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Case Report

Rehabilitation with Five Osseointegrated Implants in an Atrophic Maxilla: A Case Report

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Abstract: Tooth loss is a public health issue in Brazil, impacting nutrition, speech, aesthetics, and self-esteem. Implant-supported prostheses are considered the gold standard for replacing missing teeth. Bone resorption, a consequence of tooth loss, can lead to an atrophic ridge, making implant treatment more challenging. This paper reports a case of rehabilitation with a fixed full-arch prosthesis supported by five implants in an atrophic maxilla. The patient sought care at the RC Institute of Postgraduate Dentistry to replace her removable maxillary prosthesis with a fixed, implant-supported one. Imaging exams revealed an atrophic maxilla with reduced bone width and limited height in the posterior region due to maxillary sinus pneumatization. Surgery for the placement of five implants was performed with proper distribution and angulation. Three months after surgery, with the implants osseointegrated, the prosthetic phase began, and treatment was completed with the installation of a porcelain fixed full-arch prosthesis. The use of angled implants proved to be an excellent alternative, allowing the placement of long implants, reducing the distal cantilever, and avoiding invasive procedures. This resulted in lower morbidity, shorter treatment time, and reduced costs.

Keywords: Dental Implants; Bone Resorption; Oral Rehabilitation; Osseointegration.

1. Introduction

Edentulism is a variable condition that reflects the availability of healthcare services, cultural aspects, and the living and health conditions of the population in a given region. In Brazil, tooth loss is considered a highly prevalent public health problem with negative impacts on individuals' lives, affecting nutrition, aesthetics, and self-esteem [1,2]. Oral rehabilitation with implant-supported prostheses has been regarded as the best alternative for replacing lost teeth, yielding excellent results in terms of function (speech and mastication) and aesthetics, and providing high patient satisfaction, with a positive effect on quality of life [3, 4].

Following the loss of a tooth, physiological resorption of the alveolar process occurs immediately, characterized by a decrease in the number of trabeculae, density, and a loss of bone width and height. This resorption is a variable and irreversible process that tends to be more intense in the first year after extraction and continues throughout life. It may become so severe that it results in an atrophic alveolar ridge, complicating the placement of implants in functionally and esthetically satisfactory positions [5, 6].

The resorption pattern of the maxillary arch is centripetal, while the mandible follows a centrifugal pattern, potentially leading to discrepancies and inversion of the maxillo-mandibular relationship. In the maxilla, the main limitation is due to maxillary sinus pneumatization, while in the mandible the available bone height is determined by the presence of the mandibular canal [7,8]. The ultimate goal of implant placement is to provide long-term anchorage in the best possible three-dimensional position for a functional and esthetic prosthetic solution. Reverse planning is essential for successful rehabilitation, establishing the prosthetic goals prior to maxillary reconstruction, as the final prosthesis design determines the number and ideal position of implants [9, 10].

For the treatment of atrophic ridges, several strategies may be employed, generally following two conceptual approaches: using the remaining bone without bone grafting (such as short implants, tuberosity implants, zygomatic implants, tilted implants, or the All-on-4 concept) or increasing bone volume through grafting procedures [11-13]. The choice of treatment should be based on thorough clinical and radiographic evaluation, especially of the quantity and quality of residual bone, which are critical for primary implant stability and successful osseointegration, often requiring a combination of approaches [14-16].

All-on-4 is a general concept based on the placement of four implants to support a fixed full-arch prosthesis. For maxillary rehabilitation, the technique is subdivided into three types: All-on-4 Standard, All-on-4 Hybrid, and All-on-4 Zygoma [17,18]. All-on-4 Standard (conventional implant technique) involves two axial implants placed in the anterior maxilla and two tilted distal implants that engage the anterior wall of the maxillary sinus. All-on-4 Hybrid combines conventional implants with zygomatic implants to provide adequate support in the posterior region. This is indicated when the patient lacks sufficient bone dimensions for the Standard technique, primarily due to severe maxillary sinus pneumatization. All-on-4 Zygoma involves the placement of four zygomatic fixations (two anterior and two posterior). This is the technique of choice for cases of severe resorption, where there is insufficient bone height and width to place conventional implants. In such cases, the zygomatic bone—dense, both cortical and trabecular—is used to anchor long implants ranging from 30 to 52.5 mm [19].

