Rehabilitation of the Atrophic Posterior Maxilla With Pterygoid Implants: A Review

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The purpose of this article is to review the literature published and to assess the success of treatment of patients with atrophic posterior maxilla with pterygoid implants. Studies from 1992 to 2009 on patients with atrophic posterior maxilla rehabilitated with pterygoid implants were reviewed. Those reporting clinical series of at least 5 patients with atrophic posterior maxilla (Class IV and V of Cawood and Howell), rehabilitated with pterygoid implants and fixed prosthesis, and with 12 months minimum follow-up were included. In each study the following were assessed: number of patients, number of implants, surgical technique, prosthetic rehabilitation, success rate, bone loss, complications and patient satisfaction. Thirteen articles were included, reporting a total of 1053 pterygoid implants in 676 patients. The weighted average success of pterygoid implants was 90.7%; bone loss evaluated radiographically ranged between 0 and 4.5 mm. No additional complications compared with conventional implants were found, and patient satisfaction level with the prosthesis was high. Pterygoid implants have high success rates, similar bone loss levels to those of conventional implants, minimal complications and good acceptance by patients, being therefore an alternative to treat patients with atrophic posterior maxilla. Two anatomical locations in which implants are placed in the retromolar area can be distinguished: the pterygoid process and the pterygomaxillary region. Implant lengths and angulations vary between these two techniques.

Key Words: pterygoid implants, implants in the pterygomaxillary region and maxillary tuber region

INTRODUCTION

The rear area of the maxillary bone has many limitations for the placement of dental implants,\textsuperscript{1–3} such as poor bone quality and quantity (usually a Class III or IV according to Lekholm and Zarb),\textsuperscript{4,5} the presence of the maxillary sinus, accessibility problems, and the difficult hygiene they entail.\textsuperscript{1,6,7} In addition to these anatomic peculiarities and difficult access, there is high occlusal loading in the molar regions in comparison with other areas, resulting in a lower success rate than elsewhere in the maxillary or the mandible.\textsuperscript{3,5,7}

To solve these problems a variety of procedures have been reported in the literature: bone grafts; sinus lifts; and tilted, zygomatic, and pterygoid implants.\textsuperscript{1,2,7,8} The use of pterygoid implants was described by Tulasne\textsuperscript{9} and subsequently used by many other researchers.\textsuperscript{1–19} They are anchored in the pterygoid; however, in some studies they are placed in a more anterior position, in the pterygomaxillary area and parallel to the posterior wall of the sinus. These implants have advantages over other techniques: They allow anchorage in the posterior atrophied/resorbed maxilla without sinus lifts or bone grafts, achieving stability and high rates of long-term success. In addition, posterior cantilevers can be eliminated and axial loading is improved.\textsuperscript{1,3,5,10}

The aim of this review was to analyze the literature on pterygoid implants, studying surgical technique, prosthetic rehabilitation, success rate, bone loss, complications, and satisfaction level of patients.
MATERIALS AND METHODS

A search was made of PubMed for articles published between 1992 and 2010 using the following key words: “pterygoid implants, pterygomaxillary implants, maxillary tuber region and maxillary tuberosity AND dental implants.” Those reporting a clinical series of at least 5 patients with atrophic posterior maxilla (Class IV and V of Cawood and Howell) rehabilitated with pterygoid implants and fixed prosthesis, and with a minimum of 12 months of follow-up, were included. Of the 30 articles that appeared under “pterygoide implants,” 5 were included; 9 were excluded for not presenting clinical cases or presenting a single case, 7 for taking place before 1992, 4 because their main topic was orthodontics, 4 because they concerned zygomatic implants, and 1 for being a review of the literature. Of the 11 articles found using the keyword “pterygomaxillary implants,” 4 were included; 3 were excluded for being unrelated to the subject of this review, 2 for not presenting clinical cases, 1 for being a review of the literature, and 1 for being already included in a previous search. Of the 6 entries found under “maxillary tuber region,” 1 was included and 5 were excluded because they concerned bone grafts. Finally, of the 35 articles found under the key words “maxillary tuberosity AND dental implants,” 3 were included; 28 were excluded for not concerning the subject of this review, 3 for reporting a single clinical case, and 1 for having been included in a previous search.

