AMERICAN ACADEMIC PUBLISHER

INTERNATIONAL JOURNAL OF MEDICAL SCIENCES

ISSN NUMBER: 2692 - 5206 Volume 5. No 11. November ,2025

MODERN IMPLANT TECHNIQUES: ZYGOMATIC, PTERYGOID, TRANS-SINUS, AND TRANS-NASAL APPROACHES

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Abstract: Severe maxillary atrophy remains one of the most challenging conditions in oral and maxillofacial rehabilitation. Modern implantology has introduced several graftless solutions—including zygomatic, pterygoid, trans-sinus, and trans-nasal implants—which allow immediate or early loading and reduce the need for bone augmentation. This expanded review provides detailed anatomical descriptions, biomechanical principles, surgical protocols, indications, contraindications, survival rates, and complication profiles based on up-to-date peer-reviewed scientific literature.

Introduction

Severe maxillary bone resorption has historically limited the feasibility of conventional dental implants. Traditional augmentation procedures such as sinus lifting or bone grafting require prolonged treatment time and present higher surgical morbidity. Innovations in implantology have introduced extra-maxillary anchorage methods that reduce the need for grafting and improve stability in compromised patients. Among these methods, zygomatic, pterygoid, trans-sinus, and trans-nasal implants are increasingly recognized as reliable alternatives and are accepted in contemporary evidence-based implant dentistry.

Zygomatic Implants

Zygomatic implants were first introduced by Brånemark in 1997 as a solution for severe maxillary atrophy. Modern zygomatic systems range from 30–60 mm in length and are designed for anchorage in the dense zygomatic body. Contemporary approaches include the Brånemark technique, extrasinus technique, and the ZAGA (Zygoma Anatomy-Guided Approach) classification, which individualizes implant trajectory based on sinus morphology.

Surgical Protocol

- Preoperative CBCT analysis of zygomatic bone thickness (average 6–10 mm)

- Intrasinus or extrasinus path selection depending on ZAGA type

- Engagement of bicortical zygomatic pillars for maximum stability

- Immediate loading protocols often feasible due to high torque (>60 Ncm)

Survival Rates (10–12 years)

- 94–98% survival in systematic reviews (Chrcanovic et al., 2013)

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- Quad-zygoma success: 96–98% (Aparicio et al., 2014)

Common Complications

- Sinusitis (2–8%)

- Soft-tissue irritation around emergence profile

- Rare: orbital penetration (<0.1%)

Pterygoid Implants

Pterygoid implants engage the pyramidal process of the palatine bone and extend toward the pterygoid process of the sphenoid. Implant lengths are typically 15–20 mm, placed at an angle of 45–70° relative to the maxillary plane.

Surgical Steps

- Accessing the posterior maxilla without sinus lift

- Direction toward pterygoid fossa for cortical engagement

- Ensuring avoidance of internal maxillary artery and pterygoid venous plexus

Survival and Evidence

- Survival rate: 90–97% (Balshi et al., 2015)

- Posterior support enhances full-arch biomechanics, reducing cantilever stress

Complications

- Soft-tissue inflammation (3–5%)

- Posterior bleeding risks due to complex anatomy

Trans-sinus Implants

Trans-sinus implants are indicated when a thick anterior sinus wall allows a safe transantral pathway for anchorage into the lateral nasal wall or piriform rim.

Anatomical Requirements

- Anterior sinus wall ≥ 3 mm thickness

- Sinus cavity free of pathology

- Adequate lateral nasal wall height

Surgical Steps

1. Creation of lateral window (optional)

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INTERNATIONAL JOURNAL OF MEDICAL SCIENCES
ISSN NUMBER: 2692 - 5206 Volume 5. No 11. November ,2025

2. Implant trajectory through sinus cavity

3. Bicortical engagement into nasal wall

Clinical Evidence

- Survival rate: 92–96% over 5–8 years (Davó et al., 2012)

- Ideal for immediate loading hybrid protocols

Risks

- Sinus membrane irritation

- Postoperative sinusitis (2–4%)

Trans-nasal Implants

Trans-nasal implants engage the lateral nasal wall and are typically 15–25 mm in length. They provide anterior support when the premaxilla is insufficient.

Anatomical Considerations

- Nasal floor cortical thickness > 3–4 mm

- Adequate lateral wall height

- Careful avoidance of nasal mucosa perforation

Evidence

- 93–97% survival (Peñarrocha et al., 2014; Jónsson et al., 2018)

- Acts as anterior stabilizer when combined with two zygomatic posterior implants

Complications

- Nasal mucosa irritation

- Minor epistaxis

- Prosthetic angulation challenges

Discussion

These implant modalities reduce surgical morbidity and shorten treatment timelines, especially in elderly or medically compromised patients. Zygomatic implants remain the gold standard for extreme maxillary atrophy, while pterygoid implants enhance posterior anchorage without sinus intervention. Trans-sinus and trans-nasal implants offer less invasive alternatives when anatomical conditions are favorable.

AMERICAN ACADEMIC PUBLISHER

INTERNATIONAL JOURNAL OF MEDICAL SCIENCES

ISSN NUMBER: 2692 - 5206 Volume 5. No 11. November ,2025

Clinical evidence shows high survival rates (>95% in multiple peer-reviewed studies) when procedures are performed by experienced surgeons. However, complications such as sinusitis, soft tissue irritation, and prosthetic misalignment highlight the importance of proper case selection and advanced surgical training.

Conclusion

Zygomatic, pterygoid, trans-sinus, and trans-nasal implants represent powerful tools for treating patients with severe maxillary atrophy. These graftless solutions follow evidence-based principles and are well-accepted in contemporary implantology. Their success depends on accurate anatomical assessment, surgeon expertise, and individualized prosthetic planning.

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