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Major considerations and findings of clinical studies on zygomatic implant placement in older patients with severe maxillary atrophy: a systematic review

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Abstract

Introduction: Zygomatic implant (ZI) rehabilitation of edentulous patients with maxillary atrophy is an approach that has been used with well-standardized procedures and considerable survival. **Objective:** The aim was to address and describe the main considerations and findings of clinical studies on the placement of zygomatic implants in elderly patients with severe maxillary atrophy. **Methods:** The present study followed a concise systematic review model (PRISMA rules). The search was carried out in the PubMed, Embase, Ovid, Cochrane Library, Web of Science, and Scopus 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 116 articles were found. In total, 41 articles were fully evaluated and 25 were included and evaluated in this study. Of the initial total of articles, 28 articles were excluded because they did not meet the GRADE and AMSTAR-2 classification, and 12 were excluded because they presented a risk of bias that could compromise the credibility of the studies. The symmetric funnel plot does not suggest a risk of bias. According to the GRADE instrument, most studies presented homogeneity in their results, with X^2=92.1%>50%. It was concluded that the use of zygomatic implants is an alternative procedure, making implant rehabilitation of extensively atrophic maxillas possible when conventional procedures are not possible. Several anatomical and procedural factors, such as sinus conformation and sinus mucosa thickness, may influence the overall success of zygomatic implant rehabilitation and predispose to a higher occurrence of complications. Furthermore, dynamic navigation technology had better predictability in terms of precision and accuracy.

Keywords: Zygomatic implant. Bone atrophy. Maxillary atrophy. Elderly.

Introduction

Zygomatic implant (ZI) rehabilitation of edentulous patients with maxillary atrophy is an approach that has been used with well-standardized procedures and considerable survival [1]. The main limitation to the use of oral implants in many patients is represented by unfavorable anatomical features due to extensive resorption or degenerative processes of the alveolar bones. Various bone augmentation techniques and the use of bone grafts have been proposed and implemented, making implant insertion and integration possible in compromised anatomical sites [1-3].

In this context, ZIs were developed by Brånemark and first proposed by Aparicio et al. in 1993 for the rehabilitation of compromised maxillas [1,2]. Over the past three decades, several techniques and approaches have been described for ZI placement to improve prosthetic performance and rehabilitation. In particular, special attention has been given to the anatomically guided approach to the implant insertion route [4-8]. In this regard, the placement of ZI proves to be a reliable method to reconstruct severe maxillary atrophy and

defects in the maxillary deficiency. The placement of ZI is more complex and more challenging than the placement of conventional oral implants, especially in the quadruple approach [9-14]. The application of navigation surgery in complex craniomaxillofacial procedures has become very useful in transferring the surgical plan to the patient and in preventing adjacent anatomical injuries [15].

Also, in certain situations in which the placement of conventional implants is not possible without advanced surgical procedures, the ZI can be used as a preferable treatment option for completely and partially edentulous jaws, with insufficient bone volume [16-19]. Also, conventional treatment with implants cannot be performed on the edentulous maxilla in some patients due to advanced bone resorption and/or the presence of extensive maxillary sinuses, leading to inadequate amounts of bone tissue for anchoring the implants. For more than three decades, bone grafting before or simultaneously with implant placement has become routine in oral rehabilitation [20-22].

Given this, the present study addressed and described the main considerations and findings of clinical studies on zygomatic implant placement in elderly patients with severe maxillary atrophy.

Methods

Study Design

This study followed the international systematic review model, following the PRISMA (preferred reporting items for systematic reviews and meta-analysis) rules. Available at: http://www.prisma-statement.org/?AspxAutoDetectCookieSupport=1. It was accessed on: 08/19/2024. The AMSTAR-2 (Assessing the methodological quality of systematic reviews) methodological quality standards were also followed. Available at: https://amstar.ca/. It was accessed on: 08/19/2024.

