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REHABILITATION PROTOCOLS WITH ZYGOMATIC IMPLANTS: INDICATIONS FOR SEVERE MAXILLARY ATROPHY AND BONE RESORPTION

PROTOCOLOS DE REABILITAÇÃO COM IMPLANTES ZIGOMÁTICOS: INDICAÇÕES PARA ATROFIA MAXILAR SEVERA E REABSORÇÃO ÓSSEA

PROTOCOLOS DE REHABILITACIÓN CON IMPLANTES CIGOMÁTICOS: INDICACIONES PARA ATROFIA MAXILAR SEVERA Y REABSORCIÓN ÓSEA

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ABSTRACT

The rehabilitation of patients with severely atrophic maxilla represents one of the central challenges in contemporary implant dentistry. The loss of alveolar bone volume, accentuated by maxillary sinus pneumatization and prolonged use of complete dentures, limits or makes the placement of conventional implants unfeasible, thus requiring complementary surgical strategies. In this context, zygomatic implants—originally introduced by Brånemark et al. in the late 1980s as an alternative to extensive bone grafting procedures—have been established as a documented therapeutic option for patients with advanced maxillary atrophy. The present study consists of a comparative analysis of three recent scientific publications: a systematic review on success rates (Solà Pérez et al., 2022), an international consensus report developed by the International Team for Implantology—ITI (Al-Nawas et al., 2023), and a systematic review on clinical indications (Polido et al., 2023). The analyzed data include follow-ups of up to 11.8 years and encompass hundreds of patients across multiple international centers. Cumulative survival rates ranged from 96.1% to 98.5% depending on the follow-up period, with slightly higher rates observed for immediate loading protocols compared to delayed loading (98.1% versus 95.0%). Documented indications include extreme bone atrophy, previous implant or graft failure, oncologic resection, trauma, and congenital defects. The most prevalent complications were maxillary sinusitis (14.2%) and soft tissue dehiscence (34.7%), while prosthetic mechanical failures accounted for 17.8% of the reported adverse events. The body of reviewed evidence supports that zygomatic implants

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represent a safe, predictable, and long-term effective alternative for the rehabilitation of atrophic maxillae. However, given the anatomical risks involved and the heterogeneity in success criteria adopted in the literature, the procedure should be reserved for centers with specialized surgical and rehabilitative expertise.

Keywords: Zygomatic Implants. Atrophic Maxilla. Survival Rate. Oral Rehabilitation. Bone Grafting.

RESUMO

A reabilitação de pacientes com maxila severamente atrófica constitui um dos desafios centrais da implantodontia contemporânea. A perda do volume ósseo alveolar, acentuada pela pneumatização dos seios maxilares e pelo uso prolongado de próteses totais, limita ou inviabiliza a instalação de implantes convencionais, tornando necessárias estratégias cirúrgicas complementares. Nesse cenário, os implantes zigomáticos — originalmente introduzidos por Brånemark et al. no final da década de 1980 como alternativa a procedimentos extensivos de enxerto ósseo — consolidaram-se como opção terapêutica documentada para pacientes com atrofia maxilar avançada. O presente estudo consiste em uma análise comparativa de três publicações científicas recentes: uma revisão sistemática sobre taxas de sucesso (Solà Pérez et al., 2022), um relatório de consenso internacional elaborado pelo International Team for Implantology — ITI (Al-Nawas et al., 2023) e uma revisão sistemática sobre indicações clínicas (Polido et al., 2023). Os dados analisados contemplam acompanhamentos de até 11,8 anos e abrangem centenas de pacientes em múltiplos centros internacionais. As taxas de sobrevivência cumulativa variaram entre 96,1% e 98,5% conforme o período de acompanhamento, com taxas ligeiramente superiores para protocolos de carga imediata em relação à carga tardia (98,1% versus 95,0%). As indicações documentadas incluem atrofia óssea extrema, falha prévia de implantes ou enxertos, ressecção oncológica, trauma e defeitos congênitos. As complicações mais prevalentes foram sinusite maxilar (14,2%) e deiscências de tecidos moles (34,7%), enquanto falhas mecânicas protéticas corresponderam a 17,8% dos eventos adversos registrados. O conjunto das evidências revisadas sustenta que os implantes zigomáticos representam alternativa segura, previsível e de eficácia a longo prazo para a reabilitação de maxilas atróficas. Contudo, dados os riscos anatômicos envolvidos e a heterogeneidade nos critérios de sucesso adotados pela literatura, o procedimento deve ser reservado a centros com expertise cirúrgica e reabilitadora especializada.