Tilted implants are those placed at an angle of 30º or more relative to vertically positioned implants. They offer surgical and prosthetic advantages, such as the ability to place longer implants, increasing bone-to-implant contact, enhancing bone anchorage and primary stability; the addition of posterior support, reducing distal cantilever length and the risk of stress accumulation and resorption at the bone-implant interface, thus improving load distribution. Furthermore, they avoid bone grafting and/or invasive surgical procedures, reducing morbidity, treatment time, and costs, leading to better patient acceptance [6, 17, 18]. Studies have reported high success rates for implant-supported fixed prostheses. However, occlusal load transfer through the distal cantilever may lead to prosthetic complications such as screw loosening or fracture; fracture of the prosthetic tooth, porcelain, or metal substructure; or even implant failure. For the maxilla, a distal cantilever of no more than 10 to 12 mm is recommended [12, 13, 19, 29].

This paper aims to report a clinical case of rehabilitation with a fixed prosthesis supported by five implants in an atrophic maxilla.

2. Case Report

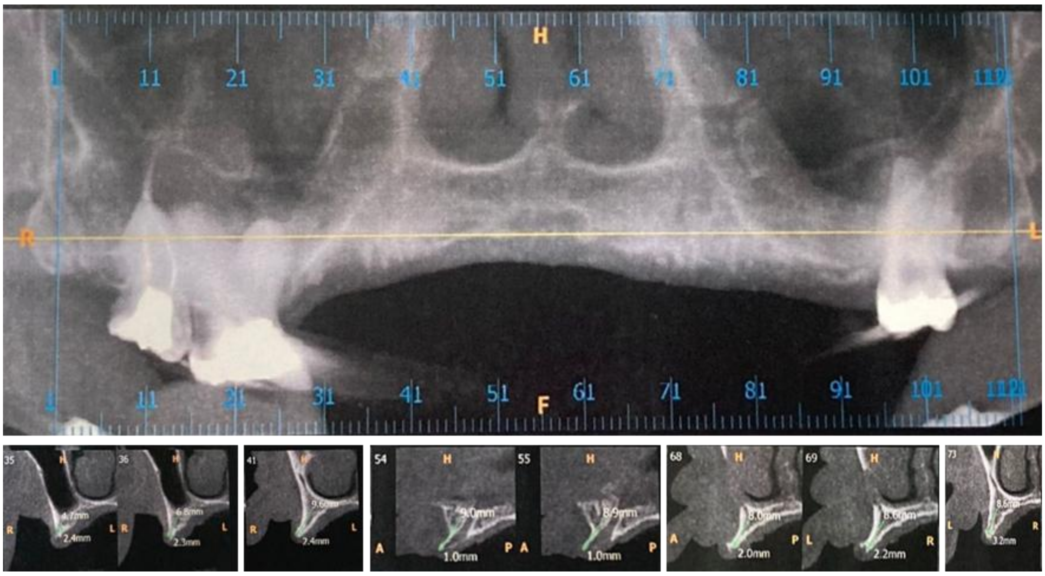
A 61-year-old female patient sought care at the Postgraduate Institute of Dentistry for a clinical evaluation, reporting a desire "to replace the upper removable denture with a fixed implant-supported prosthesis" (sic). During anamnesis, the patient stated that she had lost her teeth many years ago and had been using a removable partial denture (RPD) ever since. She denied any relevant systemic conditions or the use of medications.

In the intraoral clinical examination, all maxillary teeth were missing except for teeth 18, 17, and 28, and the maxillary residual ridge was narrow. In the mandibular arch, teeth 46 and 36 were absent, and a root remnant of tooth 37 was observed (Figure 1).

Figure 1. Initial Intraoral Appearance.

Complementary laboratory tests were requested, including a complete blood count, coagulation profile, and fasting blood glucose, as well as imaging exams (panoramic radiograph and Cone Beam computed tomography of the maxilla) (Figure 2).

