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Major indications and current clinical findings of zygomatic implant: a systematic review

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Abstract

Introduction: The lack of bone in the alveolar crest represents a major problem in aesthetic recovery in patients who have suffered dentoalveolar trauma, traumatic extractions, congenital tooth absence pathologies involving maxilla and mandible, and the possibility of deformity. In this sense, the zygomatic implant (ZI) is an alternative when there is bone loss. **Objective:** It was to carry out a systematic review of the main clinical outcomes of ZI, emphasizing the main indications. **Methods:** The present study followed the PRISMA rules. The search strategy was performed in the PubMed, Scielo, Cochrane Library, Web of Science and Scopus, and Google Scholar databases, following the rules of the word PICOS (Patient; Intervention; Control; Outcomes; Study Design). The Cochrane Instrument was used to assess the risk of bias of the included studies. **Results and Conclusion:** A total of 82 articles were found involving zygomatic implantation and the evolution of the technique. Initially, the duplication of articles was excluded. A total of 54 articles were fully evaluated and 33 were included in this study. Based on the clinical results of the last five years, some studies have broadened clinical understanding based on comparative studies to show the success rate of ZI. Even if more complications were reported for ZI that resolved spontaneously or could be handled, ZI proved to be a better modality of rehabilitation for severely atrophic jaws. Furthermore, zygomatic surgery proved to be a viable and safe alternative to conventional treatment modalities for oral rehabilitation of patients with ectodermal dysplasia syndrome. Also, there was greater accuracy and drastically reduced risk of perioperative/postoperative complications using the dynamic navigation system compared to the freehand placement of implants. Finally, guided surgery for the placement of ZI using specially designed metal jigs that must be supported by bone showed the placement of a made-to-measure provisional prosthesis, reducing surgery time, simplifying the procedure, and optimizing the result.

Keywords: Zygomatic Implant. Evolution of technique. Guided surgery. Guided zygomatic implant.

Introduction

In the scenario of lack or atrophy of bucomaxillary bone, the emphasis is on the lack of bone in the alveolar crest, which represents a major aesthetic problem in patients who have suffered dentoalveolar trauma, traumatic extractions, and congenital tooth absence pathologies [1]. In this context, tooth loss negatively affects the quality of life, compromising aesthetic functions, chewing, and speech [2,3]. In this sense, the zygomatic implant technique (ZI) is an effective alternative for the prosthetic rehabilitation of a maxilla with severe bone defect, improving the quality of the patient's prognosis, pronunciation, and chewing function [4].

Also, ZI is an alternative when there is bone loss [2-5]. The ZI is long, threaded, oxidized, and moderately rough, with lengths ranging from 30 to 52.5 mm. They have a slanted 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 [6-17].

In this context, the contact and implant-bone are referred to as bone-implant contact (BIC) and are correlated with implant survival [18-20]. An important variable that alters the zygomatic BIC is the angle at

which the implant is placed [21]. Thus, Branemark et al. [22] introduced a technique called zygomatic fixation. The objective was to achieve these new implants with a fixation in the dense zygomatic bone and, thus, rehabilitate these areas, combined or not with other types of implants. 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 the implants successful [23].

Besides, current treatments emphasize the use of virtual and guided surgery as it increases accuracy and decreases complications (including failure) of dynamic navigation in ZI placement. Guided surgery for ZI placement can utilize specially designed metal jigs that must be supported by bone [4].

Therefore, the present study aimed to carry out a systematic review of the main clinical outcomes of zygomatic implants, emphasizing the main indications.

Methods

Study Design

The present study followed a systematic review model, following the rules of systematic review - PRISMA (Transparent reporting of systematic review and meta-analysis, access available in: http://www.prisma-statement.org/).

Data Sources

The search strategy was performed in the PubMed, Scielo, Cochrane Library, Web of Science and Scopus, and Google Scholar databases, using scientific articles from 2004 to 2021.