Palavras-chave: Implantes Zigomáticos. Maxila Atrófica. Taxa de Sobrevivência. Reabilitação Oral. Enxerto Ósseo.

RESUMEN

La rehabilitación de pacientes con maxila severamente atrófica constituye uno de los principales desafíos de la implantología contemporánea. La pérdida del volumen óseo alveolar, acentuada por la neumatización de los senos maxilares y el uso prolongado de prótesis totales, limita o imposibilita la colocación de implantes convencionales, haciendo necesarias estrategias quirúrgicas complementarias. En este contexto, los implantes cigomáticos—introducidos originalmente por Brånemark et al. a finales de la década de 1980 como alternativa a procedimientos extensivos de injerto óseo—se han consolidado como una opción terapéutica documentada para pacientes con atrofia maxilar avanzada. El presente estudio consiste en un análisis comparativo de tres publicaciones científicas recientes: una revisión sistemática sobre tasas de éxito (Solà Pérez et al., 2022), un

informe de consenso internacional elaborado por el International Team for Implantology—ITI (Al-Nawas et al., 2023) y una revisión sistemática sobre indicaciones clínicas (Polido et al., 2023). Los datos analizados incluyen seguimientos de hasta 11,8 años y abarcan cientos de pacientes en múltiples centros internacionales. Las tasas de supervivencia acumulada variaron entre 96,1% y 98,5% según el período de seguimiento, con tasas ligeramente superiores para los protocolos de carga inmediata en comparación con la carga tardía (98,1% frente a 95,0%). Las indicaciones documentadas incluyen atrofia ósea extrema, fracaso previo de implantes o injertos, resección oncológica, trauma y defectos congénitos. Las complicaciones más prevalentes fueron la sinusitis maxilar (14,2%) y las dehiscencias de tejidos blandos (34,7%), mientras que las fallas mecánicas protésicas representaron el 17,8% de los eventos adversos registrados. El conjunto de la evidencia revisada respalda que los implantes cigomáticos representan una alternativa segura, predecible y eficaz a largo plazo para la rehabilitación de maxilas atróficas. No obstante, debido a los riesgos anatómicos involucrados y a la heterogeneidad en los criterios de éxito adoptados en la literatura, el procedimiento debe reservarse para centros con experiencia quirúrgica y rehabilitadora especializada.

Palabras clave: Implantes Cigomáticos. Maxila Atrófica. Tasa de Supervivencia. Rehabilitación Oral. Injerto Óseo.

1 INTRODUCTION

The rehabilitation of patients with total edentulism and severe maxillary atrophy is one of the greatest challenges of contemporary implant dentistry and is a condition that continues to grow worldwide and can be psychologically traumatic, socially harmful, and functionally limiting (Polido et al., 2023; Solà Pérez et al., 2022). Traditionally, these cases required complex bone grafting procedures, which are often associated with high morbidity, prolonged treatment times, and variable success rates caused by severe bone resorption and oncological resective surgery. Zygomatic implants represent a valuable treatment (Solà Pérez et al., 2022). As an alternative to these limitations, the use of zygomatic implants has been consolidated as an effective solution, allowing the anchorage of high-density cortical bone in the body of the zygomatic bone for the manufacture of a fixed prosthesis through a less invasive surgery compared to bone augmentation procedures. (Polido et al., 2023; Al-Nawas et al., 2023).