Data sources and research strategy

The search strategies for this systematic review were based on the descriptors health sciences (DeCS / MeSH Terms): "Zygomatic implant. Bone atrophy. Maxillary atrophy. Elderly". The research was realized from July to August 2024 and developed based on Scopus, PubMed, Science Direct, Scielo, and Google Scholar. Also, a combination of the keywords with the booleans "OR", "AND", and the operator "NOT" were used to target the scientific articles of interest.

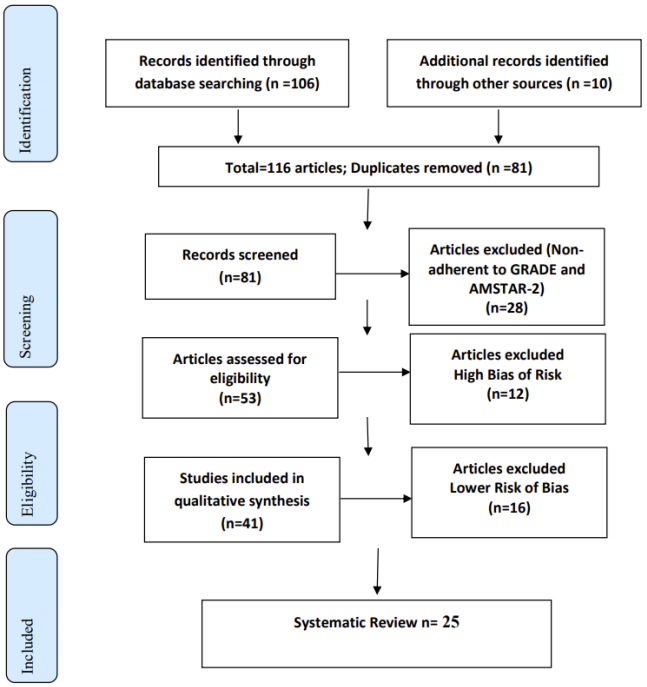
Study Quality and Bias Risk

The quality was classified as high, moderate, low, or very low regarding the risk of bias, clarity of comparisons, precision, and consistency of analyses. The most evident emphasis was on systematic review articles or meta-analysis of randomized clinical trials, followed by randomized clinical trials. 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 Cohen's d test.

Results and Discussion

A total of 116 articles were found. Initially, duplication of articles was excluded. After this process, the abstracts were evaluated and a new exclusion was performed, removing the articles that did not address the theme of this article. In total, 41 articles were fully evaluated and 25 were included and evaluated in this study. Of the initial total of articles, 28 articles were excluded because they did not meet the GRADE and AMSTAR-2 classification, and 12 were excluded because they presented a risk of bias that could compromise the credibility of the studies (Figure 1). According to the GRADE instrument, most studies presented homogeneity in their results, with X^2=92.1%>50%.

Figure 1. Study Eligibility (Systematic Review).

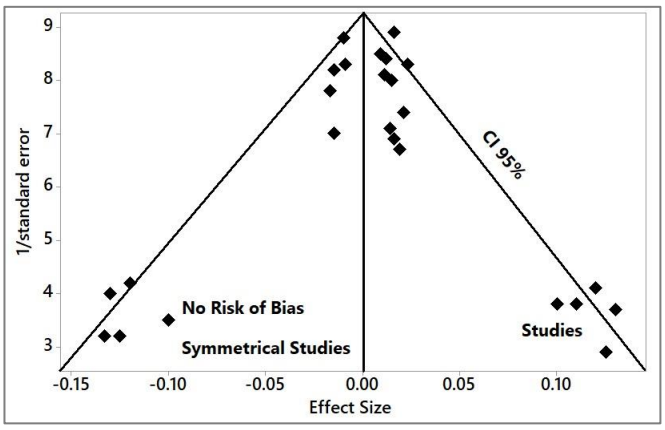


Source: Own Authorship.

Figure 2 presents the results of the risk of bias in the studies using the Funnel Plot, through the calculation of the Effect Size (Cohen's Test). The sample size was determined indirectly by the inverse of the standard error. The number of studies evaluated was n=25. The graph showed symmetric behavior, not

suggesting a significant risk of bias in studies with small sample sizes, which are shown at the bottom of the graph.

