

Pterygoid Implants in the Rehabilitation of Maxillary Atrophy: A Structured Literature Review

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Abstract

Background

Rehabilitation of the posterior maxilla in cases of advanced atrophy remains one of the most challenging tasks in implant dentistry. Bone deficiency, maxillary sinus pneumatization, and unfavorable cancellous bone characteristics often limit the use of conventional implants and require a choice between bone augmentation procedures and non-augmentation solutions.

Objective

To perform a critical synthesis of published evidence on the use of pterygoid implants in the treatment of maxillary atrophy, with particular attention to survival rates, anatomical conditions, biomechanical effects, limitations of the method, and its position among alternative treatment strategies.

Materials and Methods

A structured literature review was conducted. Clinical studies, systematic reviews, anatomical, digital, and biomechanical publications directly related to pterygoid implants or comparable non-augmentation rehabilitation methods were selected for analysis. Bibliographic details and publication metadata of key sources were additionally verified through indexed records and publisher databases.

Results

Major systematic reviews and clinical series indicate that reported survival or success rates of pterygoid implants most commonly range between 92.5% and 98.3%. Anatomical studies simultaneously demonstrate significant variability of the pterygomaxillary region, indicating that reliable application of the method is not possible without three-dimensional preoperative planning. The number of contemporary prospective studies remains limited, and their outcomes continue to be heterogeneous.

Conclusion

Pterygoid implants may be considered a clinically viable non-augmentation treatment option for patients with posterior maxillary atrophy when appropriate case selection is performed. However, the method requires precise anatomical planning, a carefully designed prosthetic strategy, and a cautious interpretation of the existing evidence base.

Keywords

Pterygoid Implants; Maxillary Atrophy; Posterior Maxilla; Dental Implantation; Structured Review.

Introduction

Following tooth loss in the maxilla, the volume of alveolar bone predictably decreases. In posterior regions, the clinical situation is further complicated by expansion of the maxillary sinus, reduced residual ridge height, and relatively low cancellous bone density. As a result, placement of conventional implants often becomes technically challenging, and treatment strategies shift toward sinus floor elevation, guided bone regeneration, short or tilted implants, as well as zygomatic solutions.

Pterygoid implantation is based on the use of cortical support within the pterygomaxillary complex. The implant trajectory passes through the maxillary tuberosity and the pyramidal process of the palatine bone toward the pterygoid process of the sphenoid bone, theoretically allowing rehabilitation without bone augmentation while simultaneously relocating distal support posteriorly.

This approach is particularly attractive in cases of severe atrophy, where reduction of cantilever length and minimization of additional surgical procedures are desirable.

However, interpreting this method as a universal alternative to all other treatment modalities would be methodologically incorrect. Its practical value depends not only on the ability to avoid sinus lifting but also on anatomical limitations of the technique, bone characteristics, the selected prosthetic design, and surgeon experience. Therefore, pterygoid implants should be evaluated critically, without a priori optimistic conclusions.

Objective of the Study

To critically analyze clinical, anatomical, and biomechanical evidence related to pterygoid implants and to determine the clinical scenarios in which this method is truly justified as part of the contemporary non-augmentation treatment armamentarium for the atrophic maxilla.

Materials and Methods

The study was conducted in the format of a structured literature review rather than a formal systematic review or meta-analysis. This design was intentionally selected to allow the application of transparent search principles and critical synthesis of sources without creating a misleading impression of higher methodological rigor in the absence of protocol preregistration and a fully auditable search log.

Full-text publications directly addressing pterygoid implants, as well as studies on comparable non-augmentation rehabilitation methods for the atrophic maxilla, were included in the analysis. The search strategy was based on combinations of the following terms:

- pterygoid implants
- pterygomaxillary implants
- atrophic maxilla
- posterior maxilla rehabilitation
- zygomatic implants
- short implants

After initial selection, bibliographic information was verified through indexed records and publisher pages of key publications.

Inclusion criteria comprised:

- clinical studies
- retrospective and prospective cohorts
- systematic reviews
- anatomical investigations
- digital planning studies
- biomechanical analyses

Studies were included if they provided extractable data regarding:

- anatomical characteristics
- implant survival
- complications
- functional rationale of the method

Exclusion criteria included:

- duplicate publications
- reports lacking clinical or anatomical relevance
- studies without clearly identifiable methodological characteristics

The resulting evidence base demonstrated heterogeneity in:

- study design
- follow-up duration
- outcome measures

Therefore, the findings were interpreted as a qualitative and semi-quantitative synthesis of the literature rather than as a basis for direct statistical comparison between studies.

Results

The most robust aggregated data originate from systematic reviews.

