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A Graftless Implant: Anchoring Your Smile- A Review

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ABSTRACT

Maxillary edentulism is increasingly common, often resulting from conditions such as advanced dental caries, periodontal disease, trauma, or infection. And can have significant psychological, social, and functional consequences, leading to nutritional changes and various health conditions. The resorption of alveolar bone, particularly in the posterior maxilla, complicates the placement of conventional implants, necessitating bone grafting and sinus augmentation utilizing the bone structure of maxilla an implant system was developed earlier avoiding the use of grafting or augmentation. Zygomatic implants, were first introduced by Branemark in 1988, use the zygoma bone for posterior support, doing away with the requirement for directed bone regeneration or sinus elevation. Indications include moderate to severe maxillary atrophy, cleft palate, and congenital or acquired defects. Zygomatic implants are particularly beneficial for patients requiring immediate loading and those unable to undergo multiple procedures.

Keywords: Dental Implants, maxilla, graft**,**

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INTRODUCTION

As implant treatment continues to evolve, a successful implant therapy requires more than just technical proficiency; it demands a thorough understanding of the fundamental biological principles, patient assessment protocols, surgical procedures, and prosthetic planning. With increasing life expectancy, the generations 85+ years of age also present a new challenge to the dental profession. Their demands, needs, financial means and physical abilities are different. Their dental treatment will be distinctly different from treatment offered to other rage groups.

As a result of the aging process, bone deteriorates in composition, structure and function, which predisposes to osteoporosis. Osteoporosis is defined as deterioration in bone mass and micro-architecture, with increasing risk to fragility fractures. Bone is a dynamic organ that serves mechanical and homeostatic functions and it undergoes a continual self-regeneration process called remodeling. Remodeling and regenerative process are in harmony in normal bone However as the age advances the formation part declines due to various systemic factors. Dental implant placement in the posterior maxilla is often complicated by reduced bone height and thickness, mainly due to sinus Pneumatization and alveolar bone respiration due to tooth loss. Traditional augmentation techniques include the lateral window sinus lift technique .[1-8]

According to the World Health Organization (WHO), losing teeth is generally the endpoint of a lifelong history of oral disease, mainly advanced dental caries, and severe periodontal disease. Resorption of the alveolar bone in the maxilla occurs in a posterior/superior and lateral to-medial direction. Pneumatization of the sinuses added to alveolar bone resorption, may lead to a limited vertical and horizontal bone volume in the posterior region. Lack of adequate anterior alveolar bone resorption may reduce the possibility of utilizing conventional implants. Rehabilitation with Conventional implant treatment cannot be performed in the edentulous maxilla in some patients because of advanced bone resorption and/or the presence of extensive maxillary sinuses, leading to inadequate amounts of bone tissue for anchorage of the implants. For over three decades, bone grafting prior to, or simultaneously with, implant placement has become routine in oral rehabilitation. For most indications, autogenously bone continues to be the ‘gold standard’ for graft material. In addition to the risks and complications of the graft procedure itself, it also involves a donor site with associated surgical morbidity, additional operating time and extra costs.

The main indication for the use of zygomatic implants was considered extreme maxillary bone atrophy, resulting from many factors. Zygomatic implants are considered a graftless solution to rehabilitate atrophic maxillae using a fixed or removable implant-supported

prosthesis. The original zygomatic Bran mark protocol include done implant in each zygoma traversing the sinus combined with two to four anterior conventional implants. This rehabilitation technique using zygomatic implant has been employed in patients presenting with severe maxilla resorption, together with the use conventional-length dental implants, with reported survival rates ranging from 96–100%.[9,10,11,23,18]

