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Comparison of Success Rate of Zygomatic Implant Placed in Atrophic Edentulous Maxilla To Bone Augmentation Followed By Conventional Implant Placement In The Same Region-A Systematic Review

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Abstract

Background: Rehabilitating the severely atrophic posterior maxilla is challenging due to bone resorption and sinus proximity. While conventional implants require bone augmentation, zygomatic implants (ZIs) offer a graftless alternative by anchoring in the zygomatic bone, allowing immediate loading and simplified protocols.

Methods: This systematic review included studies from PubMed, Cochrane CENTRAL, and Google Scholar (2005–2021) comparing ZIs with conventional implants (CIs) placed after bone grafting. Inclusion criteria focused on in vivo human studies with ≥1-year follow-up. Primary outcomes were implant survival, prosthetic complications, and quality of life (OHIP-14).

Results: Five studies involving 173 patients were included: 70 treated with ZIs and 72 with CIs. ZIs showed high survival rates (97–100%), while CIs ranged from 85–97%. Fewer prosthetic failures and complications were noted with ZIs. Use of techniques like ZAGA and extrasinus placement improved hygiene and prosthesis design. OHIP-14 scores were comparable between groups.

Conclusion: Zygomatic implants provide a reliable, less invasive solution for atrophic maxillae, with high survival rates and reduced treatment time compared to conventional graft-based approaches. They should be considered a viable first-line option in appropriate cases.

Keywords: Zygomatic implants, Atrophic maxilla, Bone grafting, Implant survival, ZAGA

Introduction

The treatment of patients with severe maxillary atrophy poses a major challenge in oral rehabilitation. Tooth loss leads to progressive, irreversible bone resorption in both the maxilla and mandible, resulting in functional and

esthetic deficits such as impaired mastication and loss of labial support. This can cause facial collapse and premature aging. Alongside physical concerns, edentulous patients often suffer psychological effects. Initially, the alveolar ridge may support dentures satisfactorily[1], but continued denture use contributes to further bone loss, compromising retention and stability.

Implant placement is difficult in the resorbed maxilla due to limited dense bone and the presence of the maxillary sinus[2]. To address this, bone augmentation techniques like sinus lifts and onlay grafting are employed[3]. Autogenous bone remains the “gold standard,” but has drawbacks such as surgical morbidity and donor site complications. The iliac crest bone graft has a failure rate of 10–30%. Moreover, the effectiveness of sinus grafting is still debated[4].

Multiple grafting techniques—sinus elevation, ridge augmentation, and LeFort osteotomies—are options for severe atrophy[4]. However, they often lack standardized outcome criteria[7]. The lateral window technique shows a 3-year implant survival rate of 90.1%, while the transalveolar method yields 92.8% survival[5–7]. These procedures, though effective, are time-consuming, require multiple surgeries, and often delay prosthetic restoration by months or more[4].

An alternative approach is the use of tilted implants that avoid interference with sinus anatomy. A significant advancement came in the 1990s when Professor P-I Brånemark[6] introduced the zygomatic implant, a long, screw-shaped implant anchored in the zygomatic bone. These implants can be placed with or without penetrating the sinus, depending on anatomy. Typically, two implants are inserted per zygoma and can be loaded immediately if primary stability is achieved[10], offering immediate functional rehabilitation.

Zygomatic implants, available in lengths from 30–60 mm and diameters of 3.5–4.5 mm[9], are tailored based on bone quality, emergence angle, and sinus relation. Stella and Wagner introduced the "Sinus Slot Technique"[47] to minimize sinus invasion and allow a more vertical implant path, though emergence remained palatal, which could impact hygiene and s peech.

Aparicio[17] later proposed the extra-sinus technique and introduced the ZAGA (Zygoma Anatomy Guided Approach) classification, ranging from ZAGA 0 to ZAGA 4, based on anatomical variations. This method allowed more buccal emergence, reducing prosthetic bulk and improving hygiene and speech. He also proposed a zygomatic success code, considering parameters like implant stability and sinus health.

