



# Major clinical relevance and considerations of zygomatic implants in elderly patients: a systematic review

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## Abstract

**Introduction:** For decades, zygomatic implants (ZI) have been used to rehabilitate atrophic maxillae and reconstruct maxillary defects, demonstrating significant survival rates, and have emerged as an alternative to extensive bone grafting. Despite their efficacy, surgical techniques for ZI placement have consistently been associated with perioperative complications, with additional problems arising later, especially in elderly patients. **Objective:** The present study developed a systematic review to address the main clinical relevance and considerations of zygomatic implants in elderly patients. **Methods:** The present study followed a concise systematic review model. 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 220 articles were found. In total, 77 articles were fully evaluated and 57 were included and evaluated in this study, and of the total of 57 articles, only 42 articles were developed in the item results of the systematic review. Of the initial total of articles, 108 articles were excluded because they did not meet the GRADE and AMSTAR-2 classification, and 20 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

$X^2=85.6\%>50\%$ . It was concluded the ZI has a high rate of survival accumulated in 12 years, with the majority of failures occurring in the early stages of the postoperative period. The main complication observed related to zygomatic implants in elderly patients was sinusitis, which can appear several years after implantation surgery. The presence of increased maxillary sinus pneumatization with advanced resorption of the posterior alveolus may result in insufficient bone to anchor the implant. Bone augmentation is generally necessary under these conditions to allow the placement of a sufficient number and length of implants. Another more serious condition would be defects of maxillectomy, aplasia of the maxillary sinus, and cleft deformities. Zygomatic implants appear to be a consolidated therapeutic option for a significantly atrophic maxilla in elderly patients, offering a promising alternative to costly heavy bone graft techniques, fewer complications, less time for rehabilitation, less required prosthodontic work, and significantly higher survival rates.

**Keywords:** Zygomatic implant. Dental Implants. Bone atrophy. Survival.

## Introduction

For decades, zygomatic implants (ZI) have been used to rehabilitate atrophic maxillae and reconstruct maxillary defects, demonstrating significant survival rates, and have emerged as an alternative to extensive bone grafting. Despite their efficacy, surgical techniques

for ZI placement have consistently been associated with perioperative complications, with additional problems arising later, especially in elderly patients [1-3].

In this sense, implant placement techniques and designs have evolved in efforts to reduce complications. A technique was introduced to minimize the aggressiveness of the osteotomy and increase prosthetic emergence, although it did not prevent sinus complications [2-4].

In this sense, in cases where the height and width of the residual bone do not allow the placement of conventional dental implants, the ZI can be considered [5-11]. In the last decades, different bone graft procedures have been advocated before or simultaneously with implant placement in routine treatments to increase the volume of bone load support [12-15]. Conventional grafting with autogenous bone has been considered the "gold standard" in the treatment of extremely atrophic jaws, but due to the high failure rates of 10-30%, additional time, and higher costs, the development and introduction of a new standard with results superior to clinical trials are essential [16,17].

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. 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 [18].

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 [19-22].

Thus, 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 [23-25].

Therefore, the present study developed a systematic review to address the main clinical relevance and considerations of zygomatic implants in elderly patients.

## 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: 07/19/2024. 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: 07/19/2024.

### Data sources and research strategy

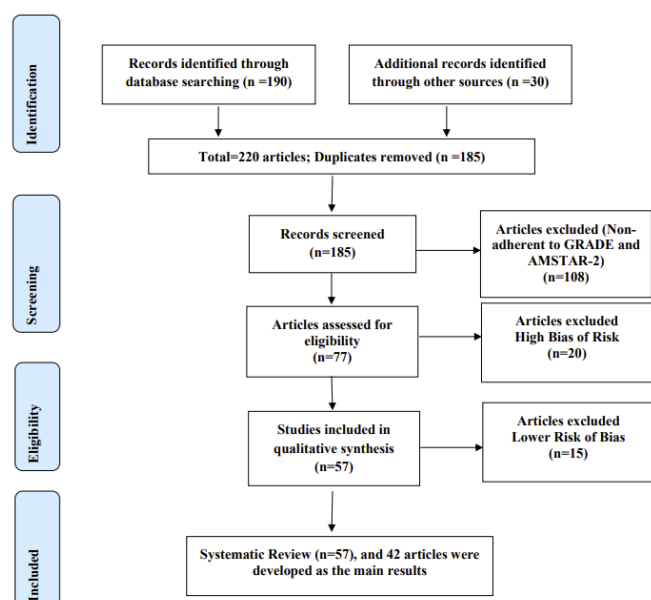
The search strategies for this systematic review were based on the keywords (MeSH Terms): "Z". The research was realized from July to August 2024 and developed based on Scopus, PubMed, Science Direct, Scielo, and Google Scholar. Also, a combination of the keywords with the booleans "OR", "AND", and the 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