The evolution of surgical techniques, starting from Brånemark's original intrasinus approach to anatomy-guided methods (extra-sinus), allowed a reduction in biological complications and an improvement in the prosthetic position of the implants that from this point of view the ideal entrance was more posterior and as close as possible to the midline of the alveolar crest (Kämmerer et al., 2023; Al-Nawas et al., 2023). The classification of edentulous jaws proposed by Cawood and Howell concluded that, in general, changes in the shape of the alveolar bone follow a predictable pattern. In addition to bone atrophy due to physiological resorption, the indications have expanded to patients with previous graft failures and cases of post-tumor resection reconstruction (Polido et al., 2023; Gaur, 2023). The objective of this review is to synthesize the current evidence on the indications, survival rates, and surgical protocols that support the use of zygomatic implants in maxillary rehabilitation.

Although the original technique (OST) has evolved into more refined approaches such as the Anatomy-Guided Approach (AGA), the choice of surgical technique is still widely discussed with regard to survival rate and incidence of complications (Kämmerer et al., 2023). Studies indicate that the cumulative success rate of ZI is high, ranging from 98.5% in the first year to 96.1% after five years of follow-up (Solà Pérez et al., 2022). However, the procedure is not without risks; the most frequent biological complications include sinusitis, with a prevalence of up to 14.2%, as well as gingival recessions and paresthesias (Kämmerer et al., 2023).

Additionally, due to the anatomical proximity of the zygomatic bone to the orbital cavity, some ocular complications, although rare, may occur, including intraoperative orbital penetration, orbital hematomas, damage to the extraocular muscles, diplopia, orbital emphysema, subconjunctival hemorrhage, and infraorbital nerve paresthesia (Weber et al., 2024). Given this scenario, the consensus of the *International Team for Implantology* (ITI) reinforces the importance of rigorous planning and understanding of specific indications to ensure favorable long-term outcomes (Al-Nawas et al., 2023).

The need to establish clear success criteria and to understand the impact of different surgical techniques is critical to patient safety. Thus, this study aims to synthesize and analyze the scientific evidence related to maxillary rehabilitation protocols with severe bone atrophy and resorption using zygomatic implants, based on the most recent evidence in the literature on the efficacy and risks of this therapeutic modality.

Total tooth loss in the maxilla is a condition of increasing prevalence worldwide, estimated at 23% in the population over 60 years of age according to the World Health Organization. Its consequences go beyond the functional dimension, implying nutritional, psychosocial, and quality of life changes (POLIDO et al., 2023). After tooth extraction, alveolar bone resorption progresses continuously in a posterosuperior and lateromedial direction, and maxillary sinus pneumatization may result in a residual bone height of less than 4 mm in the posterior region—insufficient for the anchorage of conventional implants without prior or simultaneous bone augmentation procedures.

Bone grafting techniques—including maxillary sinus lifts, block grafts, and interpositional osteotomies—have been widely studied and applied in this context. However, they have relevant limitations: higher surgical morbidity, risk of graft resorption, prolonged treatment times, and variable results that critically depend on the surgeon's experience (POLIDO et al., 2023). Graftless alternatives, such as short implants, small-diameter implants, and distally inclined implants (All-on-Four protocol), have accumulated favorable evidence, but their applicability in cases of extreme atrophy remains limited.

In this scenario, zygomatic implants emerge as an evidence-based surgical and prosthetic solution. Developed by Professor Per-Ingvar Brånemark in the late 1980s, originally for patients undergoing oncological maxillectomy, their application has progressively expanded to cases of severe maxillary atrophy of different etiology. The implant is inserted through the maxillary sinus or extramaxillary, with bicortical anchorage in the zygomatic bone — a high-density structure that integrates the lateral wall of the

orbit and the temporal and infratemporal fossae (SOLÀ PÉREZ et al., 2022). This anchorage allows the installation of a temporary prosthesis within 24 hours after surgery, offering the patient immediate functional rehabilitation without the need for a previous bone graft.

