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Major characteristics and clinical results of the all-on-four technique in implant dentistry: a systematic review

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Abstract

Introduction: In the context of dental implant methods, the all-on-four technique has proven to be beneficial in reducing stress around dental implants and is a very effective treatment option for edentulous patients. **Objective:** A systematic review was carried out to present the main characteristics and clinical results of the all-in-four technique in implant dentistry. **Methods:** The PRISMA Platform systematic review rules were followed. The search was carried out from October 2023 to January 2024 in the Scopus, PubMed, Science Direct, Scielo, and Google Scholar databases. The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument. **Results and Conclusion:** A total of 82 articles were found, 40 articles were evaluated in full and 22 were included and developed in the present systematic review study. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 12 studies with a high risk of bias and 10 studies that did not meet GRADE and AMSTAR-2. Most studies did not show homogeneity in their results, with X^2=55.7%>50%. It was concluded that technical knowledge and anatomical understanding in all-on-four mandibular surgery are essential for predictable and consistent surgical results. The all-on-four configuration proved to be biomechanically superior to parallel implants, considering the radial stresses on the implants and cortical bone. All-on-four treatments are based on the insertion of two anterior implants and two angled ones to cover a larger area. Therefore, implant-supported prostheses may have higher success and survival rates. The cost of treatment can be reduced. Chewing stress can also be minimized to a greater extent. It was observed that the lowest stress was observed in both lateral and vertical loads in the peri-implant region.

Keywords: Dental implant. All-on-four. Edentulous patients. Mandibular surgery. Implant-supported prostheses.

Introduction

In the context of dental implant methods, the all-on-four technique has proven to be beneficial in reducing stress around dental implants and is a very effective treatment option for edentulous patients. Surgical training for all-on-four mandibular surgery requires guidance and experience to perform competently [1].

The main complicating factor is the position of the nerve, however, several other factors must be considered to avoid causing complications. All-on-four jaw surgery is not as difficult as all-on-four jaw surgery to learn, however, it still requires competence in removing diseased teeth, leveling bone reduction, and placing dental implants, all done to facilitate the desired immediate function [1,2].

In the atrophic edentulous condition, for which there is commonly a great reduction in vertical height, the difficulty is further increased by the lack of bone mass, proximity of nerves, extremely dense bone, hernia of the floor of the mouth and reduction in the length of the interforaminal arch. The highly vertically resorbed mandible is treated with 3 attachments instead of 4 due to the limited length of the horizontal arch [1-3].

Furthermore, mandibular resection is performed mainly in the case of ablations of advanced intraoral

squamous cell carcinomas that spread to the jaw, as well as in benign tumors, malignant primitive endosseous tumors, traumas (car accidents, wounds), infections and osteoradionecrosis. Bone and tooth loss brings functional difficulties and aesthetic consequences with serious changes in facial contours [4,5].

These problems are accentuated as the other segments of the jaw are subjected to muscular displacement that moves towards the area left empty, leading to a severe form of malocclusion. As nerve tissue is also removed, proprioceptive sensitivity of the lower lip and sometimes the ipsilateral hemilingual is reduced or lost, worsening speech and salivation problems. Furthermore, mouth opening is often severely reduced [6,7].

Also, osseointegrated implants in the dental rehabilitation of these patients are fundamental because they are a highly predictable means of providing sufficiently stable and retentive prostheses where a profoundly altered anatomy rarely allows adequate results through conventional prosthetic rehabilitation [8-10].

Therefore, the present study carried out a systematic review to present the main characteristics and clinical results of the all-on-four technique in implant dentistry.

Methods

Study Design

The present study followed the international systematic review model, following the rules of PRISMA (preferred reporting items for systematic reviews and meta-analysis). Available at: http://www.prisma-statement.org/?AspxAutoDetectCookieSupport=1. Accessed on: 08/14/2023. The methodological quality standards of AMSTAR-2 (Assessing the methodological quality of systematic reviews) were also followed. Available at: https://amstar.ca/. Accessed on: 08/14/2023.

Data Sources and Research Strategy

The literary search process was carried out from October 2023 to January 2024 and was developed based on Scopus, PubMed, Lilacs, Ebsco, Scielo, and Google Scholar, covering scientific articles from various to the present. The descriptors (MeSH Terms) were used: "Dental implant. All-on-four. Edentulous patients. Mandibular surgery. Implant-supported prostheses", and using the Boolean "and" between the MeSH terms and "or" between historical discoveries.

