# Pterygoid Implants for Rehabilitation of Posterior Atrophic Maxilla

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## Abstract

**Aim:** The aim of this systematic review is to evaluate the survival rates of pterygoid implants in patients affected by severe atrophy of the posterior maxilla.

Materials and methods: A total of 133 articles were found by searching through electronic databases like pubmed, google scholar, science direct, research gate, springer open, Cochrane library, semantic scholar. On further screening of articles for title, abstracts and on application of exclusion criteria , 62 articles were selected. 58 potentially relevant articles were removed after removal of duplicates. 4 articles were taken for the final systematic review after applying the inclusion criteria.

**Results:** A total of 288 patients were rehabilitated 1,357 pterygoid implants. The range of follow-up varied from 3 years to 10 years. The mean cumulative survival rate calculated was 97.08%. Mean diameter of implants used were 4mm. Majority of implants varied in length of 13mm to 20mm. A total of 73 implants failed, before loading from a lack of osseointegration. All the implants analysed in this study had mean bone loss of 1.3mm (21.66%).

**Conclusion:** This systematic review suggests that, pterygoid implants are a magnificent and viable alternative to other posterior implants of the maxilla, especially in cases of atrophy. It offers a series of advantages such as: excellent posterior bone support without the need for bone grafts, reduction of pain and morbidity in the postoperative period, high biomechanical stability, high survival rate and their minimal intraoperative and postoperative complications and good acceptance by patients.

**Keywords:** Pterygoid implants, Atrophic, Posterior, Maxilla, Rehabilitation

## INTRODUCTION

With an increase in advancement in the field of medicine and science, there is an increase in the lifespan observed in the population. However, along with this benefit, edentulism has also become prevalent. As the absence of teeth is frequent in elderly people and the volume of alveolar bone is dictated by the presence of teeth, many of these patients exhibit significant bone loss, resulting in severely atrophied jaws. Moreover, rehabilitation of the severely resorbed jaw is challenging due to poor bone quality and quantity thereby reducing the bone height and width making it difficult to place implants with sufficient stability and length.

To overcome these bone deficiencies additional surgical procedures such as sinus lift, bone grafting, tilted and short implants, zygomatic implants were tried. However, these procedures have their own limitations such as tearing of the sinus membrane, rejection of bone grafts into sinus cavities, loosening of screw in tilted implants. In addition, these procedures adds on extra surgical step, increasing the overall treatment time, and higher morbidity with usage of general anesthesia in zygomatic implants. In view of these limitations, the pterygomaxillary region has been suggested as an excellent area for rehabilitation of posterior atrophic maxilla.

Tulsane inspired by Paul Tessier first described the pterygoid implants in 1992 as an alternative to conventional dental implants. Glossary of oral and Maxillofacial Implant (GOMI) defined it as an implant placed through the maxillary tuberosity, into the pterygoid plate. Placement of these implants involves their origin in the tuberosity region, follows an oblique mesiocranial direction proceeding posteriorly towards the pyramidal process of palatine bone. It subsequently proceeds upward between both wings of pterygoid process of sphenoid bone.

It provides anchorage in the posterior region of maxilla without grafting procedures, also avoiding posterior prosthetic cantilevers, and axial loading is improved. Owing to their long path, length ranges from 15-20 cm. Angulation of these implants ranges from 45-50 degrees to the maxillary bone. Pterygoid implants anchor in cortical bone, allowing for a better primary stabilisation, which is known to be a critical factor for long-term success, decreasing the treatment time as osseointegration of such implants occurs in 2-3 months.

Bicortical stabilisation of implants reduces implant micromotion during osseointegration and enhances implant survival rate, from a prosthetic viewpoint it can minimize the time upto rehabilitation, bypass need for distal cantilever and allow for immediate prosthetic loading if indicated. However, they present some inconvencies: the learning is convoluted compared to conventional dental implants, access for surgeons and oral rehabilitation is complex and serious injuries can occur in sectioning the maxillary artery or invading the pterygomaxillary fossa.

Few risks like more distal placement of implants for better prosthetic load management. Loss of implant into infratemporal fossa, trauma to nerves leading to facial sensory issues. It is radiographically difficult to assess the marginal bone loss around these implants. Pterygomaxillary region morphology has a wide range of variation between individuals, every time a pterygoid implant is planned to be placed in this area, a personalised pre-surgical radiological assessment should be performed. Various factors such as dental status (edentulous patient present an inferior density), age (density decreased as age progressed) and gender (female subjects have statistically less density) have an impact on bone density in the pterygomaxillary region.

