Prosthetic Screw Loosening After Immediate Loading of One-Piece Pterygoid Implants with Multi-Unit Abutments in the Atrophic Posterior Maxilla: A Clinical Study

Abstract

Introduction
Implant-supported fixed prostheses are the preferred treatment for restoring missing teeth in the posterior maxilla. In cases of severe atrophy, conventional implant placement becomes difficult, and alternative approaches such as pterygoid implants may be necessary.
Aim of Study: This study aimed to evaluate prosthetic screw loosening and postoperative pain after immediate loading of single-piece pterygoid implants combined with multi-unit abutments in the posterior atrophic maxilla.

Methodology
A prospective, single-group clinical study was conducted on 15 patients (8 males and 7 females; mean age 60.07 years) who received three implants: one pterygoid implant and two compressive implants. All implants were immediately restored with screw-retained prostheses using multi-unit abutments. Postoperative care included antibiotics, analgesics, and chlorhexidine rinses. Follow-up was performed for three months to assess prosthetic complications.

Results
Out of 15 patients, 12 (80%) experienced no complications, while 3 patients (20%) presented with prosthetic screw loosening after three months. The issue was resolved by re-tightening the screws with a torque of 30 N·cm, and no recurrence was observed.

Conclusion
Within the limitations of this study, immediate loading of single-piece pterygoid implants with multi-unit abutments appears to be a reliable option for rehabilitation of the atrophic posterior maxilla. Prosthetic screw loosening may occur as a short-term complication but can be successfully managed with proper torque protocols.

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Keywords

Immediate loading, Multi-unit abutments, Prosthetic screw loosening, Atrophic maxilla, Implant-supported prosthesis.

INTRODUCTION

Implant-supported fixed prostheses represent the optimal treatment option for replacing missing teeth in the posterior region of the maxilla. For patients with severe bone resorption in the maxilla, implant placement becomes difficult, especially when immediate loading is desired (1).
The posterior region of the maxilla poses a challenge for dental implant practitioners in cases of severe bone atrophy and sinus floor collapse due to air pressure. Numerous treatment options have been proposed for implant placement in this region, such as sinus floor lifting, bone grafting, the use of angled or short implants, and zygomatic implants. These treatment options involve additional surgical procedures, increased costs, a longer duration, and immediate loading cannot be applied (2-4).
Advances in dental science, and implantology in particular, have begun to shift toward procedures that are less time-consuming, lower costs, and minimal surgical procedures (5).
Anatomically, the lateral region of the maxillary tuberosity can be used for the placement of dental implants. This region is called the pterygomaxillary region. The use of pterygoid implants began several decades ago, and studies have yielded significant success (6).
In 1989, Tulasne described a method for inserting implants into the pterygoid region and interfacing them with the cortical bone formed by the posterior wall of the maxillary tuberosity, the pyramidal process of the palatine bone, and the pterygoid process of the sphenoid bone (7).
Three separate bones meet in the pterygoid region of the posterior maxilla: the pyramidal process of the palatine bone, the posterior maxilla, and the pterygoid process of the sphenoid bone (8).
All implants used as pterygoid implants were of the traditional two-piece design. Immediate loading remains controversial, and further studies have consistently been recommended to evaluate their success (7).
These pterygoid implants were interesting because of sufficient cortical bone for implant integration, and because they eliminated the need for sinus floor lifting and bone grafting procedures, thus reducing treatment duration and allowing immediate loading over the implant. pterygoid implants also provided the prosthetist with a posterior extension, avoiding the need for posterior cantilever when performing implant prostheses (9).
The pterygoid region is sensitive, dangerous, and difficult to access. Therefore, the insertion technique must be precise, and the method and instruments used must always be the same. The implant's length is essential to avoid cantilever forces resulting from the fixed prosthodontic. The implant's wide threads also improve its interface with the cortical bone, which encourages bone growth along the implant's length and ultimately enhances its stability (10).
The idea is to place an implant that can be inserted in the medial plate of the pterygoid bone after studying the patient's cone-beam scan. This requires high precision, and the implant length is determined by the distance between the alveolar bone entrance of the implant and the corresponding cortical bone to be penetrated. The most common length is 20 mm. In most cases, a longer implant must be chosen to ensure that the implant penetrates or partially penetrates the corresponding cortical bone. This ensures that the implant is not too short and does not reach the corresponding cortical bone (11).
A new design for pterygoid implants has been launched by the Swiss company TRATE. These pterygoid implants have a conical shape with Compressive threads and a self-threading end that is smaller in diameter than the implant, which helps the implant to engage properly upon insertion. Furthermore, they are one-piece implants with a multi-unit abutment (12).
When restoring a full arch with a screw-retained prosthesis, even minor variations in implant angulation can create restorative challenges. Multi-unit abutments (MUAs) can be employed to overcome these challenges, and their use is strongly recommended in full-arch screw-retained restorations. MUAs are designed in a range of angulations and are available for nearly all implant systems. One of their major advantages is that they lower the prosthetic margin closer to the soft tissue surface, thereby facilitating the dentist's clinical procedures (13).
However, their significant drawbacks, in addition to the use of small screws, include occupying considerable space within the prosthesis. The reduced occluso-gingival dimension may compromise the strength of zirconia bridges. Moreover, the screws may require periodic monitoring, which sometimes necessitates removing the prosthesis to re-tighten or replace them (14).
If a screw loosens and fractures, its removal can be highly painful and may even result in bridge fracture. The alternative is to secure the bridge directly onto the implant platform; however, this approach is not feasible for all types of prostheses and implants (15).

