Original Article

Prosthodontic Rehabilitation Using Pterygoid Implant

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Abstract

Background: Loss of teeth in the maxilla, specifically in the posterior segments, may complicate implant placement related toenlargement of the maxillary sinus through a combination of crestal resorption and pneumatization of the sinus, both natural occurrences. The posterior maxilla poses some challenges for the surgeon with limitations to implant placement. Those include low bone quality and quantity, pneumatization of the maxillary sinus and poor accessibility to the area. Low bone density at possible implant sites reduces implant success related to impairment of the primary stability of the implants.

Aim: This systematic review describes various implant treatment options for posterior maxillary rehabilitation. It highlights the use of pterygoid implants as a graft less solution with its anatomy, technique of placement, and advantages.

Results: Pterygoid implants allow restoration of the resorbed posterior maxilla in less time by avoiding the healing period required when osseous grafting would be required to place implants in the deficient ridge below the enlarged sinus.

Conclusion: Pterygoid implants should be considered when inadequate bone is present in the posterior maxilla as an alternative to osseous augmentation to permit implant placement.Pterygoid implants have high success rates, less bone loss, and good acceptance by patients thus being an excellent alternative to treat patients with severely atrophic maxilla.

Keywords: Pterygoid implant, Maxillary posterior resorption, Tuberosity, Pterygoid process

INTRODUCTION

Dental prosthetic rehabilitation based on Osseo integrated implants is a well-established and highly predictable treatment modality.[1]However, the dental rehabilitation of patient with severe posterior maxillary atrophy using Osseo integrated implants has been challenging due to lack of bone volume (pneumatization of the maxillary sinus), poor bone quality (type III and IV) and difficulty of surgical technique access.[2,3]

Loss of teeth in the maxilla, specifically in the posterior segments, may complicate implant placement related toenlargement of the maxillary sinus through a combination of crestal resorption and pneumatization of the sinus, both natural occurrences. The posterior maxilla poses some challenges for the surgeon with limitations to implant placement.[4] Those include low bone quality and quantity, pneumatization of the maxillary sinus and poor accessibility to the area.[5] Low bone density at possible implant sites reduces implant success related to impairment of the primary stability of the implants.[6-8]

Implant placement in those circumstances has traditionally required sinus augmentation to create sufficient volume of bone to house the planned implants. This may allow simultaneous implant placement at the time of grafting or may require a delay to allow graft healing before implant placement. Alternatively, implant placement into the tuberosity with engagement into the pterygoid process has been utilized to avoid augmentation of the sinus and take advantage of bone present in that region and the anatomy.

Pterygoid implants have been placed in combination with traditional implants placed mesial to the maxillary sinus (premolar area) and in combination with zygomatic implants when restoring a partially or fully edentulous maxillary arch. Implant placement in the tuberosity and pterygoid region provides posterior bone support, while not requiring sinus augmentation, utilizing bone present to house the implant. Placement of pterygoid implants is more technically demanding than placement of traditional implants either in a grafted sinus area or anterior to the maxillary antrum. Few risks associated with implant placement in pterygoid area have been reported and placement in this region allows more distal

placement of implants for better prosthetic load management. Loss of the implant into the infratemporal space, affecting pterygoid muscles, trauma to nerves leading to facialsensory issues is one of the few risks with placement of implants into this area.[9] A metanalysis from 1995through 2018 reported mean implant survival rate of 94.87%, demonstrating that pterygoid implants can be successfully used in patients with atrophic posterior maxilla.[10]

Anatomy of the posterior maxilla:

The tuberosity is the posterior portion of the maxillary alveolar ridge and presents as a convex protuberance thatis typically distal to the second molar when present. The medial and posterior boundary is the pyramidal process of the palatine bone and the anterior surface of the pterygoid process of the sphenoid bone.[11] The pyramidal process binds to the anterior surface of the pterygoid plates of the sphenoid bone and is interposed between the inferior end of the pterygoid plates and the maxillary tuberosity creating a narrow column of dense bone, referred to as the pterygoid pillar, into which the apical portion of an implant may be placed. The bone within the tuberosity is typically of poor quality; therefore, use of osseodensification with appropriate instruments such as the Densah burs (Versah LLC, Jackson, Michigan, USA) is recommended to improve bone quality around the implant being placed into the pterygoid area.

When the tuberosity has favourable dimensions in height, width, and length, an implant may be successfully placed within this osseous anatomy. However, when the volume and/or quality of the tuberosity bone is insufficient, a more medially angled and posteriorly placed implant is determined by the maxillary sinus posterior walls angle.[12] The implant requires placement parallel to the posterior sinus wall to prevent penetration of the sinus, necessitating the angled implant placement. Related to the anatomy an implant may be placed to have greater bone-implant-contact (BIC) and a tapered implant is recommended in greater length than typically placed elsewhere in the arch. Care during osteotomy preparation and implant insertion to avoid perforating the posterior wall of the maxillary sinus or the posterior aspect of the pyramidal process of the palatine bone, and the pterygoid process of the sphenoid bone. Support for pterygoid implants is derived from the maxillary tuberosity, the pyramidal process of the palatine bone, and the pterygoid process of the sphenoid bone.[13] The length of pterygoid implant ensures that the implant can engage the cortical bone of the pterygopalatine suture.

