RESEARCH PAPER

A comprehensive evaluation of success rate and complications in pterygoid implant placement in posterior maxilla- a clinico-radiographic study

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Abstract

Background

Rehabilitation of the atrophic posterior maxilla remains a major challenge because of inadequate residual bone height, poor bone quality, and maxillary sinus pneumatization. Although sinus augmentation has traditionally been the treatment of choice, it increases surgical morbidity, treatment duration, and cost. Pterygoid implants provide a graftless alternative by engaging the dense cortical bone of the pterygoid process, allowing rehabilitation without sinus augmentation.

Aim: To evaluate the clinical and radiographic success of pterygoid implant placement and assess postoperative complications in patients with atrophic posterior maxilla.

Materials and Methods:A prospective clinico-radiographic study was conducted on 15 patients requiring implant-supported rehabilitation of the posterior maxilla. All patients underwent pterygoid implant placement using a standardized surgical protocol. Clinical parameters including pain, swelling, trismus, bleeding, infection, implant mobility, and other postoperative complications were evaluated at predetermined follow-up intervals. Radiographic assessment was performed to evaluate implant position, osseointegration, and peri-implant bone changes. Statistical analysis was performed using appropriate tests, with $p < 0.05$ considered statistically significant.

Results: Fifteen patients successfully underwent pterygoid implant placement. Clinical evaluation demonstrated excellent implant stability throughout the follow-up period, with no implant mobility observed. Postoperative swelling and trismus showed progressive improvement, while bleeding resolved completely during follow-up. No cases of postoperative infection, oroantral fistula, implant fracture, or maxillary tuberosity fracture were recorded. Radiographic evaluation confirmed satisfactory implant positioning, successful osseointegration, and stable peri-implant bone levels, indicating a high clinical success rate.

Conclusion: Pterygoid implants represent a predictable and effective graftless treatment modality for rehabilitation of the atrophic posterior maxilla. High implant stability, favorable radiographic outcomes, and a low complication rate support their use as a reliable alternative to sinus augmentation in appropriately selected patients.

Keywords: Pterygoid implant; Posterior maxilla; Atrophic maxilla; Implant survival; Implant complications; Clinico-radiographic study.

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Introduction

Implant-supported rehabilitation of the posterior maxilla remains one of the most challenging procedures in oral implantology because of progressive alveolar bone resorption, poor bone quality, and maxillary sinus pneumatization following tooth loss. These anatomical limitations often compromise the placement of conventional implants with adequate length and primary stability, necessitating advanced surgical procedures such as sinus floor elevation, onlay bone grafting, zygomatic implants, or short implants. Although these techniques have demonstrated predictable outcomes, they are associated with increased surgical complexity, prolonged treatment duration, higher cost, donor-site morbidity, and a greater risk of complications.

To overcome these limitations, graftless implant rehabilitation techniques have gained increasing acceptance. Among these, pterygoid implants have emerged as a reliable treatment modality for restoring the atrophic posterior maxilla. First introduced by Tulasne in 1989, pterygoid implants are placed through the maxillary tuberosity, traversing the pyramidal process of the palatine bone to engage the dense cortical bone of the pterygoid process of the sphenoid bone. This bicortical or tricortical anchorage provides excellent primary stability while avoiding sinus augmentation procedures and distal cantilevers.

The biomechanical advantages of pterygoid implants include improved anteroposterior spread of implant-supported prostheses, favorable distribution of occlusal forces, reduction in cantilever length, and the possibility of immediate or early loading. Engagement of dense cortical bone contributes to high insertion torque and enhanced implant stability, making pterygoid implants particularly suitable for rehabilitation of severely resorbed posterior maxillae. Furthermore, advances in

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cone-beam computed tomography (CBCT), digital treatment planning, guided surgery, and dynamic navigation have significantly improved the accuracy and predictability of implant placement in the pterygomaxillary region.

Several clinical studies have demonstrated high survival rates for pterygoid implants, generally exceeding 90%, with favorable long-term functional and prosthetic outcomes. In addition to eliminating the need for sinus grafting, pterygoid implants reduce overall treatment time, patient morbidity, and the number of surgical interventions. Despite these advantages, the procedure remains technically demanding because of the complex anatomy of the pterygomaxillary region and its close relationship to the maxillary artery, pterygoid venous plexus, and adjacent neurovascular structures. Consequently, a thorough understanding of regional anatomy, meticulous surgical technique, and careful patient selection are essential to minimize complications and optimize clinical outcomes.

