

REVIEW ARTICLE

An Introduction to the Longest Fixtures: Zygomatic Implants

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ABSTRACT

Zygomatic implants have been used for dental reconstruction in patients with insufficient bone in the maxillary posterior region due to tumor resection, trauma, or atrophy. They are an alternative to bone grafting and distraction osteogenesis. Brånemark introduced these zygoma implants not only as a solution to obtain posterior maxillary anchorage but also to facilitate the rehabilitation process. The zygoma implant is a therapeutic option that deserves consideration in the treatment planning process and has become a rescue procedure that allows for continuity of care without resorting to a removable denture. The purpose of this study is to review the developments that have taken place in zygomatic implant placement over years, including anatomic information for installing the zygomatic implants, implant placement techniques, stabilization, and prosthodontic procedures.

Keywords: Bone grafting, Resorbed maxilla, Sinus lift, Zygomatic implants.

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INTRODUCTION

Dental implants are one of the most predictable options for tooth replacement. The primary predictor for implant to success depends on the quality and quantity of the available bone.¹ The conventional implant treatment cannot be performed in the edentulous maxilla because of the extensive bone resorption and the presence of maxillary sinuses close to the crest of the ridge, leading to inadequate amounts of bone for anchorage of the implants. Such cases often require some type of bone augmentation procedures in order to increase the volume of available bone. The pneumatization of the sinus or bone resorption can be one of the reasons for insufficient bone volume.

Hence, the insertion of implants in this region remains extremely unpredictable. To ensure acceptable success rates, the minimal bone height required for the placement of a conventional implant in the posterior region should be at least 10 mm.² The contact surface between the implant and the bone is advanced with the use of wider diameter implants. These implants limit the biomechanical complications in the treatment of posterior maxilla. Many patients present maxillary ridges with bone heights of 0.8 to 6 mm.³ Such cases require bone augmentation procedures, such as onlay/inlay bone grafting.⁴

INDICATIONS

In certain situations where the placement of conventional implants is not possible without advanced surgical procedures, zygomatic implants can be used as a preferable treatment option for completely and partially edentulous maxillae presenting as insufficient bone volume.⁵ Placement of conventional implants in the anterior region and zygomatic fixtures in the posterior region offers much better anchorage for a fixed bridge when compared with an implant placed with bone augmentation procedures. Zygomatic fixtures are also indicated when the harvesting of the iliac crest bone graft is contraindicated.

IMPLANT DESIGN

The original zygomatic implant is a self-tapping titanium implant with a machined surface and is available in various lengths from 30 to 52.5 mm. The apical part has a threaded design with diameter of 4 mm and the crestal part has a diameter of 4.5 mm. The implant head is angulated at 45° and consists of an inner thread for the connection of Brånemark system abutments. The commercially available zygomatic implants have a roughened oxidized surface (Fig. 1).

ZYGOMATIC ARCH: AS AN ANCHORAGE

The zygomatic bone can be compared with a pyramid, offering an interesting anatomy for the insertion of implants.⁶ Histologic analysis⁷ of the zygoma shows regular trabeculae and compact bone with an osseous density of 98%. Due to this high bone density, the zygomatic bone has also been used in the treatment for maxillofacial

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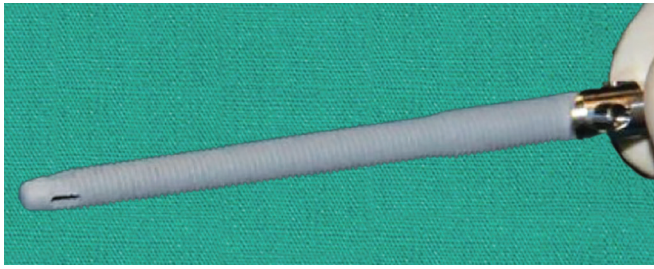


Fig. 1: Zygomatic implant

fractures, for the insertion of miniplates,⁸ and during orthodontic treatment, offering a fixed anchorage⁹ to allow dental arch retractions. In maxillofacial prosthesis, the zygoma bone is also utilized for the placement of extraoral implants retaining a facial prosthesis. After maxillectomy, zygomatic implants can be connected with standard ones¹⁰ to anchor a screwable prosthesis. In a recent study on cadavers, it was established that the average length of the zygoma was 14.1 mm, allowing the insertion of zygomatic implants (Figs 2A and B).