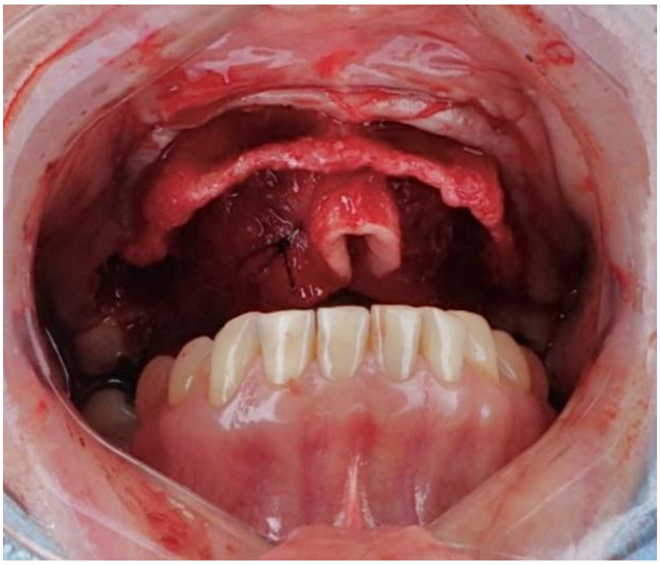
Figure 2. Final Panoramic Radiograph.



After analyzing the imaging exams, the case was diagnosed as an atrophic maxillary ridge, with insufficient bone width and limited height in the posterior region due to bilateral pneumatization of the maxillary sinuses. The proposed treatment plan was the rehabilitation with a fixed prosthesis supported by four well-distributed implants in the maxilla. It was decided to preserve teeth 18 and 28 to maintain vertical occlusal dimension, and extraction of tooth 17 was planned, as it was extruded and its preservation was deemed unfavorable for the prosthetic phase.

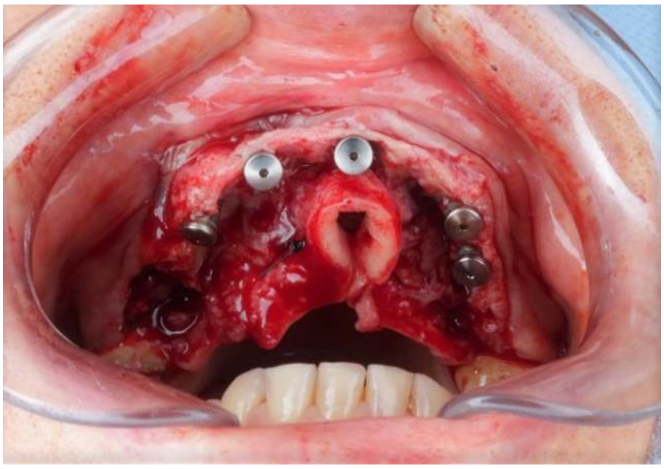
Initially, implant placement surgery and extraction of tooth 17 were performed. After antisepsis, local anesthesia, a crestal incision, and full-thickness flap elevation, an extremely thin residual bone ridge was observed (Figure 3).

Figure 3. Ridge aspect after flap elevation, showing horizontal bone deficiency.



Prior to implant placement, a bone expansion system (Bone Expander – Maximus®) was used to expand the bone and increase its density. Five external hexagon-type implants (E-fix – Titanium-fix®), with a diameter of 3.75 mm and lengths of 13 mm, 11.5 mm, and 8.5 mm, were placed. As an alternative to the vertical bone limitation in the posterior region and the pneumatization of the maxillary sinus, implant angulation was employed (Figure 4). To fill and cover exposed threads, particulate lyophilized bovine bone matrix was used in association with blood concentrates. The suture was then performed, and the patient received postoperative care instructions. Fourteen days later, the patient returned for suture removal and fabrication of a mucosa-supported provisional complete denture, which was used during the osseointegration period.

Figure 4. Ridge with implants placed.



A three-month healing period was observed before reopening and exposing the implant platforms to begin the prosthetic phase. After three months, osseointegration was assessed using the ISQ, with average values of 65 ± 5 for axial implants and 68 ± 4 for tilted implants, confirming sufficient stability for the prosthetic phase [28]. Straight and angled mini abutments were used as intermediate components to correct the angulation of the tilted implants (Figures 5 and 6).

Figure 5. Transfer copings in position, highlighting the need for angled components.

Figure 6. Straight and angled mini abutments in position.

