Original Article

Zygomatic versus Pterygoid Implants in Atrophic Maxilla: A Prospective Clinical Comparative Study

Prakhar Dhanare[1], Shaji Thomas[2], Ashutosh Dutt Pathak[3], Jasleen Chhabra[4], Pooja Patidar[5], Ankita Dekate[6]

Post graduate student, Department of Oral and Maxillofacial Surgery, People's College of Dental Sciences and Research Centre, People's University, Bhopal, Madhya Pradesh, prakhardhanare@gmail.com
Professor and Head, Department of Oral and Maxillofacial Surgery, People's College of Dental Sciences and Research Centre, People's University, Bhopal, Madhya Pradesh, drshajithomasomfs@gmail.com
Professor, Department of Oral and Maxillofacial Surgery, People's College of Dental Sciences and Research Centre, People's University, Bhopal, Madhya Pradesh, dr.adpathak@yahoo.com
Post graduate student, Department of Oral and Maxillofacial Surgery, People's College of Dental Sciences and Research Centre, People's University, Bhopal, Madhya Pradesh, jasleenchhabra23599@gmail.com
Post graduate student, Department of Oral and Maxillofacial Surgery, People's College of Dental Sciences and Research Centre, People's University, Bhopal, Madhya Pradesh, poojapatidar0799@gmail.com
Post graduate student, Department of Oral and Maxillofacial Surgery, People's College of Dental Sciences and Research Centre, People's University, Bhopal, Madhya Pradesh, ankitadekate069@gmail.com

Abstract

Background: Rehabilitation of the severely atrophic maxilla is challenging because conventional implant placement is often limited by reduced bone volume and poor posterior support. Zygomatic and pterygoid implants are graftless alternatives used to achieve fixed full-arch rehabilitation in such cases. The current study was undertaken to compare the clinical, surgical, and functional outcomes of zygomatic implants and pterygoid implants in patients with atrophic maxilla.

Methods: This prospective comparative clinical study included 24 patients with atrophic maxilla requiring implant-supported full-arch rehabilitation. The patients were divided into two groups: Group I received zygomatic implants and Group II received pterygoid implants, with 12 patients in each group. The evaluated parameters included surgical time, insertion torque, immediate loading, postoperative pain, postoperative edema, implant survival, prosthetic survival, complications, marginal bone loss, patient satisfaction, masticatory efficiency, and speech comfort.

Results: The implant survival rate was 95.8% in both groups, and prosthesis survival was 100% in both groups at 12 months. Mean surgical time was significantly higher in the zygomatic implant group than in the pterygoid implant group. Postoperative pain and edema were significantly greater in the zygomatic implant group during the early healing period. Sinus-related complications were seen only in the zygomatic implant group, whereas soft tissue complications and prosthetic screw loosening were minimal in both groups.

Conclusion: Both zygomatic and pterygoid implants were effective for rehabilitation of the atrophic maxilla. Although survival and prosthetic outcomes were similar, pterygoid implants showed lower early postoperative morbidity.

Keywords:
Atrophic maxilla; Zygomatic implants; Pterygoid implants; Graftless rehabilitation; Implant survival

Received date: 5/1/2026
Accepted date: 10/2/2026
Published date: 09/4/2026

INTRODUCTION:

Rehabilitation of the severely atrophic maxilla remains one of the more demanding problems in implant dentistry. Marked bone loss, maxillary sinus pneumatization, poor posterior support, and unfavorable bone quality often make placement of conventional implants difficult without additional procedures. Although bone grafting, sinus augmentation, and staged reconstruction can be used, these methods may increase treatment time, cost, surgical morbidity, and patient discomfort. For this reason, graftless treatment options have become increasingly important in the management of advanced maxillary atrophy. [1-4]

Zygomatic implants were introduced as a solution for patients with severe maxillary resorption by using the zygomatic bone for anchorage when conventional implant support is inadequate. Over time, they have emerged as a reliable option for full-arch rehabilitation of the atrophic maxilla, with systematic reviews reporting high survival rates and acceptable long-term outcomes. However, zygomatic implant placement is technically demanding and may be associated with complications such as sinus-related problems, soft tissue issues, and prosthetic challenges. [1-4]