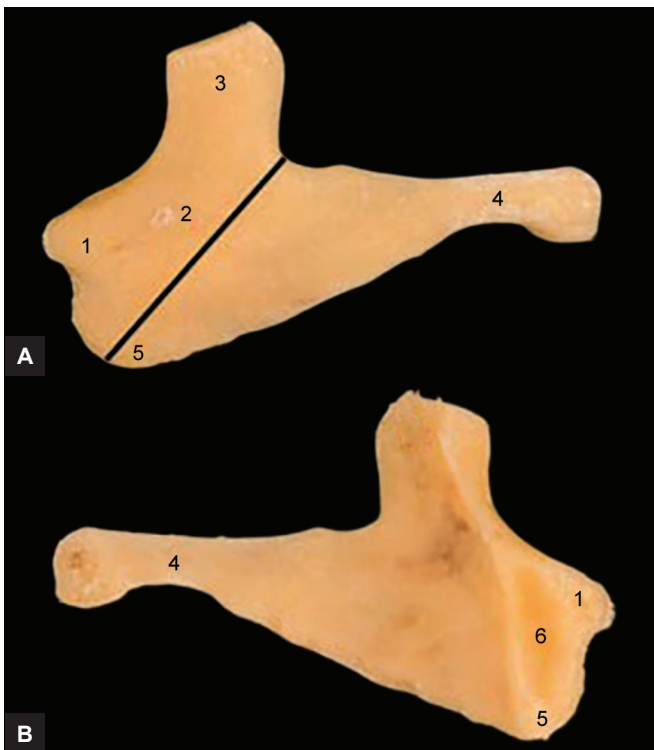
PRESURGICAL EVALUATION

Computed tomography (CT) is required for the evaluation of the zygomatic implant site. The available bone in the zygomatic arch and in the residual alveolar crest has to be surveyed. Clinical examination is not enough

for this evaluation and radiologic assessment has to be considered. The oral pantomogram can give distorted information, and therefore, the examination of choice is the spiral CT, which makes two- and three-dimensional (3D) imaging possible. The CT scan also gives the opportunity to evaluate the health of the maxilla and the sinus. Sinusitis, polyps, or any other sinus pathology can be eliminated. The density, length, and volume of the zygomatic bone can be evaluated and special templates for inserting the zygomatic implants can be fabricated on stereolithographic models to facilitate the orientation of the zygomatic implants¹¹ during the surgery, with minimum errors in angulation and position. The angulation, expected emergence site, and the relation of the implant body to the maxillary sinus and lateral wall should be evaluated (Fig. 3).

SURGICAL PROCEDURE

The zygomatic fixture placement procedure should involve atraumatic surgery, avoiding overheating in the zygoma bone as well as in the maxilla under sterile environment. Although the procedure can be carried out under local anesthesia, but for the patient's comfort, it has been done under total anesthesia or neuroleptic deconnection. A palatal 45° incision is given along the entire maxillary crestal region, the soft tissue is completely reflected from maxillary crest to zygomatic buttress, and the suborbital nerve is identified. A window is then created by drilling at the upper limit between the zygomatic bone and the sinus to determine the orientation of the zygoma and to reflect the Schneiderian membrane.



Figs 2A and B: Zygomatic complex: (A) Facial surface (black line: Plane of the intended direction of the implant placement); and (B) medial surface: (1: Infraorbital rim; 2: Foramen of the nervus zygomaticofacialis; 3: Processus zygomaticofrontalis; 4: Zygomatic arch; 5: Crista zygomaticoalveolaris; 6: Maxillary sinus)

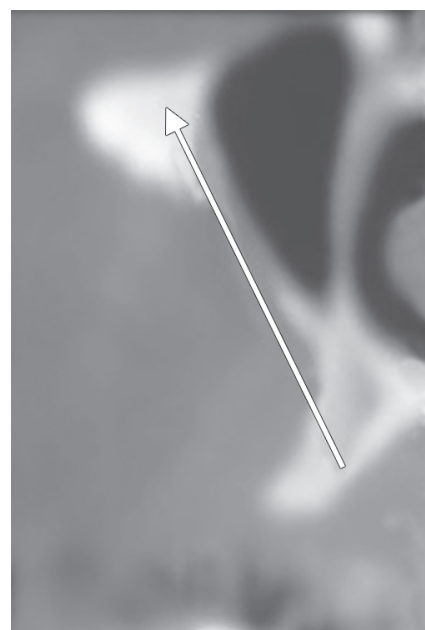


Fig. 3: Tomographic section showing preoperative planning of an extrasinus zygomatic implant

This window will also be helpful for cooling the drills to avoid overheating¹² during the surgical procedure. Different drills are then used with increasing diameters, ending with the insertion at low speed of the self-tapping zygomatic fixture. The length of this is carefully chosen by using a special gauge. After insertion of the implant, a cover screw is placed on the top of it and the soft tissues are sutured. There are no evidence-based arguments that advocate the use of a membrane to cover the window made in the sinus. The other conventional implants, if required, are placed during the same surgical procedure. The abutments are screwed on the implants and an immediate provisional prosthesis is provided at the time of second-stage surgery.

PROSTHETIC PROCEDURE

The prosthetic procedure of zygomatic fixtures follows conventional protocols for cemented or screw-retained implant-supported dental prosthesis. As the emergence of the zygomatic implant is often 10 to 15 mm medial to the ridge, the prosthesis should be designed to enable proper oral hygiene in the area. The prosthesis is made of gold and acrylic or gold and porcelain, like standard screwed reconstruction on conventional implants. Although screwed bridges allow a better adjustment of the occlusion, overdentures retained by bars are also considered sometimes because of cantilever due to the palatal emergence of the zygomatic implants and to the distance between the two maxillae or simply the resorption of the maxilla. Considering the biomechanical aspects of the prosthetic procedures on zygomatic implants, it is well known that when masticatory load is administered to a rigid semicircular arch connecting four anterior implants and two zgomatics, the masticatory load in the posterior region is dissipated to the bony support situated in the zygoma.