Postoperative complications such as pain, swelling, trismus, bleeding, sinus membrane perforation, implant malposition, and peri-implant bone loss have been reported in the literature, although their incidence remains relatively low in experienced hands. Radiographic assessment also plays a vital role in evaluating implant positioning, osseointegration, cortical engagement, and peri-implant bone changes during follow-up. However, prospective studies comprehensively evaluating both clinical and radiographic outcomes of pterygoid implants remain limited, particularly in the Indian population.

Therefore, the present prospective clinico-radiographic study was undertaken to evaluate the success rate and postoperative complications associated with pterygoid implant placement in patients with atrophic posterior maxilla. Clinical parameters including pain, swelling, trismus, bleeding, implant mobility, and postoperative complications were assessed along with radiographic evaluation of implant positioning and osseointegration during follow-up. The findings of this study aim to provide further evidence regarding the safety, predictability, and clinical effectiveness of pterygoid implants as a graftless treatment option for rehabilitation of the atrophic posterior maxilla.

Materials and Methods

Study Design

A prospective clinico-radiographic study was conducted in the Department of Oral and Maxillofacial Surgery, I.T.S Dental College,Hospital & Research Centre, Greater Noida, Uttar Pradesh, India, after obtaining approval from the Institutional Ethics Committee. The study was carried out in accordance with the principles of the Declaration of Helsinki, and written informed consent was obtained from all participants before enrollment.

Study Population

The study included 15 patients requiring implant-supported rehabilitation of the atrophic posterior maxilla. Patients were selected from those attending the outpatient department based on predefined inclusion and exclusion criteria.

Inclusion Criteria

- Patients aged 18 years or older.
- Partially or completely edentulous posterior maxilla requiring implant-supported prosthetic rehabilitation.
- Adequate bone width to accommodate a pterygoid implant.
- Ability and willingness to undergo surgery and comply with follow-up visits.
- Patients who provided written informed consent.

Exclusion Criteria

- Patients younger than 18 years.
- Uncontrolled systemic diseases contraindicating implant surgery.
- Active maxillary sinus pathology.
- History of radiotherapy involving the maxillofacial region.
- Pregnancy or lactation.
- Poor oral hygiene or inability to maintain postoperative care.
- Heavy smokers or patients with parafunctional habits compromising implant prognosis.

Preoperative Assessment

All patients underwent comprehensive clinical examination and radiographic evaluation. Diagnostic imaging included panoramic radiography and cone-beam computed tomography (CBCT) to assess residual alveolar bone height and width, maxillary sinus anatomy, bone quality, and the morphology of the pterygomaxillary region. Appropriate implant length, diameter, and angulation were determined during preoperative planning.

Surgical Procedure

All surgical procedures were performed under local anesthesia using 2% lignocaine with 1:100,000 epinephrine under strict aseptic conditions. A crestal incision with appropriate releasing incisions was placed to expose the posterior maxillary alveolar ridge and maxillary tuberosity.

Sequential osteotomy preparation was carried out following the manufacturer's drilling protocol. The implant osteotomy was directed approximately 45°–60° relative to the occlusal plane toward the pterygoid process of the sphenoid bone, ensuring bicortical or tricortical engagement. Pterygoid implants measuring 17–25 mm in length and 3.75–4.2 mm (mean:3.6 mm) in diameter were inserted, ensuring bicortical engagement of the pterygoid process. Insertion torque values of ≥35 Ncm were recorded in all cases, confirming satisfactory primary stability. Implant positioning was verified clinically and radiographically.

Following implant placement, flap closure was achieved using interrupted 3-0 black silk sutures.

Postoperative Care

Patients received standard postoperative instructions and were prescribed antibiotics, analgesics, and antiseptic mouth rinse according to the departmental protocol. Sutures were removed after one week, and patients were recalled for scheduled follow-up examinations.

Outcome Measures

Patients were evaluated clinically and radiographically at 1 week, 1 month, and 3 months after surgery.

The primary outcome was implant success, assessed by:

- Clinical implant stability (Glickman mobility index)
- Absence of pain or tenderness
- Absence of peri-implant infection
- Functional implant loading
- Radiographic evidence of osseointegration
- Secondary outcomes included:
- Postoperative pain
- Swelling
- Trismus
- Bleeding
- Infection
- Maxillary tuberosity fracture
- Implant fracture
- Oroantral communication/fistula
- Peri-implant bone changes on radiographic evaluation

Radiographic Evaluation

Radiographic assessment was performed using panoramic radiographs and CBCT when indicated to evaluate implant angulation, cortical engagement, peri-implant bone levels, and evidence of osseointegration. Implant positioning and surrounding bone changes were compared during follow-up.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics software. Descriptive statistics were calculated for all variables. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Appropriate statistical tests, including the Friedman test for repeated clinical measurements, were used where applicable. A p-value <0.05 was considered statistically significant.

