



Zygomatic Implants

Dr. Srivikram P – SRM Kattankulathur Dental College and Hospital

Dr. Shafath Ahmed A – Professor of Department of Prosthodontics and Crown & Bridge, SRM Kattankulathur Dental College and Hospital

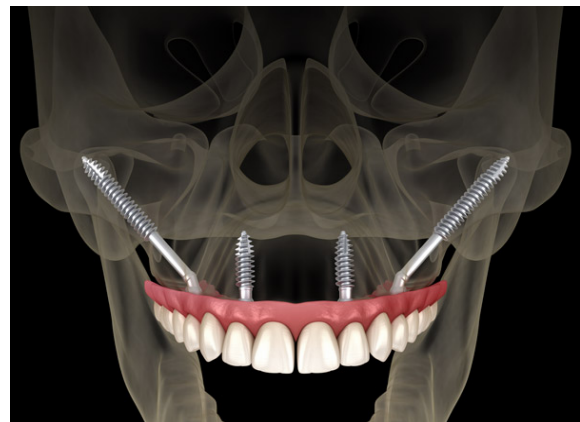
Dr. V Vidyashree Nandini – Professor and HOD of Department of Prosthodontics and Crown & Bridge, SRM Kattankulathur Dental College and Hospital

Submitted: 25-08-2024

Accepted: 05-09-2024

ABSTRACT: Conventional implants cannot be placed in patients with severe atrophied maxilla resulting in insufficient amount of bone remaining for anchorage. Routinely, grafts were the preferred technique. However there are drawbacks associated with this procedure, Branemark proposed surgical/prosthetic rehabilitation with zygomatic implants to overcome them. This review addresses the criteria for zygomatic implants, indications, presurgical evaluation of the patient, prosthetic guidelines to be followed, and surgical procedures such as the intra-sinus and extra-sinus approaches. It also reviews the prosthetic procedures involved, implant design, evolution of zygomatic implants, case studies and clinical outcomes along with the post-operative complication and the recent advancements in zygomatic fixture technique.

maxilla is considering the zygomatic bone as a anchorage for implant placement as proposed by Prof. Branemark in 1988.



I. INTRODUCTION:

Literature evidence documents the success of implant-supported prosthesis in addressing edentulousness. But, the extension of this to maxillary intervention is questionable due to atrophy of bone and pneumatization of the maxillary sinus. Various alternative techniques are practised.

Conventional implants as a treatment for edentulous maxilla are hindered by the extensive bone resorption presented and the large sinus cavity, hence there is not enough bone tissue for the implant anchorage. Bone augmentation procedures have become a vital solution for addressing the lack of adequate bone in the edentulous maxilla. These procedures aim to regenerate or increase bone volume, providing a solid foundation for dental implants. Some of the most common techniques used are sinus lift, ridge augmentation, guided bone regeneration and onlay grafting.¹

A flexible alternative for treating individuals reporting with severely atrophied

ZYGOMATIC IMPLANTS:

Dental implants have transformed restorative dentistry, providing patients with a dependable solution for missing teeth.² However, severe maxillary bone loss often makes conventional implants impractical due to inadequate bone volume. In such challenging cases, zygomatic implants offer an innovative alternative.^{3,4} These implants leverage the dense zygomatic bone (cheekbone) to deliver stable anchorage for dental prostheses, enabling successful rehabilitation even in the absence of sufficient maxillary bone.^{5,6}

INDICATIONS FOR ZYGOMATIC IMPLANTS:

➤ Severe Maxillary Atrophy

- Patients with extensive bone resorption in the maxilla, often due to prolonged edentulism, periodontal disease, or trauma, may lack the necessary bone volume for traditional implants. Zygomatic implants utilize the



denser bone of the zygomatic arch, bypassing the need for maxillary bone.⁵

➤ **Previous Implant Failures**

- Individuals who have experienced multiple failures with conventional implants due to inadequate bone support or poor bone quality can benefit from the increased stability provided by zygomatic implants.⁴

