Dentistry 3000

Vol 13, No 1 (2025)
ISSN 2167-8677 (online)
DOI 10.5195/d3000.2025.1063

Survival of Immediate-Loaded Pterygoid Implants with Multi-Unit Abutments in the Atrophic Posterior Maxilla

Mohamad Droubi, Mazen Zenati

Faculty of Dentistry, Damascus University, Damascus, Syria

Abstract

Objective: Rehabilitation of the atrophic posterior maxilla is challenging due to insufficient bone quantity and quality. Conventional approaches, such as sinus floor elevation or onlay bone grafting, are associated with higher morbidity, longer treatment times, and increased complications. Pterygoid implants offer a less invasive alternative, utilizing dense cortical bone in the pterygoid apophysis and posterior maxillary tuberosity to provide distal anchorage and full-arch prosthetic support, while avoiding the need for sinus augmentation. Clinical evidence indicates high survival rates, making them a reliable option for posterior maxillary rehabilitation. **Materials and Methods:** This prospective clinical study included 15 patients (aged 49–78 years) with unilateral posterior maxillary tooth loss that was unsuitable for conventional implants. Each patient received one pterygoid implant and two compressive implants. Preoperative planning included CBCT scans. Surgical procedures involved flap elevation, precise drilling, and manual insertion with high insertion torque. Immediate prosthetic loading was performed within seven days. Postoperative care included antibiotics, analgesics, chlorhexidine mouthwash, and oral hygiene instructions. Implant failure was defined as detectable mobility or conditions requiring removal. **Results:** All 45 implants (15 pterygoid and 30 compressive) survived over the 12-month follow-up, with no failures observed at 3, 6, or 12 months. Survival rates were 100% for both implant types, and no differences were noted across follow-up periods. **Conclusions:** Pterygoid implants demonstrate high survival rates and represent a predictable, minimally invasive option for posterior maxillary rehabilitation. Proper preoperative planning and surgical expertise are essential, and further long-term studies are recommended to confirm standardized protocols and durability.

Open Access

Citation: Droubi M, et al. (2025) Survival of Immediate-Loaded Pterygoid Implants with Multi-Unit Abutments in the Atrophic Posterior Maxilla. Dentistry 3000. 1:a001 doi:10.5195/d3000.2025.1063
Received: October 3, 2025
Accepted: October 15, 2025
Published: November 4, 2025

Email: Mohamad.salah.droubi@gmail.com

Introduction

Rehabilitation of the atrophic posterior maxilla remains one of the most challenging cases of implant dentistry due to the amount and quality of bone that is missing in this location [1,2]. Conventional treatment strategies, such as onlay bone grafting or elevation of the sinus floor, have been widely utilized to circumvent these anatomical deficits. Though these methods have been able to provide adequate bone volume to accommodate implant placement, they are typically associated with increased surgical morbidity, higher treatment cost, longer treatment time, and a high incidence of intra- and postoperative complications, including sinus membrane perforation and graft resorption. Such drawbacks have prompted the development of alternative treatments that can bypass the utilization of complex grafting protocols [3].

Among such alternatives, the use of extramaxillary anchorage, particularly zygomatic implants, has been the subject of significant interest. Zygomatic implants have the advantage of involving the engagement of the zygomatic bone, thereby offering stability in the presence of severe maxillary resorption [4,5]. However, the procedure is technically demanding, involves specific training, specialized equipment, and has increased rates of complications such as sinusitis, paresthesia, or oroantral communication. Due to these limitations, pterygoid implants are a valuable and less invasive choice for posterior maxillary rehabilitation [6,7].

Pterygoid implants, first introduced some decades back, take advantage of the dense cortical bone of the pterygoid apophysis and posterior maxillary tuberosity. Their anatomical location provides space to place long implants that can provide excellent posterior

Vol 13, No 1 (2025) DOI 10.5195/d3000.2025.1063

support, skipping sinus augmentation procedures altogether [8,9]. Moreover, they provide for distal anchorage that allows for full-arch prosthetic rehabilitation even when severely atrophic maxillae are present. This singular biomechanical feature shortens cantilever lengths in prostheses and improves load distribution, possibly leading to better long-term results [10].

