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Pterygoid Implants: A New Treatment Modality in Severe Atrophic Maxillary Ridge

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Abstract

Pterygoid implants are a newer and a valuable treatment modality for rehabilitation of posterior atrophic maxilla. Posterior atrophic maxilla has been a challenging entity for the surgeons for implant placement. A wide range of surgical techniques are described in the available literature for the reconstruction purpose, comprising of sinus floor augmentation, alveolar distraction, guided bone regeneration, use of zygomatic implants and pterygoid implants/ pterygo-maxillary implants.

Keywords: Pterygoid Implants, Ttphil, Maxilla, Atrophic Ridge, Rehabilitation, Sphenoid Bone

Introduction

With the advancements in recent times, restoration of edentulous ridges with the implant has proven to have a higher success rates (84-92%) with the availability of sufficient bone in the maxillary ridges. Although, atrophied maxilla is not an uncommon finding, it makes the conventional implant system unsuitable for rehabilitation in such situation.[1] Implant placement in the posterior atrophic maxilla poses a challenge for various different reasons, the obstructions include the presence of maxillary sinus, low quality/quantity of available bone and the inherent problem of accessibility to the surgical area.[2,3,4] In order to eliminate these limitations, a variety

of choices are available today (sinus lift, bone grafts, alveolar distraction, guided bone regeneration, short implants,tilted/zygomatic implants, pterygoid implants.[5,6,7-11] Sinus floor augmentation, being the most popular surgical intervention, has gained popularity in the last three decades.[10,11] However, it has its own drawbacks, such as sinus membrane perforation, bone graft infection and sinusitis).[10-16] These unnecessary surgical intervention can be eliminated by using pterygoid implants. Implants placed in pterygomaxillary region depicts ossteointegration providing retention and stability.[17] Various terms have been used to refer pterygoid implants, throughout the literature (tuberosity implants / pterygomaxillary implants) as they are placed through the maxillary tuberosity (most distal aspect of maxillary alveolar process) into the pterygoid plate.[18-20]

History

- Pterygoid implant was first proposed by Linkow (1975) [21]
- First described by Tulsane JF in 1992, thereby used by many other researchers
- Paul Tessier (1989) was credited for proposing the idea of implant placement in the pterygoid region. .[17,22,23]

Pterygoid Anatomic Radiographic Prediction (Parp) [24]

PARP is a diagnostic prediction for implant placement in pterygomaxillary region, it was proposed by **Luis et al.** The PARP predicts the difficulty to be encountered, simultaneously suggesting the type and length of implant to be used.

Parp Type	Sinus Invasion	Available Bone	Type Of Implant To Be Used
PARP 1	No	>13 mm	Retromolar/ Pterygoid
PARP 2	Yes	10 mm – 13 mm	Retromolar/ Pterygoid
PARP 3	Yes	5- 9 mm	Pterygoid
PARP 4	Yes	<5 mm	Pterygoid

Table 1: Classification of PARP

Definition	Vrielinck et al.[25] stated that " The pterygoid implant enters in the region of the former second molar, follows an intrasinusal trajectory in a dorsal and mesio-cranial direction, where it subsequently perforates the posterior sinusal wall and the pterygoid plates."
Bone type	The pyramidal process of the palatine bone and the pterygoid process of the sphenoid are dense cortical bone.[26,27,28]
Vital structures	Internal maxillary artery, posterior or superior alveolar nerve, pterygoid muscles[27], infratemporal fossa, pterygopalatine fossa, nasopharynx and sphenoid sinus.[26]
Angulation of implant	45º -50º

Concept Of Implant Placement In Pterygoid Region

Discussion

Pterygoid implants has the benefit of providing an anchorage in the posterior atrophied maxilla, eliminating the requirement of sinus lifts or bone grafting and enhancing the axial loading. Placement of these implants can be acceptable in two different sites such as pterygoid process or the pterygomaxillary process. The available literature depicts no clear difference between the two sites of implant placement and there is no consensus present concerning the nomenclature of pterygoid implants.