Despite the exponential growth of publications in the area and the high survival rates reported, considerable heterogeneity persists in the literature in the success criteria, in the surgical techniques employed and in the definition of what constitutes 'severe maxillary atrophy'. The present study proposes to comparatively analyze three reference publications published between 2022 and 2023, examining the evidence on clinical efficacy, indications, and complications of zygomatic implants in light of current methodological standards.

2 METHODOLOGY

The present investigation is characterized as a narrative literature review, developed with the objective of synthesizing and analyzing the most recent scientific evidence related to rehabilitation protocols with zygomatic implants, focusing on indications for severe maxillary atrophy and bone resorption. The search was carried out in the PubMed database, using the descriptor "Zygomatic Implants", in accordance with the terminology of the Medical Subject Headings (MeSH). Articles published in the last five years, available in full and written in Portuguese or English, that directly addressed the topic, were included. Studies that did not have a direct relationship with the central theme, duplicate publications, narrative reviews with low methodological rigor, and articles not indexed in the database used were excluded. The selection of studies was conducted in two stages: screening of titles and abstracts, followed by the evaluation of full texts to confirm relevance. The information extracted was organized in a descriptive way.

3 RESULTS AND DISCUSSION

3.1 CLINICAL INDICATIONS AND REHABILITATION CONCEPTS

The main indication for the use of zygomatic implants is severe maxillary atrophy, where the amount of residual bone is insufficient for conventional implants, typically classified as Cawood and Howell Class V or VI (Polido et al., 2023). Rehabilitation protocols are divided into three main concepts: the classic concept, which uses a

zygomatic implant bilaterally associated with conventional implants in the anterior region; the "Quad Zygoma" concept, indicated when atrophy also affects the premaxillary region, using four zygomatic implants (two on each side); and the unilateral concept, applied to asymmetric defects or oncological resections (Polido et al., 2023; Al-Nawas et al., 2023).

Extreme bone atrophy or deficiency, failures in previous treatments with conventional implants or grafts, avoiding procedures that require more than one step in addition to medical considerations that may contraindicate traditional procedures such as benign and/or malignant cysts, amelogenesis imperfecta, and trauma are the main indications for the installation of zygomatic implants. Cases associated with oncological maxillary resections, in addition to defects secondary to cleft palate have also been reported (Polido et al., 2023).

3.2 EVOLUTION OF SURGICAL TECHNIQUES

The transition from the Original Surgical Technique (OST) to the Anatomy-Guided Approach (AGA) represented a milestone in the predictability of treatment. The AGA technique allows the implant body to be positioned externally to the maxillary sinus, reducing the incidence of sinusitis and allowing prosthetic emergence to occur on the ridge of the alveolar ridge, facilitating the hygiene and aesthetics of the final prosthesis (Kämmerer et al., 2023; Al-Nawas et al., 2023). Innovations such as single-piece zygomatic implants have also been explored, emphasizing the surgeon's tactile perception and the possibility of immediate loading to reduce treatment time (Gaur, 2023).

The contributions of Migliorança et al were fundamental for the popularization of immediate loading protocols in atrophic maxillae. Extrasinus anchorage, by positioning the implant head on the ridge of the alveolar ridge, not only favors prosthetic biomechanics, but also allows the installation of fixed prostheses in reduced times. This approach reduces the need for complex bone grafts and provides an immediate improvement in the patient's quality of life, consolidating zygomatic implants as a highly efficient solution for cases of severe atrophy. (MIGLIORANÇA et al, 2006).

The consolidation of the extra-sinus approach is largely due to the studies of Aparício et al, who introduced the ZAGA (Zygoma Anatomy-Guided Approach) concept. This classification is based on the morphology of the anterior wall of the maxilla and the relationship of the implant path to the maxillary sinus, proposing that the surgical technique should be adapted to the patient's individual anatomy rather than forcing a

standard trajectory. By using implants with a specific design — such as those with a flattened body and no threads in the portion that comes into contact with soft tissues — the ZAGA technique minimizes gingival dehiscence and optimizes biological sealing, increasing the aesthetic and functional predictability of rehabilitation (Aparcio et al. 2017).