Nevertheless, it has been shown that the internal maxillary artery arises 1cm above to pterygomaxillary suture as it enters the pterygopalatine fossa. Therefore, the distance from the artery to the lower end of pterygomaxillary suture is 25mm. Because of the absence of vital structures in the insertion area, it is a safe working area for surgeons. Any bleeding in this region will be from the veins of the pterygoid muscle and it can be stopped quickly once the intraosseous fixation is inserted and will not restart once the implant is stabilised.

These implants have high success rate, similar bone loss levels to those of conventional implants, minimal complications and good acceptance by the patients. Therefore, they constitute a reliable alternative for treating patient's with atrophic posterior maxilla, also the bone density of pterygoid process is greater than the bone density of maxillary tuberosity, therefore it should be the choice for implant anchoring in the posterior atrophic maxilla.

**Aim**

The aim of this systematic review is to evaluate the survival rates of pterygoid implants in patients affected by severe atrophy of the posterior maxilla.

## MATERIAL AND METHODS

**Search Approach**

A rigorous search for the articles on the role Pterygoid implants for the rehabilitation of posterior atrophic maxilla was conducted. The search was conducted in multiple stages. The initial step involved a search for existing systematic review of literatures on the subject with the help of electronic databases like Pubmed, Google scholar, Science direct, Researchgate, Springer open, Cochrane library, Semantic scholar. The search terms were Pterygoid implants, atrophy, posterior maxilla. The next step involved a manual search of reference articles to identify other relevant articles for the final selection

**Search Results**

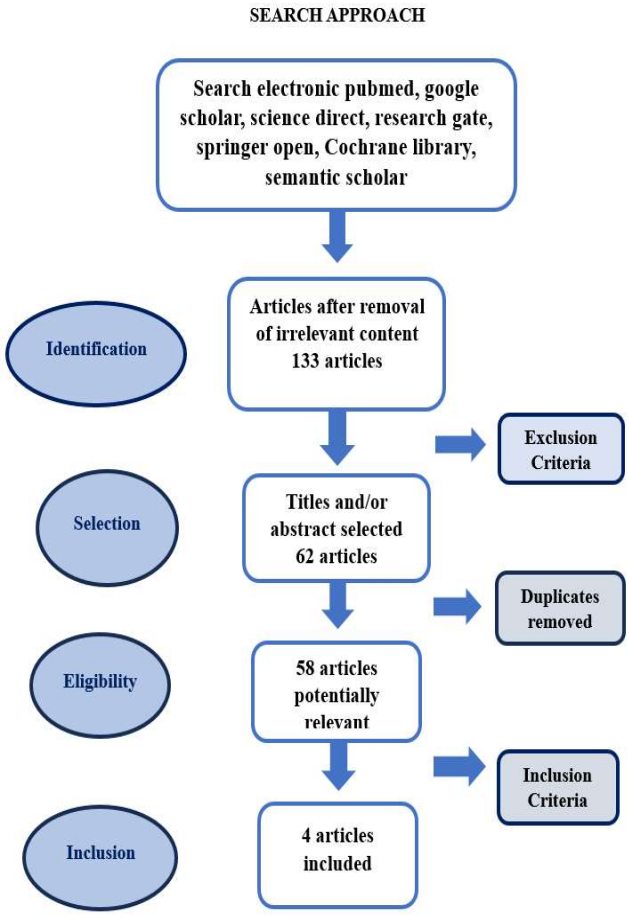
A total of 133 articles were found by searching through electronic databases like Pubmed, Google scholar, Science direct, Researchgate, Springer open, Cochrane library, Semantic scholar. On further screening of articles for titles, abstracts and on application of exclusion criteria, 62 articles were selected. 58 potentially relevant articles were removed after removal of duplicates. 4 articles were taken for the final systematic review after applying the inclusion criteria.

