



Review on the Role of Pterygoid Implants in Atrophic Maxilla

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ABSTRACT:

Pterygoid implants have emerged as a viable solution for restoring dental function in patients with atrophic maxilla, particularly when traditional dental implants are not feasible due to severe bone loss. These implants utilize the dense cortical bone of the maxillary tuberosity, pyramidal process of the palatine bone, and pterygoid process of the sphenoid bone, offering excellent stability and avoiding the need for complex procedures like sinus lifts and bone grafting. The placement of pterygoid implants requires precise surgical techniques and an in-depth understanding of the anatomical structures, often aided by advanced imaging tools like CBCT scans and dynamic navigation systems. Pterygoid implants provide a less invasive alternative, reduced treatment times, and the potential for immediate loading, making them a popular choice for patients with significant maxillary atrophy. This review discusses the indications, surgical techniques, clinical efficacy, advantages, and technological advancements of pterygoid implants.

Keywords: Pterygoid Implants, Atrophic Maxilla, Dental Implants, Bone Resorption, Surgical Technique

Introduction

The maxilla, which forms the upper jaw, cheeks, and the lower parts of the eye sockets, can become severely atrophic due to prolonged denture use or loss of teeth from conditions like advanced periodontal disease. This atrophy, often resulting from tooth loss, trauma, or congenital defects, causes the resorption of the alveolar ridge and significant bone loss, making traditional dental implant placement difficult.¹ In such cases, pterygoid implants provide an effective solution, offering stability and support for dental prosthetics in the atrophic maxilla where conventional implants may not be feasible. The placement of pterygoid implants begins in the tuberosity area and proceeds in an oblique mesiocranial direction, moving posteriorly toward the pyramidal process, and then upward between the wings of the pterygoid process of the sphenoid bone. The atrophic maxilla, often resulting from long-term edentulism or bone resorption due to aging, presents a significant challenge in prosthodontics.² The lack of sufficient bone volume in the posterior maxilla typically necessitates complex surgical procedures such as sinus lifts or bone grafting. However, these techniques may be impractical or contraindicated in certain patients. Pterygoid implants, placed in the pterygoid process, offer a solution by utilizing the existing bone structures in the posterior maxilla.³ The pterygoid process is part of the sphenoid bone and is located in the posterior aspect of the maxilla. It provides a stable and robust anchorage for implants due to its dense cortical bone. The positioning of pterygoid implants allows them to bypass the sinus cavity, making them particularly valuable in patients with limited bone height in the posterior maxilla. Proper knowledge of the anatomy and careful surgical planning are crucial for successful implantation. This approach makes pterygoid implants a promising alternative for restoring dental function in patients with significant maxillary bone loss.⁴ This review examines the role of pterygoid implants in rehabilitating the atrophic maxilla, especially when traditional methods are inadequate due to bone resorption.

Indications

Pterygoid implants provide an effective alternative by utilizing the dense cortical bone of the maxillary tuberosity, pyramidal process of the palatine bone, and pterygoid process of the sphenoid bone. These implants, first described by Tulasne in 1989, engage dense cortical bone, offering excellent stability. The bone thickness in this region allows the implants to integrate up to 8-9 mm of bone, with the apex extending into the pterygoid fossa.⁵ Indications for pterygoid implants include severe atrophic maxilla, where bone loss limits the placement of conventional implants in the posterior maxillary area; failed sinus lift or bone grafting procedures, where patients may not be candidates for further grafting due to inadequate bone; and rehabilitation of the edentulous maxilla, particularly when conventional implants cannot provide sufficient support.⁶ Studies show high short-term survival rates for pterygoid implants, with modern micro-roughened implants achieving a 99% survival rate after three years. These implants avoid the need for sinus elevation and bone grafting, making the procedure less invasive compared to zygomatic implants, and can be placed under local anesthesia, allowing for quicker treatment times and immediate loading. However, placement requires a high level of surgical skill due to the region's complex anatomy, and clinicians must be well-versed in the surgical anatomy.⁷ Cone beam computed tomography (CBCT) is useful for treatment planning. Pterygoid implants are suitable

for partially or completely edentulous arches and maxillectomy defects but are contraindicated in patients with trismus, limited mouth opening, or conditions such as absent maxillary tuberosity or obstructed access due to impacted third molars.⁸

Surgical Technique

The placement of pterygoid implants involves a specialized surgical approach that requires precision and expertise. The implants are inserted through the buccal mucosa, with the trajectory directed toward the pterygoid plate, and then anchored securely into the dense bone of the pterygoid process.⁹ This technique is less invasive than traditional bone grafting methods, offering a more straightforward option for patients, and can often be performed under local anesthesia, which reduces overall treatment time and recovery. However, the procedure demands a high level of surgical skill, as the correct angle and path of the implant must be carefully controlled to avoid injury to vital structures and to ensure proper implant integration. To improve surgical outcomes and reduce associated risks, a new classification system for pterygoid implants has been proposed.¹⁰ This system categorizes the implants based on the anatomical structures involved, providing a structured framework for surgical planning. This classification helps in understanding the different anatomic challenges each case presents and allows for better preparation, leading to more predictable results. Additionally, advanced placement techniques, such as the L70 approach, have been identified to optimize the biomechanical stability of pterygoid implants, particularly in patients with poor bone quality.¹¹ The L70 approach involves positioning the implant at a specific angle to maximize engagement with the dense cortical bone of the pterygoid process. This technique is especially beneficial in cases where the bone structure is compromised due to atrophy or other factors, providing enhanced stability and improving long-term outcomes for the implant. As implant placement techniques evolve, these innovations continue to expand the potential applications of pterygoid implants, offering a viable solution for patients with challenging maxillary conditions.¹²