Various techniques for augmentation to improve the anatomic situation in poor bone support cases have been proposed like, on lay type maxillary ridge augmentation, inlay type maxillary ridge augmentation and sinus lift procedures but all these caused patient discomfort, sensitivity and pain in the donor site . Also, the maxilla must remain load free for 6 months to allow the grafted bone to consolidate and the implants to osseointegration. The last two decades the zygoma implant has proven to be an effective option in the management of the atrophic edentulous maxilla. The Branemark system was introduced for the prosthetic rehabilitation of maxilla. The bone of the zygomatic arch was used for anchorage of a long implant, together with conventional implants, used as an anchor for prostheses. This technique has enabled sufficient rehabilitation of many thereby improving their quality of life . They have been successfully used to support prosthesis in cases of patients who have undergone maxillectomy or where conventional implants cannot be placed due to atrophic maxilla or in cases where sinus grafts cannot be done or is a failure. The overall success rate of zygomatic implants is 97% as reported by Branemark.

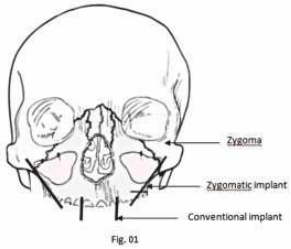


Fig. 01

What are zygomatic implants?

These are implants which are 30 – 50 mm long and 4 mm wide, usually inserted from the palatal side. They have a 45tilted platform and derive their anchorage in the zygoma. They extend into the zygomatic process for good primary stability. They lie below the mucosa of the lateral wall of the sinus

Indications

Zygomatic implants though are indicated and suggested by a lot of experienced surgeons and dentists.

1. When there is adequate bone anteriorly, and it is desired to provide implant stabilization posteriorly.

2. When the patient has anterior teeth but posteriorly has edentulous regions associated with extensive bone resorption.
3. In case of maxillectomy.
4. Patients with grafting procedures are inevitable

Contraindications

The absolute contraindications include the following: a restricted mouth opening not allowing for instrumentation; an inability of the patient to tolerate anesthesia; and the presence of maxillary and/or zygomatic pathologic features. The relative contraindications include the following: active maxillary sinus pathologic features .[5,11,12,13]

Radiographic examination.

Prior to implant placement, a thorough radiological analysis of the zygomatic bone, orbital, infratemporal fossa, nasal cavity, and maxillary sinus is imperative**.** Once the clinical examination is complete, radiographic examination allows for bone parameters and subsequent surgical planning. Accurate radiographic evaluation plays a key role in treatment planning for any implant placement. Literature review points at the emphasizing importance of three-dimensional imaging in implant dentistry. Conventional two-dimensional radiographic techniques often provide limited information regarding the spatial relationship between the maxillary sinus, zygomatic bone, and surrounding structures. In contrast, 3 dimensional like CBCT enables clinicians to visualize these structures in multiple planes.

Cone-beam computed tomography (CBCT) has become a widely utilized imaging modality in dental and maxillofacial practice for any implant placement. CBCT enables clinicians to visualize the anatomical relationship between the various anatomical structures like maxillary sinus, zygomatic bone, and surrounding structures, thereby assisting in determining implant length, angulations. With the help of 3d implant software it's more easy to plan the treatment strategy which has further emphasized the reliance on CBCT imaging for preoperative assessment. The diagnostic accuracy of CBCT measurements, the reliability of anatomical visualization, and the identification of potential errors or pitfalls that may influence surgical planning and clinical outcomes are few advantages of this modality. Accurate preoperative planning is essential due to the complex anatomical trajectory and proximity to critical structures such as the maxillary sinus and orbit. Cone-beam computed tomography (CBCT) has gained widespread use in implant dentistry because of its ability to provide three-dimensional visualization of craniofacial structures. However, concerns remains regarding the diagnostic accuracy and potential clinical limitations of CBCT imaging in planning zygomatic implant placement. Most investigations reported minimal discrepancies between CBCT-based measurements and intra operative findings, generally within clinically

acceptable ranges. Collectively, the available evidence indicates that CBCT remains a valuable imaging modality for digital treatment planning in zygomatic implant rehabilitation, although careful interpretation is essential to minimize potential diagnostic errors.