➤ **Maxillectomy Patients**

- Patients who have undergone partial or complete maxillectomy (removal of the upper jaw) due to cancer, tumors, or severe trauma often face significant challenges in dental rehabilitation. Zygomatic implants can provide a stable foundation for prosthetic reconstruction in these cases.²

➤ **Avoidance of Bone Grafting**

- For patients who are not ideal candidates for extensive bone grafting procedures due to medical conditions, patient preference, or previous graft failures, zygomatic implants offer a less invasive and more immediate alternative.³

➤ **Immediate Functional and Aesthetic Restoration**

- Zygomatic implants can often be loaded with temporary prostheses immediately after placement, providing patients with immediate functional and aesthetic benefits. This is particularly advantageous for patients seeking a quicker rehabilitation process.⁴

➤ **High Surgical Risk Patients**

- Individuals with systemic conditions or compromised health who face higher surgical risks with traditional bone grafting procedures may find zygomatic implants a safer option, reducing the need for multiple surgeries and lengthy recovery times.⁵

➤ **Complex Anatomical Conditions**

- Patients with complex anatomical variations or severe bone deficiencies, which make conventional implant placement difficult or impossible, can achieve successful outcomes with zygomatic implants.^{3,4}

PRESURGICAL EVALUATION FOR ZYGOMATIC IMPLANTS:

1. Clinical examination:

- **Intra-oral examination:** Evaluation of patient's oral hygiene, periodontal health, and presence of any infections.⁵
- **Medical history:** A detailed medical history of the patient to ensure the presence of any

systemic conditions that could affect healing and osseointegration.⁴

2. Radiographic examination:

- **Orthopantomography (OPG):** A screening tool to assess the structure of the maxilla and the zygomatic bone.⁵
- **Computed Tomography (CT) or Cone Beam CT (CBCT) Scans:** 3D images allows precise evaluation of bone quantity and quality, even the anatomical relationship between the maxillary sinus and the adjacent structures.⁷

3. Anatomical considerations:

- **Maxillary bone quality:** The amount of bone atrophy and maxillary resorption.⁵
- **Quality of the zygoma bone:** Ensuring that the zygomatic bone is dense enough to offer stability for the implant.⁴
- **Maxillary sinus anatomy:** To evaluate the size and position of the maxillary sinus to plan the path of insertion and to avoid any unnecessary complications.⁷

PROSTHETIC GUIDELINES:

1. Prosthetic design:

- **Fixed vs. removable prostheses:** Fixed or removable prosthesis can
- be planned according to the patient's preference, bone quality and anatomical considerations.⁵
- **Immediate loading:** Temporary prostheses can be given to the patient soon after implant placement providing immediate aesthetic and functional benefits.⁸

2. Occlusal scheme:

- Implant protected occlusion.⁹

3. Prosthetic components and materials:

- Abutment selection must be based on the angulation and depth of the implant.⁸
- Prosthetic materials should be durable and esthetically pleasing.
- Some popular choices are zirconia and acrylic.⁵

➤ **SURGICAL PROCEDURE:**

PLACEMENT TECHNIQUES FOR ZYGOMATIC IMPLANTS:

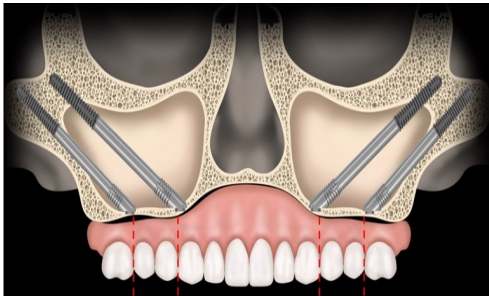
There are two primary approaches for implant placement:

- intra-sinus approach
- extra-sinus approach

INTRA-SINUS APPROACH:



Description: This approach involves placing the implant through the maxillary sinus and anchoring it in the zygomatic bone.



Preoperative assessment:

1. **Imaging studies:** CT or CBCT is essential for assessing the quality of the bone, anatomy of the sinus and the relationship between critical structures.⁵
2. **Virtual Surgical Planning:** A virtual model of the anatomy of the patient facilitates precise planning to help with implant placement and the development of surgical guides.¹⁰
3. **Patient Evaluation:** A detailed patient's history is crucial for planning the procedure.