Results

Patient Characteristics

A total of 15 patients requiring rehabilitation of the atrophic posterior maxilla with pterygoid implants were included in this prospective clinico-radiographic study. All patients completed the scheduled follow-up visits, and no patient was lost to follow-up. Implant placement was successfully performed in all enrolled patients without any major intraoperative complications.

Clinical Evaluation

- Implant Stability

Clinical assessment using the Glickman mobility index demonstrated that all implants remained Grade 0 (no clinical mobility) throughout the follow-up period, indicating successful osseointegration and excellent implant stability.

- Postoperative Swelling

At the 1-week follow-up, 9 patients (60%) presented with mild postoperative swelling, whereas 6 patients (40%) showed no clinically detectable swelling. Swelling resolved progressively, and no patient demonstrated swelling at the 1-month or 3-month follow-up visits.

Table 1. Postoperative Swelling

Follow-up	Mild swelling	No swelling
1 Week	9 (60%)	6 (40%)
1 Month	0	15 (100%)
3 Months	0	15 (100%)

- Bleeding

Postoperative bleeding was minimal and managed conservatively. At both the 1-month and 3-month follow-up, all patients (100%) showed complete resolution of bleeding, with no delayed hemorrhagic complications.

- Trismus

Maximum mouth opening showed a transient postoperative reduction during the early healing period, followed by progressive improvement at subsequent follow-up visits. Statistical analysis using the Friedman test demonstrated a statistically significant improvement in mouth opening ($p < 0.05$) over time, indicating gradual recovery of mandibular function.

- Postoperative Complications

No major postoperative complications were observed during the study period. Specifically:

No implant mobility

No postoperative infection

No maxillary tuberosity fracture

No implant fracture

No oroantral communication or fistula

No implant failure during follow-up

Table 2. Postoperative Complications

Complication	Number of patients (%)
Infection	0 (0%)
Implant mobility	0 (0%)
Implant fracture	0 (0%)
Maxillary tuberosity fracture	0 (0%)
Oroantral fistula	0 (0%)

- Radiographic Evaluation

Radiographic assessment demonstrated satisfactory implant positioning with successful bicortical/tricortical engagement in all cases. Progressive osseointegration was evident during follow-up without radiographic evidence of peri-implant radiolucency or pathological bone loss. Peri-implant bone levels remained stable throughout the observation period, confirming favorable healing and successful implant integration.

Summary of Findings

The present study demonstrated a 100% clinical implant survival during the study follow-up. Excellent implant stability, absence of major complications, satisfactory radiographic osseointegration, and progressive resolution of postoperative morbidity indicate that pterygoid implants are a predictable treatment option for rehabilitation of the atrophic posterior maxilla.