Figure 2. The symmetric funnel plot does not suggest a risk of bias between the small sample size studies that are shown at the bottom of the graph.



Source: Own Authorship.

Major Outcomes

The success of zygomatic implant (ZI) in elderly patients depends on the quality and quantity of the patient's alveolar bone. Grafting procedures have been commonly used to rehabilitate atrophic maxillae. The use of 4 zygomatic implants has become an important treatment option in the rehabilitation of atrophic maxillae. The quad zygoma technique is a method applied in cases where conventional implants cannot be used in the anterior maxilla. An alternative to the use of quad zygomatic implants is the transnasal placement with zygomatic implants and subperiosteal implants [20]. In this sense, ZI describes high overall survival rates in medium-long follow-up. A study carried out by the authors Di Cosola et al. (2021) [21] retrospectively analyzed whether some patient- and implant-related characteristics are correlated with implant success or the onset of complications. The outcomes evaluated were implant failure, infectious complications, early neurological complications, and general complications. A total of 33 patients (14 men, 17 women, mean age 59.1) who received 67 zygomatic implants were included in the study. The mean duration of follow-up was 141.6 months (min. 109; max. 198). During this period, a total of 16 (23.88%) implants in 8 (24.24%) patients were removed and 17 (51.51%) patients with 36 (53.73%) implants reported complications. Immediate loading resulted in a significantly lower risk of complications compared with two-stage prosthetic rehabilitation. A sinus mucosal thickness >3 mm emerged as correlated with a higher occurrence of infectious complications. Severe and extreme pneumatization of the sinus was significantly correlated with the incidence of overall complications and implant failure. A large sinus width was predisposed to a higher risk of neurological complications, infectious complications, and implant failure.

The authors Penmetsa et al. (2024) [22] analyzed the accuracy and predictability of zygomatic implants in atrophic maxilla using conventional and dynamic navigation methods through a randomized controlled clinical trial. A total of 40 ZIs were placed in systemically healthy individuals. ZI placement was done using the freehand technique in the control group, and the test group involved implant placement using a dynamic navigation system, and entry, apex, and angular deviations were assessed. The mean deviations at the entry site (2D) in the navigation system (2.53–1.42) compared with the freehand method (4.15–1.29) were statistically significant. The variation in the freehand group was greater than the navigation method at the apex (3D). The navigation method had higher accuracy in angular deviation than the freehand method (4.02 ± 1.80 and 12.67 ± 2.11). Furthermore, accuracy was verified on the right and left sides in the conventional and dynamic groups.

The main clinical finding of the present study is a 20-year retrospective clinical study with 72 patients that determined the survival rate of conventional anterior implants placed in combination with ZI according to the Brånemark technique and identified risk factors for implant failure. A total of 236 anterior and maxillary implants were included, with a mean follow-up of 12.1 years. Kaplan-Meier analysis showed cumulative overall survival rates of 95.3% at 1 year, 94.8% at 2 years, 93.0% at 5 years, 90.5% at 10 years, 81.6% at 15 years, and 67.7% at 20 years. Survival regression showed an association between bruxism and implant failure, as well as implants with an overdenture. Implants with a length ≤ 10 mm had a significantly shorter survival time [2].

Also, autogenous bone grafts combined or not with Le Fort I osteotomy (LFIO) and ZI are two reliable techniques for fixed rehabilitation of atrophic maxillae. ZIs allow a reduced duration of the treatment without the need for grafting, immediate loading, and, in principle, less morbidity. In this context, a retrospective study compared these two oral health-related quality of life (QoL) protocols (HRQoL), as well as analyzed the survival rates of implants and prostheses and biological complications. Twenty-one patients were included in the autogenous bone graft group and 22 in the ZI group. QoL was assessed postoperatively using the OHIP-14 questionnaire. The median OHIP-14 scores were respectively 6.5 (interquartile range [IQR] 2.0-13.0) and 6.0 (IQR 3.0-10.0) with no significant difference (p=0.97). The implant/prosthesis survival rates were

97.9%/100% and 97.1%/95.5%. Biological complication rates were 33.3% and 36.4%, with no significant difference (p = 0.83). Therefore, the type of surgery or prosthesis does not seem to affect the final HRQoL, implant, and prosthesis survival rates, or rates of biological complications [3].