Pterygoid implants represent another graftless alternative, especially for the atrophic posterior maxilla. By engaging the dense bone of the pterygomaxillary region, they can provide distal anchorage, reduce the need for sinus lift procedures, and help avoid long posterior cantilevers. Published reviews and meta-analyses suggest favorable survival and good clinical utility, but the technique is also sensitive to surgical skill because of difficult access, implant angulation, and nearby anatomical structures. [5-7] Taken together, the literature is stronger for each technique individually than for direct prospective comparison between them. This makes a comparative prospective study valuable to assess their clinical performance, complications, prosthetic outcomes, and suitability in patients with atrophic maxilla.[8]

MATERIALS AND METHODS:

This prospective comparative clinical study was conducted in the Department of Oral and Maxillofacial Surgery/Implantology among patients presenting with atrophic maxilla requiring implant-supported fixed rehabilitation. Adult patients with severe posterior maxillary atrophy, inadequate bone volume for conventional posterior implants, and willingness to undergo advanced implant rehabilitation were included in the study. Patients with uncontrolled systemic disease, active maxillary sinus pathology, history of head and neck radiotherapy, severe parafunctional habits, poor oral hygiene, or inability to attend follow-up visits were excluded.

A total of 24 patients were enrolled consecutively and divided into two groups of 12 each based on the treatment planned after clinical and radiographic assessment. Group I received zygomatic implants and Group II received pterygoid implants. All patients underwent detailed history taking, intraoral examination, photographic documentation, diagnostic casts, and cone beam computed tomography for evaluation of residual bone, sinus anatomy, zygomatic bone engagement, and pterygomaxillary anatomy. Routine hematological investigations and fitness for surgery were obtained before the procedure. Written informed consent was taken from all participants, and institutional ethical committee approval was obtained before the start of the study.

All surgical procedures were performed under local anesthesia with conscious sedation/general anesthesia depending on case requirement. In the zygomatic implant group, bilateral zygomatic implants were placed with anterior conventional implants to support a full-arch prosthesis.

In the pterygoid implant group, bilateral pterygoid implants were placed along with anterior conventional implants. Primary implant stability at placement was recorded using insertion torque. Immediate or early loading was carried out when adequate primary stability was achieved.

The patients were followed postoperatively at 1 week, 1 month, 3 months, 6 months, and 12 months. The outcome measures included surgical duration, pain score using visual analogue scale, postoperative edema, implant survival, prosthetic success, sinus-related complications, soft tissue complications, and patient satisfaction. Standardized radiographic evaluation was performed at baseline, 6 months, and 12 months. The collected data were entered into a master sheet and compared between the two groups to evaluate clinical and functional outcomes over time.

RESULTS:

A total of 24 patients with atrophic maxilla were included in the study, with 12 patients each in the zygomatic implant group and the pterygoid implant group, and their clinical, surgical, postoperative, and 12-month functional outcomes were compared.

Table 1 shows that the two study groups were comparable at baseline with respect to age, gender distribution, duration of edentulism, insertion torque, and immediate loading, as there was no statistically significant difference between them. However, the mean surgical time was significantly higher in the zygomatic implant group than in the pterygoid implant group, indicating that zygomatic implant placement was a more time-consuming procedure.

Table 1. Baseline demographic and intraoperative characteristics of the study groups

Variable	Zygomatic implants (n=12)	Pterygoid implants (n=12)	Test value	p value
Age (years), Mean ± SD	58.42 ± 6.21	56.83 ± 5.94	t = 0.64	0.529
Male, n (%)	7 (58.3)	6 (50.0)	$\chi^2 = 0.17$	0.683
Female, n (%)	5 (41.7)	6 (50.0)		
Duration of edentulism (years), Mean ± SD	6.08 ± 1.93	5.75 ± 1.71	t = 0.44	0.663
Surgical time (minutes), Mean ± SD	118.50 ± 14.26	89.33 ± 11.48	t = 5.46	<0.001*
Insertion torque (Ncm), Mean ± SD	47.25 ± 5.11	43.92 ± 4.83	t = 1.64	0.116
Immediate loading achieved, n (%)	11 (91.7)	10 (83.3)	Fisher exact	0.529

*Significant

Table 2 shows that patients treated with zygomatic implants experienced significantly higher pain and edema during the early postoperative period, especially on day 1 and day 3, compared with those treated with pterygoid implants. Sinus-related complaints such as transient sinusitis and nasal stuffiness were observed only in the zygomatic implant group, although the overall complication profile remained low in both groups.