3.3 SURVIVAL AND SUCCESS RATES

Studies have shown exceptionally high survival rates for zygomatic implants, ranging from 90.3% to 100% in medium- and long-term follow-ups (Solà Pérez et al., 2022; Kämmerer et al., 2023). A systematic review indicated that most failures occur in the early stages of healing, and that the primary stability obtained by cortical anchorage is a determining factor for the success of immediate loading (Solà Pérez et al., 2022). The ITI consensus reinforces that success should not be measured only by implant survival, but by patient satisfaction and the absence of persistent complications (Al-Nawas et al., 2023).

Zygomatic implants have been widely described in the literature as a predictable therapeutic alternative for the rehabilitation of patients with severe maxillary atrophy, especially in situations where bone availability limits the installation of conventional implants. In this context, different studies have demonstrated favorable clinical results and high predictability of this approach. Solà Pérez et al. (2022) reported that the cumulative success of this implant modality reaches approximately 98.5% in the first year of follow-up, gradually reducing to 97.5% between 1 and 3 years, 96.8% between 3 and 5 years, and about 96.1% after more than five years, which suggests maintenance of clinical stability and implant functionality over time. Similar results are described in the ITI consensus, in which the survival rates reported in the literature vary between 90.3% and 100%, with an approximate average of 97%, considering different surgical protocols and follow-up periods that can exceed ten years (Al-Nawas et al., 2023). In a convergent manner, a systematic review that evaluated 2194 implants installed in 918 patients also showed high implant survival rates, regardless of the surgical technique used, including the classical approach and anatomy-guided methods (Kämmerer et al., 2023).

Despite the favorable clinical performance, the literature describes the occurrence of some complications associated with the procedure. Among the most frequently reported complications are sinusitis, inflammation of peri-implant tissues, sensory changes, and oroantral fistulas, although the overall incidence of these events remains

relatively low (Kämmerer et al., 2023). In addition, due to the anatomical proximity to orbital structures, less common complications may occur, such as infraorbital paresthesia, periorbital hematomas, orbital emphysema, or orbital perforation, emphasizing the importance of careful surgical planning and the experience of the professional responsible for the procedure (Weber; Koschitzki, 2024). Thus, in general, the available data indicate that this technique has high clinical success and consistent outcomes. However, differences in surgical protocols, evaluation criteria, and follow-up periods may still hinder direct comparison between studies, highlighting the need for greater methodological standardization and prospective investigations with long-term follow-up, in order to strengthen the available scientific evidence base.

Much has already been elucidated about the success in rehabilitation with zygomatic implants, studies show that both the original approach (OST) and the anatomy-guided technique (AGA) present similar clinical results. In a study with 923 ZI using the OST technique, the implants had a survival rate of 90.3-100%, compared to the anatomy-guided technique in which 1302 ZI had a rate of 90.4-100%. In his systematic review, Chrcanovic noted that the cumulative 12-year survival rate was 95.21% with 4556 ZIs, with most failures detected in the early postoperative stages. The biggest advantage of this technique when compared to conventional implant treatment is the ability to bear load immediately after surgery, restoring the patient's oral function and aesthetics. Both techniques, OST and the anatomy-guided technique, had a relatively low failure rate in protocols with immediate loading, being 2.56% and 1.75%, respectively. In an analysis of 103 failures collected in a review of 4566 ZIs, the reported failure rate in the immediate loading protocol was 1.7%. Despite the high survival and success rates reported with both proposed techniques, prosthetic and biomedical complications, and especially surgical complications should be widely discussed, aiming to minimize the number of failures and the long-term failure rate (Kämmerer et al., 2023).