The implant length and angulation varies for the two locations. For the placement in pterygoid process (plates) the preferred implants are longer with distal angulation between 35º-55º, which depends on the location of sinus floor and the height of tuberosity. However, shorter implants with an angulation of 10º-20º are used for the pterygomaxillary region, in order to stimulate the proper angulation of the third molar.[22] The use to pterygoid implants is indicated for all the age groups and systemic conditions, even a diabetes type 2 (HbA1c<7%) patient is appropriate for restoration of missing tooth via pterygoid implant.[29] These implants ranges from 15 mm to 20 mm in length, due to their longer path,[17,23] they have a pointed, self-tapping apex ensuring enchorage.[30] These implants achieve bi-cortical anchorage, enhancing the axial loading and eradicating the posterior canteliver.[22] With a wide thread profile, the implant neck provides compression in the tuberosity region.[30] Under the supervision of Henri Diedrich with the collaboration of the Swiss company TRATE new implants designed are surface treated with hydroxyapatite/tricalciumphosphate (HA/TCP) having a conical shape with compressive threads (3.5 or 4.5 mm diameter and length of 16, 18, 20 mm).[30]

The placement of these implants decreases the overall treatment expense due to the ability of the clinician to avoid unnecessary addition of certain techniques (such as sinus lift, bone grafting).[31] A simple and efficient technique allows a faster surgery with less morbidity.[31] many studies depict technical difficulty, requiring surgical expertise with proper anatomy knowledge.[31] The greater palatine foramen may constitute a major risk for intra oral bleeding.[2] Other common complications includes pain and trismus, which can be managed easily.[32] Hemorrhage from the internal maxillary artery is rare (as it is located 25 mm away from the pterygomaxillary suture.[5]

Balshi et al. (1995) [33-36] conducted a three clinical series of pterygoid implants with 41 patients (follow-up period of 1 month to 63 months) reported success rate of 86.3%. In 1999, they increased their study sample to 356 implants, obtaining a cumulative success rate of 88.2%. Again in 2005, they placed 164 implants with a higher success rate of 96.3%. The authors related this increase in success rate of implant survival with the change of implant surface from machined to titanium oxide.

Ridell et al. [37] placed 22 implants in the posterior maxillary region with a follow-up of 12 years and reported a 100% success rate.

Gaining the anchorage from junction of three different bones (the pyramidal process of the palatal bone, the pterygoid process of the sphenoid bone and the maxillary tuberosity), often leading to improper terminology usage related to pterygoid implants. A significant difference between the pterygoid implant and the tuberosity implant is that the pterygoid implant are engaged in dense cortical part of pterygoid bone and the palatal bone, while tuberosity implants are directed and engaged in cancellous maxillary bone of poor quality.[14,15,38]

Surgical Technique

The technique demonstrated by Valeron and Valeron is used to prepare the implant site (by combining drills and osteotomes, starting with a round bur to create an entry point). The smallest straight osteotome is used to start the preparation of the implant bed followed by a pilot drill, establishing a pathway and determining the direction of the implant axis. Thereafter, successive straight osteotomes and drills are used to increase the diameter.

Implant placement in pterygomaxillary region is within the maxillary tuberosity, parallel to the posterior wall of the sinus, with the same technique described by Valeron and Valeron with the only difference of using curved osteotomes rather than the straight osteotomes.

It was suggestive by Valeron et al. to use osteotomes in order to preserve maximum bone and reduce surgical risks (hemorrhages). While, Nocini et al. utilized anatomically modified osteotomes to ease access to maxillary tuberosity area. Penarrocha et al. used bur and osteotomes simultaneously gaining the advantage of the two techniques, while placing the implants in pterygomaxillary region. Osteotomes were used to minimize the surgical risk, preserve bone, for tactile control, whereas, the drills were used to facilitate the formation of implant bed (especially in dense cortical bone area).[22]

In a study conducted by Candel et al.[39] in 676 patents for 1,053 pterygoid implants. They reported a success rate of 90.7%. Making it a viable alternative for posterior atrophic maxillary rehabilitation.