Surgical Procedure:

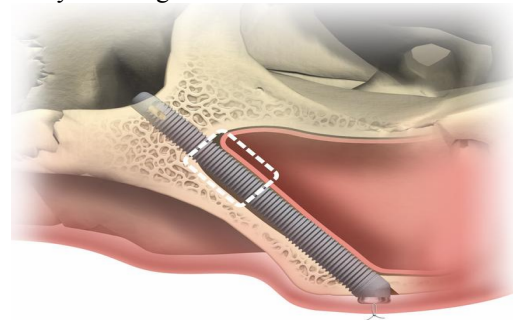
1. **Anesthesia:** The procedure is usually performed under local anesthesia with sedation or general anesthesia.¹¹
2. **Flap creation:** To create access to the sinus and the underlying bone, a surgical flap is made, exposing the alveolar bone and the lateral wall of maxillary sinus.⁸
3. **Osteotomy:** The osteotomy is performed by drilling a hole through the alveolar ridge and the lateral wall of the maxillary sinus, finally reaching the zygomatic bone.⁴
4. **Implant Insertion:** The zygomatic implant is inserted through the hole created, travelling through the sinus and anchoring with the zygomatic bone. The angulation and depth are important for the stability and integration of the implant.¹¹
5. **Sinus membrane management:** Techniques such as membrane elevation or even the use of protective barriers can be done to prevent perforation into the sinus and other complications.⁸
6. **Closure and Healing:** The next step is to suture the surgical flap. A temporary prosthesis can be placed immediately and a permanent process fitted after the healing period of around 4 to 6 months.¹²

Several complications such as sinusitis, sinus membrane perforation, implant failure and soft

tissue irritation may be faced. To avoid perforation of the sinus, protective barriers can be placed. Care must be taken not to injure the surrounding soft tissues. Implant failure can happen due to infection, improper placement and poor integration to the surrounding tissue.

EXTRA-SINUS APPROACH:

Description: Here, the implant avoids the sinus thereby reducing the risk of sinus-related issues.⁵



Procedure: The only difference here is that the hole is drilled directly into the zygomatic bone, completely bypassing the sinus cavity. Then, the implant is inserted through the hole and placed into the zygomatic bone with its coronal portion emerging outside the sinus. The risk of complications to the sinus is highly diminished, being a huge advantage. It is also widely used in patients with larger sinus cavities or patients with a history of previous sinus issues.¹³

PROSTHETIC PROCEDURE:

Prosthetic placement for zygomatic implants follows conventional guidelines for implant-supported dental bridges, which can be either cemented or screw-retained.¹¹

- Cemented bridges offer a natural appearance and ease of placement but require precise cementation to avoid complications like peri-implantitis.¹⁴
- Screw-retained bridges provide easier retrieval for maintenance but may have aesthetic challenges due to visible screw access holes.¹⁵

Key design considerations include ensuring sufficient space around the implants for cleaning tools like interdental brushes and floss, and using smooth, easy-to-clean materials such as polished titanium or glazed ceramic.¹⁶

IMPLANT DESIGN

Implants are longer and engage the dense zygomatic bone, typically ranging from 30 to 55 mm long.¹¹ The design often includes tapered or



cylindrical bodies with threads that enhance primary stability during placement.¹³ This stability is critical due to the biomechanical demands placed on zygomatic implants, which must support functional loads effectively.