**Inclusion Criteria**

1. Cross sectional studies, observational studies, prospective studies, retrospective studies.
2. Case control and cohort studies
3. Controlled Clinical trials
4. English Language
5. Patients affected by severe atrophy of Posterior maxilla
6. Minimum follow up period of 3 years

**Exclusion Criteria**

1. Inaccurate data for analysis
2. Incomplete data for analysis
3. Insufficient description of post-operative outcome
4. Model studies



# TABLES

**Table 1: The study design of included studies**

| S.No. | Author | Year of publication | Study design |
|---|---|---|---|
| 1. | Balshi et al | 2013 | Retrospective |
| 2. | Curi et al | 2015 | Retrospective |
| 3. | Vitomir et al | 2023 | Retrospective cohort |
| 4. | Pablo et al | 2024 | Retrospective |

**Table 2: Total Number of patients with pterygoid implants**

| S.No. | Author | Year of publication | No. of patient's with pterygoid implants |
|---|---|---|---|
| 1. | Balshi et al | 2013 | NR |
| 2. | Curi et al | 2015 | 56 |
| 3. | Vitomir et al | 2023 | 119 |
| 4. | Pablo et al | 2024 | 113 |

**Table no 3: range of follow up**

| S.No. | Author | Year of publication | Range of follow-up |
|---|---|---|---|
| 1. | Balshi et al | 2013 | 10 years |
| 2. | Curi et al | 2015 | 3 years |
| 3. | Vitomir et al | 2023 | 4 years |
| 4. | Pablo et al | 2024 | 7 years |

**Table 4: Total no. of pterygoid implants**

| S.No. | Author | Year of publication | Total no. of pterygoid implants |
|---|---|---|---|
| 1. | Balshi et al | 2013 | 930 |
| 2. | Curi et al | 2015 | 66 |
| 3. | Vitomir et al | 2023 | 183 |
| 4. | Pablo et al | 2024 | 178 |

**Table 5: Survival rate**

| S.No. | Author | Year of publication | Survival rate |
|---|---|---|---|
| 1. | Balshi et al | 2013 | 93.75% |
| 2. | Curi et al | 2015 | 99% |
| 3. | Vitomir et al | 2023 | 97.3% |
| 4. | Pablo et al | 2024 | 98.3% |

**Table 6: Failures**

| S.No. | Author | Year of publication | Failures |
|---|---|---|---|
| 1. | Balshi et al | 2013 | 62 |
| 2. | Curi et al | 2015 | NR |
| 3. | Vitomir et al | 2023 | 5 |
| 4. | Pablo et al | 2024 | 6 |

## DESCRIPTION OF STUDIES

**1. Balshi et al (2013)** All Brånemark System 4.0-mm-diameter implants delivered into the pterygomaxillary region were separated into 7- to 13-mm and 15- to 18-mm groups and were retrospectively analysed. Of all implants delivered, 930 of the 992 osseointegrated for a Cumulative success rate of 93.75%. This suggested that increased implant length in the pterygomaxillary region results in higher osseointegration rates. The implant apex better engages the cortical bone between the medial and lateral pterygoid plates and thereby increasing the primary as well as the secondary stability.

**2. Curi et al (2015)** performed a retrospective study on 56 patients with atrophic posterior maxilla rehabilitated with 66 pterygoid implants between 1999 and 2010 and followed for atleast 3 years after implant loading. Pterygoid implants were positioned at different angles: 6 implants were positioned at 15 degrees, 14 implants were placed at 30 degrees, 12 implants were placed at 60 degrees, remaining 34 implants were positioned at 45 degrees. Of the 66 pterygoid implants placed into function, 62 of them survived during the cumulative follow up period of 3 years. The overall 3-year success rates were 99% for pterygoid implants.

**3. Vitomir et al (2023)** A total of 119 patients who received 183 pterygoid implants with fixed prostheses were analysed retrospectively. Most implants in the pterygoid region (71.5%) were 4.1 mm in diameter (87.4%) and 15 mm in length (60.1%). Based on the findings of this retrospective cohort study, the following conclusions were drawn: Pterygoid implants could be a viable and predictable modality for rehabilitating the atrophic posterior maxilla because of their high survival rate and their minimal intraoperative and postoperative complications. However, knowledge of anatomy, preoperative planning, and proper surgical skills are imperative for a favorable outcome.

**4. Pablo et al (2024)** conducted a retrospective analysis of pterygoid implant data from 2003 to 2023 which included 178 pterygoid implants placed in the 113 patients eligible for the study were analysed. The percentage of success at 7 years was evaluated. This study aims to show that pterygoid implants are a magnificent and viable alternative to other posterior maxillary implants, especially those affected by atrophy. Pterygoid implants offer biomechanical and survival characteristics similar or superior to the so called conventional implants and avoid a series of surgical and prosthodontic procedures more difficult than the ones required by other implants in many occasions. The percentage of global success of 98.3% was achieved.