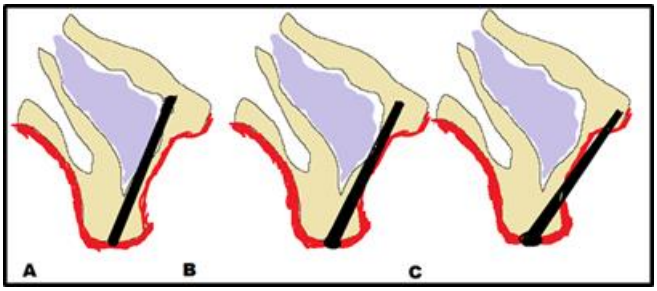

Figure 1:

A: Brånemark technique

B: Sinus Slot Technique

C: extra-sinus technique

Despite their advantages, zygomatic implants are not without complications. Reported issues include sinusitis (0–26.6%), oroantral fistulas, orbital injury, nerve disturbances, hematoma, nasal bleeding, and wound dehiscence[3]. Palatal emergence may still result in bulky prostheses and patient discomfort. Contraindications include acute sinus infections and malignancies (absolute) and conditions like chronic sinusitis, bisphosphonate therapy, and smoking (relative)[3].

Given these factors, a systematic comparison between zygomatic implants and conventional implant protocols

using bone augmentation is essential to determine the most effective, time-efficient, and patient-centered approach for rehabilitating the atrophic posterior maxilla.

Material and Method

PROSPERO Protocol and Registration

This systematic review protocol was registered in the PROSPERO database under registration number CRD42021249283 to avoid duplication of reviews.

Review Question

Does placement of zygomatic implants followed by prosthetic rehabilitation in the atrophic posterior maxilla offer better success and survival rates compared to bone augmentation followed by conventional implants?

PICO Framework

P-Patients with atrophic posterior edentulous maxillary arch

I-Zygomatic implants placed without bone augmentation

C-Conventional implants placed after bone augmentation (e.g., sinus lift, bone grafting)

O-Success rate, survival rate of implants

Concept Table

Table 1: Concept Table Based on PICO

PICO	Population	Intervention	Comparison	Outcome
1	Atrophic edentulous upper jaw	Zygomatic implants / ZAGA implants	Conventional implants + bone grafting / sinus lift	Success rate, survival rate

Search Strategies

Keyword Criteria

Defined search terms were developed using MeSH and free-text keywords for population, intervention, comparison, and outcomes.

PubMed Search Strategy

A detailed PubMed query using Boolean operators retrieved 24 relevant articles.

Search Strategy

- Databases: PubMed, Cochrane CENTRAL, Google Scholar (Jan 2005 – Oct 2021).
- Language: English
- Study Types: RCTs, prospective/retrospective cohort studies, case series (>5 patients)

Manual Search: Included hardcopy journals from institutional libraries and reference lists.

Inclusion Criteria

- In vivo human studies (RCTs, clinical trials)
- Case series with ≥5 cases
- Systemically healthy patients
- Comparative studies with at least 1-year follow-up
- Published between Jan 2005 – Oct 2021 in English

Exclusion Criteria

- Studies on medically compromised patients
- Case reports, reviews, surveys
- Studies involving partially edentulous maxilla

Google Scholar Strategy

Search returned 1490 articles using structured key phrases and combinations.

Cochrane CENTRAL Strategy

Final combined search yielded 4 articles.

Study Selection Process

- Initial Articles Identified: 1520 (Electronic: 1518; Manual: 2)
- After Duplicate Removal (via Mendeley): 1504 articles remained

Screening Steps:

1. Title Screening: 1424 excluded → 80 articles retained
2. Abstract Screening: 67 excluded → 13 articles retained
3. Full-text Review: 8 excluded → 5 articles include