EVOLUTION OF ZYGOMATIC IMPLANTS:

Initially developed by Dr. Branemark in the 1980s, these implants were designed to anchor in the dense zygomatic bone, providing an alternative to bone grafting procedures.¹⁷ Early designs focused on ensuring sufficient length and angulation to achieve primary stability.¹³ Over time, advancements in imaging technology have enhanced the precision of placement and reduced surgical risks.⁵ Modern zygomatic implants are now available in various lengths (typically 30-55 mm) and designs, including tapered or cylindrical shapes with surface treatments to promote osseointegration.¹⁷ These implants can support fixed or removable prostheses, offering functional and aesthetic benefits.¹³

CASE STUDIES AND CLINICAL OUTCOMES:

CASE STUDY I: Rehabilitation of maxillectomy patient:

A 55-year-old patient had undergone a maxillectomy due to cancer and presented with severe maxillary bone loss. For this patient, four zygomatic implants were placed using the intra-sinus approach, after which a temporary prosthesis was given to the patient immediately. The implants were observed to be of great stability and after 6 months, the temporary prosthesis was replaced with a permanent one, resulting in hugely improved functionality and aesthetics.¹⁸

CASE STUDY II: Management of severe maxillary atrophy:

A female patient of age 63, had presented with severe maxillary atrophy and had a history of multiple failed conventional implants. Since the patient had a large sinus cavity, an extra-sinus approach was followed to place two zygomatic implants bilaterally. After a healing period of 6 months, the patient was given a fixed prosthesis and a follow-up after 2 years showed stable implants with no signs of infection or failure.¹⁹

CLINICAL OUTCOMES:

Studies have shown that zygomatic implants present with high survival rates often exceeding 95% over periods of 5 – 10 years.²⁰ A systematic review states a survival rate of 97.86%

over 12 months to 12 years with an observation that sinusitis and soft tissue irritations were manageable with appropriate surgical techniques and postoperative care.²¹

ZYGOMATIC STABILITY:

Zygomatic implants placed in the extra-sinus region may exhibit varying levels of stability due to the biomechanics of their positioning. Limited or absent anchorage at the implant head height can lead to modest movement without immediate clinical symptoms.²² The zygomatic bone, where these implants anchor, possesses an elastic modulus that allows it to flex under applied forces. However, rotational movement must be avoided as it can indicate implant failure.²³ Splinting implants together can eliminate rotational movement and improve overall stability, thereby reducing the risk of complications associated with implant movement.

POST-OPERATIVE COMPLICATIONS:

1. **Sinusitis:** Inflammation or infection of the maxillary sinus can occur if the sinus membrane is compromised during surgery or due to inadequate healing.²⁴
2. **Soft Tissue Complications:** Issues such as mucositis or peri-implantitis, characterized by inflammation and possible infection around the implant site, can occur if oral hygiene is not maintained.²⁵
3. **Implant Failure:** Although uncommon, zygomatic implants can fail due to factors such as infection, improper placement, or insufficient osseointegration.²⁶
4. **Nerve Injury:** Damage to nearby nerves during surgery can lead to sensory disturbances or numbness in the cheeks, lips, or gums.²⁷
5. **Prosthetic Complications:** Problems with the prosthetic restoration, such as loose screws, fracture of the prosthetic components, or improper fit, may necessitate adjustments or replacement.²⁸
6. **Pain and Discomfort:** Patients may experience persistent pain or discomfort, especially during the initial healing phase.²⁹
7. **Bone Resorption:** Gradual bone loss around the implant site can occur over time, potentially affecting the stability of the implant-supported prosthesis.³⁰

Managing post-operative complications involves regular follow-up visits, patient education on oral hygiene practices, and early intervention if any signs of complications arise.³¹



ZYGOMATIC FIXTURE TECHNIQUE: RECENT ADVANCEMENTS:

Recent developments in zygomatic fixture techniques have focused on improving surgical precision, enhancing biomechanical stability, and reducing complications associated with traditional approaches. Here are some key advancements:

1. **Guided Surgery:** Utilizing advanced imaging technologies like cone-beam computed tomography (CBCT) and computer-aided design (CAD), guided surgery techniques have become more prevalent. These technologies allow for precise pre-operative planning and the creation of surgical guides, which improve the accuracy of zygomatic implant placement.^{32,33}
2. **Shorter Implants:** Innovations in implant design have led to the development of shorter zygomatic implants. These implants are designed to engage the dense zygomatic bone while reducing the need for invasive surgery and the risk of complications associated with longer implants.^{32,33}
3. **Improved Surface Treatments:** New surface treatments and coatings on zygomatic implants promote faster osseointegration and greater long-term stability. Enhanced surface roughness and bioactive coatings encourage faster bone healing and reduce the risk of implant failure.^{32,33}
4. **Biologically Oriented Preparation Technique (BOPT):** BOPT involves a minimally invasive surgical approach that preserves soft and hard tissues around the implant site. This technique aims to maintain natural aesthetics and reduce post-operative discomfort while ensuring optimal functional and esthetic outcomes.^{32,33}
5. **Immediate Loading Protocols:** Advances in immediate loading protocols allow for the placement of temporary prostheses on zygomatic implants shortly after surgery. This approach provides immediate restoration of function and aesthetics, improving patient satisfaction and quality of life.^{32,33}
6. **Customized Solutions:** Increasingly, zygomatic implants are being customized to fit individual patient anatomy and specific clinical needs. This customization improves the precision and predictability of treatment outcomes while optimizing patient comfort and recovery.^{32,33}

II. CONCLUSION:

In conclusion, zygomatic implants provide a great treatment option for patients with complex anatomical challenges. Their ability to provide immediate, stable, and aesthetically pleasing results underscores their value in contemporary restorative dental practice. As surgical techniques and technologies continue to evolve, the role of zygomatic implants is likely to expand, providing even greater benefits to patients worldwide.

REFERENCES:

- [1]. Esposito, M., et al. (2009). "Interventions for replacing missing teeth: augmentation procedures of the maxillary sinus." *Cochrane Database of Systematic Reviews*, (3): CD008397.
- [2]. Branemark, P.I., Hansson, B.O., Adell, R., et al. "Osseointegrated implants in the treatment of the edentulous jaw. Experience from a 10-year period." *Scandinavian Journal of Plastic and Reconstructive Surgery*, vol. 16, no. 1, 1977, pp. 1-132. doi:10.3109/02844317709012901
- [3]. Bedrossian, E. "Implant treatment planning for the edentulous patient: A graftless approach to immediate loading." John Wiley & Sons, 2010
- [4]. Malevez, C., Hermans, M., Vrielinck, L., et al. "Clinical outcome of 103 consecutive zygomatic implants: A 6-48 months follow-up study." *Clinical Oral Implants Research*, vol. 15, no. 1, 2004, pp. 18-22. doi:10.1111/j.1600-0501.2004.00996.x
- [5]. Aparicio, C., Manresa, C., Francisco, K., et al. "The long-term use of zygomatic implants: A 10-year clinical and radiographic report." *Clinical Implant Dentistry and Related Research*, vol. 16, no. 3, 2014, pp. 447-459. doi:10.1111/cid.12053
- [6]. Chrcanovic, B.R., Abreu, M.H., Almeida, A.M., et al. "Survival and complications of zygomatic implants: A systematic review." *Oral and Maxillofacial Surgery*, vol. 24, no. 4, 2020, pp. 1-16. doi:10.1007/s10006-020-00911-8
- [7]. Quílez, J.B., Guijarro-Martínez, R., Aboul-Hosn Centenero, S., Hernández-Alfaro, F. "Virtual quad zygoma implant placement using cone beam computed tomography: sufficiency of malar bone volume, intraosseous implant length, and