Subsequently, an impression was taken for the fabrication of the record base and wax rim. After marking the midline, smile line, and canine lines, as well as defining the vertical dimension of occlusion, a trial of the teeth set in wax was performed (Figures 7A and 7B). Upon evaluation, with satisfactory esthetics and function observed, the process proceeded with the fabrication and trial of the metal framework (Figure 8A). Finally, porcelain was applied, followed by the installation and delivery of the final fixed full-arch prosthesis (Figures 8B, 9A, and 9B).

Six months after the installation of the fixed full-arch prosthesis, the patient returned for a follow-up and maintenance appointment. She reported a significant improvement in masticatory efficiency and comfort following the placement of the fixed prosthesis, as assessed by a validated satisfaction questionnaire, with scores of 8/10 for comfort and 9/10 for masticatory function (Figures 10A, 10B, and 11). During the six-month follow-up period, no complications such as peri-implant inflammation or the need for prosthetic adjustments were observed. However, the literature indicates that long-term complications, such as peri-implant bone resorption or mechanical failures, may occur. Periodic maintenance, including radiographic and clinical evaluations, is essential to ensure the longevity of the rehabilitation.

Figure 7. A. Teeth set in wax. B. Try-in of the teeth set in wax.

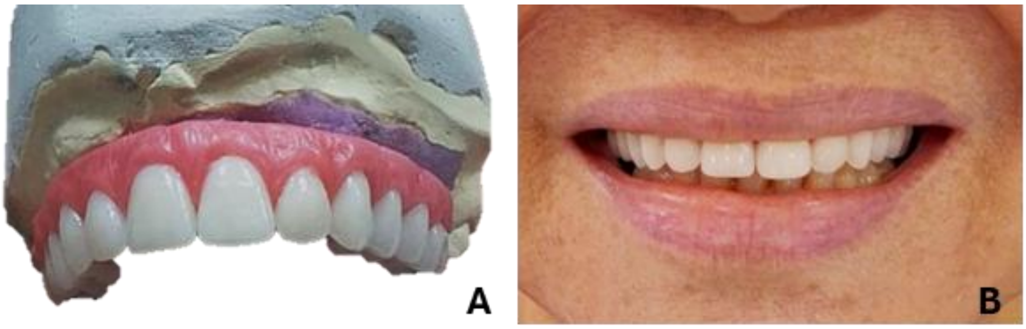


Figure 8. A. Metal framework for ceramic prosthesis. B. Ceramic fixed prosthesis (buccal view).

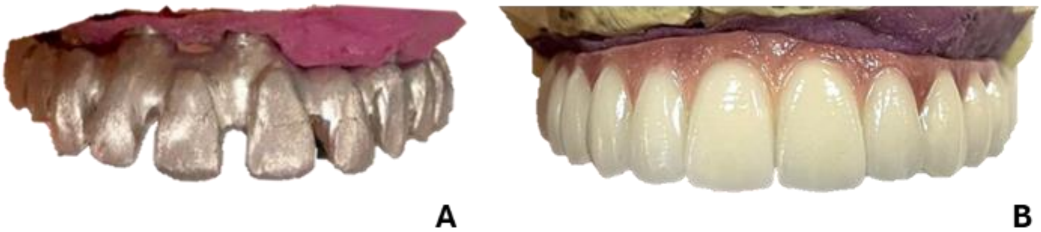


Figure 9. A. Metal framework for ceramic protocol. B. Ceramic protocol prosthesis (buccal view).