Also, prosthetic rehabilitation of the atrophic edentulous maxilla is a challenge for which ZI stands out from traditional techniques with reduced treatment duration and immediate loading. Some studies showed that the implant survival rate was 100.0 % over follow-up periods varying from 5 to 47 months [18-23]. During postoperative follow-up, two patients presented with slight palate inflammation. The results obtained with ZI are satisfactory in terms of reproducibility and speed of rehabilitation of the maxillary. When the patient wishes for a fixed prosthetic rehabilitation, the solution provided by the ZI becomes more common in the daily practice of the clinician [24,25].

According to the main guidelines for the placement of the ZI, in the appropriate bone zone 1 and the absence of bilateral bone in zones 2 and 3, two to four axial implants are indicated [26,27]. Typically, two to four conventional implants are distributed in the anterior maxilla plus a zygomatic implant on each premolar/molar side. In the appropriate bone zone 1 and absence of bone in zones 2 and 3 on only one side. A single zygomatic implant is placed and conventional implants are placed in the anterior maxilla and on the opposite side of the zygomatic implant. In inadequate bone zone 1 and adequate immaculate bone in zones 2 and 3. An anterior zygomatic implant, together with conventional posterior implants, can solve the problem [28].

In the absence of bone in the three areas of the maxilla. Four zygomatic implants can be used for rehabilitation. In the presence of inadequate bone in zones 1, 2, or 3 in a partially edentulous patient, it is recommended to place three implants to support a partial denture. Also, the use of ZI in partially edentulous patients requires more clinical validation before widespread use can be advocated [29].

Thus, a study systematically reviewed and compared the survival rates (SR) of oral rehabilitation performed with 2 ZI combined with two regular implants (IR) versus 4 ZI [18]. The literature search resulted in a total of 417 studies, of which 6 were included in this study. For the control group (2 ZI + 2 IR) and the test group (4 ZI), the implant RS was 98.6% and 97.4%, respectively, with 95.0% CI. There were no statistically significant differences in terms of SR between the two groups, with p = 0.286. Therefore, the analysis of the data showed favorable results for the treatment with 4 ZI. The results showed no statistical differences in the use of 1 or another treatment, in terms of survival and failure rates. The reduction in treatment time and morbidity related to regenerative approaches may be its main advantage. In conclusion, ZI seems to be the treatment of choice for the rehabilitation of the severely atrophic maxilla.

In this sense, the indications for ZI can be for the treatment of severely atrophic edentulous jaws without using any bone augmentation procedure [30-34]. There may be two different clinical situations involved, treatment of the partially edentulous jaw severely atrophic, avoiding breast elevation or other grafting procedures; and maxillary reconstruction after partial or total maxillectomy, ZI can be used to fix maxillary obturators as an alternative to non-implanted obturators, local and regional flaps and microvascular free flaps [35-39].

Finally, ZI can provide the only solutions for patients with severely atrophic posterior maxilla, especially those that result from surgical removal of tumors, and for patients who cannot tolerate conventional removable prostheses. These patients can be treated satisfactorily if a comprehensive preoperative evaluation is performed, followed by careful case planning, meticulous surgical technique, and appropriate biomaterial selection [40,41].

Conclusion

It was concluded that the use of zygomatic implants is an alternative procedure, making implant rehabilitation of extensively atrophic maxillas possible when conventional procedures are not possible. Several anatomical and procedural factors, such as sinus conformation and sinus mucosa thickness, may influence the overall success of zygomatic implant rehabilitation and predispose to a higher occurrence of complications. Furthermore, dynamic navigation technology had better predictability in terms of precision and accuracy.

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