



Major clinical outcomes for optimization of zygomatic implants: a systematic review

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Abstract

Introduction: In the context of implantology, the rehabilitation of an atrophic maxilla is a challenge. In case of severe resorption, zygomatic implants (ZI) are indicated and loading of the implants is advised at the end of the surgery. Also, quad zygomatic implants have been used as a treatment option for patients with severely resorbed maxilla. **Objective:** The present study aimed to carry out a systematic review of the main approaches and clinical outcomes of zygomatic implantation in the last ten years. **Methods:** The present study followed the PRISMA rules and a model of literary review presenting and publishing case series, prospective, retrospective, randomized, double-blind, placebo-controlled trials in humans with a time of the last ten years were selected and analyzed. **Results and Conclusion:** Under the objective proposed in this study, it was concluded that the ZI has a high 12-year cumulative survival rate, with most failures occurring in the early stages of the postoperative period. Furthermore, the zygomatic bone is a viable site for zygomatic implants and the use of specialized implant planning software is an important tool to achieve predictable results for ZI. Preliminary data one year after loading suggest that immediately loaded ZIs were associated with fewer prosthetic failures, fewer implant failures, and shorter time required for functional loading.

Keywords: Implants. Zygomatic Implant. Quad zygomatic implants. Immediate loading. Survival. Clinical trials.

Introduction

In the context of implantology, the rehabilitation of an atrophic maxilla is a challenge [1]. In case of severe resorption, zygomatic implants (ZI) are indicated and loading of the implants is advised at the end of the surgery. Furthermore, the procedures can be completed with the positioning of a custom-made provisional prosthesis, reducing the duration of the surgery, simplifying and optimizing the results [1].

In this sense, the lack of bone in the alveolar crest represents a major problem in aesthetic recovery in patients who have suffered dentoalveolar trauma, traumatic extractions, pathologies of congenital tooth absence involving the maxilla, and mandible, and the possibility of deformity [2,3]. In this context, tooth loss negatively affects the quality of life, compromising aesthetic functions, chewing, and speech [3].

Furthermore, studies have shown that the placement of the primary implant at the time of resection surgery is an effective means of accelerating rehabilitation along with early loading protocols. Thus, the ZI provides remote anchorage for a variety of oral and facial prostheses that contribute to the improvement of the function and quality of life of patients undergoing treatment for maxillary and midfacial tumors [4].

Also, quad zygomatic implants have been used as a treatment option for patients with the severely resorbed maxilla. However, data on the mean success rate of the prosthesis, ZI survival, and associated complications are scarce. Although data analysis has shown favorable results for rehabilitation of severely

resorbed maxillae using quad zygoma with high prosthetic success and high implant survival rate, further long-term clinical studies are needed to strengthen the evidence [5].

In this sense, the ZI is an alternative when there is bone loss [6-9]. The ZI features an inclined head, designed to allow placement of the prosthesis 45 along the axis of the implant, providing an excellent ability to retain, support, and stabilize the prosthesis [10-13]. ZI is also applied when there is low bone quality and quantity [14-13].

In this context, bone-implant contact is correlated with implant survival [14-19]. An important variable that alters the zygomatic bone-implant contact is the angle at which the implant is placed [20-22]. Thus, Branemark et al. [23] introduced a technique called zygomatic fixation. Thus, the ZI provides anchorage, as it crosses the maxillary tuberosity, passes through the pyramidal apophysis of the palatine bone, and is part of the pterygoid process of the sphenoid bone, making implants successful [24,25].

Therefore, the present study aimed to carry out a systematic review of the main approaches and clinical outcomes of zygomatic implantation in the last ten years.

Methods

Study Design

The rules of the Systematic Review-PRISMA Platform (Transparent reporting of systematic reviews and meta-analysis-[HTTP://www.prisma-statement.org/](http://www.prisma-statement.org/)) were followed.

Data sources and research strategy

The search strategies for this systematic review were based on the keywords (MeSH Terms): "*Implants. Zygomatic Implant. Quad zygomatic implants. Immediate loading. Survival. Clinical trials*". The research was carried out in November 2021 to February 2022 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.