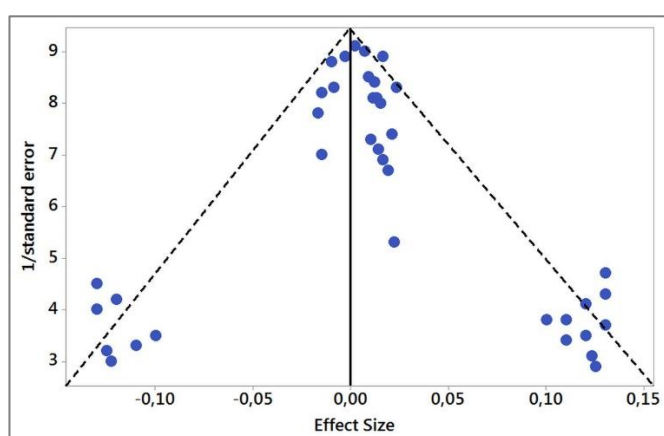
A total of 220 articles were found. Initially, duplication of articles was excluded. After this process, the abstracts were evaluated and a new exclusion was performed, removing the articles that did not address the theme of this article. In total, 77 articles were fully evaluated and 57 were included and evaluated in this study. And of the total of 57 articles, only 42 articles were developed in the item results of the systematic review. Of the initial total of articles, 108 articles were excluded because they did not meet the GRADE and AMSTAR-2 classification, and 20 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  $X^2=85.6\%>50\%$ .



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  $n=39$ . 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.  $N=42$  studies.



Source: Own Authorship.

## Major Results

The main clinical finding of the present study is a 20-year retrospective clinical study with 72 elderly 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% in 20 years. Survival regression showed an association between bruxism and implant failure, as well as implants with an overdenture. Implants with a length  $\leq 10$  mm had a significantly shorter survival time [5].

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 [6].

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 [1-3]. Some studies showed that the implant survival rate was 100.0 % over follow-up periods varying from 5 to 47 months [21-23]. During postoperative follow-up, two patients presented with slight palate inflammation [24]. 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 to the zygomatic implant. In the 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. 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 [21].

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; 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].

Also, ZI can provide the only solutions for patients with the severely atrophic posterior maxilla, especially those that result from surgical removal of tumors, and for patients who cannot tolerate conventional removable prostheses [40-45]. 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 [46-51].

In cases where a ZI is considered for oral rehabilitation, a computerized surgical stent must be

used, a delayed loading protocol must be in place, and a rigid connector must be placed between the implant and the prosthesis for better distribution of occlusal loads [52-55], and the implants must be placed in an arc shape to neutralize the flexing forces [56,57].

Besides, a literature review study, with 32 analyzed articles, reported the current evidence for the use of ZI in head and neck cancer patients for prosthetic rehabilitation of midface and maxilla defects. Overall survival rates of 77% -100% were reported with few complications, although only four centers had data on 20 or more patients. Primary implant placement at the time of resection surgery is an effective means of accelerating rehabilitation along with early loading protocols. The role of radiotherapy in implant failure has not been fully elucidated, and ZI can be used successfully in irradiated patients. Thus, ZI can provide remote anchorage for a variety of oral and facial prostheses that contribute to improving the function and quality of life of patients undergoing treatment for maxillary and midfacial tumors [34].

Also, a systematic review study with 12 scientific articles evaluated the accuracy and complications of dynamic navigation in the placement of ZI. According to the Joanna Briggs Institute tool, the average score for case reports ( $\pm$  standard deviation) was 6.4 (range, 9/9 to 8/9) and the average score for observational studies ( $\pm$  standard deviation) was 5.66 (variation, 5/9 to 7/9) as measured by the New Castle Ottawa tool. The materials included pointed out that greater precision and a drastic reduction in the risk of perioperative/postoperative complications were reported using the dynamic navigation system compared to placing freehand implants [31].