Hung et al. , Xiaojun et al, Chen et al. , Hung et al. , Zhu et al., and , Jorba-García et al. found computer-aided dynamic navigation to have greater accuracy than the free-hand conventional approach for the placement of conventional-length dental implants. Nevertheless, Brief et al. also found that, although computer-aided navigation techniques are significantly more accurate than free-hand conventional techniques, the level of accuracy provided by the free-hand conventional technique is sufficient for most clinical situations. However, Aydemir et al. reported that the conventional free-hand technique provides greater accuracy at the coronal entry-point and apical end-point levels than the computer-assisted dynamic navigation technique in the placement of ZIs. Computed tomography aids in evaluating the zygomatic implant site for bone parameters and the sinus status. As conventional method the implant is placed through inside the maxillary sinus and the head emerges in the alveolar Crest. According to Bedrossian et al. the maxilla can be divided into three zones: zone 1, the premaxilla; zone 2, the premolar area; and zone 3, the molar area. The clinician can determine the availability of bone in all three zone using Cone beam computed tomography. The use of three-dimensional imaging techniques, along with virtual surgical planning, enables a comprehensive analysis of anatomical structures. The following parameters are employed during the data acquisition process: 90 kV, 10 mA, and a duration of 36 s, with a Field of View (FOV) set at either 15 × 12 or 18 × 16 cm .or as specified by the clinician .The scan ranged from supraorbital edge to mandibular base was taken into consideration.[9,14to 22]

Davo, David and Malo et al. have focused that quad zygoma surgery is indicated for patients classified under Class V-VI. According to their research for quad zygoma surgery, the zygomatic bone width should be at least 1.8–2 mm, the distance between two implants should be a minimum of 5 mm, and anterior implants should be positioned at least 3 mm away from the infraorbital nerve. The zygomatic bone (ZB) is a quadrangular structure that can also be compared to a pyramid that articulates with other four bones: the maxillary, the frontal, the temporal and the sphenoidal. In dental implants, when there is no adequate bone volume permitting their anchorage, zygomatic implants are long screw-shaped implants developed as a partial or complete alternative to bone augmentation procedures for the severely atrophic maxilla. The potential main advantages of zygomatic implants could be that bone grafting may not be needed and a fixed prosthesis could be loaded sooner.[24 to 27]

It is crucial to evaluate the zygoma's structure and determine the suitable apex point for implant insertion. The success and durability of ZI the procedure hinge on the extent of bone-implant contact (BIC) within the zygoma, so that it remains in a safe place which will not disturb the normal structures. The zygoma's mesial aspect is close to the infratemporal fossa, home to vital neurovascular elements like the pterygoid plexus, maxillary artery and its offshoots, and the maxillary and mandibular nerve branches. Injury to these structures can result in severe complications, including deep hematomas, sensory and motor impairments, and potentially fatal outcomes. Moreover, orbital cavity penetration has been reported as a intra-operative complication with the incidence of 5.9%.

Classification of alveolar bone resorption level

Knife-edge ridge form of the residual ridge, insufficient in width and exceeding 5 mm in height, was classified as Class IV alveolar bone resorption. Conversely, a flat residual ridge, insufficient in width and less than 5 mm in height, was classified as Class V/ VI alveolar bone resorption. The level of alveolar bone resorption was assessed individually on each side, utilizing both two-dimensional and three-dimensional CBCT reconstructed images.[28]

Disadvantages;

1. Should never be considered as a first line of approach when treating the edentulous maxilla or one with missing molar teeth, but rather is of use in a very few number of cases.
2. Technique should be evaluated as it can lead to a variety of complications.
3. Speech problems are encountered with multiple zygoma implants.
4. Access to the surgical site.

Complications.

The Penetration into the nasal cavity or antral cavity by the implants.