In each study the following were assessed: number of patients, number of implants, length of the implants, surgical technique, prosthetic rehabilitation, success rate, bone loss, complications, and patient satisfaction.

RESULTS AND DISCUSSION

Thirteen articles were included, reporting a total of 1053 pterygoid implants in 676 patients. In the articles reviewed, implant lengths ranged from 7 mm to 20 mm. Implants of 7 mm and 8.5 mm were only placed in two studies: Bahat et al placed 1 implant of 7 mm and Balshi et al placed 1 implant 8.5-mm long in the pterygomaxillary region. All the other researchers placed implants with lengths between 10 mm and 20 mm. Shorter implants were inserted in the pterygomaxillary region and longer implants were anchored in the pterygoid process; longer implants were used to compensate for the poor quality of the posterior maxilla and achieve an adequate intraosseous fixation in the pterygoid process. Pterygoid implants had a diameter between 3.75 and 4 mm. The follow-up period lasted between 6 and 123 months. The number of patients, number of implants, lengths, and diameters are detailed in the Table.

Surgical procedure

The literature describes 2 different anatomic locations where pterygoid implants are placed: the pterygoid process (Figure 1) and the pterygomaxillary region (Figure 2). These are frequently not clearly distinguished by authors; however, because

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of the differences between these locations, different implant-placement techniques should be used. Implants are inserted in the pterygoid process using a technique that requires surgical experience and detailed knowledge of anatomy of the area. The implant is anchored in the pterygoid plate of the sphenoid bone, through the maxillary and palatine bones and with distal angulation between 35° and 55°, depending on the maxillary sinus floor and the height of the bone of the tuberosity. The internal maxillary artery crosses 1 cm above the pterygopalatine suture as it enters the pterygopalatine fossa. Therefore, the distance from the artery to the lower end of the pterygopalatine suture is 25 mm. Because of the absence of vital structures in the insertion area, it is a safe working area for the surgeon. Any bleeding in this region will be from the veins of the pterygoid muscle, and it can be stopped quickly once the intraosseous fixation is inserted and will not restart once the implant is stabilized.

The implant site is prepared combining drills and straight osteotomes, according to the technique described by Valerón and Valerón and used by other researchers. The entry point is determined with a round bur. Preparation of the implant bed then starts with the smallest straight osteotome (Figure 3), followed by a pilot drill to establish the direction of the implant axis. Preparation continues with consecutive cylindric osteotomes in combination with drills of increasing diameter (Figure 4).

Implants in the pterygomaxillary region are placed within the maxillary tuberosity, near or parallel to the posterior wall of the sinus. The surgical procedure is similar to that of implants anchored in the pterygoid process, the only difference being the use of curved instead of straight osteotomes (Figure 5). The angle should 10° to 20° degrees to simulate the proper angulation of the third molar. Bahat et al consider it necessary to open the patient’s mouth a minimum of about 35 mm to achieve good implant angulation (Figure 6). The implant site is carved with drills with increasingly larger diameters. However, Valerón et al recommend the use of osteotomes, which preserve more bone and reduce surgical risks, especially hemorrhages. Nocini et al used anatomically modified osteotomes to facilitate access to the maxillary tuberosity area. Peñarrocha et al combined burs and osteotomes to place 68 implants pterygomaxillary region in 45 patients, thus joining the advantages of the 2 techniques: osteotomes minimize surgical risk, preserve more bone, and allow more (tactile) control/feel in such an inaccessible area, whereas drills facilitate the creation of the bed, especially in the dense cortical bone area.

**Success rate**

The success of implants was assessed using Albrektsson’s and Buser’s clinical and radiologic criteria. The weighted average success of pterygoid implants was 90.7%.

Balshi et al reported 3 clinical series of pterygoid implants. In 1995, they made a preliminary study in which 51 pterygoid implants with machined surface were placed in 41 patients with a follow-up period of 1–63 months. The success rate was 86.3%. In 1999, they increased the sample to 356 implants, obtaining a success rate of 88.2% with a follow-up of 54 months. In 2005, they placed 164 pterygoid implants with treated surfaces and, after 54 months of follow-up, observed a success rate that was statistically significantly higher than in previous studies (96.3%).