Table 2. Postoperative clinical outcomes and complications in the study groups

Variable	Zygomatic implants (n=12)	Pterygoid implants (n=12)	Test value	p value
Pain score (VAS), Mean ± SD				
Postoperative day 1	6.42 ± 1.08	5.33 ± 0.98	t = 2.58	0.017*
Postoperative day 3	4.50 ± 0.90	3.67 ± 0.78	t = 2.39	0.026*
Postoperative day 7	1.75 ± 0.62	1.33 ± 0.49	t = 1.84	0.079
Edema score, Mean ± SD				
Day 1	2.17 ± 0.58	1.58 ± 0.51	t = 2.63	0.015*
Day 3	1.58 ± 0.51	1.17 ± 0.39	t = 2.20	0.039*
Day 7	0.42 ± 0.51	0.25 ± 0.45	t = 0.86	0.400
Complications, n (%)				
Transient sinusitis/sinus discomfort	3 (25.0)	0 (0.0)	—	0.064
Nasal stuffiness	2 (16.7)	0 (0.0)	—	0.136
Soft tissue inflammation	1 (8.3)	2 (16.7)	—	0.529
Prosthetic screw loosening	1 (8.3)	1 (8.3)	—	1.000
No complication	7 (58.3)	9 (75.0)	—	0.384

*Significant

Table 3 shows that both zygomatic and pterygoid implants achieved similar implant survival and complete prosthesis survival at 12 months, indicating high clinical success in both groups. Marginal bone loss, patient satisfaction, masticatory efficiency, speech comfort, and overall treatment outcome were also comparable, suggesting that both treatment modalities provided equally favorable functional and prosthetic results.

Table 3. Implant survival, radiographic findings, functional outcomes, and overall treatment success at 12 months

Variable	Zygomatic implants (n=12)	Pterygoid implants (n=12)	Test value	p value
Number of remote anchorage implants placed	24	24	—	—
Number of failed remote implants	1	1	—	1.000
Implant survival rate (%)	95.8	95.8	—	1.000
Prosthesis survival rate (%)	100.0	100.0	—	1.000
Marginal bone loss around supporting conventional implants (mm), Mean ± SD	0.82 ± 0.21	0.76 ± 0.18	t = 0.75	0.461
Patient satisfaction score (0–10), Mean ± SD	8.92 ± 0.67	8.58 ± 0.79	t = 1.14	0.266
Masticatory efficiency score (0–10), Mean ± SD	8.67 ± 0.78	8.42 ± 0.67	t = 0.84	0.409

Speech comfort score (0–10), Mean ± SD	8.25 ± 0.87	8.50 ± 0.67	t = 0.79	0.438
Successful treatment outcome, n (%)	11 (91.7)	11 (91.7)	—	1.000
Acceptable with minor complication, n (%)	1 (8.3)	1 (8.3)	—	1.000
Failed treatment outcome, n (%)	0 (0.0)	0 (0.0)	—	—

DISCUSSION

The present prospective comparative study evaluated two graftless treatment options for rehabilitation of the atrophic maxilla: zygomatic implants and pterygoid implants. The main findings of this study were that both groups showed similarly high implant survival and complete prosthesis survival at 12 months, while the zygomatic implant group required significantly longer surgical time and showed greater early postoperative pain and edema. Sinus-related complaints were seen only in the zygomatic implant group, whereas patient satisfaction and functional outcomes were high in both groups. These findings suggest that both approaches are clinically effective, but their short-term morbidity profiles are not identical. [9-16]

In the present study, both groups demonstrated an implant survival rate of 95.8% and a prosthesis survival rate of 100% at 12 months. This is in agreement with published reviews showing that zygomatic implants have consistently high survival in severely resorbed maxilla, generally in the mid-to-high 90% range, and that pterygoid implants also provide favorable long-term survival in the atrophic posterior maxilla.[9-15] The similarity in survival between the two groups in our study indicates that both methods can serve as dependable anchorage strategies when case selection, surgical planning, and prosthetic execution are appropriate. Our findings therefore support the current view that graftless rehabilitation of the atrophic maxilla can be predictably achieved with either remote anchorage approach. [9-15]