SOFT TISSUE COMPLICATIONS

Zygomatic implant has complex prosthesis system from the biologic point of view because of the interfaces between different tissues, such as sinus mucosa, oral mucosa, and bone. The passage of the fixture itself through the sinus cavity does not seem to provoke any soft tissue reactions, as evaluated by sinuscopy of 14 patients. A few clinical follow-up studies on zygomatic implants stated soft tissue complications intraorally or in the maxillary sinus like Becktor et al¹³ had to remove three of 31 implants because of recurrent sinusitis, in spite of the implants being stable clinically. They proposed that explanations for their problems were either the internal threaded abutment screw channel of the zygomatic im-

plant that generated a communication from the oral cavity into the maxillary sinus, which may have led to sinusitis, or a lack of osseointegration at the marginal level in the palatal area, which resulted in transverse movability of the zygomatic implant and a pump effect during function. Another study reported that 9 out of 20 zygomatic implants were associated with periimplant bleeding and increased probing depths, possibly caused by difficulties in implementing appropriate hygiene because of the positioning of the zygomatic implant head and abutment, and the design of the prosthesis.¹⁴

RECENT DEVELOPMENTS OF THE ZYGOMATIC FIXTURE

Placement in Local Anesthesia

This procedure is recommended. If the operator is experienced, it takes less than 1.5 hours. The local anesthetic procedure¹⁵ comprises normal infiltration anesthesia in the buccal sulcus region from the central incisor to the third molar using lidocaine with epinephrine (about 3.6 mL), posterior superior alveolar nerve block about 1 cm palatal to the bone crest, intraorally approaching infraorbital nerve block using lidocaine with epinephrine or felypressin with 1.8 mL of prilocaine, blocking of the sphenopalatine ganglion along the greater palatine foramen using lidocaine with epinephrine or felypressin with 1.8 mL of prilocaine, and infiltration anesthesia around the zygomatic area through the skin extraorally using about 3.6 mL of lidocaine with epinephrine.

Extrasinus Placement

One drawback with the zygomatic implant technique is the palatal emergence of the implant head, which is often the cause to maintain the implant body within the boundaries of the maxillary sinus. This commonly results in a bulky dental prosthesis at the palatal aspect, which sometimes leads to discomfort and problems with oral hygiene. Therefore, an extrasinus approach to placement of zygomatic implants¹⁶ has been developed to obtain the implant head emergence at or near the top of the residual alveolar crest, usually in the second premolar or first molar regions (Fig. 4). The implant body preferably engages the lateral bone wall of the maxillary sinus while penetrating the zygomatic bone. The implant site is prepared without making an opening to the maxillary sinus and otherwise follows the standard drilling steps for zygomatic implants with this extrasinus approach; no opening of the sinus wall is made.¹⁷ Because, the implant path is along or lateral to the sinus wall, the engagement of the zygomatic bone can be viewed. One concern with the extrasinus technique may be the long-term effect of

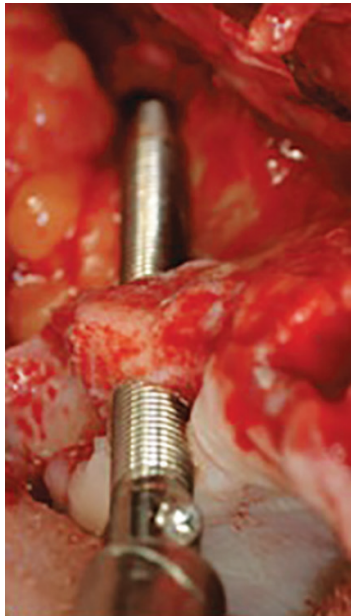


Fig. 4: Clinical photograph showing a zygomatic implant passing through an extreme buccal concavity from the alveolar crest (bottom) to the zygoma (top)

exposed threads close to the soft tissue at the lateral aspect of the zygomatic implants.

Computer-guided Implant Placement

This is an innovative technique and involves a new clinical approach to provide the direction to guide drilling.¹⁸ This would enable the surgeon to form a starting point for the access of the zygoma position into the alveolar bone. This facilitates the coronal aspect of the zygoma implant in the best prosthetic position, which is a great advantage for laboratory fabrication of the final prosthesis. It also gives the surgeon an opportunity to study and evaluate the 3D anatomy of the patient prior to the surgery.

CONCLUSION

The zygomatic implant has revolutionized the treatment procedure of placement of implants in posterior atrophic maxilla, by eliminating the complicated procedures of bone augmentations complementary to sinus lift. Sinus lift itself is an extensive procedure invading the integrity of the maxillary sinus, thus encompassing surgical complications leading to delayed healing. The delayed healing leads to patient compliance.

The zygomatic implants have become more successful due to primary stability achieved from the compact zygoma and the ease of placement due to recent advances in computer-aided design/computer-aided manufacturing and cone beam computed tomography in fabrication of surgical stents. Still further research is

required in the field of zygomatic implants to make it a more viable option for the treatment of posterior atrophied maxilla.

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