Descriptors (MeSH Terms)

The main MeSH Terms used were "*Zygomatic Implant. Evolution of technique. Guided surgery. Guided zygomatic implant*". For greater specification, the description "guided zygomatic implant" for refinement was added during the searches, following the rules of the word PICOS (Patient; Intervention; Control; Outcomes; Study Design).

Selection Of Studies And Risk Of Bias In Each Study

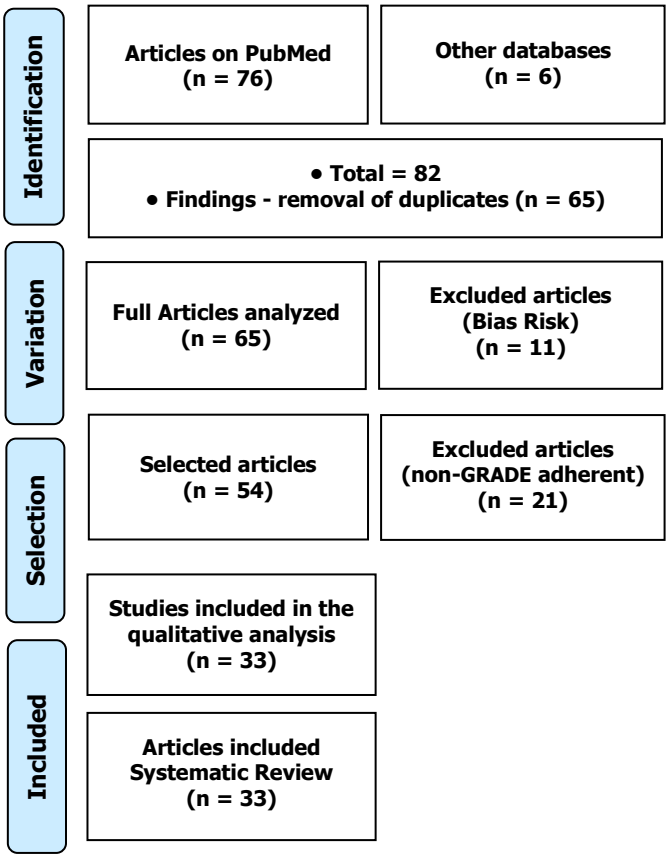
Two independent reviewers (1 and 2) performed research and study selection. Data extraction was performed by reviewer 1 and fully reviewed by reviewer 2. A third investigator decided some conflicting points and made the final decision to choose the articles. Only studies reported in Portuguese and English were evaluated. The Cochrane Instrument was used to assess the risk of bias of the included studies.

Results and Development

Summary of Findings

A total of 82 articles were found involving zygomatic implant and technique evolutions. Initially, the duplication of articles was excluded. After this process, the abstracts were evaluated and a new exclusion was performed, based on the elimination of articles with biases that could compromise the reliability of the results, according to the rules of the Cochrane instrument, as well as articles that presented low quality in their methodologies, according to the GRADE classification. A total of 54 articles were fully evaluated and 33 were included in this study (**Figure 1**).

Figure 1. Flowchart showing the article selection process.



Main Current Findings

According to the clinical results of the last five years, some studies have expanded the clinical understanding based on comparative studies to show the success rate of ZI [24-26]. Thus, a randomized study compared the clinical outcome of immediately loaded ZI-supported cross-arch maxillary prostheses versus conventional implants placed in augmented bone. In

total, 71 edentulous patients with severely atrophic maxillae without sufficient bone volume to place 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 of 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) [27].

For immediate loading, the ZI had to be inserted with an insertion torque greater than 40 Ncm. Metal-reinforced acrylic temporary prostheses, screwed with a screw, were provided to be replaced with permanent Procera Implant Bridge Titanium prostheses (Nobel Biocare, Gothenburg, Sweden), with ceramic or acrylic veneer 4 months after initial loading. Patients were followed up to 1 year after loading. Therefore, preliminary data one year after loading suggests that immediately loaded ZI were associated with statistically significantly fewer prosthetic failures (one versus six patients), implant failures (two versus eight patients), and time required for functional loading (1,3 days versus 444.3 days) when compared to conventionally loaded augmentation procedures and dental implants. Even though more complications were reported for ZI, they proved to be a better modality of rehabilitation for severely atrophic jaws. Long-term data is necessary to confirm or dispute these preliminary results [27].