Vrielinck et al placed 14 pterygomaxillary implants and had a success rate of 71% after an average follow-up of 6–24 months. The failures occurred because the implants did not follow the drilled bed and were therefore out of place. Ridell et
Bone loss was assessed by the following researchers: Peñarrocha and colleagues, Bahat, Ridell and colleagues, Balshi and colleagues, and Park and Cho. Peñarrocha et al assessed bone loss in panoramic radiographs calibrated with CliniView (version 5.1, GE Healthcare Finland Oy, Tuusula, Finland) after the surgery and a year after loading, giving an average marginal bone loss of 0.71 mm. Bahat assessed it in a series of periapical parallelized radiographies before surgery, after the first surgery, after exposing the implants, 6 and 12 months after loading, and every year from then on; the result was an average bone loss of less than 2 mm. Ridell et al calculated bone loss in periapical and panoramic radiographs, measuring the mesial and distal aspects of the implants, and found values between 0 and 3.5 mm in partially edentulous patients and from 0 to 4.5 mm in totally edentulous patients. These authors compared bone loss of implants placed in the maxillary tuberosity and in the anterior area, finding no statistically significant differences after an 8-year follow-up. Balshi et al obtained a mean bone loss of 1.3 mm mesially and 1.1 mm distally, assessing it radiographically at the time of the prosthesis delivery and after 6 to 12 months. Panoramic radiographs were used because the implant position did not allow periapical radiographs to be taken; distortion was calculated using the known dimension of the implant. Park and Cho evaluated bone loss in panoramic radiographs using a distance measurement program (Startpacs). They obtained an average bone loss of 0.93 mm in implants placed in the pterygomaxillary region 6 years after prosthetic loading.

Complications

One of the major surgical risks that may occur during the surgery is bleeding, because of the proximity of the internal maxillary artery, which runs 1 cm above the pterygomaxillary suture; this complication is rare, not having been mentioned in any of the studies reviewed here. Valerón and Valerón described a minor venous bleeding caused by the insertion of the drill a few millimeters into the retropterygoid area. It was resolved with local hemostatic methods.

Krekmanov reported problems when anchoring the implants into the pterygoid process. An implant was lost during placement due to drilling beyond the pterygoid process. Vrielinck et al lost 4 of 6 implants due to problems in placing them in the initially drilled implant bed and having to place them in a different position, which resulted in insufficient bone anchorage.

Satisfaction level

Patient satisfaction level was assessed in 3 studies. Peñarrocha et al used a visual analog scale from 0 to 10 and obtained an 8.9 overall satisfaction; neither discomfort because of the distal extension of
the prosthesis nor difficulties in speech or hygiene were reported. Balshi et al.\textsuperscript{3,6} found that patients tolerated the distal and palatal position of the prosthesis without problems. According to Balshi and colleagues, hygiene in the posterior area is more difficult for patients, and they recommend smoother restorations to prevent plaque accumulation. No implants were lost due to plaque accumulation or gingival hypertrophy in these 2 clinical series.\textsuperscript{3,6} Krekmanov\textsuperscript{14} reported trismus, tension, and pain in the area at the time of prosthesis placement.

**Should implants be placed in the pterygoid process or the pterygomaxillary region?**

The findings in the literature showed no clear differences between pterygoid and pterygomaxillary implants. The classic technique of pterygoid implants was described by Tulasne,\textsuperscript{9} in which implants were anchored in the pterygoid plate, which provides a stable anchor as it is a very dense bone. This technique used 22-mm-long implants. Many researchers have subsequently modified the technique without changing the nomenclature, and increasingly more implants are placed in the pterygomaxillary region without anchorage in the pterygoid process. These implants are shorter and parallel to the posterior wall of the maxillary sinus. Some researchers, including Bahat\textsuperscript{8} and Balshi,\textsuperscript{3,6,10} have placed implants as long as 7 or 8.5 mm in this region. No consensus exists regarding the nomenclature of these implants; it would be interesting to distinguish between the 2 anatomic retromolar locations in which implants are placed, the pterygomaxillary region and the pterygoid process.

**CONCLUSIONS**

Pterygoid implants have high success rates, similar bone loss levels to those of conventional implants, minimal complications, and good acceptance by patients; therefore, they are an alternative for treating patients with atrophic posterior maxilla. Two anatomic locations in which implants are placed in the retromolar area can be distinguished: the pterygoid process and the pterygomaxillary region. Implant lengths and angulations vary between these 2 techniques.

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