Radiographic analysis is important to understand the patient's particular anatomy and plan the point of initiation into the bone by the drills as well as theangulation that will parallel the posterior sinus wall andkeep the implant within the osseous anatomy.

The pterygopalatine fossa (PPF) is considered as a key area in the deep space, which needs to be evaluated carefully during head and neck imaging. The PPF is confined by the junction of three bones (maxilla, palatine, and sphenoid). Fat, the pterygopalatine ganglion, the maxillary division (V2) of the trigeminal nerve and its branches, the Vidian (pterygoid) nerve, the distal branches of the maxillary artery, and a few emissary veins are the contents of the PPF.[15,16] The thickest buttress of bone is medial to the alveolar ridge. The ideal placement for the implant is through the pterygoid process into the pterygoid fossa.[14]

The thickest area of supporting bone is located in the middle part of the pterygoid process between plates. This 3-4 mm medial to the alveolar ridge, the implant should angle slightly medially to bisect dense point of bone in the pterygoid region. The hamular process on the medial pterygoid plate is palpable in the oropharynx. Implants are placed laterally to this landmark.[14] The pterygoid implants, when used in full arch rehabilitation, eliminate distal cantilevers, an extension of posterior occlusion, and the finest distribution of functional loads.[13,17-19]

Classification of the posterior maxillary implant-based on anatomic location by Reiser[20]
- Tuberosity – pyramidal process
- Tuberosity – pterygoid process
- Tuberosity – pyramidal process – pterygoid process
- Pyramidal process – pterygoid process
- Maxillary tuberosity

PARP (pterygoid anatomic radiographic prediction):

Luis et al. proposed the classification of diagnostic prediction PARP for implantology in the pterygomaxillary region. Through the PARP, the choice of implant is individualized for each patient, acting as a guide to make implantology accessible in the pterygomaxillary region to the greatest number of specialists. From the degree of sinus invasion obtained after a three-dimensional (3D) computerized tomography (CT), the PARP establishes the prediction of the difficulty impliedby implantology in this anatomical region, as well as theappropriate choice of the type of implant and length with whichto approach it.

The PARP classification allows working only in the pterygomaxillary region with retromolar implants[21]
- PARP 1. It is the simplest scenario when there is no sinus invasion, and we have a bone in all its route. In these cases, the length of the implant depends on the bone density.
- PARP 2. The patient presents with a sinus invasion but still has >10 mm of the remaining bone. In case of having good bone density, it would be more appropriate to place a conventionally conceptualized retromolar implant.

- PARP 3. This is a case of medium-high difficulty, with sinus invasion leaving a bone surface between 5 mm and 9 mm of remaining bone. In these cases, due to the scarce remnant of alveolar bone and the air of the sinus invasion, the pterygoid anchor will always be used in the apophasis of the same name, with a suitable density.
- PARP 4. In the majority of cases of a large sinus invasion, leaving only a remaining bone smaller than 5 mm, the possibility of using long pterygoid implants or opting for other surgical approaches will be evaluated.

Table 1: Classification of PARP

PARP 1	PARP 2	PARP 3	PARP 4
Without sinus invasion	With or without minimal sinus invasion	Moderate sinus invasion	Critical sinus invasion
Bone >13 mm	10–13 mm remaining bone	5–9.99 mm remaining bone	<5 mm remaining bone
Retromolar/pterygoid	Retromolar/pterygoid	Pterygoid	Pterygoid

PROTOCOL FOR PTERYGOID IMPLANT PLACEMENT

A. Diagnostic level

Preclinical record:
a. Clinical assessment summary/relevant medical history:
b. Pretreatment Photographs: Extraoral: Frontal, lateral, oblique
Intraoral: Frontal, right, left, upper, and lower occlusal View
c. Radiographs: OPG, CBCT, RVG.

B. Surgical level

Presurgical stereolithography model
Pterygoid implants are suited to all age groups and systemic conditions unless there is a frank surgical contraindication. Patients with diabetes Type 2 (HbA1c <7 %) are suitable for pterygoid implant. To take clinical advantage of pterygoid implants surgical guides and stereolith models are necessary, fabrication of which is done by conversion of patients CT scan images (Dicom) to STL format. Virtual planning of implant placement and clinical angle measurement should be done. Surgical metal template is fabricated with markings of point of entry and drilling angulation as per the planned sites. The use of a surgical guide avoids perforations into adjacent anatomical sites (palatal or buccal). Models help to identify the patient-specific anatomy, point of entries, exit and mesiodistal, and buccpalatal angulations.