3.4 COMPLICATIONS AND RISK MANAGEMENT

Despite its success, the technique is not without risks. Maxillary sinusitis remains the most frequent biological complication, occurring in about 3.7% to 5.4% of cases, often related to perforation of the Schneiderian membrane or the lack of adequate sealing at the ridge (Kämmerer et al., 2023; Al-Nawas et al., 2023). Neurological complications, such as infraorbital nerve paresthesia, and serious ocular complications, including

damage to the orbit and retrobulbar hematomas, although rare, require in-depth anatomical knowledge on the part of the surgeon to avoid irreversible damage to vision (Weber and Koschitzki, 2024; Al-Nawas et al., 2023).

Table 1

Comparison between surgical techniques, survival, and complications

Comparison Criteria	Original technique (OST)	Anatomy-guided approach (AGA/ZAGA)	Main Reference
Positioning	Inside the maxillary sinus (lateral window)	Extrasinusal (respects bone anatomy)	Kämmerer et al. (2023)
Survival Rate	High (94.4% to 95%)	Higher (98.2% to 100%)	Kämmerer et al. (2023)
Incidence of Sinusitis	Higher (up to 14.2%)	Significantly lower	Kämmerer et al. (2023)
Nervous paresthesias	Increased frequency	Lower Frequency	Kämmerer et al. (2023)
Immediate Charge	Applicable, but with technical limitations	Highly compatible and frequent	Solà Pérez et al. (2022)
Orbital Risk	Moderate (depending on the angle)	Reduced by anatomical planning	Weber; Koschitzki. (2024)

As noted in Table 1, the transition from the original technique (OST) to the anatomy-guided approach (AGA/ZAGA) resulted not only in improved implant survival rates, but also in a considerable reduction in the most common postoperative complications, such as maxillary sinusitis (Kämmerer et al., 2023).

3.5 SURVIVAL RATES AND CUMULATIVE SUCCESS

The three publications analyzed converge in demonstrating high survival rates for zygomatic implants. Solà Pérez et al. (2022) calculated the cumulative success rate (TSC) weighted by the number of patients in four follow-up ranges: 98.5% (≤1 year, n=411), 97.5% (1–3 years, n=1,229), 96.8% (3–5 years, n=656), and 96.1% (>5 years, n=1,025). The logarithmic regression of the data showed excellent fit (R^2=0.993), with the equation: TSC(%) = 0.9835 − 0.012 · LN (monitoring in years), indicating that failures are concentrated in the first years of function.

The ITI consensus (Al-Nawas et al., 2023), based on a meta-analysis of 18 case series (623 patients, 1,349 implants), reported a mean survival of 96.2% [95% CI: 93.8–97.7] at a mean follow-up of 75.4 months (6.3 years), ranging from 36 to 141.6 months. The annual incidence of failures was 0.7%, with a higher concentration in the first year (2%) compared to subsequent years (0.5%/year). These findings corroborate those of

Solà Pérez et al. and are comparable to the survival rates of conventional implants described in the literature for atrophic maxilla rehabilitation with alternative techniques.

Regarding the loading protocol, the ITI consensus identified a statistically significant superiority of immediate loading over late loading: 98.1% [95% CI: 96.2–99.0] versus 95.0% [95% CI: 91.7–97.1], with mean follow-ups of 73.6 and 69.3 months, respectively. This finding is in line with the use profile identified by Polido et al. (2023), in which 104 of the 209 patients received immediate loading — a protocol that is now predominant in international clinical practice. It is important to note, however, that immediate loading presupposes adequate primary stability of the implant and a high level of coordination between the surgical and rehabilitation teams.

3.6 CLINICAL INDICATIONS

The review by Polido et al. (2023) constitutes the most detailed contribution on documented indications. In 209 patients, the indications were: extreme bone atrophy or bone deficiency (n=118; 56.5%), previous failure of grafts and/or implants (n=34; 16.3%), preference to avoid stepwise grafting procedures (n=29; 13.9%), maxillary resections due to pathology (n=16; 7.7%), defects related to cleft palate (n=7; 3.3%), and medical conditions that contraindicate grafts (n=5; 2.4%).

