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Case Report

Rehabilitation of the Atrophic Maxilla with the Hybrid All-on-Four Technique Associated with Pterygoid Implants: Case Report

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Abstract: The rehabilitation of the atrophic maxilla is a challenge in implant dentistry, requiring effective and minimally invasive techniques. The All-on-Four technique is a well-established alternative, characterized by the placement of four implants in the anterior and posterolateral regions of the edentulous maxilla, providing support for a full-arch implant-supported prosthesis. This approach reduces costs, morbidity, and treatment time. In cases of poor bone quality, adapting the protocol by including pterygoid implants—referred to as the hybrid All-on-Four technique—offers an effective and predictable solution with high success rates. This study presents the rehabilitation of a patient with an atrophic maxilla using the hybrid All-on-Four technique. Six implants, including pterygoid implants, were placed, eliminating the need for bone grafting. The rehabilitation was completed with a full-arch implant-supported prosthesis, ensuring adequate functionality and aesthetics. It was concluded that the hybrid All-on-Four technique associated with pterygoid implants is a safe and efficient alternative for the rehabilitation of atrophic maxillae, particularly in patients with limited bone quality.

Keywords: Dental Implants; Bone Resorption; Edentulous Maxilla.

1. Introduction

Edentulism, characterized by the complete loss of natural teeth, is a prevalent condition across various age groups and geographic regions. Studies indicate that in 2010, oral health issues affected 3.9 billion people worldwide, with dental caries, periodontitis, and edentulism being the most prevalent conditions, with rates of 35.4%, 10.8%, and 2.3%, respectively. In Brazil, the 2010 National Oral Health Survey revealed that 53.7% of the elderly population was edentulous, reflecting a high prevalence among older adults [1, 2].

Severe maxillary bone loss, frequently associated with edentulism, can lead to significant complications such as difficulties in mastication, speech alterations, and aesthetic concerns. Additionally, it is linked to systemic health issues, including malnutrition and psychological disorders. The prevalence of edentulism increases with age and is more common in individuals over 60 years old. People with lower income and education levels

are at greater risk of tooth loss, and the lack of access to adequate dental services contributes to the rising incidence of edentulism [3, 4].

Dental implants are widely recognized as a safe and effective therapeutic solution for the treatment of both partial and total edentulism. The height and thickness of the residual alveolar ridge play a crucial role in the success and longevity of implants [5]. Early loss of posterior teeth often results in maxillary sinus pneumatization and significant reductions in bone height, sometimes extending to the basal bone. These factors, aggravated by excessive load caused by ill-fitting prostheses, make implant placement in the posterior maxillary region a considerable challenge [7]. The rehabilitation of the atrophic maxilla requires specific therapeutic approaches, such as maxillary sinus lifting, guided bone regeneration, the use of short or tilted implants, and implant placement in alternative regions such as the pterygoid, zygomatic, or tuberosity areas [7]. Despite the effectiveness of these techniques, each has inherent limitations and risks, including higher morbidity, invasiveness, and prolonged treatment time [8].

The All-on-Four technique, introduced by Paulo Maló in 1993, has emerged as an effective alternative for full-arch rehabilitation, eliminating the need for bone grafts in many cases. However, it is crucial to understand the failure rates and long-term complications associated with this method. A narrative review published in August 2024 analyzed failure rates in rehabilitations using the All-on-Four protocol. The results indicated that implant survival rates ranged from 94% to 99%. Smoking was identified as the primary risk factor for failures, being present in all analyzed studies. The presence of bruxism was also considered relevant, though to a lesser extent. Other factors, such as sex, maxillary bone condition, systemic diseases, and previous periodontitis, did not show a significant impact on failure rates [8].

Additionally, a systematic review published in 2014 evaluated the All-on-Four treatment concept in terms of implant survival rates, fixed prostheses, and changes in proximal bone levels. The results showed that out of 4,804 implants, 74 failed within the first 12 months, with failures mainly associated with prosthetic complications [9, 10]. The average bone loss was 1.3 ± 0.4 mm after 12 to 60 months of follow-up. It is important to highlight that, although failure rates are relatively low, prosthetic complications, such as fractures of the acrylic prosthesis, were observed in some cases [11, 12]. However, in situations with low bone density, adapting to hybrid protocols, such as the hybrid All-on-Four technique associated with pterygoid implants, presents a promising solution [13, 14]. These implants offer high primary stability, allow for immediate loading, and reduce the need for posterior cantilever extensions, optimizing biomechanics and treatment predictability [15, 16].