Study Quality and Risk of Bias

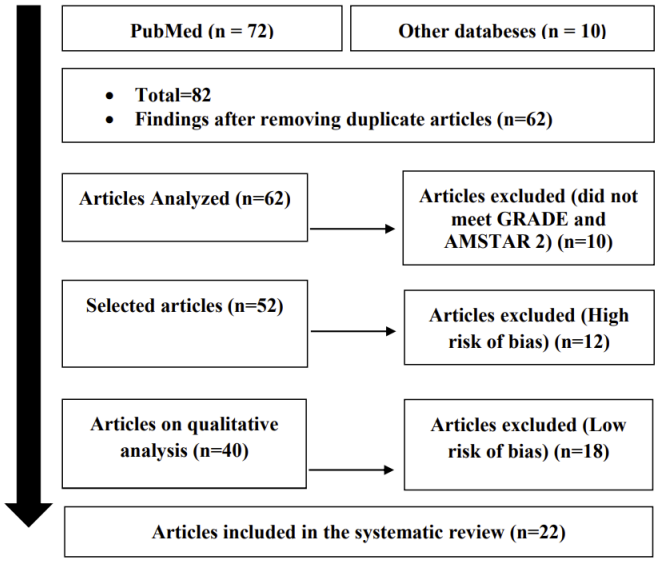
Quality was classified as high, moderate, low, or very low in terms of risk of bias, clarity of comparisons, precision, and consistency of analyses. The most evident emphasis was on systematic review articles or meta-analyses of randomized clinical trials, followed by randomized clinical trials. The low quality of evidence was attributed to case reports, editorials, and brief communications, according to the GRADE instrument. The risk of bias was analyzed according to the Cochrane instrument by analyzing the Funnel Plot graph (Sample size versus Effect size), using the Cohen test (d).

Results and Discussion

Summary of Findings

A total of 82 articles were found that were subjected to eligibility analysis, with 22 final studies being selected to compose the results of this systematic review. The studies listed were of medium to high quality (Figure 1), considering the level of scientific evidence of studies such as meta-analysis, consensus, randomized clinical, prospective, and observational. The biases did not compromise the scientific basis of the studies. According to the GRADE instrument, most studies showed homogeneity in their results, with X^2=55.7%>50%. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 12 studies with a high risk of bias and 10 studies that did not meet GRADE and AMSTAR-2.

Figure 1. Article selection and exclusion process.

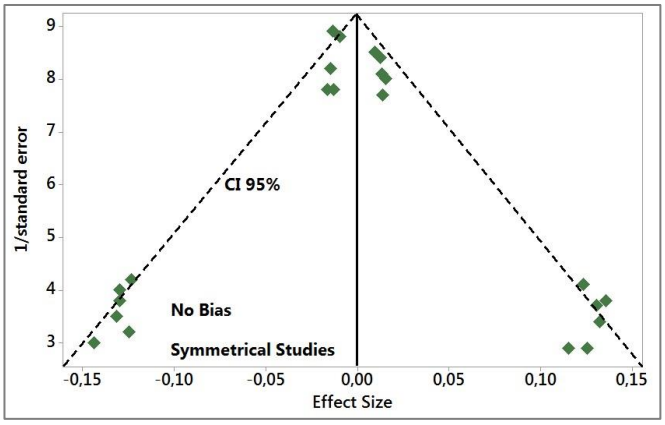


Source: Own authorship.

Figure 2 presents the results of the risk of bias of the studies using the Funnel Plot, showing the calculation of the Effect Size (Magnitude of the difference) using the Cohen Test (d). Precision (sample size) was determined indirectly by the inverse of the standard error (1/Standard Error). This graph had a

symmetrical behavior, not suggesting a significant risk of bias, both between studies with a small sample size (lower precision) that are shown at the bottom of the graph and in studies with a large sample size that are presented at the top.

Figure 2. The symmetric funnel plot suggests no risk of bias among the small sample size studies that are shown at the bottom of the graph. High confidence and high recommendation studies are shown above the graph (n=22 studies).



Source: Own authorship.

Major Clinical Outcomes

Conventional implant printing techniques can introduce distortions into the structure that can lead to a lack of precision in the prosthesis. The misfit between the restoration and the implants facilitates the occurrence of biomechanical failures and complications of the prosthesis due to inadequate stress dissipation. Digital impressions present an alternative to eliminate distortions from the procedure, improving the fit between the restoration and implants [1,2].

Among the different types of digital impressions, photogrammetry has emerged as an alternative for multiple implant impressions. Thus, a clinical case study described the photogrammetric technique for full-arch, all-on-four rehabilitation of a 68-year-old patient with an implant-supported fixed restoration in the mandible. The photogrammetric technique has proven to be a successful digital alternative to conventional printing of multiple implants. Aesthetics and function remained stable during a 1-year follow-up period. No biomechanical or biological complications were observed [11].

A study analyzed the distribution of stresses in 3D Finite Element (FE) models at the bone, implant, and structure level of different designs for implant-supported fixed prostheses in completely edentulous patients, comparing results in entire and partially resected jaws using the all-on-four. It was observed that the tensions on the implants are greater in the entire mandible than in the resected mandible, the tensions of the structure and the cancellous bone are comparable in all cases, in the resected mandible, the maximum tension levels at the cortical bone/implant interface are greater than in whole jaw rehabilitation. The opposite applies to maximum stresses in the outer cortical bone, measured radially relative to the implant from the point of maximum stress at the interface. In the resected mandible, the all-on-four configuration was biomechanically superior to parallel implants, considering the radial stresses on the implants and cortical bone. A design with four parallel implants minimizes stress on a resected jaw while, across the entire jaw, all-on-four rehabilitation is superior at all levels (bone, implant, and structure) [12].