## RESULT

**Study selection process**: The eligible studies were searched using electronic databases like Pubmed, Google scholar, Science direct, Researchgate, Springer open, Cochrane library, Semantic scholar from 2013 to 2024. The search terms were Pterygoid implants, atrophy, posterior maxilla. After the title and abstract evaluation 133 studies were included. From that 58 full text articles assessed for eligibility and were selected. After evaluating the inclusion and exclusion criteria 4 suitable articles were taken for the study.

**Characterstics of the included study:** The extracted data and the characteristics of the studies included in the final analysis. It includes 4 studies, from these 3 were retrospective, 1 study was cohort. A total of 288 patients were rehabilitated 1,357 pterygoid implants. The range of follow-up varied from 3 years to 10 years. The mean cumulative survival rate calculated was **97.08%.** 2 out of 4 studies used Branemark company of pterygoid implants. Others used biohorizons, lasik bioniq, nobel biocare company of pterygoid implants. Mean diameter of implants used were 4 mm. Majority of implants varied in the length of 13mm to 20mm. A total of 73 implants failed. All pterygoid implant failures occurred before loading from a lack of osseointegration. All the implants analysed in this study had mean bone loss of **1.3 mm (21.66%).**

## DISCUSSION

Maxillary bone is different in its function, physiology, and bone density from the mandible. These differences, along with its varied anatomy, challenge the implant placement in harmony with planned prosthetic restoration. Extremely atrophic maxillae are the most challenging task for restorative dentists. Pterygoid implant may be considered as a promising alternative to 3D maxillary reconstruction, sinus lifts, and bone augmentation technique. They allow anchorage in the posterior atrophied/resorbed maxilla, achieving proper stability, and high rates of long-term success.

In addition, posterior cantilevers can be eliminated and axial loading is improved. The dense cortical bone in the pterygoid region is favourable for anchoring the pterygoid implants bicortically. The classic technique of pterygoid implants was described by Tulasne, in which implants were anchored in the pterygoid plate, which provides a stable anchor as it is a very dense bone. This technique used 22-mm- long implants. The current systematic review was undertaken with inclusion of 4 studies to evaluate the success rates of pterygoid implants in participants affected by severe atrophy of the posterior maxilla.

The results of the present retrospective study demonstated that pterygoid implants had a survival rate comparable with that of endosseous implants placed in other maxillary regions. Most of the implants in the present study (93%) were at least 15 mm in length. The majority of the implants had a diameter of 4.1 mm. The appropriate length and diameter of pterygomaxillary implants enhances the anteroposterior spread of the mechanical load.

Apical engagement into the dense cortical bone also plays a crucial role in initial implant stability and the ability to immediate load said implant. However, penetrating these cortical plates requires the proper implant length. This study found that implants in the 15- to 18-mm group had a CSR higher (94.16%) than and statistically significant to the 7- to 13-mm group (88.06%). These results suggest that longer implants, which are better able to fully engage the cortical plates found in the pterygomaxillary region, may play a role in increased survival rates of implants in this region. To achieve the desired stability, an implant must transverse the tuberosity for the apex to engage the cortical plates. Implants that are placed solely in the tuberosity usually require a wider diameter implant for more support because there is a high presence of cancellous bone in that region. Penetration through the cortical pterygoid plates with the implant apex should also be considered as a proper method to achieve high osseointegration rates. Mean bone loss around pterygoid implants at 36 months after loading was 1.21mm. Balshi et al assessed marginal bone loss of 1.3mm mesially and 1.1mm distally.

So this all favours the use of pterygoid implants as a very good option in certain cases such as the atrophic posterior maxilla due to it's good primary stability, very high success with minimal complications and good acceptance by patients. Pterygoid implants had no remarkable complications compared with conventional implants and the level of patient satisfaction was high.

**CONCLUSION**

In conclusion, this systematic review suggests that, pterygoid implants are a magnificent and viable alternative to other posterior implants of the maxilla, especially in cases of atrophy. The rehabilitation of the posterior maxilla using pterygoid implants offers a series of advantages such as : excellent posterior bone support without the need for bone grafts, reduction of pain and morbidity in the postoperative period, high biomechanical stability, high rate of survival and their minimal intra operative and post operative complications and good acceptance by patients.

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