A significant difference was observed in mean surgical time, which was higher in the zygomatic implant group. This finding is clinically understandable because placement of zygomatic implants involves a longer implant trajectory, more demanding angulation, closer relation to the maxillary sinus and orbit, and greater dependence on advanced surgical experience. Reviews of zygomatic implant techniques have repeatedly emphasized that the procedure is technique-sensitive and associated with a broader spectrum of intraoperative and postoperative events than conventional implant placement.[9-13] In contrast, pterygoid implants are also technique-sensitive, but they generally avoid the sinus cavity and provide distal anchorage through the pterygomaxillary region, which may explain the shorter operative time in our study.[14-16] The slightly higher insertion torque seen in the zygomatic implant group, although statistically non-significant, may reflect the dense anchorage obtained in the zygomatic bone.

Postoperative morbidity was greater in the zygomatic implant group during the early healing phase. Pain and edema scores were significantly higher on day 1 and day 3, although this difference reduced by day 7. This pattern suggests that the additional tissue dissection and wider surgical field associated with zygomatic implant placement may produce a more intense early inflammatory response. Similar observations are indirectly supported by reports describing the greater technical complexity and complication burden of zygomatic surgery.[9-13]

On the other hand, prospective evaluation of pterygoid-supported immediate rehabilitation has shown favorable short-term tolerance with minimal complications in properly selected patients, which is in line with the lower pain and swelling recorded in our pterygoid group.[16] Thus, while both methods were successful, pterygoid implants appeared to offer a somewhat smoother early postoperative recovery in the present sample.[16]

An important observation in this study was the occurrence of transient sinusitis or sinus discomfort and nasal stuffiness only in the zygomatic implant group. Although these events were limited and manageable, they are clinically relevant because sinus-related complications are among the most frequently discussed drawbacks of zygomatic implants in the literature.[9-13] Recent reviews have identified sinusitis as one of the common biological complications of zygomatic implant treatment, with incidence varying according to surgical technique and follow-up duration.[9-11] In contrast, the pterygoid implant literature has generally described fewer sinus-specific complications because this approach relies on posterior cortical anchorage without traversing the zygomatic-maxillary pathway.[14-16] The present findings therefore support the concept that zygomatic implants remain a highly effective option, but require careful sinus evaluation, meticulous planning, and close postoperative monitoring.

Soft tissue inflammation and prosthetic screw loosening were infrequent in both groups and did not differ meaningfully. This is encouraging, because prosthetic success is a major determinant of overall treatment acceptance in full-arch implant rehabilitation. The absence of prosthesis failure in either group suggests that once osseointegration and prosthetic stabilization are achieved, both zygomatic and pterygoid anchorage systems can support a reliable definitive restoration. [11,14-16] The low marginal bone loss seen around the supporting conventional implants in both groups also indicates a stable peri-implant environment during the first year. While many zygomatic implant reviews focus primarily on survival and complications rather than detailed crestal bone outcomes, the available evidence generally supports acceptable biological performance when these reconstructions are properly maintained. [11-15]

Patient satisfaction, masticatory efficiency, and speech comfort were high in both groups, and no statistically significant intergroup difference was noted. This result is important from a clinical standpoint because patients with atrophic maxilla often seek not only survival of implants but also rapid restoration of function, comfort, and confidence. Even though the zygomatic implant group experienced higher early postoperative morbidity, this did not appear to compromise overall 12-month satisfaction. This agrees with current evidence showing that both remote anchorage approaches can provide meaningful functional rehabilitation and good prosthetic acceptance when used in well-planned full-arch treatment. [11,14-16] It is possible that the benefits of fixed rehabilitation outweighed the short-term discomfort associated with surgery in both groups.

Overall, the present study suggests that both zygomatic and pterygoid implants are effective options for the management of the atrophic maxilla. However, the two methods appear to differ mainly in surgical burden and early postoperative morbidity rather than in short-term survival or prosthetic success. From a practical standpoint, pterygoid implants may be preferred when adequate posterior anatomy permits their placement and when a less morbid graftless approach is desired, whereas zygomatic implants remain extremely valuable in cases with more severe maxillary deficiency.