Pterygoid implants, described by Tulasne (1992), follow an oblique trajectory from the maxillary tuberosity toward the pterygoid process, providing anchorage in dense cortical bone [17, 18]. Studies demonstrate high success rates and longevity associated with this technique, which eliminates additional surgical procedures and expands rehabilitative possibilities for patients with severe bone atrophy [19-21]. This study aims to explore the application of pterygoid implants in the hybrid All-on-Four technique, presenting a clinical case that illustrates its feasibility, effectiveness, and impact on the rehabilitation of atrophic maxillae, with emphasis on the integration between surgical and prosthetic aspects.

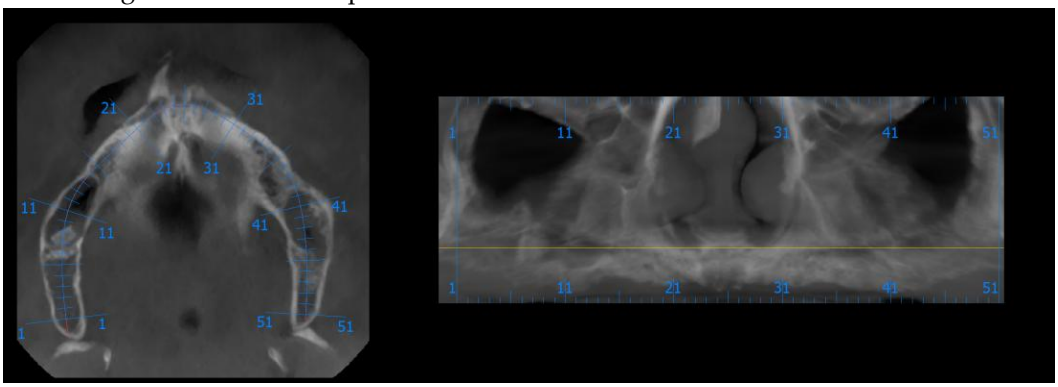
2. Case Report

A 65-year-old female patient of mixed ethnicity sought care in an implantology specialty clinic, reporting dissatisfaction with her unstable upper complete denture (Figure 1A), which caused difficulties in eating and speaking. The clinical examination revealed a low smile line (Figure 1B) and a seemingly atrophic maxilla due to a reduced bone volume in height and vestibulo-lingual dimensions (Figure 1C). To complement the clinical assessment, imaging exams were requested, including a panoramic radiograph (Figure 2) and cone-beam computed tomography (CBCT) scan (Figure 3), which confirmed severe maxillary bone resorption.

Figure 1. A. Initial frontal image with an upper complete denture. B. Initial frontal image showing the edentulous smile. C. Image highlighting maxillary bone loss, showing reduced bone height and vestibulo-lingual width.

Figure 2. Initial panoramic image of the maxilla showing severe resorption and the presence of a lesion in tooth 35, followed by periodontal disease.

Figure 3. Computed Tomography of the atrophic maxilla with 2/2mm transaxial sections, confirming severe bone resorption.



With the information obtained from clinical and imaging examinations, the treatment plan was defined using six implants, applying the hybrid All-on-Four technique with two distal implants tilted to tangentially engage the distal wall of the maxillary sinus and anchored in the pterygoid region. The decision to use six implants instead of the conventional four was based on a detailed evaluation of the patient's bone quality and specific anatomical limitations.