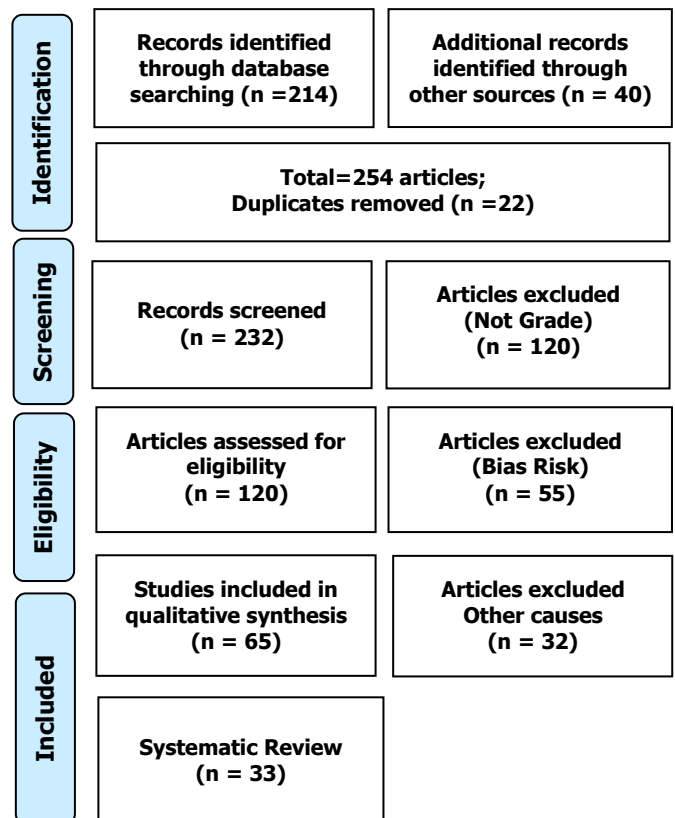
Study Quality and Bias Risk

The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument.

Results and Discussion

A total of 254 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, 112 articles were fully evaluated and 33 were included and evaluated in this study (Figure 1).

Figure 1. Flow Chart of Study Eligibility (Systematic Review).



In line with the literary findings, some studies have extended clinical understanding to show the success rate of ZI [1-5, 26-28]. Thus, a study evaluated the anatomical factors that influence the virtual planning of ZI using cone-beam computed tomography. CBCT scans were performed on 268 maxillary edentulous patients. The concavity sizes found were as follows: 34.95% small, 52.30% medium, and 7.35% large. The mean insertion angle was 43.2 degrees and the mean apical implant anchorage was 9.1 mm. The most frequent implant length was 40mm. Significant differences were found when comparing the different types of concavities to the installation angle, the distance from the apical portion of the implant in contact with the zygomatic bone, and the side-to-side thickness of the zygomatic bone ($p < 0.001$). The medium-sized maxillary sinus concavity had the greatest apical anchorage of the implant (9.7mm) and was the most frequent type

(52.30%). Therefore, the zygomatic bone is a viable site for zygomatic implants and the use of specialized implant planning software is an important tool to achieve predictable results for ZI [25].

Also, a randomized study compared the clinical outcome of immediately loaded cross-arch maxillary prostheses supported by ZI versus conventional implants placed in augmented bone. In total, 71 edentulous patients with severely atrophic maxillae without sufficient bone volume for the placement of dental implants or when it was possible to place only two implants in the anterior area (minimum diameter of 3.5 mm and length of 8 mm) and less than 4 mm diameter bone height substantially, were randomized according to a parallel group design to receive ZI (35 patients) to be loaded immediately versus grafted with a xenograft, followed after 6 months of graft union by the placement of six to eight dental implants. conventional submerged for 4 months (36 patients). For immediate loading, the ZI had to be inserted with an insertion torque greater than 40 Ncm. Therefore, preliminary data at one year after loading suggest that immediately loaded ZIs were associated with fewer prosthetic failures (one versus six patients), fewer implant failures (two versus eight patients), and shorter time required for functional loading (1.3 days versus 444.3 days) when compared with augmentation procedures and conventionally loaded dental implants. Even though more complications were reported for ZI, they proved to be a better rehabilitation modality for severely atrophic jaws. Long-term data are necessary to confirm or contest these preliminary results [29].

Besides, a segment of that same study also compared the clinical outcome of immediately loaded maxillary cross-arch prostheses supported by ZI versus conventional implants placed in augmented bone. A total of 71 edentulous patients with severely atrophic maxillae, who did not have enough bone volume to place dental implants or when it was possible to place only two implants in the frontal area (minimum diameter of 3.5 mm and length of 8 mm) and less than 4.0 mm of bone height subantrally were randomized according to a parallel-group design. They (35 patients) received zygomatic implants to be loaded immediately versus grafted with a xenograft, followed, after 6 months of graft union, by the placement of six to eight conventional dental implants, submerged for 4 months (36 patients). To be loaded immediately, the zygomatic implants needed to be inserted with an insertion torque greater than 40 Ncm. Patients were followed up for 4 months after loading. No augmentation procedures failed. Three patients dropped out of the augmentation group. Therefore, preliminary data at four months after loading suggest that zygomatic implants were

statistically significantly less associated with prostheses (one versus six patients) and implant failure (one patient lost three implants versus 35 implants in eight patients), as well as the time required for functional loading (1.3 versus 444.3 days) when compared with augmentation procedures and conventionally loaded dental implants. Even if more complications were reported for ZI that resolved spontaneously or could be manipulated, zygomatic implants proved to be a better rehabilitation modality for severely atrophic jaws [30].