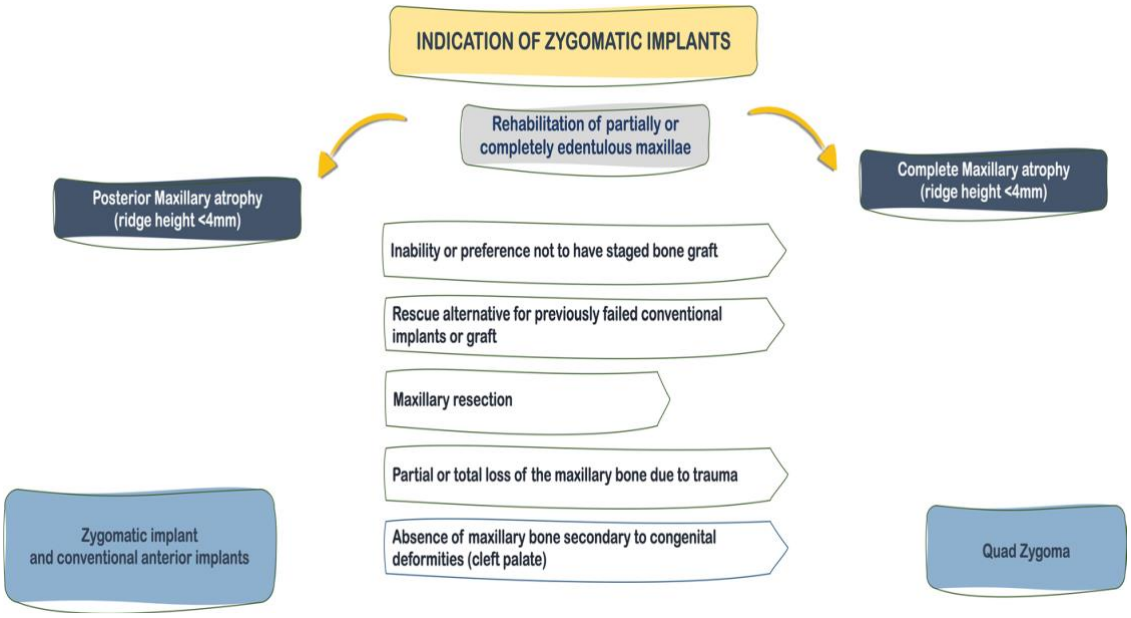
1. Persistent infection.
2. Overloading
3. Speech alteration.
4. Problems in maintaining hygiene.
5. Apical excess emergence in the infratemporal fossa, buccosinusal fistula secondary to defective surgical closure, and chronic gingivitis.
6. Severe sinus infection. (Due to sinus perforation.)
7. Intracerebral penetration of a zygomatic implant Inserted in the pterygoid region.[29]

One of the most critical complications that can occur after placing zygomatic implants is the accidental penetration of the patient's eye socket by a drill or implant. Zygomatic implants concur that the success criteria for traditional implants do not directly apply to zygomatic

implants. Thus, Aparicio et al. outlined four distinct criteria to be considered: offset of the definitive prostheses, rhino sinus condition, soft tissue infection, and stability. Evaluating these criteria allows a practitioner to categorize a patient into one of the following five conditions.

1. Success condition I: The optimal stage.
2. Success condition II: A deviation from the norm without clinical impact.
3. Success condition III: A borderline situation with clinically evident alterations, yet still treatable.
4. Condition IV: Reflects a surviving implant supporting the prosthesis but not evaluated by the proposed criteria.
5. Condition V: Represents implant failure.

Zygomatic implants should be performed under general anesthesia in a safe environment but the operator should be highly aware of the anatomy. Although virtual planning software and guided surgery splints might not be essential for the placement of zygomatic implants, many authors advocate for their use, as they can minimize risks and enhance precision.[30]



Reinforce that zygomatic implant placement is a reliable approach in challenging anatomical situations, including after maxillectomy. Another investigation by Mathevosyan *et al.* of patients with maxillary oncology defects reported that prostheses fixed to zygomatic implants were effective in restoring oral function and aesthetics. A study by Ugurlu *et al.* On zygomatic-implant-supported mid-facial prostheses reported the same success for the zygomatic implant. Zygomatic implant-supported prostheses provide a highly effective rehabilitation option for post-maxillectomy patients, offering significant improvements in both functional and esthetic outcomes. Biomechanical Analysis of Zygomatic Implants, done by Alberto suggests that improvement would ensure patient safety by providing a

comprehensive and accurate as-assessment of the performance of zygomatic implants, ultimately minimizing the potential risks associated with their clinical use.