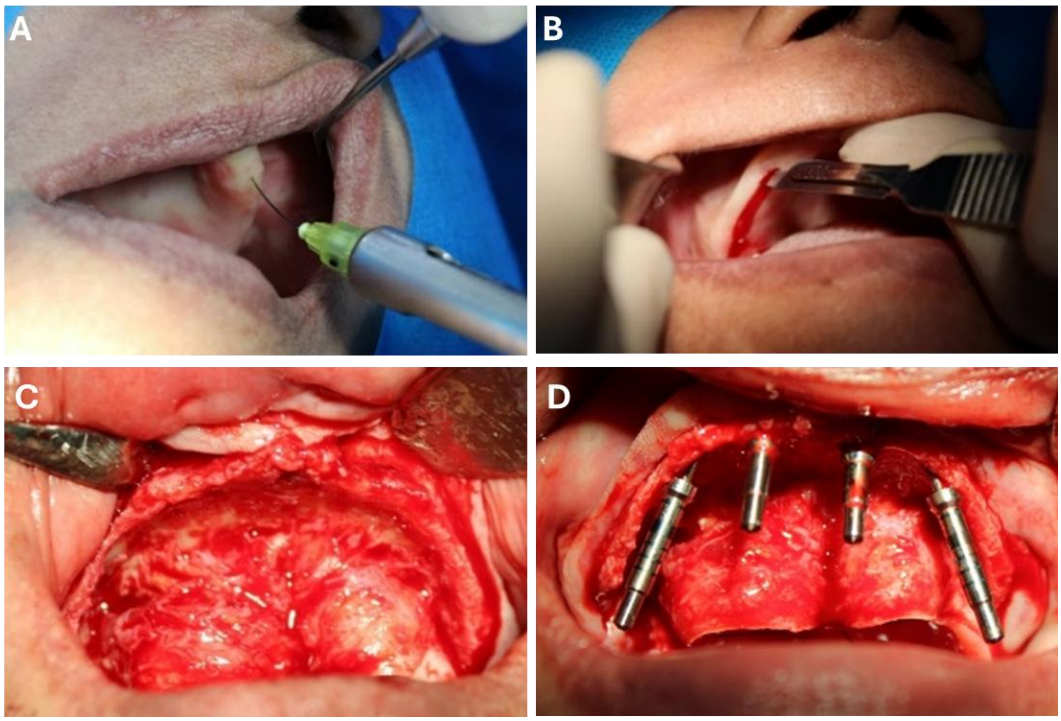
Computed tomography and panoramic radiography revealed severe bone resorption, indicating that, to achieve optimal stability and properly distribute occlusal forces, additional implants were necessary. The inclusion of pterygoid implants was chosen to

provide additional anchorage, especially in the posterior region, where bone quality was insufficient to support conventional implants. This also eliminated the need for bone grafting, optimizing biomechanics and reducing the risk of implant failure.

The patient signed the Informed Consent Form. Preoperative medications were administered 30 minutes prior to surgery, including 1g of amoxicillin, 8mg of dexamethasone, and 15mg of midazolam. The surgical procedure began with extraoral antisepsis using 2% chlorhexidine and intraoral rinsing with 0.12% chlorhexidine, followed by local anesthesia with Articaine® 1:100,000 in the following regions: bilateral infraorbital nerve, bilateral posterior superior alveolar nerve, bilateral greater palatine nerve, and nasopalatine nerve, combined with terminal infiltrations.

After achieving complete anesthesia, a crestal incision was performed in the maxilla extending to the bilateral tuberosity region (Figure 4). Releasing incisions were made, followed by a full-thickness mucoperiosteal flap elevation using a syndesmotome, and the palatal tissue was sutured with 3-0 silk thread to enhance visualization of the surgical area.

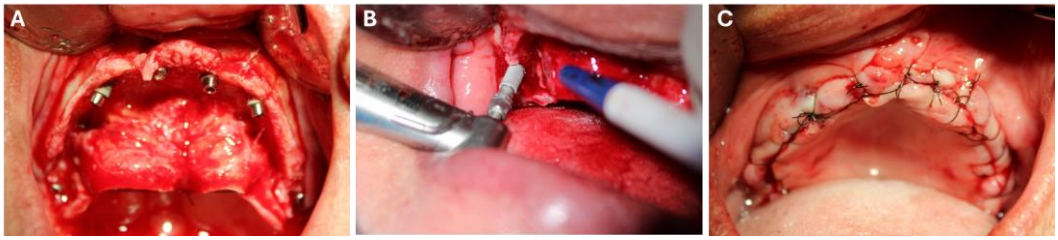
Figure 4. A. Surgical sequence with infiltrative anesthesia. B. Incision along the maxillary bone crest. C. Suturing and exposure of the surgical area. D. Parallel guides showing implant inclination and parallelism.



The Tryon® implant system was used, and drilling procedures followed the manufacturer's guidelines. Two distal drillings were performed, tangentially engaging the anterior wall of the maxillary sinus at a 45° inclination. Two mesial drillings were placed laterally to the incisive foramen, verified with parallel guides, using a palatal approach to preserve the buccal plate (Figure 4). Additionally, two drillings in the bilateral tuberosity region were angled, tangentially engaging the distal wall of the maxillary sinus and extending to the pterygoid.