Another study compared the outcome of oncologic site preparation for ZI using conventional preparation with rotary drills or piezoelectric surgery with dedicated inserts for placement of two ZI per zygoma. Twenty edentulous patients with severely atrophic maxillae without sufficient bone volume for dental implant placement and less than 4 mm bone height subantrally had their hemi-maxillae randomized according to an open mouth design in implant site preparation with conventional rotational preparation. or piezoelectric surgery. In two patients, drills were also used on the piezoelectric surgery side to allow for the preparation of the implant sites. One implant for the conventional drill group did not reach an insertion torque greater than 40 Ncm as it fractured the zygoma. No patient dropped out and two distal oncologic implants failed in the same patient (one per group), who was not prosthetically rehabilitated. Six complications occurred at perforated sites and three at piezoelectric surgery sites (two patients had bilateral complications), the difference not being statistically significant (P (McNemar test) = 0.375; odds ratio = 4.00; 95% CI of odds ratio: 0.45 to 35.79) The implant placement with conventional drills took an average of 14.35 ± 1.76 min and with piezoelectric surgery 23.50 ± 2.26 min, with the implant placement time being significantly shorter with the conventional perforation (difference = 9.15 ± 1.69 min; 95%CI: 8.36 to 9.94 min; $p < 0.001$) Postoperative hematomas were more frequent in perforated sites ($p = 0.001$), and 16 patients considered both techniques equally acceptable, while four preferred piezoelectric surgery ($p = 0.125$). Both drilling techniques achieved similar clinical results, but conventional drilling required 9 minutes less and could be used in all cases, although it was more aggressive. These results may be system-dependent, therefore, cannot be reliably generalized to other zygomatic systems [31].

Based on recent studies, new challenges have been presented. The management of patients with a severely atrophic or resected maxilla by ZI can be a surgical challenge. This retrospective cohort study evaluated the survival percentage of ZI placed over 18 years. In total, 88 ZI were placed in 45 patients aged between 42 and 88 years. Of the 88 implants, 54 were loaded

immediately. The implant survival rate was 94.32%, with five implants failing during the study period. Failures were not significantly associated with sex, surface finish, implant length, anatomy-guided zygomatic approach classification, or implant position ($p > 0.05$). All failed implants were fitted with fixed prostheses. Failures occurred between 6 months and 15 years after placement. This ZI study performed in patients with severely atrophic and resected maxilla confirms that this approach is a predictable method to support fixed or removable dentures for up to 18 years, demonstrating high survival rates [32].

In addition, a meta-analysis study included sixty-eight studies, comprising 4556 ZI in 2161 patients with 103 failures. The cumulative survival rate at 12 years was 95.21%. Most failures were detected in the 6-month post-surgical period. Studies ($n = 26$) that evaluated loading exclusively showed a statistically lower ZI failure rate than studies ($n = 34$) that evaluated loading protocols ($p = 0.003$). Other studies ($n = 5$) that evaluated the ZI for rehabilitation of patients after maxillary resections showed lower survival rates. Postoperative complications were as follows: sinusitis, 2.4%; soft tissue infection, 2.0%; paresthesia, 1.0%; and oroantral fistulas, 0.4%. However, these numbers may be underestimated, as many studies did not mention the prevalence of these complications. Therefore, the ZI has a high cumulative 12-year survival rate, with most failures occurring in the early postoperative stages. The main complication observed related to ZI was sinusitis, which can appear several years after implant surgery [33].

Conclusion

Under the objective proposed in this study, it was concluded that the ZI has a high 12-year cumulative survival rate, with most failures occurring in the early stages of the postoperative period. Furthermore, the zygomatic bone is a viable site for zygomatic implants and the use of specialized implant planning software is an important tool to achieve predictable results for ZI. Preliminary data one year after loading suggest that immediately loaded ZIs were associated with fewer prosthetic failures, fewer implant failures, and shorter time required for functional loading.

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Ethics approval

Not applicable.

Informed consent

Not applicable.

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@.

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