Clinical Efficacy

Pterygoid implants have demonstrated excellent survival rates, with some studies reporting success rates as high as 100%, while an overall survival rate of 97.43% has been observed across a variety of research (D'Amario et al., 2024). These implants are typically longer than conventional dental implants, providing enhanced stability. The increased length allows pterygoid implants to utilize the dense cortical bone of the pterygomaxillary region, which not only offers robust support but also negates the need for sinus lift procedures or bone grafting—common hurdles in patients with significant posterior maxillary atrophy. This makes pterygoid implants particularly advantageous for patients suffering from posterior maxillary atrophy, as they provide a viable solution that avoids the need for more invasive grafting techniques (Şahin, 2023).¹³ Numerous studies have highlighted the high success rates of pterygoid implants, with many indicating success rates above 90%. Long-term outcomes are generally positive, as these implants offer stable anchorage for prosthetic rehabilitation, particularly in cases of severe maxillary atrophy where other methods may be less effective. Despite the overall positive results, it is essential for clinicians to carefully monitor patients for potential complications, such as peri-implantitis or implant failure.¹⁴ Regular follow-up is critical to ensure the longevity and functionality of pterygoid implants, as with any implant treatment, to detect and address any issues early. The high success rates of pterygoid implants, coupled with their ability to bypass the need for bone grafting and sinus lifts, make them an increasingly popular option for restoring function and aesthetics in patients with compromised maxillary bone structure.¹⁵

Advantages of Pterygoid Implants

Pterygoid implants provide several distinct advantages for patients with an atrophic maxilla, offering a highly effective solution for those who face challenges with conventional implant placement.¹⁶ These implants help distribute occlusal forces across the posterior maxilla, which significantly enhances biomechanical stability and reduces the risk of implant failure. Their ability to anchor in the dense cortical bone of the pterygoid process also allows them to offer exceptional stability, even in cases of severe bone resorption, where traditional implants might struggle. One of the key benefits of pterygoid implants is their potential to minimize or even eliminate the need for extensive bone grafting. This not only streamlines the overall treatment process but also reduces the treatment time and lowers associated costs. Furthermore, pterygoid implants can often be immediately loaded, facilitating faster rehabilitation and reducing the time patients must wait to restore full function. The placement of these implants is less invasive compared to traditional sinus lift surgeries, which typically involve more complex procedures, a higher risk of complications, and longer recovery times. The less invasive nature of pterygoid implants leads to fewer complications, quicker healing, and a more comfortable experience for patients. As a result, pterygoid implants offer a promising and efficient solution for restoring the function and aesthetics of the maxilla in patients with severe bone atrophy, with the added benefit of simplifying and accelerating the treatment process.^{16,17}

Technological Advancements

The incorporation of dynamic navigation systems has proven to substantially improve the precision of pterygoid implant placement, surpassing the accuracy of traditional free-hand methods. Over the years, guided digital implant planning has revolutionized dentistry, particularly in the realm of maxillofacial surgery for patients with atrophic maxilla. Advanced imaging technologies, such as Cone Beam Computed Tomography (CBCT) and intraoral scanning, now allow for the three-dimensional (3D) mapping of a patient's unique anatomical structure. This technological advancement enables the virtual planning of implant placement with exceptional attention to detail, ensuring the ideal positioning and angulation of pterygoid implants. From these digital plans, custom surgical templates or models are created, which play a crucial role during the actual surgery. These templates ensure that the implant is placed with precise accuracy, minimizing invasiveness and reducing the overall surgery time. The ability to digitally plan and guide the implant

placement helps clinicians avoid complications, optimize the use of available bone, and achieve better functional and aesthetic outcomes. This innovative approach significantly enhances the safety, accuracy, and predictability of pterygoid implant procedures. By reducing human error and offering a more controlled environment, dynamic navigation systems ensure that the implants are positioned optimally, leading to improved success rates and patient satisfaction. For patients with atrophic maxilla, this technology represents a major step forward, providing a more efficient, less invasive, and highly precise solution for restoring the functionality and appearance of their smile.^{18,19,20}

Conclusion

The successful placement of pterygoid implants demands a high level of precision in surgical technique and a comprehensive understanding of the underlying anatomy. It is essential to avoid damage to vital structures, such as the internal maxillary artery and the pterygopalatine fossa, during the procedure. A thorough preoperative assessment is critical to evaluate bone quality and ensure that the implants are securely anchored. While pterygoid implants offer considerable benefits, challenges persist, especially concerning the complexity of the surgical process. Additionally, further research is needed to confirm long-term outcomes and optimize the techniques for implant placement.

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