Zygomatic implant therapy remains a robust solution for the edentulous diabetic patient with significant bone loss, demonstrating favorable longitudinal survival. In the field of dental implants, DM(diabetes mellitus) is a well-known risk factor, mainly because it disrupts the body's ability to heal, produce collagen, and maintain a healthy immune system. The excellent primary stability achieved in the dense zygomatic bone and the possibility of avoiding grafted bone (which may heal poorly in diabetics) could theoretically offset some risks associated with diabetes. Diabetes remains a significant complicating factor, noticeably increasing the likelihood of implant failure, sinusitis, and peri-implantitis when compared to the general population. Ultimately, while diabetes introduces a layer of complexity, zygomatic implants remain a predictable and invaluable tool.

Zygomatic implants may serve as a valuable option in cases of severe maxillary atrophy where grafting is not feasible, as they enable functional rehabilitation. These implants offer the surgeon an alternative when planning implant-supported prosthetic and rehabilitation treatment, especially in patients with severely atrophied upper jaws, where bone grafting is impossible or has previously failed. And also, a reliable and predictable option for immediate loading prosthesis, which is relevant for the comfort, confidence and aesthetics of the patient.[31 TO 42]

Successful outcomes rely on prosthodontic-driven treatment planning, careful prosthesis design, appropriate material selection, and meticulous occlusal management. Immediate loading protocols are feasible when provisional prostheses provide rigidity and proper occlusal control.

Post-maxillectomy patients often face significant challenges related to chewing, speech, facial symmetry, and overall quality of life due to the loss of facial structures. Therefore, understanding the functional and esthetic outcomes of zygomatic implant-supported prostheses in post-maxillectomy patients, providing evidence of their effectiveness in improving chewing, speech, and facial symmetry while demonstrating high implant survival and patient satisfaction. The placement of zygomatic implants (ZI) has been described in various literatures, cases of tumour resection in the posterior maxillary regions, but few studies describe unilateral fixed prosthetic rehabilitations. Unilateral rehabilitation raises questions regarding immediate loading and the biomechanical distribution of masticator forces.

A Study done by Sockalingum highlights the potential of ZI as a viable alternative in the unilateral prosthetic rehabilitation of adults who have undergone extensive maxillary surgery.

Literature from the past decade confirms zygomatic implants as a durable and efficient solution for full-arch rehabilitation of the atrophic maxilla. As quoted in a review by Aswani L et al., high survival rates highlight the biomechanical advantage of cortical anchorage in the zygomatic bone. CBCT-based planning enhances anatomical assessment, particularly sinus morphology and zygomatic bone volume Guided surgery improves placement precision, minimizing risks to orbital and sinus structures.

As reviews by the authors, Gupta et al, evidence supports zygomatic implants as a reliable and effective treatment option with high long-term survival rates for the rehabilitation of the severely resorbed maxilla. Their ability to provide stable anchorage without extensive bone grafting reduces treatment time, surgical morbidity, and overall cost while enabling immediate loading in selected cases.[43 TO 56]

Zygomatic implants have profoundly transformed the management of severe jaw atrophy. Chrcanovic et al. highlighted a 12-year cumulative survival rate of 95.21% based on 4556 zygomatic implants with most failures occurring during the early postoperative period. The immediate loading turned out to be the primary advantage of this graft-free approach, enabling the patient's oral function and aesthetic therapy following surgery, compared with conventional implant therapy. Despite the consistently high survival rates reported, operative, biomechanical, and prosthodontic complications require careful consideration. The final indication for the use of zygomatic implants must consider the type of restoration planned the anatomy of the residual ridge and the zygomatico maxillary region, the patient's overall health and preferences, as well as the experience of the surgical and restorative teams. [43 to 56]