Aim of the research

This study aimed to evaluate subsequent pain and the number of analgesic tablets consumed after immediate loading of single-piece pterygoid implants and multi-unit abutments in the posterior region of the atrophic maxilla.

MATERIALS AND METHODS

The study was designed as a prospective, single-group, interventional clinical study. The research sample consisted of 15 patients, representing 15 cases, each with three implants: one pterygoid implant and two compressive implants.
The approval of the Ethics Committee at Damascus

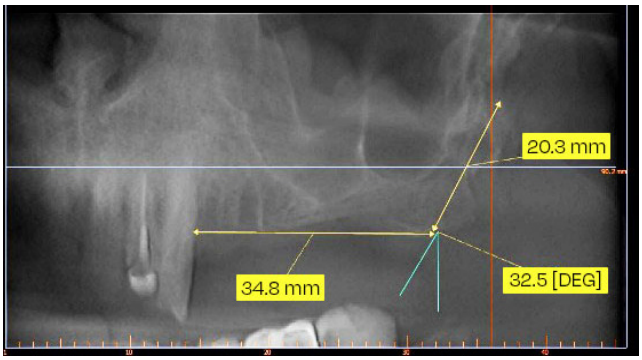

Fig. 1
Planning for pterygoid and Compressive implants.

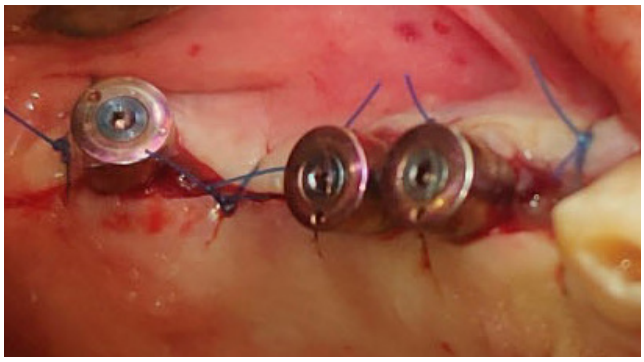

Fig. 2 After the dental implant was placed and sutured were performed.

University was obtained under the number (DN-15042025-H25), and the study was registered in the (ISRCTN-BiomedCentral) database with the identifier (ISRCTN77752182) and the link (https://www.isrctn.com/ISRCTN77752182).

The research sample was selected from patients attending to the Oral and Maxillofacial Surgery clinic in the Damascus University. These patients, aged between 49 and 78 years, had unilateral maxillary posterior dentition loss, and were found to be unsuitable for conventional implant placement.

The study was conducted in the dental implant clinic within the Department of Oral and Maxillofacial Surgery at the Faculty of Dentistry at Damascus University between 2022 and 2025. After informing the patients of the purpose and nature of the study in written and verbal form, ensuring their understanding and answering their questions, written informed consent was obtained from the patients participating in the study.

For the inclusion criteria, the patient should have good oral health and a history of tooth loss in the premolar and molar regions of the maxilla. The height of the alveolar ridge between the crest of the alveolar bone and the floor of the maxillary sinus should be less than 4 mm, with a vestibular bone width in the premolar region greater than 4 mm.

The inferior angle of the anterior wall of the maxillary sinus must be anterior to the second premolar. Additionally, the last extraction in the included area must have occurred more than two months ago, and there should be sufficient occlusal space for prostheses. The patient's consent must be obtained after a full explanation of the research procedures.

For the exclusion criteria, the patient should not have any metabolic diseases affecting normal bone metabolism, such as hyperparathyroidism or osteoporosis. Patients with bruxism should be excluded. The patient must not be on medications that cause bone metabolism disorders, such as corticosteroids, hormonal treatments, or chemotherapy, and should not have received radiation therapy to the face or neck. Finally, the patient must not have any contraindications due to systemic diseases such as leukemia or coagulation disorders.