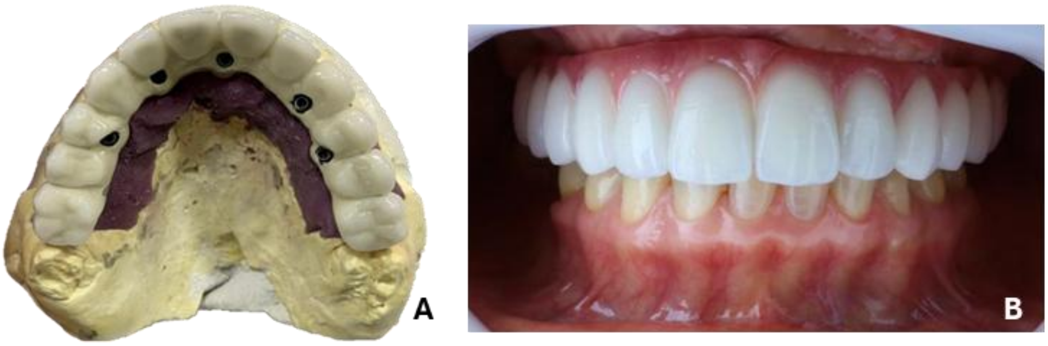
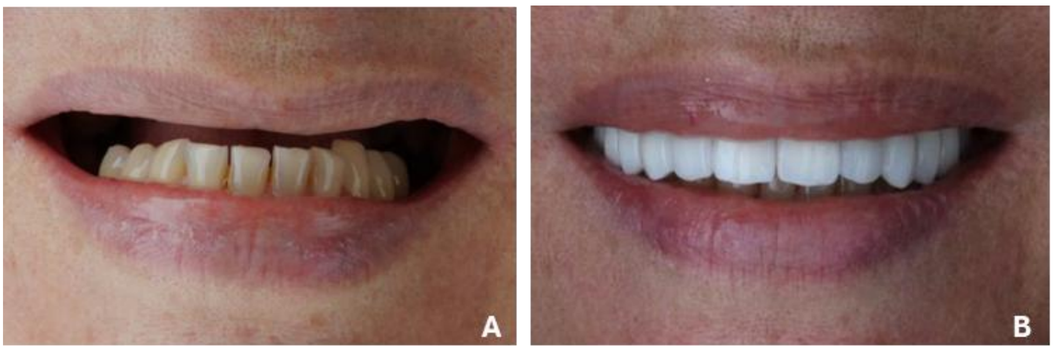


Figure 10. A. Initial appearance. B. Final appearance.



3. Discussion

The placement of implants in fully edentulous arches is considered the "gold standard" for the treatment of edentulous patients. The literature consistently reports that these patients have a clear preference for fixed implant-supported prostheses, as they offer greater masticatory efficiency and comfort, and require fewer repairs. Long-term follow-up studies of implant-supported fixed prostheses in the maxilla demonstrate implant survival rates ranging from 95.5% to 92%, confirming this treatment as a scientifically validated option. In contrast, implant failure rates in maxillary overdentures are significantly higher [12,19–21].

Figure 11. Final Panoramic Radiograph.

Treating the severely atrophic maxilla with implants is challenging due to horizontal and vertical bone resorption, along with compromised bone quality, especially in the posterior region, as a result of maxillary sinus pneumatization. These factors directly influence treatment decisions, which typically follow one of two paths: using the residual bone or increasing bone volume through grafting procedures [10,16,22].

Although bone grafting can yield excellent results, it is a technically demanding procedure that may result in complications such as graft failure, surgical site infection, poor postoperative outcomes, increased morbidity, prolonged treatment time, and higher financial costs for the patient. Additionally, a five-year retrospective analysis reported that maxillary implants placed in native bone have higher survival rates and less bone resorption than those placed in grafted bone [5,17,23]. The use of tilted implants eliminated the need for bone grafts or sinus lift procedures, reducing the treatment duration by an estimated 3–6 months and lowering the costs associated with additional surgeries. The patient reported minimal postoperative discomfort and rapid adaptation to the fixed prosthesis, indicating both clinical and psychological benefits.

Although zygomatic implants are a viable alternative for severely atrophic maxillae, the decision to use tilted implants in this case was based on the sufficient amount of residual bone and the possibility of applying less invasive techniques, such as bone expansion. This approach avoided more complex procedures, reduced morbidity, and shortened treatment time. The use of five implants instead of four (as in the All-on-4 concept) was also considered to improve load distribution, even though additional implants were not strictly necessary due to the stability achieved. In this case, the residual bone was used to place five well-distributed implants in the maxilla, employing the technique of tilting the posterior implants, which allowed for the placement of longer implants (11.5 mm and 13 mm), increasing the bone-to-implant contact area and avoiding the need for maxillary sinus floor elevation. A particulate lyophilized bovine bone matrix was used solely to cover exposed threads.