Clinical outcomes and survival rates of pterygoid implants have been examined by an increasing volume of literature over the last decade. Araujo et al. (2019), in arguably the most comprehensive systematic review to date, had a survival rate of 94.9% from pooled estimates of different clinical studies and demonstrated the stability of this treatment modality. Similarly, Bidra (2023) was at 95.5%, highlighting that pterygoid implants are capable of providing outcomes comparable with conventional implants placed in more favorable anatomical locations. These results further support their role as a trustworthy treatment option [3,6]. Later studies have confirmed these. D'Amario et al. (2024) and Raouf and Chrcanovic (2024) provided meta-analytic evidence of 97% to 99% survival, further supporting the role of pterygoid implants as a high-survival treatment. Their evaluations also revealed that survival outcomes are similar across different follow-up periods, though with slight discrepancies due to differences in study design, experience of operators, and patient selection criteria [10,11].

On the other hand, future clinical evidence remains somewhat restricted. The early results, as noted by Mirdah et al. (2025), were good in terms of early survival rates but also highlighted that anatomical challenge, bone quality, and factors related to the patient—oral hygiene compliance and health in general—still play a major role in long-term predictability. This means that while pterygoid implants are predictable, they must be carefully planned preoperatively, and technically skilled surgical capability must be employed in order to attain the best results [12].

Collectively, the literature has shown pterygoid implants to be a reliable, minimally invasive option for sinus augmentation procedures during the rehabilitation of the atrophic posterior maxilla. Their survival rate is consistently reported to be greater than 94%, with many of these studies attaining or surpassing 97–99% [10,11]. These findings compare well with conventional implant therapy and highlight the potential of pterygoid implants to reduce treatment complexity, morbidity, and overall rehabilitation time intervals. Nonetheless, disparity in success reported highlights the need for discerning patient selection, strict attention to particular surgical protocols, and follow-up over the long term. Subsequent investigations with a focus on standardized surgical techniques, multicenter randomized controlled trials, and extended follow-up periods will be significant to establish conclusive results regarding their predictability and late outcome.

This study aimed to evaluate the survival rates of pterygoid implants 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 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 the Oral and Maxillofacial Surgery clinic at 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 had to 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 was obtained after a full explanation of the research procedures.

For the exclusion criteria, patients with any metabolic diseases affecting normal bone metabolism, such as hyperparathyroidism or osteoporosis were not included. Patients with bruxism should be excluded. Also, no patients on medications that caused bone metabolism disorders, such as corticosteroids, hormonal treatments, or chemotherapy, and patients receiving radiation therapy to the face or neck were not included. Finally, patients that had any contraindications to implants due to systemic diseases such as leukemia or coagulation disorders were not included.

A CBCT scan was performed before beginning the surgery. This was to verify measurements and dimensions, ensuring accurate planning of the 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 ranged in length from 8-12 mm and diameters from 3.5-4 mm, and Root p implants were placed in the posterior maxillary sinus area with the implant tilted at an angle ranging from 15-45°. Implant diameters range from 3.5 to 4.5 mm and lengths from 18-20 mm.

For compressive implants, the initial drill was used to drill the cortical bone. Then, we moved on to a pilot drill with a diameter of 2 mm. This completed the preparation for implants with a diameter less than 4 mm. For implants with a diameter of 4 mm, we prepared a second drill with a diameter of 2.5 mm. The implant was then inserted manually with the implant insertion tool, ensuring that the insertion torque is 35 N cm.

For pterygoid implants, we began with a hand drill to determine the desired angle of drilling. We then moved on to a 2 mm pilot drill, completing the preparation for 3.5 mm implants. For 4.5 mm implants, we prepared a second 2.5 mm drill, the implant was then inserted using an implant insertion tool, ensuring that the insertion torque is greater than 35 N cm.

After the three implants were inserted with an insertion torque greater than 35 N cm, the gingival flap was then repositioned and

Vol 13, No 1 (2025) DOI 10.5195/d3000.2025.1063

sutured around the abutments. The implant transfer was then placed, and impressions were taken using rubber. The impressions were sent to the lab for prosthetics (ceramic on metal). The healing abutments were then placed on the multi-unit abutments.

The patient was advised to avoid rinsing the mouth on the first day following surgery. Cold compresses could be applied to the cheek on the surgical site immediately after the procedure, alternating every 4 hours for the first few hours. An analgesic might be taken if necessary to manage pain.

Oral hygiene procedures were suggested to 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.