Methods

A. *Preoperative Stage:* A CBCT scan should be performed before beginning the surgery. This will help verify measurements and dimensions, ensuring accurate planning of the surgical procedure (Fig. 1).

B. *Surgical Procedure:* The mouth was disinfected using a 0.12% chlorhexidine rinse, and the perioral skin was cleaned with a polyvidone iodine solution. Local infiltration anesthesia was administered using Lidocaine 2% with Adrenaline (1:80,000) in the premolar and maxillary canine regions, where the Compressive implant would be placed. Nerve block anesthesia was then performed using Lidocaine 2% with Adrenaline (1:80,000) in the tuberosity region, where the pterygoid implant would be located.

A full-thickness vestibular mucoperiosteal envelope flap was created to minimize healing time. The flap was carefully elevated while preserving the periosteum, ensuring an optimal healing process.

After exposing the alveolar bone, the implants' sites were prepared according to the protocol followed in this study: two compressive implants. Root m implants range in length from 8-12 mm and diameters from 3.5-4 mm, and Root pterygoid implants are placed in the posterior maxillary sinus area with the implant tilted at an angle ranging from 15-45°. Implant diameters range from 3.5-4.5 mm and lengths from 18-20 mm.

For Compressive implants, the initial drill is used to drill the cortical bone. Then, we move on to a pilot drill with a diameter of 2 mm. This completes the preparation for implants with a diameter less than 4 mm. For implants with a diameter of 4 mm, we prepare a second drill with a diameter of 2.5 mm the implant is then inserted manually with the implant insertion tool, ensuring that the insertion torque is 35 N·cm.

For pterygoid implants, we begin with a hand drill to determine the desired angle of drilling. We then move on to a 2 mm pilot drill, completing the preparation for 3.5 mm implants. For 4.5 mm implants, we prepare a second 2.5 mm drill, the implant is then inserted using an implant insertion tool, ensuring that

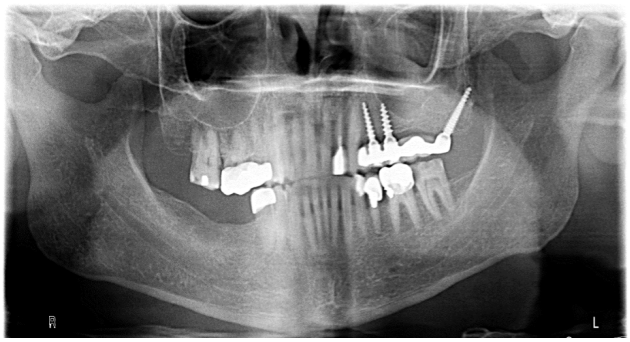

Fig. 3

the insertion torque is greater than 35 N·cm.
After the three implants are inserted with an insertion torque greater than 35 N·cm, the gingival flap is then repositioned and sutured around the abutments. The implant transfer is then placed and impressions is taken using rubber. The impressions are sent to the lab for prosthetics (ceramic on metal). The healing abutments is then placed on the multi-unit abutments (Fig. 2). In order to minimize potential complications in the pterygoid region, careful preoperative planning was carried out using CBCT to evaluate bone height and anatomical structures (Fig. 3). The osteotomy entry was initiated using a manual drill at the planned angulation, following the contour of the maxillary tuberosity, until contact with the pterygoid plate was achieved; the osteotomy was then completed using a surgical motor. A flapless technique was avoided in this region to ensure direct visualization and control of the surgical field. Drilling was performed at low speed (initially manual and then 600 rpm using a surgical motor) under copious irrigation to minimize the risk of overheating and to preserve bone viability. These measures were adopted to reduce intraoperative bleeding, prevent neurovascular injury, and enhance implant stability (Amin et al., 2021; Chrcanovic & Abreu, 2020; Aparicio et al., 2014).

C. *Postoperative Care:* The patient was advised to avoid rinsing the mouth on the first day following surgery. Cold compresses should be applied to the cheek on the surgical site immediately after the procedure, alternating every 4 hours for the first few hours. An analgesic may be taken if necessary to manage pain.
Oral hygiene procedures should begin the day after surgery. The patient was prescribed the following medications: amoxicillin 875 mg + clavulanic acid 125 mg every 12 hours, and diclofenac potassium 50 mg as needed for pain, not to exceed 150 mg per day. Additionally, a 0.12% chlorhexidine mouthwash should be used twice daily (for 60 seconds) for 7 days, starting the day after surgery.