There is variation in the literature regarding the number of implants required for full-arch maxillary rehabilitation. Some studies recommend the placement of six to eight implants for a fixed maxillary prosthesis, arguing that this approach reduces load transmission to each implant and decreases distal cantilever length. The literature suggests that short cantilevers (≤ 10 mm) are ideal for maximizing mechanical strength, and a cantilever-to-anteroposterior (CL:AP) ratio of 1:3 is recommended for predictable outcomes, especially when using standard-diameter implants (3.75 mm, as used in this case) [29,20,3]. However, long-term follow-up studies have confirmed the high success rates of the All-on-4 concept (ranging from 95.2% to 100%), which benefits from the use of tilted distal implants [8,12,16,24]. In this case, the distal cantilever length was 9 mm, resulting in a CL:AP ratio of 1:3—within the literature's recommended parameters for minimizing mechanical complications. Some sources allow cantilevers up to 2.5 times the AP distance under ideal conditions when using five implants, but no more than two distal pontics are advised [29].

Studies have also investigated the influence of implant number and angulation on cortical bone stress distribution using the All-on-4 technique. They concluded that tilted implants combined with short cantilevers reduce stress on the peri-implant cortical bone. Other findings indicate that support polygons formed by four or five implants offer better stability and load distribution [24]. Agliardi et al. [7] rehabilitated twenty maxillae using two axial and four tilted implants; after 31.3 months of follow-up, they reported survival rates of 97.5% for axial implants and 99.2% for tilted implants [7]. In prospective and retrospective studies reviewed, no significant difference in success rates was found between tilted and axial implants when used in multiple-unit prostheses [23,25].

In the case presented, five implants were used, considering inter-implant distance. This aligns with Asawa et al. [26], who state that increasing the distance between implants improves load distribution. According to Tischler, Datch, and Bidra [27], the greater the number of implants, the smaller the space between them, which may lead to prosthetic complications, such as framework fractures, and hinder oral hygiene [27]. Although six months results are promising, long-term studies are necessary to confirm the stability of the rehabilitation and monitor for late complications.

4. Conclusion

The treatment of atrophic maxillae with implant-supported full-arch prostheses remains a clinical challenge, primarily due to reduced bone height and width, compromised maxillary bone quality, and the presence of critical anatomical structures that hinder ideal three-dimensional implant placement. For this reason, several approaches have been proposed to overcome these limitations in the rehabilitation of atrophic ridges.

Among the treatment modalities, the use of tilted implants has proven to be an excellent option. It offers biomechanical advantages by reducing distal cantilever length and improving load distribution, while avoiding more invasive procedures. This reduces morbidity, shortens treatment time, and lowers financial costs, resulting in high patient acceptance and extremely favorable outcomes.

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Research Ethics Committee Approval: We declare that the patient approved the study by signing an informed consent form, and that 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.

References

1. Silva ET, Oliveira RT, Leles CR. Fatores associados ao edentulismo funcional em idosos brasileiros. Comun Ciênc Saúde. 2016;27(2):129-138.
2. Cardoso M, et al. Edentulism in Brazil: trends, projections and expectations until 2040. Cien Saude Colet. 2016;21(4):1239-1245.
3. Rocha SS, et al. Próteses Totais Fixas Tipo Protocolo Bimaxilares: relato de caso. Rev Odontol Bras Central. 2013;21(60):21-27.