- relationship to the sinus according to the degree of alveolar bone atrophy." *International Journal of Oral and Maxillofacial Surgery*, 2018
- [8]. Quirynen, M., Gijbels, F., Jacobs, R. "Anatomical and radiographic considerations for the zygoma implant." *Journal of Clinical Periodontology*, vol. 38, no. 4, 2011, pp. 366-371. doi:10.1111/j.1600-051X.2010.01691.x
- [9]. Misch CE, Bides MW. Implant-protected occlusion. *International Journal of Dental Symposia*. 1994 ;2(1):32-37. PMID: 9117850.
- [10]. J. Bertos Quílez, R. Guijarro-Martínez, S. Aboul-Hosn Centenero, F. Hernández-Alfaro. "Virtual quad zygoma implant placement using cone beam computed tomography: sufficiency of malar bone volume, intraosseous implant length, and relationship to the sinus according to the degree of alveolar bone atrophy." *International Journal of Oral and Maxillofacial Surgery*, 2018
- [11]. Aparicio, C., et al. "The long-term use of zygomatic implants." *Clinical Implant Dentistry and Related Research*, 2014
- [12]. Malevez, C., et al. "Clinical outcome of 103 consecutive zygomatic implants." *Clinical Oral Implants Research*, 2004
- [13]. Chrcanovic, B. R., Albrektsson, T., & Wennerberg, A. "Zygomatic implants: A systematic review of clinical outcomes." *Journal of Dentistry*, vol. 44, 2016, pp. 41-58. doi:10.1016/j.jdent.2015.11.011
- [14]. Glauser, R., et al. "Immediate occlusal loading of Brånemark implants applied in various jawbone regions: a prospective, 1-year clinical study." *Clinical Implant Dentistry and Related Research*, 2001
- [15]. Taylor, T. D., et al. "Cemented versus screw-retained implant restorations: a critical review." *International Journal of Oral and Maxillofacial Implants*, 2004
- [16]. Quirynen, M., et al. "The influence of surface characteristics of dental implants on plaque accumulation and peri-implant mucositis." *Clinical Oral Implants Research*, 2006
- [17]. Aparicio, C., et al. "Zygomatic implants: indications, techniques, and outcomes." *Medical Principles and Practice*, 2012
- [18]. Aparicio, C., et al. "Rehabilitation of maxillectomy patients with zygomatic implants: A report of two cases." *International Journal of Oral and Maxillofacial Surgery*, 2005
- [19]. Chrcanovic, B. R., et al. "Zygomatic implants in the management of patients with severe maxillary atrophy: A case series." *Clinical Implant Dentistry and Related Research*, 2016
- [20]. Esposito, M., et al. "Zygomatic implants for the rehabilitation of atrophic maxillae: A systematic review." *Clinical Oral Implants Research*, 2014
- [21]. Aparicio, C., et al. "Systematic review of survival rates for zygomatic implants: Results of a 12-year observation." *Journal of Prosthodontics*, 2010
- [22]. Aparicio, C., et al. "Extra-sinus zygomatic implants: Technical and biomechanical considerations." *Clinical Implant Dentistry and Related Research*, 2014
- [23]. Chrcanovic, B. R., et al. "Biomechanics of zygomatic implants: A comprehensive review." *Journal of Dentistry*, 2016
- [24]. Bedrossian, E. "Implant treatment planning for the edentulous patient: A graftless approach to immediate loading." Mosby, 2011
- [25]. Chrcanovic, B. R., et al. "Soft tissue complications in zygomatic implants: A review." *Clinical Oral Implants Research*, 2016
- [26]. Aparicio, C., et al. "Implant failure in zygomatic implants: Causes and management." *Journal of Oral Implantology*, 2014
- [27]. Esposito, M., et al. "Nerve injury during zygomatic implant placement: Incidence and prevention." *Journal of Dentistry*, 2014
- [28]. Bedrossian, E. "Prosthetic complications with zygomatic implants: An overview." *International Journal of Oral and Maxillofacial Surgery*, 2011
- [29]. Chrcanovic, B. R., et al. "Pain and discomfort in the initial healing phase



- of zygomatic implants: A review." *Journal of Oral Rehabilitation*, 2016
- [30]. Aparicio, C., et al. "Bone resorption in zygomatic implants: Long-term outcomes." *Clinical Implant Dentistry and Related Research*, 2014
- [31]. Esposito, M., et al. "Managing post-operative complications in zygomatic implants." *Journal of Clinical Periodontology*, 2014
- [32]. Brånemark, P. I., et al. (2004). Zygoma fixture in the management 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.
- [33]. Kämmerer, P.W., Fan, S., Aparicio, C. et al. Evaluation of surgical techniques in survival rate and complications of zygomatic implants for the rehabilitation of the atrophic edentulous maxilla: a systematic review. *Int J Implant Dent* 9, 11 (2023).