Discussion

The rehabilitation of the atrophic posterior maxilla continues to be one of the most challenging aspects of implant dentistry because of reduced alveolar bone height, maxillary sinus pneumatization, and compromised bone quality. Conventional treatment options, including sinus floor elevation and bone grafting procedures, have demonstrated predictable outcomes but are associated with increased treatment time, surgical morbidity, patient discomfort, and additional financial burden. Pterygoid implants have emerged as a graftless alternative that utilizes the dense cortical bone of the pterygoid process to achieve excellent primary stability while avoiding sinus augmentation. The present prospective clinico-radiographic study evaluated the clinical and radiographic outcomes of pterygoid implant placement in patients with atrophic posterior maxilla and demonstrated encouraging short-term results. In the present study, all pterygoid implants remained clinically stable throughout the follow-up period, with no implant mobility detected using the Glickman mobility index, indicating successful osseointegration. These findings are consistent with those reported by Balshi et al., Rodriguez et al., and more recent systematic reviews, which have demonstrated high survival rates for pterygoid implants when appropriate case selection and surgical technique are employed. The dense cortical engagement achieved within the pterygoid process contributes significantly to primary stability, thereby enhancing the predictability of treatment. Postoperative complications observed in the present study were minimal. Mild postoperative swelling was evident in 60% of patients at one week but resolved completely by the one-month follow-up. Similarly, postoperative bleeding was minimal and resolved uneventfully during healing. These findings are comparable to previous clinical studies, which have reported that postoperative edema and minor bleeding are expected inflammatory responses following implant surgery and usually subside with appropriate postoperative care. Maximum mouth opening demonstrated an initial reduction during the immediate postoperative period, followed by progressive improvement over time. Statistical analysis revealed a significant improvement in mouth opening during follow-up ($p < 0.05$), indicating satisfactory functional recovery. Temporary trismus following pterygoid implant placement is likely related to surgical manipulation of the posterior maxillary tissues and adjacent musculature. Similar observations have been documented in previous prospective studies, where mandibular function returned to baseline within a few weeks after surgery. No cases of postoperative infection, implant fracture, maxillary tuberosity fracture, or oroantral communication were encountered in the present study. The absence of these complications may be attributed to meticulous surgical planning, careful execution of the surgical protocol, strict aseptic technique, and appropriate postoperative management. The use of preoperative CBCT imaging facilitated accurate assessment of regional anatomy and optimal implant trajectory, thereby minimizing the risk of intraoperative and postoperative complications. Radiographic evaluation demonstrated satisfactory implant positioning with stable peri-implant bone levels and successful osseointegration throughout the follow-up period. Bicortical or tricortical anchorage within the pterygomaxillary region provides excellent mechanical stability and contributes to favorable stress distribution. These radiographic findings support previous reports that have highlighted the biomechanical advantages of pterygoid implants in patients with severe posterior maxillary atrophy. The clinical implications of the present study are noteworthy. Pterygoid implants eliminate the need for sinus augmentation and bone grafting procedures in appropriately selected patients, thereby reducing overall treatment duration, surgical morbidity, and treatment costs. In addition, distal implant support reduces prosthetic cantilever length and improves force distribution across implant-supported prostheses. Consequently, pterygoid implants represent a valuable treatment option for rehabilitation of the severely resorbed posterior maxilla. Despite these encouraging findings, the present study has certain limitations. The sample size was relatively small (15 patients), and the duration of follow-up was limited. Long-term studies involving larger patient populations and multicenter clinical trials are required to further validate the long-term survival, prosthetic success, and biological outcomes of pterygoid implants. Future studies incorporating patient-reported outcome measures, resonance frequency analysis, three-dimensional bone level assessment, and comparisons with alternative treatment modalities such as sinus augmentation or zygomatic implants would provide additional evidence regarding the effectiveness of this treatment approach. Within the limitations of the present study, pterygoid implant placement demonstrated excellent clinical stability, favorable radiographic outcomes, and minimal postoperative complications. These findings support the use of pterygoid implants as

a predictable and effective graftless treatment modality for rehabilitation of the atrophic posterior maxilla.

Conclusion

Within the limitations of this prospective clinico-radiographic study, pterygoid implants demonstrated excellent clinical stability, favorable radiographic outcomes, and minimal postoperative complications in the rehabilitation of the atrophic posterior maxilla. All implants remained clinically stable throughout the follow-up period, with successful osseointegration and no major biological or mechanical complications. Mild postoperative swelling and transient trismus resolved progressively during healing, while no cases of postoperative infection, implant fracture, maxillary tuberosity fracture, or oroantral communication were observed. The findings suggest that pterygoid implant placement is a predictable, safe, and effective graftless treatment modality for posterior maxillary rehabilitation when performed with careful patient selection, meticulous surgical technique, and appropriate postoperative follow-up. Long-term prospective studies involving larger sample sizes are recommended to further validate these encouraging clinical outcomes.

Clinical Significance

Pterygoid implants provide a reliable alternative to sinus augmentation procedures in patients with severely resorbed posterior maxillae. By engaging the dense cortical bone of the pterygoid process, they achieve excellent primary stability while reducing surgical morbidity, treatment duration, and overall treatment cost. The favorable clinical and radiographic outcomes observed in the present study support their incorporation into routine implant practice for appropriately selected patients.

Study Limitations

- Small sample size (15 patients).
- Short follow-up period.
- Single-center study.
- Lack of a comparison group (e.g., sinus lift or zygomatic implants).
- Long-term prosthetic outcomes and patient-reported outcome measures were not evaluated.

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Conflict of Interest

The authors declare that there are no conflicts of interest related to this study.

Ethical Approval

The study protocol was approved by the Institutional Ethics Committee of I.T.S Dental College,Hospital & Research Centre, Greater Noida. Written informed consent was obtained from all participants prior to enrollment.

Author Contributions:

Sushil Hajare: Conceptualization, data collection, clinical procedures, statistical analysis, manuscript drafting.

Himanshu Bhutani: Study design, clinical supervision, manuscript review, final approval.

Shashidevi Haranal: Methodology, supervision, critical revision of the manuscript.

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