Besides, although ZI presents a unique treatment option for patients with severe maxillary resorption, the palatine-positioned ZI platforms will result in significant buccal-palatal cantilever, speech disorders, and unhygienic prosthetic contours. Thus, a study presented a new preoperative workflow to help achieve predictable surgical and prosthetic results with ZI. With ZI, the application of a prosthesis-driven approach is possible. However, it involves a unique application of the traditional principles of biomechanics and soft tissues of implantology and the digital integration of prosthetic and surgical treatment plans. The objective of ZI placement should be the effort to obtain platforms as close as possible to the central fossae and cingulate of prosthetic teeth [32].

A study evaluated 141 ZI in 45 patients for reconstruction of severely atrophic jaws. The mean age of the patients was 51.76 (range: 23 to 72) years. Three patients were rehabilitated with removable prostheses, 19 patients with fixed prostheses, and 23 patients with



hybrid prostheses. The overall complication rate was 5.67% (two zygomatic implants developed infection [1.4%], one zygomatic implant developed peri-implantitis [0.7%], and three zygomatic implants developed sinusitis [2.1%] and two zygomatic implants showed unsuccessful prosthetic rehabilitation [1.4%]. The follow-up period ranged from 6 to 36 months. The clinical complications of zygomatic ZI are acceptable and their survival rates are similar to those of endosteal implants. Also, the ZI can contribute to prosthetic rehabilitation [33].

Another study included sixty-eight studies, comprising 4556 ZI in 2161 patients with 103 failures. The cumulative 12-year survival rate was 95.21%. Most of the failures were detected within the 6-month post-surgical period. Studies (n=26) that exclusively evaluated load showed a statistically lower rate of ZI failure than studies (n=34) evaluating loading protocols (p=0.003). Other studies (n=5) evaluating ZI for the rehabilitation of patients after maxillary resections had lower survival rates. In this context, complications in the postoperative period were as follows: sinusitis, 2.4%; soft tissue infection, 2.0%; paresthesia, 1.0%; and oroantral fistulas, 0.4%. However, these numbers can be underestimated because many studies did not mention the prevalence of these complications [18].

In this sense, the ZI offers an effective alternative for the treatment of an atrophic jaw. Survival decreases during the first year after surgery and is more related to local infection than to the number of ZI. Also, the survival of osseointegrated implants can be related to the use of adequate pre-surgical exams and the parameters used during surgical procedures [1,3].

A systematic review study showed the result of ZI loaded immediately, with an average follow-up of 12 months. The survey provided 236 titles for immediately loaded zygomatic implants and resulted in 106 abstracts for analysis. Full-text analysis was performed on 67 articles, resulting in the inclusion of 38 articles for this systematic review. Therefore, it was shown that the immediate loading of zygomatic implants for the restoration of the severely atrophic maxilla presents a viable alternative for the treatment of the atrophic maxilla [19].

Finally, another systematic review study showed that the reliability of oral rehabilitation by four ZI without previous support has yet to be determined. The study evaluated the predictability of this approach to implant survival, technical and biological complications, and quality of life. Human clinical trials in which oral rehabilitation was performed using four ZI without additional placement of standard implants were included. The weighted average of the ZI survival rate was 96.7%. Also, patient satisfaction levels were high.

Therefore, rehabilitation of the maxilla by four zygomatic implants without previous support is a reliable approach [9].

## Conclusion

It was concluded the ZI has a high rate of survival accumulated in 12 years, with the majority of failures occurring in the early stages of the postoperative period. The main complication observed related to zygomatic implants in elderly patients was sinusitis, which can appear several years after implantation surgery. The presence of increased maxillary sinus pneumatization with advanced resorption of the posterior alveolus may result in insufficient bone to anchor the implant. Bone augmentation is generally necessary under these conditions to allow the placement of a sufficient number and length of implants. Another more serious condition would be defects of maxillectomy, aplasia of the maxillary sinus, and cleft deformities. Zygomatic implants appear to be a consolidated therapeutic option for a significantly atrophic maxilla in elderly patients, offering a promising alternative to costly heavy bone graft techniques, fewer complications, less time for rehabilitation, less required prosthodontic work, and significantly higher survival rates.

## CRedit

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## Conflict of Interest

The authors declare no conflict of interest.

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It was performed.

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