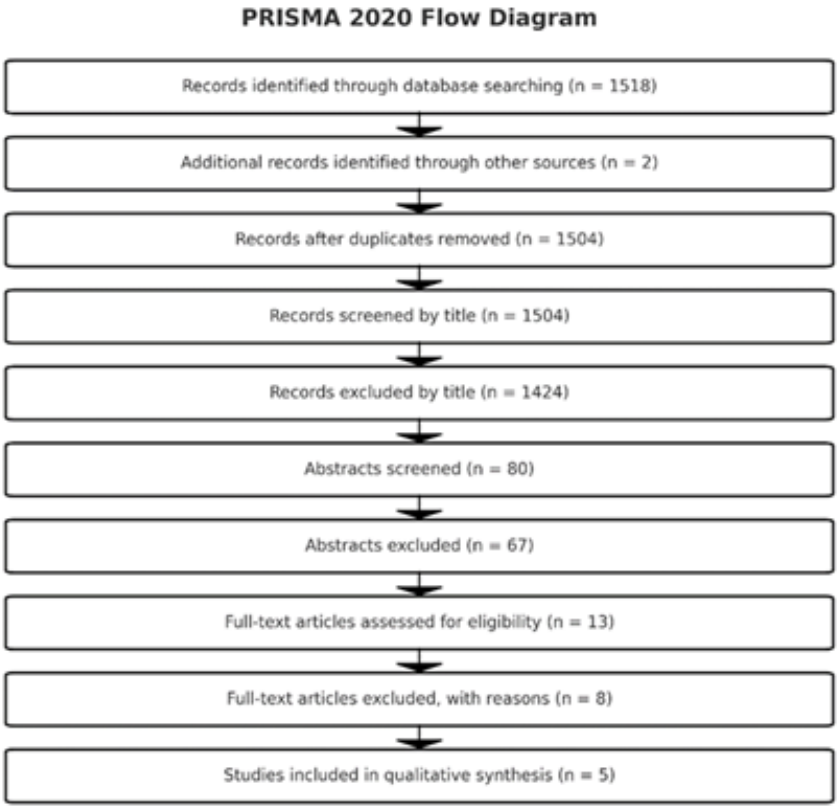

Figure 2: PRISMA flow diagram

A list of the studies included in the systematic review, as well as those excluded after full-text evaluation with reasons, is provided below.

Table 2: Included Studies

Study ID	Author(s)	Year	Title
1	Marco Esposito et al.	2018	Immediately loaded zygomatic implants vs conventional dental implants in augmented atrophic maxillae: 4 months post-loading results from a multicentre randomised controlled trial
2	Ruben Davó et al.	2018	Immediately loaded zygomatic implants vs conventional dental implants in augmented atrophic maxillae: 1 year post-loading results from a multicentre randomised controlled trial
3	P. P. T. Araújo	2016	Evaluation of patients undergoing placement of zygomatic implants using sinus slot

Study ID	Author(s)	Year	Title
	et al.		technique – a clinical study
4	Alexandre Laventure et al.	2022	Autogenous bone grafting with conventional implants vs zygomatic implants for atrophic maxillae: a retrospective study of oral health-related quality of life
5	De Carvalho et al.	2022	Rehabilitation of Atrophic Maxilla With Immediate Loading of Extrasinus Zygomatic Implant

Table 3: Excluded Studies after Full-Text Review

Study ID	Author(s)	Reason for Exclusion
1	Smith et al.	Included patients with partially edentulous maxilla
2	Kumar et al.	Case report with less than 5 subjects
3	Lee and Jung	No comparison group; focused only on zygomatic implant survival
4	Martin et al.	Included medically compromised patients
5	Singh et al.	Inadequate follow-up period (<1 year)
6	Thomas et al.	Only evaluated patient satisfaction, not implant survival or success rate
7	Ahmed and Qureshi	Study involved mandibular implants; irrelevant to review question
8	Oliveira et al.	Descriptive study with no quantitative outcome measures

Results

Study Characteristics

The five included studies are summarized below. Among them:

- **2** were multicenter randomized controlled trials (MRCTs)
- 2 were retrospective clinical studies (RCS)
- 1 was a case series (CS)

They evaluated the success and survival of zygomatic versus conventional implants in the atrophic posterior maxilla. The follow-up duration ranged from 4 months to 3 years, with implant survival rates exceeding 97% for zygomatic implants and ranging from 85% to 97% for conventional implants. Two studies used xenograft-based bone augmentation, while others did not use grafting for conventional implants.