Surgical phase:

The pterygoid implant is placed using a tilted concept, i.e., TTPHIL technique, surgical metal guide fabricated using the stereolith model. The implant is placed for the second to third molar edentulous space toward the junction formed by the posteroinferior projection of the sphenoid, palatine process and the maxillary surface with distal angulation of 25–45 degree depending on the maxillary floor and height of tuberosity. The implant site is prepared using a pilot drill and a final tapered drill (Single drill concept) in a superior, posterior, distal, and palatal direction. The entry point and angulations of drills are guided by the metal template. The implant used is 18–25 mm long and3.75 mm or 4.2 mm in diameter. To check for the stability of theimplant torque value of >40N cm are to be obtained if immediate loading is desired. Multiunit abutments with varying lengths (3–5 mm) and angulations (30°, 40°, and 50°) are placed.

Parallelism was obtained on the same day of surgery. Postoperative panoramic radiographs confirmed the position of the implants. Tulasne[22] proposed the pterygoid implant technique using a 22 mm long implant, which was anchorage to the pterygoid plate through maxilla and palate with distal angulation between 35° and 55°. The osteotome technique minimizes surgical risk, preserves bone, with better tactile control, whereasthe drills facilitate the formation of the implant bed, especially in the dense cortical bone area.[23-26]

C. Prosthetic level:

For partial or full arch rehabilitation with posterior pterygoid implants and anterior implants, the prosthetic protocol was as follows. A two-step open tray direct impression technique is used with putty and light body material after splinting of multiunitimpression copings. Multiunit implant analogs are attached to the impression copings; gingival mask is poured around implant analog and die stone is poured to form the final cast. Jig trail, Jaw relation, and bite registration are done, recorded and sent to the lab for CAD CAM designing screw-retained fixed prosthesis. Before final cementation metal trial and bisque trial are done.

DISCUSSION:

Pterygoid implants have seen increased usage to aid in avoiding augmentation when the maxillary sinus has enlarged and/or periodontal bone loss presents with inadequate height for implant placement in the posterior maxilla. Bone in the tuberosity is typically not affectedby sinus enlargement and presents with bone to allow longer implants to be placed at or distal where the 2ndmolar would be restoratively. With greater degrees of crestal resorption that will require greater angulation of the pterygoid implant to engage the available bone and preplanning through CBCT evaluation of the area is needed to determine what angulation of implant placement and whether a 15 or 18 mm implant will engage the osseous

structures of the pterygoid area. Additionally, the PTG implant may also be utilized anterior to the maxillary sinus, skirting the mesial sinus wall when adequate bone is present in the premolar area of the arch to either connect with a PTG implant at the tuberosity or implants placed anterior to this implant. Those cases being treatedwith zygomatic implants may also be supplemented withpterygoid implants allowing better posterior stabilization for improved load handling during function.

TREATMENT OPTIONS FOR POSTERIOR MAXILLARY REHABILITATION

1. Maxillary sinus floor elevation.
2. Zygomatic implants.
3. Short implants.
4. Tilted implants.

Maxillary sinus floor elevation:

The reduced vertical bone height in the posterior maxillary region is often a major obstacle to the placement of dental implants. Elevation of the maxillary sinus floor with or without grafting is the only solution for this problem. Various surgical techniques such as endoscopically controlled technique,[27]hydraulic pressure technique,[28] and antral membrane balloon elevation technique[29]have been presented to access the sinus cavity and elevate the sinus membrane.[30,31]

Zygomatic implants:

The technique sensitive zygoma implants are indicated for severely resorbed maxilla this engages zygomatic bone for anchorage.[32]These implants are screw-shaped in commercially pure titanium of variable lengths of 30– 52.5 mm.[33] The concept can be expanded when required by inserting two zygomatic implants in a more anterior position (quad zygoma).

Short implants: The short implant is considered as an alternative in a situation which is characterized by limited vertical bone height. It used to avoid bone augmentation procedures in maxillary and mandibular posterior regions. Standard implants have a length of approximately >8 mm, while short implants are usually referred designed with intrabony lengths of ≤8 mm.[32]

Tilted implants:

Since the 19th century, tilted concept in the posterior region of the maxilla was demonstrated as one of the alternativesto bone grafting. Using tilted implants, distribution of axial,shear, and transverse forces would not be harmful due to greater anterior-posterior coverage of the design, which has been proven by 3D finite element analysis of stress levels. Tilting of the implants reduces the cantilever length by increasing the inter-implant distance and decreasing compressive stress. Multiple studies have suggested the use of tilted implants for maxillary rehabilitation using immediate loading.[34,35]

CONCLUSION:

Utilization of pterygoid implants allows restoration of the resorbed posterior maxilla in less time by avoiding the healing period required when osseous grafting would be required to place implants in the deficient ridge below the enlarged sinus. Treatment costs for the patient are also shortened by elimination of maxillary sinus augmentation procedures. Pterygoid implants should be considered when inadequate bone is present in the posterior maxilla as an alternative to osseous augmentation to permit implant placement. Extremely atrophic maxillae are the most challenging task for restorative dentists. Pterygoid implant provides a reasonable alternative to 3D maxillary reconstruction, sinus lifts, and bone augmentation technique. Many authors have reported success rates of pterygoid implants ranging from 90% to 100% after follow-up period ranging from 1 to 12 years with minimal complications. Avoidance of a prosthetic distal cantilever with good stability fit for immediate loading is possible with this technique.

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