The ITI consensus systematized these indications in three Consensus Statements: (1) zygomatic implants are indicated in maxillary bone atrophy or deficiency; (2) are an alternative when the maxillary bone is totally or partially absent due to resection, trauma, or birth defects; (3) are indicated as a rescue alternative in cases of failure of previously placed implants and/or grafts. The concept of a quadruple zygomatic implant — two implants per side, without anchorage in conventional anterior implants — was used in 107 of the 209 patients in the review by Polido et al., and is indicated especially when there is no adequate bone in the anterior region of the maxilla.

A relevant limitation identified by Polido et al. (2023) is the absence of an objective and uniform criterion to define 'extreme bone atrophy'. The alveolar bone height mentioned as the threshold for indication of zygomatic implants ranged from 2 mm to 8 mm in the studies analyzed, with a median of 4 mm in the posterior region. This heterogeneity makes it difficult to standardize protocols and compare studies, and it is recognized as a gap to be filled by future studies with three-dimensional assessment of bone volume.

3.7 SURGICAL AND PROSTHETIC COMPLICATIONS

Maxillary sinusitis emerges as the most prevalent and clinically relevant biological complication. Solà Pérez et al. (2022) found that rhinosinusitis corresponded to 33.7% of the complications reported in the reviewed studies. The ITI consensus (Al-Nawas et al., 2023) reported a total prevalence of 14.2% [95% CI: 8.8–22.0] over a median follow-up of 65.4 months, ranging from 2.8% to 36.4% across studies. Differences in the rate of sinusitis were observed between surgical techniques: in the original intrasinus technique, the pooled rate was 9.5% (0–37.5%), while in the anatomy-guided approach (extramaxillary/ZAGA) it was 4.4% (0–11.8%), suggesting that the extramaxillary technique may reduce the incidence of this complication by preserving the sinus membrane intact.

Most cases of sinusitis were successfully treated with antibiotic therapy and/or surgical meatotomy, with no impairment of implant survival in most reports. However, the ITI consensus recognizes sinusitis as the complication most frequently associated with zygomatic implant loss, although no causal relationship is clearly established in the available literature.

Soft tissue dehiscence and complications were reported in 34.7% of the cases by the review by Solà Pérez et al. (2022), representing the most frequent complication category in absolute terms. The ITI consensus (Al-Nawas et al., 2023) detailed that recession exposing 2 to 3 turns was observed in 14% of implants in a 72-month study, while infectious dehiscences affected 9% of implants at follow-up of up to 141.6 months. Prosthetic mechanical complications accounted for 17.8% of adverse events in the studies reviewed by Solà Pérez et al. (2022), including fractures of the metal substructure, chipping of lining material, and loosening or fracture of screws and abutments.

In intraoperative terms, the ITI consensus recorded specific complications such as implant malposition, penetration into the orbital cavity (described in 4 cases in 3 studies, including one with lateral rectus muscle injury), and perimalar subcutaneous emphysema. These data reinforce the anatomical complexity of the procedure and the need for specialized training, three-dimensional pre-surgical planning, and mastery of the anatomy of the midface.

4 CONCLUSION

The comparative analysis of the three publications allows us to establish, with a reasonable degree of evidence, that zygomatic implants constitute a safe, predictable, and effective therapeutic alternative for the rehabilitation of patients with severely atrophic maxilla—especially in those in whom bone grafting procedures are contraindicated, unsuccessful, or unwanted. Cumulative survival rates greater than 96% at follow-ups of more than five years are comparable to those reported for conventional implants under favorable conditions.

The immediate loading protocol demonstrated survival rates slightly higher than the late loading, in addition to offering functional and aesthetic rehabilitation within 24 hours, which represents a significant benefit for the quality of life of the patients. However, its application requires integrated surgical-prosthetic planning and adequate primary implant stability.