4. Cunha G, et al. Atrophic maxilla reconstruction with autogenous iliac graft and guided dental implants. J Craniofac Surg. 2018 Nov;29(8):2218-2219.
5. Sierra-Sanchez J, et al. Predictability of short implants (<10 mm) as a treatment option for the rehabilitation of atrophic maxilla: a systematic review. Med Oral Patol Oral Cir Bucal. 2016;21(3):e392-e402.
6. Mittal Y, Jindal G, Garg S. Bone manipulation procedures in dental implants. Indian J Dent. 2016;7(2):86-94.
7. Agliardi EL, et al. Immediate full-arch rehabilitation of the severely atrophic maxilla supported by zygomatic implants: a prospective clinical study with minimum follow-up of 6 years. Int J Oral Maxillofac Surg. 2017;46(12):1592-1599.
8. Spencer KR. Implant-based rehabilitation options for the atrophic edentulous jaw. Aust Dent J. 2018;63(1):100-107.
9. Misch CM. Maxillary autogenous bone grafting. Oral Maxillofac Surg Clin North Am. 2011;23(2):229-238.
10. Peñarrocha-Oltra D, et al. Rehabilitation of the atrophic maxilla with tilted implants: review of the literature. J Oral Implantol. 2013;39(5):625-632.
11. Zanettini LMS, et al. Use of recombinant human bone morphogenetic protein-2 associated with lyophilized bovine bone in reconstruction of atrophic maxilla. J Craniofac Surg. 2018;29(7):1934-1938.
12. Durkan R, Oyar P, Deste G. Maxillary and mandibular all-on-four implant designs: a review. Niger J Clin Pract. 2019;22:1033-1040.
13. Corbella S, Taschieri S, Del Fabbro M. Long-term outcomes for the treatment of atrophic posterior maxilla: a systematic review of literature. Clin Implant Dent Relat Res. 2013;17(1):12-132.
14. Monje A, et al. Influence of atrophic posterior maxilla ridge height on bone density and microarchitecture. Clin Implant Dent Relat Res. 2013;17(1):111-119.
15. Mertens C, et al. Reconstruction of the severely atrophic edentulous maxillae with calvarial bone grafts. Clin Oral Implants Res. 2016;28(6):749-756.
16. Sayed S, Hassan M, Emarah M. All-on-4 versus all-on-6 implant concepts for rehabilitation of edentulous maxilla: short-term randomized clinical and radiographic study. Egypt Dent J. 2020;66:659-670.
17. Chaware SH, et al. The rehabilitation of posterior atrophic maxilla by using the graftless option of short implant versus conventional long implant with sinus graft: a systematic review and meta-analysis of randomized controlled clinical trial. J Indian Prosthodont Soc. 2021;21:28-44.
18. Esposito M, et al. Immediately loaded zygomatic implant vs. conventional dental implant in augmented atrophic maxilla: 4 months post loading result from multicentre randomized controlled trial. Eur J Oral Implantol. 2018;11:11-28.
19. Kern JS, et al. A systematic review and meta-analysis of removable and fixed implant-supported prostheses in edentulous jaws: post-loading implant loss. Clin Oral Implants Res. 2015;:1-22.
20. Misch CM. Maxillary autogenous bone grafting. Oral Maxillofac Surg Clin North Am. 2011;23(2):229-238.
21. Rocha SS, et al. Próteses Totais Fixas Tipo Protocolo Bimaxilares: relato de caso. Rev Odontol Bras Central. 2013;21(60):21-27.
22. Mertens C, et al. Reconstruction of the severely atrophic edentulous maxillae with calvarial bone grafts. Clin Oral Implants Res. 2016;28(6):749-756.
23. Mehta SP, et al. Clinical success between tilted and axial implants in edentulous maxilla: a systematic review and meta-analysis. J Indian Prosthodont Soc. 2021;21:217-228.
24. Maló P, et al. All-on-4® treatment concept for the rehabilitation of the completely edentulous mandible: a 7-year clinical and 5-year radiographic retrospective case series with risk assessment for implant failure and marginal bone level. Clin Implant Dent Relat Res. 2014;17:531-541.
25. Zincir OO, Parlar A. Comparison of stresses in monoblock tilted implants and conventional angled multiunit abutment-implant connection systems in the all-on-four procedure. BMC Oral Health. 2021;21(646):1-13.
26. Asawa N, et al. Angulated implants: an alternative to bone augmentation and sinus lift procedure: systematic review. J Clin Diagn Res. 2015;9(3):10-13.
27. Tischler M, Patch C, Bidra AS. Rehabilitation of edentulous jaws with zirconia complete-arch fixed implant-supported prostheses: an up to 4-year retrospective clinical study. J Prosthet Dent. 2018;120(2):204-209.
28. Moraes MM, de Oliveira M, Silva J, et al. The role of urban green spaces in the context of the COVID-19 pandemic: a case study of the city of São Paulo, Brazil. Sustain Cities Soc. 2020;61:102338. doi:10.1016/j.scs.2020.102338.
29. Kondo Y, Sakai K, Minakuchi H, Horimai T, Kuboki T; JSOI Clinical Guideline Working Group collaborators. Implant-supported fixed prostheses with cantilever: a systematic review and meta-analysis. Int J Implant Dent. 2024;10:57. doi:10.1186/s40729-024-00573-8.