After completing suturing, the implant abutments were placed, and an impression was immediately taken using a condensation silicone material in a single stage. The following day, a verification jig was prepared by attaching the implant abutments to the stone model using pattern resin, and the jig was tested in the patient's mouth to verify the accuracy of the impression. Next, the metal framework for the restoration was designed and 3D-printed using laser technology. The metal framework was then tried in to ensure it fits accurately onto the abutments and the gingiva. The bridge was 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 was in proper contact with the gingiva. Finally, the restoration was glazed and fixed with screws tightened to 15 N cm, according to the manufacturer's instructions. The screw holes were sealed with composite material, and a Teflon barrier was placed. All prosthetic steps were completed within seven days of surgery. Failure was defined as the presence of any detectable mobility of the implant and/or any condition requiring implant removal. The implants were followed up for one year after immediate loading.

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.

The frequencies of implant survival and failure were calculated for the studied implants across the three follow-up periods. The results are summarized in Table 1.

As shown in Table 1, no implant failures were observed among the studied implants at any of the follow-up periods. All applied and studied implants remained fully retained throughout the observation period. Consequently, there were no differences in implant survival/failure rates across follow-up periods, and therefore, the application of the Wilcoxon test to compare survival/failure between follow-up stages was not warranted.

Discussion

The present study demonstrated a 100% survival rate for pterygoid implants, which is remarkably high compared to most outcomes reported in the literature. Over the past decade, numerous clinical studies and systematic reviews have evaluated the long-term performance of pterygoid implants, generally showing favorable but slightly lower success rates. For example, Bidra (2023) [6] conducted a systematic review and reported a cumulative survival of 95.5% over six years, emphasizing that pterygoid implants provide a reliable alternative to zygomatic implants in atrophic maxillae. Similarly, Araujo et al. (2019) [3], in one of the largest systematic reviews including nearly 1,900 implants, found a survival rate of 94.9%. These findings reinforce the concept that pterygoid implants are a predictable treatment modality, though outcomes vary slightly among different cohorts and follow-up durations.

Meta-analytical data also corroborate these results. D'Amario et al. (2024) [11] analyzed 1,882 implants across 1,024 patients and reported a survival rate of 97.4%, further supporting the long-term reliability of pterygoid implants. Raouf and Chrcanovic (2024) [10] conducted a systematic review comparing pterygoid and tuberosity implants, reporting similar survival outcomes between the two techniques, thereby highlighting the clinical versatility of posterior maxillary anchorage solutions. Retrospective series, such as the one by Curi et al. (2015) [13], found 99% survival over three years, suggesting that these implants consistently yield excellent results across different populations and clinical settings.

On the other hand, prospective studies sometimes demonstrate slightly lower survival rates. For instance, Mirdah et al. (2025) [12] reported 88.6% survival at one year, noting that early failures were often related to anatomical limitations and bone quality rather than prosthetic complications. These findings emphasize the importance of case selection and meticulous surgical planning, as the anatomical complexity of the pterygoid region can influence outcomes. Similarly, Signorini et al. (2021) [14] reported favorable survival rates in a short-term follow-up, but highlighted the need for longer longitudinal studies to fully assess long-term predictability.

When comparing these findings to the present study, the observed 100% survival rate indicates that under controlled clinical conditions, with proper patient selection, careful preoperative planning, and precise surgical execution, pterygoid implants can achieve survival rates equal to or even higher than those previously reported. Differences in outcomes may be attributed to multiple factors, including study design (retrospective versus prospective), sample size, operator experience, and follow-up duration. Additionally, the prosthetic protocols adopted—such as immediate loading versus delayed loading—may also play a role in influencing success rates.

The superior outcomes in the present study may also reflect advancements in imaging modalities, such as cone-beam computed tomography (CBCT), which enhance preoperative assessment and reduce the risk of surgical complications. Furthermore, the use of new implant designs may have contributed to the high survival rate observed. These findings align with the broader body of literature affirming the predictability of pterygoid implants but suggest that under optimized conditions, survival can approach 100% [7,15].

Taken together, these results underscore the clinical reliability of pterygoid implants as a viable option for the rehabilitation of the atrophic posterior maxilla. They not only provide a predictable survival rate but also reduce the need for more invasive procedures such as sinus grafting or zygomatic implant placement. Future studies, particularly long-term multicenter prospective trials, are necessary to validate these findings across diverse patient populations and clinical contexts.

Conclusion

Within the limitations of this study, pterygoid implants demonstrated high survival rates and represented a predictable, minimally invasive alternative for posterior maxillary rehabilitation. Current evidence supports their reliability, yet further long-term prospective studies are warranted to establish standardized protocols and confirm their long-term clinical performance.

Funding

None.

Data Availability

The authors can provide data on demand.

Competing Interests

None.