Six conical Morse taper implants were placed 1mm infra-bone (Figure 5A). In the right and left pterygoid regions, 3.5x13mm implants were used (Figure 5B), with insertion torques of 20N. The two mesial implants were 3.5x10mm, while the angulated implants in the mesial maxillary sinus region were 3.5x11.5mm bilaterally, all with torques above 30N. The procedure was completed with festooned suturing using 3-0 nylon thread (Figure 5C).

Figure 5. A. Installed implants. B. Pterygoid implant placement. C. Festooned suturing.



After surgery, the following medications were prescribed: Amoxicillin 500mg every 8 hours for 7 days, Nimesulide 100mg every 12 hours for 3 days, and Dipyrone sodium 500mg every 6 hours for 3 days, along with postoperative care instructions. Ten days after the procedure, the sutures were removed, and the patient's old complete denture was adjusted and used as a temporary prosthesis. After six months, a panoramic X-ray was requested (Figure 6) to evaluate bone healing and implant positioning for reopening and fabrication of the definitive upper full-arch prosthesis. The prosthesis was installed without any cantilever due to the bilateral pterygoid implants (Figures 7A to 7C).

Figure 6. Panoramic image after 6 months.

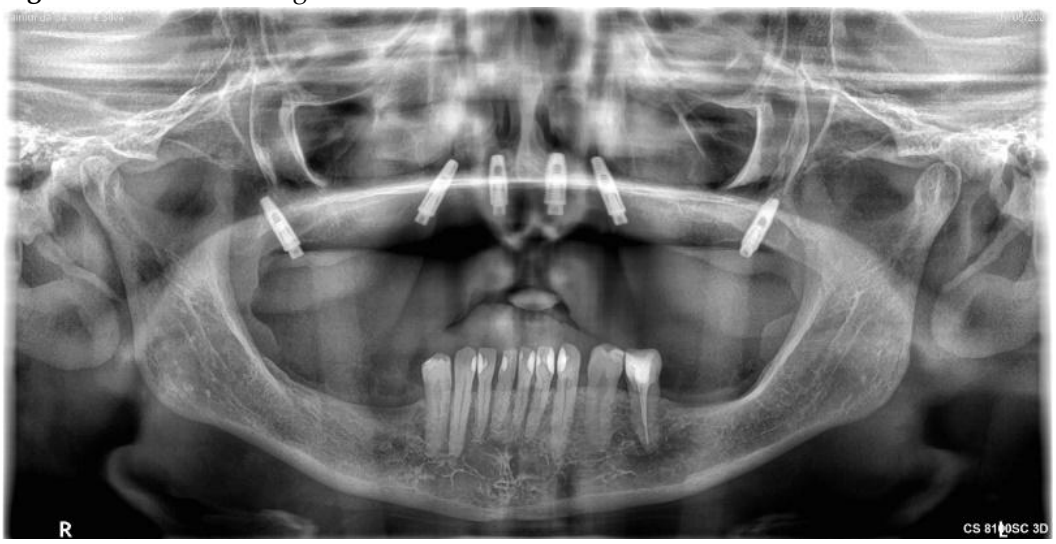


Figure 7. A to C. Images demonstrating the definitive upper full-arch prosthesis.

3. Discussion

The study by [22] shows that to overcome the challenges of rehabilitating the atrophic maxilla, surgical procedures such as bone grafting, maxillary sinus lifting, tilted implants (All-on-Four concept), short implants, and zygomatic implants can be used. However, it is important to highlight that these methods are not free from possible complications. Balaji (2017) and Restelato (2023) report that any of these procedures require professional experience, as they carry risks such as membrane perforation, postoperative wound infection, bone sequestration formation, hematoma, maxillary sinusitis, oroantral fistula,

wound dehiscence, graft loss, displacement of the dental implant into the maxillary sinus, longer healing time, and patient discomfort [23, 24].

The study by [25] showed that using grafts for maxillary ridge reconstruction can be performed with different materials and in various situations, achieving 94% to 95% success rates in implants placed in the grafted maxillary bone remnant using autogenous bone harvested from the symphysis or mandibular ramus. However, [24] noted that due to the need for a donor site, limited availability, and associated morbidity, alternative biomaterials are increasingly being used with convincing success rates. Meanwhile, [26] affirm that both techniques—with and without grafts—yield similar implant survival rates of 90% to 100%, with few or no postoperative complications, concluding that bone grafting does not increase implant survival.