Protocol For Pterygoid Implant Placement [29]

1. Diagnostic level:

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

2. Surgical level:

- Presurgical Stereolithography Model

Surgical guides (used to avoid perforations into adjacent anatomical sites) and stereolith models (to identify patient-specific anatomy, point of entries, exit and mesiodistal, buccopalatal angulations) are required for gaining the clinical advantage of pterygoid implants, which is fabricated by conversion of patients CT Scan images (Dicom) to STL format. Various others steps are followed such as virtual planning of implant placement, clinical angle measurement, the surgical metal template is fabricated with markings of point of entry and drilling angulation according to the planned sites.

- Surgical phase

A tilted concept is utilized for pterygoid implants (i.e. TTPHIL technique) in conjunction with surgical metal guide (fabricated using stereolith model). The placement of implant is done from the second molar edentulous space to the third molar edentulous space towards the junction of the following bones (posteroinferior projection of the sphenoid, palatine process, maxillary surface) with distal angulation of 25-45 degrees (depending on the maxillary floor and height of tuberosity). A pilot drill in combination with a final tapered drill (single drill concept) is used to prepare the implant bed, with entry point and angulation guided by the metal template. For the immediate implant loading the torque value should be of >40N should be obtained. Multiunit abutments with a range of lengths (3-5 mm) and angulations (30, 40, 50 degrees) are placed and parallelism obtained. Confirming the postoperative implant position via OPG.

Tulasne[40] demonstrated a technique for pterygoid implant placement using a 22 mm long implant, anchorage to the

maxilla and palate with distal angulation between 35 – 55 degrees. The osteotomes being used for the tactile control and bone preservation and the drills for the preparation of implant bed.[22]

3. Prosthetic level:

Partial or complete arch rehabilitation can be achieved by following a two- step open tray direct impression technique comprising of:

- Splinting of multiunit impression copings followed by putty and light body material.
- Attachment of the multiunit implant analogs to the copings
- Gingival mask is poured around the implant analog
- Final cast is obtained by pouring die stone
- Bite registration, jaw relation, jig trail are recorded and sent to the lab (for CAD CAM designing)
- Metal trial and bisque trial are done (prior to cementation)

The Tall Tilt Pin Hole Immediate Loading Concept (TTPHIL-ALL TILT)

It is a flapless (single drill) technique. An overall radiographic evaluation is necessary which comprises of CBCT, panoramic films with the fabrication of stereolithography models and surgical guides. Further, the dicom images are converted into STL files following which surgical planning is done. Various studies are performed to evaluate the bone density with identification of the anatomical structures, mandating the need for maintaining adequate safety distance from the palatine neurovascular bundle, inferior maxillary artery, pterygoid plexus, distance from alveolar ridge to apical portion of the pterygoid apophysis, nasal cortex, anterior and posterior walls of maxillary sinus. Demarcation of the ideal implant angulation and length are marked along with the entry point and exit point on the sagittal and coronal view (considering the walls of maxillary sinus) following which are reproduced in the stereolith models (used for mock surgery, patient education, fabrication of surgical templates). During the surgical procedure the sleeve is incorporated with the surgical guide to guide the direction of the drill.[41]

Indications [41]

- Edentulous posterior maxillary atrophic ridge
- For Immediate loading (eliminating cantilever)
- Aids in zygomatic implants and short implants
- Failed grafting

Contraindications [29,41,42]

- Severely devitalizing systemic disease
- Inaccessible posterior maxilla
- Reduced mouth opening
- Absence of tuberosity
- Impacted third molars

Conclusion

During the past few years pterygoid implants have gained enormous amount of interests. As the use of these implants aid in the elimination of sinus lifts, bone grafting or zygomatic implants, leading to decrease in an overall cost. Pterygoid implants have a high success rate and minor complications. Therefore, they are considered as a good alternative for atrophic posterior maxillary region.

Declaration of Patient Concent

The authors certify that they have obtained all the appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their/images and other clinical information to be reported in the journal. The patient(s) understand that their name and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be granted.

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