- In a meta-analysis by Araujo et al., involving:
634 patients

- 1,893 pterygoid implants
- the mean survival rate was:
94.87%
 - A systematic review by Bidra and Huynh-Ba reported survival rates of approximately:
95.5%
 - An updated review of modern rough-surface implants demonstrated a comparable cumulative survival rate of:
95.5% over a six-year period
 - In a systematic review by Raouf and Chrcanovic, including:
2,245 patients
3,446 implants
 - the ten-year cumulative survival rate for pterygoid implants was:
92.5%
 - Among individual clinical series, a retrospective study by Cea-Arestin et al., analyzing:
178 implants
113 patients
 - reported an overall success rate of:
98.3%
 - In the study by Rodríguez et al., a modified surgical protocol was evaluated in a series of:
454 implants
 - with a mean follow-up period of approximately:
6 years
 - According to Curi et al., the three-year survival rate of pterygoid implants reached:
99%
 - while prosthesis survival was:
97.7%
 - with a mean marginal bone loss of:
1.21 mm

Prospective studies remain relatively limited.

- Signorini et al. reported:
100% survival and success after one year in a cohort of immediately loaded full-arch prostheses.
- A later prospective study by Mirdah et al. demonstrated:
88.57% overall success after one year

and indicated that outcomes were more strongly influenced by:

- bone quality
- complications

These findings confirm the clinical potential of the method while simultaneously demonstrating that short-term outcomes remain sensitive to patient selection and surgical technique.

Anatomical and Digital Planning Findings

Anatomical and digital studies consistently indicate significant variability in the pterygomaxillary region.

In a retrospective cone-beam computed tomography study by Salinas-Goodier et al., the mean dimensions of the pterygomaxillary junction were:

- Width: 7.5 mm
- Height: 12.51 mm
- Volume: 321.7 mm³

In another CBCT-based study by Rodriguez et al., analysis of:

202 scans demonstrated that the pterygoid plate region exhibits greater bone density than the maxillary tuberosity region.

Contemporary studies on digital planning and navigation confirm that three-dimensional assessment of implant trajectory improves predictability of access to dense cortical support.

Biomechanical Considerations

Biomechanically, the primary advantage of pterygoid implantation is associated with posterior relocation of distal support.

This allows:

- reduction of cantilever length
- improvement of the anteroposterior spread

which may reduce stress concentration in full-arch prosthetic constructions.

However, this biomechanical advantage is realized only when:

- prosthetic planning is correct
- stable cortical engagement is achieved

Discussion

Pterygoid implants occupy an intermediate position between short implants and more invasive distal anchorage solutions, particularly zygomatic implants.

The principal advantage of the method lies in the use of dense cortical support without mandatory sinus lifting, theoretically reducing surgical trauma and enabling faster transition to definitive rehabilitation.

Nevertheless, it would be incorrect to consider pterygoid implantation as a direct substitute for all alternative treatment modalities.

Favorable survival rates reported in systematic reviews are largely based on retrospective series that differ substantially in:

- follow-up duration
- implant length
- loading protocols
- success criteria

Even in recent publications, short-term outcomes appear to depend significantly on:

- bone quality
- local anatomy
- complication rates

Clinical and Technological Considerations

Technological aspects of the procedure are equally important.

According to Balshi et al., both:

- freehand surgical protocols

guided surgical techniques may be successfully applied in clinical practice.

However, their effectiveness depends heavily on:

- adherence to surgical protocol
- surgeon experience

In another retrospective series, the same authors reported more favorable osseointegration outcomes with longer implants, likely due to increased engagement of dense cortical bone.

However, these findings should not be generalized to all clinical situations.

Prosthetic Considerations

The prosthetic component of the method is no less important than the surgical stage.

More posteriorly positioned support indeed reduces cantilever length.

However, the biomechanical advantage is achieved only when:

- the prosthetic design is appropriate
- primary stability is sufficient

Otherwise, avoidance of augmentation procedures may be offset by technical complications, including:

- screw loosening
- prosthetic overload

Practical Recommendations

The method is most justified in cases of:

- severe posterior maxillary atrophy
- situations where bone augmentation is undesirable
- cases where augmentation would excessively increase surgical burden

Preoperative planning should be based on:

- cone-beam computed tomography
- evaluation of implant trajectory
- assessment of bone thickness
- identification of neurovascular risks

Pterygoid implants are particularly indicated in:

- full-arch rehabilitation
- cases requiring reduction of cantilever length
- situations requiring posterior relocation of distal support

The technique should be performed by a surgeon who:

- has detailed knowledge of pterygomaxillary anatomy
- is proficient in digital planning
- has experience in complex prosthetic rehabilitation

Conclusion

Pterygoid implants should be regarded as a clinically justified non-augmentation option for rehabilitation of the atrophic posterior maxilla. Modern systematic reviews, anatomical investigations, and clinical series confirm the applicability of the method. However, the overall evidence base remains heterogeneous and requires cautious interpretation. Further development of this field is likely to depend not on mechanical expansion of indications but on: more precise anatomical stratification, standardization of success criteria, accumulation of high-quality prospective data.

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