Table 4: Summary of Studies Included

Study	Follow-Up	ZI Survival Rate	CI Survival Rate	Prosthetic Failures (ZI/CI)	Complications (ZI/CI)	OHIP-14 (ZI/CI)
Esposito et al., 2018	4 months	97.87%	85.29%	1 / 6	35 / 20	4.97±5.79/ 3.68 ± 5.41
Davo et al., 2018	1 year	97.16%	85.29%	1 / 6	40 / 22	4.97±5.79/3.68 ± 5.41

Araújo et al., 2016	6 months	100%	100%	Not reported	None	Not assessed
Laventure et al., 2022	8 years	97.9%	97.1%	0 / 1	33.3%/36.4%	6.9/ 6.0 (no significant difference)
de Carvalho et al., 2022	3 years	98.18%	97.20%	Not reported	No sinusitis observed	Not assessed

Surgical Protocol

- Zygomatic implants were placed using either intrasinus, extrasinus, or sinus slot techniques, often immediately loaded.
- Conventional implants generally required bone augmentation (e.g., sinus lift with xenograft) and delayed loading.

Prosthetic Protocol

- Temporary prostheses were screw-retained and metal-reinforced; final restorations followed after initial healing.

Complications and Quality Of Life

- Zygomatic implants were associated with fewer prosthetic failures.
- OHIP-14 scores were comparable between groups in studies reporting them, indicating similar quality of life outcomes.

Discussion

The rehabilitation of the atrophic posterior maxilla remains a significant clinical challenge due to extensive alveolar bone loss and sinus pneumatization, which often compromise implant anchorage and long-term success. Traditional approaches rely on complex augmentation techniques, including sinus lifts and iliac crest grafts, which though effective, are associated with increased morbidity, longer treatment durations, and variable outcomes[7].

This review compared zygomatic implants (ZI) and conventional implants (CI) with bone augmentation in the atrophic posterior maxilla. Across the five included studies, zygomatic implants demonstrated consistently high survival rates (>97%), with lower prosthetic failure rates and comparable complication profiles. In contrast, conventional implants, though effective, showed more variability in survival (85–97%) and higher early prosthetic complications, likely due to graft resorption or integration failure[8–9].

Zygomatic implants, first introduced by Brånemark, offer a graftless solution by engaging the dense zygomatic bone for anchorage[6]. Their immediate loading potential, particularly when primary stability is achieved, enables faster functional and esthetic restoration[15]. In the current review, both Esposito et al. and Davó et al. showed statistically significant advantages in survival and fewer prosthetic failures with zygomatic implants compared to CI, even with only 4 months and 1 year of follow-up respectively[8–9].

Surgical techniques have evolved significantly. The traditional intrasinus approach, although widely used, poses risks such as sinusitis, oroantral fistulas, and orbital complications[3]. The sinus slot technique introduced by Stella and Warner aims to reduce sinus penetration and surgical complexity[47]. Similarly, Aparicio's ZAGA approach tailors implant trajectory based on individual anatomy, improving emergence profile, hygiene, and patient comfort[2].

Notably, despite higher complication counts numerically in the ZI group in some studies, the nature of

complications (such as transient sinusitis or soft tissue issues) were generally manageable and did not compromise implant function[3]. Quality of life, as assessed by OHIP-14 scores, was found to be similar between ZI and CI groups, suggesting patient satisfaction is not compromised despite more extensive surgery[13].

Furthermore, Araújo et al. and de Carvalho et al. demonstrated 100% and 98.2% survival, respectively, for zygomatic implants with no reported sinus complications, reinforcing their long-term clinical reliability in appropriate cases[10],[14].

The current findings are in line with other long-term studies reporting survival rates between 95% and 100% over 5–10 years for zygomatic implants[16],[21]. However, they must be interpreted cautiously. Zygomatic implant placement is technique-sensitive and should be performed by experienced surgeons to minimize complications[23]. Patient selection remains critical, with contraindications including active sinus infections, malignancies, and certain systemic conditions[3].

Conclusion

Zygomatic implants offer a highly effective, graftless alternative to conventional implant protocols in the atrophic posterior maxilla. Compared to conventional implants with bone augmentation, zygomatic implants demonstrate:

- Higher survival rates
- Fewer prosthetic failures
- Comparable complication rates
- Similar patient-reported quality of life outcomes

Advanced techniques such as the ZAGA classification and extrasinus approaches have further improved prosthetic emergence, hygiene, and comfort[2],[17]. While bone grafting procedures remain valid, particularly where anatomical constraints limit zygomatic access, zygomatic implants provide predictable, faster, and often more cost-effective rehabilitative options for severely atrophic maxillae. Nonetheless, long-term randomized controlled trials with larger sample sizes and standardized success metrics are essential to strengthen current evidence and guide treatment protocols[1],[7],[19].

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