D. *Prosthetics Phase:* After completing the suturing, the implant abutments are placed, and an impression is immediately taken using a condensation silicone material in a single stage. The following day, a verification jig is prepared by attaching the implant abutments to the stone model using pattern resin, and the jig is tested in the patient's mouth to verify the accuracy of the impression. Next, the metal framework for the restoration is designed and 3D-printed using laser technology. The metal framework is then tried in to ensure it fits accurately onto the abutments and the gingiva. The bridge is then veneered without glazing and tried again to adjust the occlusion, ensuring that each tooth has 3 to 4 contact points without any premature contacts, and that the restoration is in proper contact with the gingiva. Finally, the restoration is glazed and fixed with screws tightened to 15 N·cm, according to the manufacturer's instructions. The screw holes are sealed with composite material, and a Teflon barrier is placed. All prosthetic steps should be completed within seven days of surgery (Fig. 4).

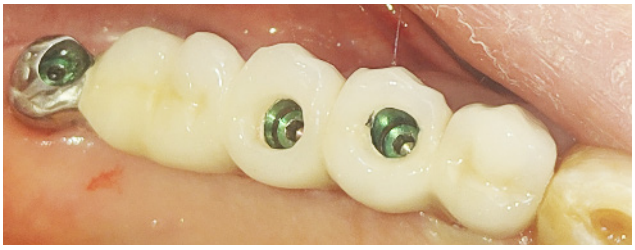

Fig. 4 Immediate final prosthesis was placed on the three implants, screws retained.

RESULTS

The study sample included 15 patients, with 15 wing implants and 30 compressive implants. The mean age was 60.07 years, with 8 males and 7 females.
Descriptive Statistics of Prosthetic Complications
The frequencies of prosthetic screw loosening after three months in the studied sample were recorded, and the results are presented in Table 1.
The results presented in Table 1 indicate the occurrence of screw loosening after three months in three cases (20%), whereas no prosthetic complications were observed in the remaining studied cases.

DISCUSSION

Pterygoid implants are considered an effective surgical option for the rehabilitation of edentulous maxillae, particularly in cases where sinus augmentation or extensive bone grafting is to be avoided. Nevertheless,

Prosthetic complications	Number of patients	%
No complications	12	80%
Screw loosening after 3 months	3	20%
Total	15	100%

Tab. 1 Percentages of prosthetic screw loosening after three months in the studied patients.

these implants are not free from risks, as several studies have reported the occurrence of both surgical and prosthetic complications that may affect treatment success. The literature indicates that surgical complications associated with pterygoid implants include bleeding, trismus, pain, and neurosensory disturbances such as temporary paresthesia. One study reported that severe bleeding could result from vascular injury in the pterygoid region, necessitating surgical intervention to control the hemorrhage (16).

Furthermore, a comparative study between pterygoid and tuberosity implants demonstrated a lower survival rate in pterygoid implants, suggesting that surgical complications may be more frequent in these cases (17).

With regard to prosthetic complications, the literature has highlighted potential challenges in prosthetic design when using pterygoid implants, particularly in techniques such as All-on-4. These approaches demand complex designs for crowns and bridges, which may increase the risk of prosthetic failure if not meticulously planned and executed.

In the present study, the prosthetic design was relatively simple, consisting of a single pterygoid implant in combination with two Compressive implants on one side of the maxilla. This approach reduced the likelihood of subsequent prosthetic complications. Immediate loading was applied using multi-unit abutments, which facilitated the delivery of an optimal screw-retained prosthesis.

The only prosthetic complication observed was screw loosening in three patients (20%) during the three-month follow-up period. This issue was managed by re-tightening the screws with an insertion torque of 20 N·cm. None of these cases experienced recurrence of the complication, which may be attributed to the increased insertion torque applied during screw fixation.

Xu (16) demonstrated that re-torquing the abutment screw approximately 10 minutes after the initial tightening significantly reduces the loss of preload caused by the settling effect, which is a well-known mechanical reason for screw loosening. This additional re-torquing step enhances the stability of the implant–abutment connection (18).

Similarly, Alsubaiy (19) highlighted that applying a torque value of 32 N·cm followed by re-torquing after 10 minutes is a reliable clinical protocol to maintain preload over time. Such recommendations align with biomechanical strategies designed to prevent prosthetic screw loosening in implant prosthodontics.

CONCLUSION

Within the limitations of this study, immediate loading of single-piece pterygoid implants with multi-unit abutments appears to be a reliable option for rehabilitation of the atrophic posterior maxilla. Prosthetic screw loosening may occur as a short-term complication but can be successfully managed with proper torque protocols.

Funding

This research has no funder.

Data availability

The authors can provide data on demand.

Ethics approval and consent to participate

The approval of the Ethics Committee at Damascus University was obtained under the number (DN-15042025-H25), and the study was registered in the (ISRCTN-BiomedCentral) database with the identifier (ISRCTN77752182) and the link (https://www.isrctn.com/ISRCTN77752182). All patients signed informed consent before they were included in the study sample.

Competing interests

The authors declare no conflict of interest.

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