A segment of that same study also compared the clinical outcome of immediately loaded ZI-supported cross-arch maxillary prostheses versus conventional implants placed in augmented bone [28]. 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 bone height, were randomized according to a 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, zygomatic implants needed to be inserted with an insertion torque greater than 40 Ncm. Patients were followed up to 4 months after loading. No augmentation procedures failed. Three patients dropped out of the augmentation group. Therefore, preliminary data from 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 time required for functional loading (1.3 versus 444.3 days) when compared to augmentation procedures and dental implants with conventional loading. Even if more complications were reported for ZI, which resolved spontaneously or could be manipulated, ZI proved to be a better modality of rehabilitation for severely atrophic jaws [28].

Furthermore, a retrospective case series study of clinical cases evaluated the outcomes of patients with ectodermal dysplasia syndrome undergoing ZI surgery. Materials and methods: A total of 9 patients with ectodermal dysplasia syndrome aged 21 to 56 years (mean age 36.8) with severe maxillary atrophy were included in this study. The mean follow-up of patients was 55 months. The overall implant survival rate was 100% without complications. Therefore, zygomatic surgery proved to be a viable and safe alternative to conventional treatment modalities for oral rehabilitation of patients with ectodermal dysplasia syndrome [29].

In addition, a systematic review study evaluated the accuracy and complications of dynamic navigation in ZI placement. A total of 94 studies were evaluated and, finally, 12 articles were included. The results showed that there was greater accuracy and drastically reduced risk of perioperative/postoperative complications using the dynamic navigation system compared to the freehand placement of implants [30].

Also, a study looked at a new method through guided surgery for ZI placement using specially designed metal jigs that must be supported by bone. The procedure ended with the placement of a made-to-measure provisional prosthesis. This method can reduce surgery time, simplify the procedure and optimize the result. Thus, 19 of the 20 patients included in the study had successful implants and prostheses at the time of analysis [31].

Another study compared the outcome of oncological site preparation for ZI using conventional preparation with rotary burs 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 substantially had their Hemi-maxillas randomized according to an open-mouth design in implant site preparation with conventional rotary preparation or piezoelectric surgery. In two patients, drills were also used on the piezoelectric surgery side to allow the preparation of the implant sites. An implant for the group of conventional drills did not reach an insertion torque greater than 40 Ncm, as it fractured the zygoma. No patient dropped out and two distal cancer 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 odds ratio: 0.45 to 35.79) Implant placement with conventional drills took an average of 14.35 ± 1.76 min and with piezoelectric surgery 23.50 ± 2.26 min, with implant placement time being significantly shorter with 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 the 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, they cannot be reliably generalized to other zygomatic systems [32].

Also, 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 had 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 have not mentioned the prevalence of these complications. Therefore, 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

Based on the clinical results of the last five years, some studies have broadened clinical understanding based on comparative studies to show the success rate of ZI. Even if more complications were reported for ZI that resolved spontaneously or could be handled, ZI proved to be a better modality of rehabilitation for severely atrophic jaws. Furthermore, zygomatic surgery proved to be a viable and safe alternative to conventional treatment modalities for oral rehabilitation of patients with ectodermal dysplasia syndrome. Also, there was greater accuracy and drastically reduced risk of perioperative/postoperative complications using the dynamic navigation system compared to the freehand placement of implants. Finally, guided surgery for the placement of ZI using specially designed metal jigs that must be supported by bone showed the placement of a made-to-measure provisional prosthesis, reducing surgery time, simplifying the procedure, and optimizing the result.

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Data sharing statement

No additional data are available.

Conflict of interest

The authors declare no conflict of interest.

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