Therefore, all-on-four treatments are based on the insertion of two anterior implants and two angled ones to cover a larger area. Therefore, implant-supported prostheses may have higher success and survival rates. There is also no need to place extra implants, so the cost of treatment can be reduced [1].

Added to this, chewing stress can also be minimized to a greater extent. Stress distribution is ideal around the implant, bone, and fixation system [15]. The authors encompassed the developed all-on-four treatment concept, which is a full-arch fixed prosthesis with immediate loading anchored with four implants in the mandible or maxilla. The all-on-four concept includes two axially inclined implants in the anterior region and two posteriorly inclined implants. Based on long-term follow-up, it has been observed to be a successful procedure because angled posterior implants avoid anatomical structures, allow for longer implant placement, and decrease posterior cantilever [15].

Furthermore, the authors Mahantshetty et al. [16] observed that the peri-implant region presented a lower concentration of stresses in vertical and lateral loads. Due to the angulations used during implant placement, the fixation of the bar, the cancellous bone, and the cortical bone presented high tension. Furthermore, Takahashi et al. [17] observed maximum tension around the posterior implant on the right side. Also, the authors Ozan et al. [18] revealed that reducing the cantilever length by tilting posterior implants resulted in a decrease in stress values in the abutment, prosthetic screw, peri-implant bone, and 3D FEA-based metal structure.

The implant technology developed as the all-on-four concept was found to be a substitute for the conventional implant method [19]. It was observed that the lowest stress was observed in both lateral and vertical loads in the peri-implant region. The all-on-four approach is a very effective treatment option with excellent clinical results for edentulous patients [15,17].

A study evaluated stress and strain values in conventional multi-unit angular abutment-implant connection systems and monobloc dental implants used in the all-on-four procedure with finite element analysis. Two master models were created by placing four implants connected to multiunit abutments (group A) in the interforaminal region of a completely edentulous mandible and four monobloc implants (group B) in the same region of another completely edentulous mandible. Group A implants were classified according to their diameter as: 3.5 mm (M1A), 4.0 mm (M2A), and 4.5 mm (M3A). Likewise, group B implants were classified as M1B, M2B and M3B. In the six models rehabilitated with fixed acrylic prostheses, a force of 100 N was applied to the anterior region of the implant and a force of 250 N to the posterior cantilever in the axial and oblique directions of 30°. Therefore, in monobloc implant systems under axial and oblique forces, greater stress is accumulated in the bone, prosthesis screw, and implant compared to multi-unit abutment-implant connection systems [20].

The authors Türker et al. (2021) [21] through 3D finite element analysis (FEA) investigated the stresses in abutments, screws, and prostheses that are generated by occlusal loads through different occlusal schemes in the all-on-Four concept. 3D models of the maxilla, mandible, implants, implant substructures, and prostheses were designed according to the All-on-Four concept. Forces were applied from occlusal contact points formed in maximum intercuspation and eccentric movements in canine guidance occlusion (CGO), group function occlusion (GFO), and lingualized occlusion (LO). Von Mises stress values for abutments and screws and strain values for prostheses were obtained and the results were evaluated comparatively. It was observed that the stresses in the screws and pillars were distributed more evenly in the GFO. Maximum deformation values for the prosthesis were observed in the GFO model for lateral movement in both the maxilla and mandible. Within the limits of the present study, GFO can be suggested to reduce stresses in screws, abutments, and prostheses in the all-on-four concept.

Finally, authors Zor et al. (2022) [22] expressed the differences in stress distribution of dental implants with various designs and thread diameters based on the all-on-four concept with three-dimensional (3D-FEA). A 3D model of a fully edentulous mandible was used to perform FEA. For Von Mises stresses, the highest stress values were detected in the distal implants for all models. Distal implants also had the highest stress values for vertical loading. It turned out that the Von Mises stresses were concentrated around the neck of the implant. In all models, the highest stresses Pmax and Pmin occurred in the bone around the distal implant. It was noted that implants with active thread presented the highest tension values Pmax and Pmin.

Conclusion

It was concluded that technical knowledge and anatomical understanding in all-on-four mandibular surgery are essential for predictable and consistent surgical results. The all-on-four configuration proved to be biomechanically superior to parallel implants, considering the radial stresses on the implants and cortical bone. All-on-four treatments are based on the insertion of two anterior implants and two angled ones to cover a larger area. Therefore, implant-supported prostheses may have higher success and survival rates. The cost of treatment can be reduced. Chewing stress can also be minimized to a greater extent. It was observed that the lowest stress was observed in both lateral and vertical loads in the peri-implant region.

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Ethical Approval

Not applicable.

Informed consent

Not applicable.

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Data sharing statement

No additional data are available.

Conflict of interest

The authors declare no conflict of interest.

Similarity check

It was applied by Ithenticate@.

Peer Review Process

It was performed.

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