The main limitations of the available literature lie in the heterogeneity of the success criteria used by the different authors, the lack of an objective definition of the atrophy threshold that indicates the use of zygomatic implants to the detriment of conventional alternatives, and the scarcity of randomized clinical trials with long follow-up periods. Future studies with standardized datasets, three-dimensional assessment of bone volume, and patient-centered outcome measures—including quality of life and satisfaction—are needed to consolidate and refine current clinical recommendations.

Finally, the consensus in the literature is unequivocal regarding the complexity of the procedure: zygomatic implants should be performed by teams with specific surgical and rehabilitation expertise, in qualified centers, with three-dimensional preoperative planning and systematic long-term clinical follow-up.

REFERENCES

Al-Nawas, B., et al. (2023). ITI consensus report on zygomatic implants: Indications, evaluation of surgical techniques and long-term treatment outcomes. International Journal of Implant Dentistry, 9(28), 1–10.

Gaur, V. (2023). Zygomatic approach with single-piece implants: A technical note. Journal of Dental Specialities, 11(1), 1–7.

Kämmerer, P. W., et al. (2023). Evaluation of surgical techniques in survival rate and complications of zygomatic implants for the rehabilitation of the atrophic edentulous maxilla: A systematic review. International Journal of Implant Dentistry, 9(11), 1–13.

Polido, W. D., et al. (2023). Indications for zygomatic implants: A systematic review. International Journal of Implant Dentistry, 9(17), 1–14.

Solà Pérez, A., et al. (2022). Success rates of zygomatic implants for the rehabilitation of severely atrophic maxilla: A systematic review. Dentistry Journal, 10(151), 1–18.

Weber, M. I., & Koschitzki, E. (2024). Ocular complications of zygomatic dental implants: A systematic review. Cureus, 16(8), e67535.

Al-Nawas, B., et al. (2023). Relatório de consenso da ITI sobre implantes zigomáticos: Indicações, avaliação de técnicas cirúrgicas e resultados do tratamento a longo prazo. International Journal of Implant Dentistry, 9(28). https://doi.org/10.1186/s40729-023-00489-9

Brånemark, P.-I., et al. (2004). Zygomatic bone fixture in the treatment of advanced atrophy of the maxilla: Technique and long-term results. Scandinavian Journal of Plastic and Reconstructive Surgery and Hand Surgery, 38(2), 70–85.

Brennand Roper, M., et al. (2023). Long-term treatment outcomes with zygomatic implants: A systematic review and meta-analysis. International Journal of Implant Dentistry, 9(21).

Kammerer, P. W., et al. (2023). Evaluation of surgical techniques on survival rate and complications of zygomatic implants for the rehabilitation of the atrophic edentulous maxilla: A systematic review. International Journal of Implant Dentistry, 9(11).

Polido, W. D., Machado-Fernandez, A., Lin, W.-S., & Aghaloo, T. (2023). Indicações para implantes zigomáticos: Uma revisão sistemática. International Journal of Implant Dentistry, 9(17). https://doi.org/10.1186/s40729-023-00480-4

Solà Pérez, A., et al. (2022). Taxas de sucesso de implantes zigomáticos para a reabilitação da maxila severamente atrófica: Uma revisão sistemática. Dental Journal, 10(151). https://doi.org/10.3390/dj10080151

Aparício, C. (2017). Zygomatic implants: The ZAGA concept. Barcelona: Quintessence Publishing.

Aparício, C., et al. (2017). The ZAGA concept: Zygoma anatomy-guided approach. In Zygomatic implants: The ZAGA concept (pp. 1–20).

Migliorança, R. M., et al. (2006). Implantes zigomáticos: Uma alternativa para a reabilitação de maxilas atróficas. Revista da EAP/APCD, 60(4), 278–283.

Migliorança, R. M. (2008). Reabilitação de maxilas atróficas com implantes zigomáticos. São Paulo: Santos.