In a narrative review written by Kulkarny., et al suggest a multidisciplinary approach, leveraging advanced digital planning and verified occlusal concepts, is essential to minimize technical complications and ensure long-term quality of life. L Gupta et al., in their narrative suggest the significance of zygomatic implants. This review also quoted other authors findings as: systematic reviews, by Polido et al. (2023), have attempted to consolidate and clarify the clinical indications for zygomatic implants. This review also mentions the importance of Cone-beam computed tomography (CBCT) is indispensable for assessing bone availability, sinus anatomy, and implant trajectory. Digital planning software allows virtual implant placement, angulations control, and selection of appropriate implant length. [57,58]

In a study done by Venkatachalam et al. narrates that zygomatic implants, as a graft less and promising solution to the rehabilitation of atrophied maxillary arches, have excellent surgical outcomes with varied advantages. They also emphasized on the significance of cbct. The authors concluded by saying that Zygomatic implants could be advocated as the most successful and reliable fixed rehabilitation option in terms of its minimally invasive and

painless protocols, along with the shorter duration of the treatment course culminating in desirable aesthetics to the patients of all age group.

In a letter written by Mohammadreza Talebiardakani. emphasizes on the zygomatic implant and its treatment strategy. However, severe maxillary atrophic ridges caused by periodontitis, trauma malignancies, and developmental problems can notably alter the treatment course. Presurgical prosthetic planning, 3D imaging analysis, application of surgical guides, and navigation systems can considerably impact surgical outcomes. Grecchi., et al in their case study describes about the need for a alternative implant supporting system. They also quotes about the current strategy in placing implants. The use of zygomatic implants reduced the time of treatment and the number of surgical operations. The need of bone grafting may be replaced and bypassed by the use of remaining existing anchorage bone sites in the maxillary tuberosities, pterygoid plates or zygomatic bone. "Extreme bone atrophy" is the quote given by the author when describing about the indication for zygomatic implant system. Maxillary edentulism is a growing condition worldwide. According to the World Health Organization (WHO). Zygomatic implants are considered a graftless solution to rehabilitate atrophic maxillae using a fixed or removable Implant-supported prosthesis. In severe atrophy, avoidance of extensive staged bone grafting and immediate loading are potential benefits of zygomatic implants, but not indications. There is a recent growth in the utilization of zygomatic implants as a chosen alternative in comparison to simultaneous or staged grafting options, due to the possibility of a faster treatment time and immediate loading. An adequate prosthetic plan and a detailed 3Dimaging analysis are mandatory to assess all surgical alternatives and their associated risks and suggest an adequate treatment plan. Zygomatic implants have, in many cases; shown improved clinical results compared with bone grafting and represent a possible new gold-standard procedure in compromised maxillary bone. Grafting to treat severely resorbed maxillae is currently the gold standard procedure, but failure rates of 10–30% have been reported in the literature. Zygomatic implant placement is a less invasive technique when compared to bone grafting. The grafting procedures increase the number of surgical procedures, overall cost, and treatment duration, causing severe discomfort for the patients. Zygomatic implants have been indicated for severely atrophic maxilla and have shown promising outcomes.[59to 64]

CONCLUSION

Zygomatic implants are designed to restore the upper jaw by anchoring directly into the maxillary bone avoiding the use of conventional graft material. An advanced approach to rehabilitate the severely atrophic maxilla using extra-maxillary anchored implants. They provide notable benefits in terms of both functionality and appearance, with a high success

rate, shorter operation times, and immediate loading capabilities. Overall, zygomatic implants are a cost effective, reliable option for restoring the edentulous maxilla, improving patient outcomes and quality of life.

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