The main limitations of this study were the small sample size, non-randomized design, and relatively short follow-up of 12 months. Further prospective studies with larger samples and longer follow-up are needed to define the long-term comparative advantages of these two treatment modalities.

CONCLUSION

Both zygomatic implants and pterygoid implants showed high implant survival and complete prosthesis survival over 12 months in patients with atrophic maxilla. Zygomatic implants required longer surgical time and were associated with greater early postoperative pain, edema, and sinus-related complaints. Pterygoid implants showed lower short-term postoperative morbidity while maintaining comparable functional and prosthetic outcomes. Within the limits of this study, both techniques were effective graftless options, but pterygoid implants appeared to offer a more favorable early recovery profile

REFERENCES:

1. Brånemark PI, Gröndahl K, Öhrnell LO, Nilsson P, Petruson B, Svensson B, et al. Zygoma fixture in the management of advanced atrophy of the maxilla: technique and long-term results. Scand J Plast Reconstr Surg Hand Surg. 2004;38(2):70-85.
2. Aparicio C, Manresa C, Francisco K, Claros P, Alández J, González-Martín O, et al. Zygomatic implants: indications, techniques and outcomes, and the zygomatic success code. Periodontol 2000. 2014;66(1):41-58.
3. Chrcanovic BR, Abreu MH. Survival and complications of zygomatic implants: a systematic review. Oral Maxillofac Surg. 2013;17(2):81-93.
4. Ramezanzade S, Yates J, Tuminelli FJ, Keyhan SO, Yousefi P, Lopez-Lopez J. Zygomatic implants placed in atrophic maxilla: an overview of current systematic reviews and meta-analysis. Maxillofac Plast Reconstr Surg. 2021;43(1):1.
5. Bidra AS, Huynh-Ba G. Implants in the pterygoid region: a systematic review of the literature. Int J Oral Maxillofac Surg. 2011;40(8):773-781.
6. Candel E, Peñarrocha D, Peñarrocha M. Rehabilitation of the atrophic posterior maxilla with pterygoid implants: a review. J Oral Implantol. 2012;38(Spec No):461-466.
7. Araujo RZ, Santiago JF Jr, Cardoso CL, Benites Condezo AF, Moreira RWF, Curi MM. Clinical outcomes of pterygoid implants: systematic review and meta-analysis. J Craniomaxillofac Surg. 2019;47(4):651-660.
8. Aalam AA, Krivitsky-Aalam A, Kurtzman GM, Mahesh L. The severely atrophic maxilla: decision making with zygomatic and pterygoid dental implants. J Oral Biol Craniofac Res. 2023;13(2):202-206.
9. Gabriele G, Chisci G, Cascino F, Ricci NM, Marruganti C, Ferrari M. Technique-related survival rate and complications of zygomatic implant placement: a systematic review and meta-analysis. Int J Oral Maxillofac Implants. 2023;38(5):855-875.
10. Kämmerer PW, Fan S, Aparicio C, Bedrossian E, Davó R, Morton D, et al. Evaluation of surgical techniques in survival rate and complications of zygomatic implants for the rehabilitation of the atrophic edentulous maxilla: a systematic review. Int J Implant Dent. 2023;9(1):11.
11. Brennand Roper M, Vissink A, Dudding T, Pollard A, Gareb B, Malevez C, et al. Long-term treatment outcomes with zygomatic implants: a systematic review and meta-analysis. Int J Implant Dent.

2023;9(1):21.
12. Lorusso F, Conte R, Inchingolo F, Festa F, Scarano A. Survival rate of zygomatic implants for fixed oral maxillary rehabilitations: a systematic review and meta-analysis comparing outcomes between zygomatic and regular implants. Dent J (Basel). 2021;9(4):38.
13. Solà Pérez A, Pastorino D, Aparicio C, Pegueroles Neyra M, Khan RS, Wright S, et al. Success rates of zygomatic implants for the rehabilitation of severely atrophic maxilla: a systematic review. Dent J (Basel). 2022;10(8):151.
14. 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. J Stomatol Oral Maxillofac Surg. 2024;125(5):101951.
15. Raouf K, Chrcanovic BR. Clinical outcomes of pterygoid and maxillary tuberosity implants: a systematic review. J Clin Med. 2024;13(15):4544.
16. 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. J Prosthet Dent. 2021;126(1):67-75.