A systematic review by [27] demonstrated that the rehabilitation of completely edentulous atrophic maxillae with tilted implants and immediate loading showed no differences in implant survival or marginal bone resorption when compared to axially placed implants. The study by [28] highlighted the same advantages, indications, and benefits of tilted implants in the All-on-Four technique, such as reducing the need for bone grafts, simplified and less invasive surgical procedures, less postoperative discomfort, and lower costs. This approach allows immediate prosthetic rehabilitation for patients seeking faster treatment without compromising the expected success of rehabilitation [29, 30].

According to [30], in cases of poor bone quality, the All-on-Four technique alone may not be sufficient, requiring the surgeon to combine it with other techniques to ensure successful rehabilitation. This involves transitioning from four implants to the hybrid All-on-Four technique, incorporating two additional pterygoid implants. The study by [23] describes that in this new protocol, the implant is placed in the posterior maxilla, near the tuberosity and behind the maxillary sinus, in what is called the pterygoid or pterygomaxillary region. According to [31], pterygoid implants are a safe and effective option for overcoming bone limitations.

The study by [32] states that patients with atrophic maxillae caused by tooth loss require rehabilitation, and pterygoid implants provide a less invasive alternative with fewer surgical interventions, despite technical challenges. This subject has been growing in importance in recent years. [33] and [34] also emphasize the benefits of eliminating prosthetic cantilevers with pterygoid implants, as well as their bicortical anchorage. However, [23], in a case report, highlighted a challenge of the technique: patient mouth opening, due to the distal position of these implants during prosthesis placement, which aligns with the findings of the present study.

The surgery was performed using a manual approach, without intraoperative navigation or guided surgery. Although these technologies could provide greater precision, the clinical experience of the team and detailed preoperative radiographic evaluation allowed for adequate implant positioning planning [35, 36]. However, we recognize that the use of guided surgery or intraoperative navigation could further enhance precision, particularly in the angulation of pterygoid implants, improving stability and reducing the risk of errors [37].

The study by [40], in a bibliographic analysis, stated that the pterygoid implant technique is useful and important for the technical-surgical knowledge of dental surgeons, as it demonstrates high success rates, stability, biomechanical advantages, and bone loss levels comparable to conventional implants. This makes it an excellent alternative for rehabilitating atrophic maxillae. These findings agree with the studies of [40] and [16], which reported over 90% success rates with pterygoid implants. The presented studies demonstrate that restoring the posterior maxillary portion with pterygoid implants is beneficial, as these implants offer biomechanical stability and eliminate the need for prosthetic cantilever extensions. The success rate of these implants is comparable to that of implants placed in other maxillary regions [16, 23, 41].

Although the inclusion of pterygoid implants significantly contributed to eliminating the need for prosthetic cantilevers, this study did not include a quantitative analysis of occlusal load and stress distribution [38]. For a more precise biomechanical assessment, finite element analysis (FEA) or another simulation method would be required to better understand occlusal force distribution and the stabilization of the implant-supported structure. Previous studies indicate that proper load distribution on pterygoid implants can reduce stress in other areas of the prosthesis, promoting greater longevity and long-term stability [39].

It is also important to discuss the potential risks and complications associated with pterygoid implants. Although they have high success rates, complications such as implant overload, distal bone resorption, and prosthetic fractures may occur over time. Implant overload is particularly concerning when load distribution is not optimized, as it can lead to implant failure or prosthetic fractures [40]. Additionally, distal bone resorption, especially around pterygoid implants, may be a concern in patients with severe bone resorption, affecting long-term stability. The scientific literature suggests that to mitigate these risks, it is essential to ensure proper planning, precise implant placement, and long-term follow-up [41].

4. Conclusion

The hybrid All-on-Four technique, incorporating pterygoid implants, presents itself as an effective, predictable, and safe solution for the rehabilitation of severely atrophic maxillae. It offers a high success rate when indication parameters are properly assessed. This approach maximizes the use of the remaining bone structure, avoids regenerative procedures, and reduces morbidity, treatment time, and costs, while restoring function and aesthetics, significantly contributing to improving the patient's quality of life.

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Research Ethics Committee Approval: We declare that the patient approved the study by signing an informed consent form, and the study followed the ethical guidelines established by the Declaration of Helsinki.

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Conflicts of Interest: The authors declare no conflicts of interest.

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