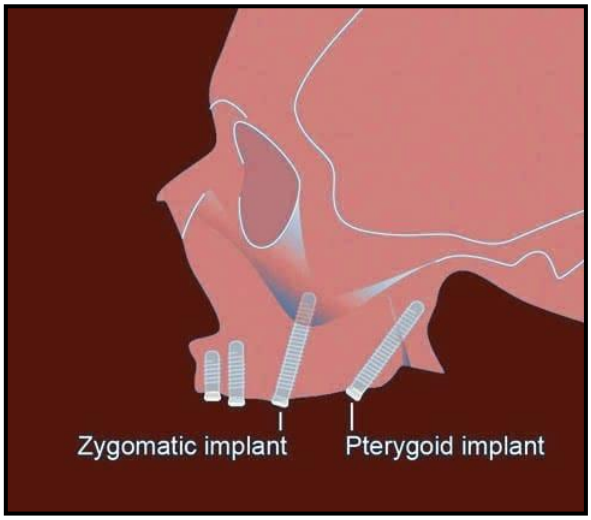

Fig 7: Zygomatic and pterygoid implants (Courtesy: Internet).

These may require a couple of convention implants to be placed anteriorly. These long implants avoid the need for grafting and allow the second stage at 4 months. The Zygomatic implant engages the body of the zygomatic bone by either passing through the sinus or external to the sinus. The biomechanical aspect of zygomatic implants is that the rigid semi-circular arch connecting the four implants transfers

the masticatory load to the bony support situated in the zygoma.

The pterygoid implants also belonging to the non-graft techniques maintain the sinus integrity and has a very high osseointegration index. It exhibits low complications. It facilitates a short healing time, along with the provision of immediate loading. Unlike the zygomatic implant, the pterygoid implant does not have palatal emergence.

CONCLUSION

The zygomatic and pterygoid implants appear to be a promising development in the field of a dental implant. These offer an appealing substitute to the grafting procedure and are being used successfully for over ten years.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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