Vol 13, No 1 (2025) DOI 10.5195/d3000.2025.1063

References

1. Candel-Martí E, Carrillo-García C, Peñarrocha-Oltra D, Peñarrocha-Diago M. Rehabilitation of atrophic posterior maxilla with zygomatic implants. Journal of Oral Implantology. 2012;38(5):653-7.
2. Jimoh O, Jan M, Luc V, Henri D. Rehabilitation of Atrophic Maxilla using Pterygoid Implants: Case Reports. Mod App Dent Oral Health 1 (1)-2018. MADOHC MS ID. 2015;103.
3. Araujo RZ, Júnior JFS, Cardoso CL, Condezo AFB, Júnior RM, Curi MM. Clinical outcomes of pterygoid implants: Systematic review and meta-analysis. Journal of Cranio-Maxillofacial Surgery. 2019;47(4):651-60.
4. Chrcanovic BR, Abreu MHNG. Survival and complications of zygomatic implants: a systematic review. Oral and maxillofacial surgery. 2013;17(2):81-93.
5. Vrielinck L, Blok J, Politis C. Survival of conventional dental implants in the edentulous atrophic maxilla in combination with zygomatic implants: a 20-year retrospective study. International Journal of Implant Dentistry. 2022;8(1):27.
6. Bidra AS, Peña-Cardelles JF, Iverson M. Implants in the pterygoid region: An updated systematic review of modern roughened surface implants. Journal of Prosthodontics. 2023;32(4):285-91.
7. Maryam S, Oral P, Ayub MS. Evaluating The Success Rate of Pterygoid Implants In The Rehabilitation Of The Posterior Maxilla: A Comprehensive Review And Meta-Analysis. Health Affairs. 2024;12(4).
8. Szabó ÁL, Nagy ÁL, Lászlófy C, Gajdács M, Bencsik P, Kárpáti K, et al. Distally tilted implants according to the all-on-four® treatment concept for the rehabilitation of complete edentulism: a 3.5-year retrospective radiographic study of clinical outcomes and marginal bone level changes. Dentistry Journal. 2022;10(5):82.
9. Toti P, Marchionni S, Menchini-Fabris GB, Marconcini S, Covani U, Barone A. Surgical techniques used in the rehabilitation of partially edentulous patients with atrophic posterior mandibles: A systematic review and meta-analysis of randomized controlled clinical trials. Journal of Cranio-Maxillofacial Surgery. 2017;45(8):1236-45.
10. Raouf K, Chrcanovic BR. Clinical outcomes of pterygoid and maxillary tuberosity implants: a systematic review. Journal of Clinical Medicine. 2024;13(15):4544.
11. D'Amario M, Orsijena A, Franco R, Chiacchia M, Jahjah A, Capogreco M. Clinical achievements of implantology in the pterygoid region: a systematic review and meta-analysis of the literature. Journal of Stomatology, Oral and Maxillofacial Surgery. 2024;125(5):101951.
12. Mirdah WF, Goyal R, Singh A, Singh N, Laxmi SK, Tarpara KJ, et al. Clinical Outcomes and Success Factors of Pterygoid Implants in the Posterior Atrophic Maxilla: A Prospective Study. Cureus. 2025;17(4):e82820.
13. Curi MM, Cardoso CL, Braga Ribeiro KdC. Retrospective study of pterygoid implants in the atrophic posterior maxilla: implant and prosthesis survival rates up to 3 years. International Journal of Oral & Maxillofacial Implants. 2015;30(2).
14. Signorini L, Faustini F, Samarani R, Grandi T. Immediate fixed rehabilitation supported by pterygoid implants for participants with severe maxillary atrophy: 1-Year postloading results from a prospective cohort study. The Journal of Prosthetic Dentistry. 2021;126(1):67-75.
15. Rastelli S, Capogreco M, D'Amario M, Falisi G, Severino M, Iacomino E. Pterigoid implants: A viable alternative for the rehabilitation of the posterior sectors of the atrophic maxilla. Oral & Implantology. 2024;16(1).

Table 1. Percentage of implant survival/failure across three follow-up periods.

Implant Outcome	Implant Type	3 Months	6 Months	12 Months	3 Months (%)	6 Months (%)	12 Months (%)
Survival	Pterygoid	15	15	15	100%	100%	100%
Survival	Conventional 1	15	15	15	100%	100%	100%
Survival	Conventional 2	15	15	15	100%	100%	100%
Failure	Pterygoid	0	0	0	0%	0%	0%
Failure	Conventional 1	0	0	0	0%	0%	0%
Failure	Conventional 2	0	0	0	0%	0%	0%
Total	–	45	45	45	100%	100%	100%