Zygomatic Implants: A Rescue Treatment Modality for Severely Resorbed Maxilla

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Abstract: Severely resorbed maxilla poses a complex problem to place a conventional implant which makes prosthetic rehabilitation of edentulous maxilla difficult. Several factors such as maxillary sinus pneumatization, reduced bone quality and quantity diminish the amount of bone for implant placement. Augmenting a severely resorbed maxilla with various bone graft materials is associated with few limitations such as increase in treatment cost, necessity of second surgical site and prolonged healing time. To overcome such situations Zygomatic Implants were introduce for prosthetic rehabilitation of severely resorbed maxilla. The purpose of this Review article is to provide detail information regarding zygomatic implant design, surgical and prosthetic procedure, zygomatic implant success code and outcome of treatment.

Keywords: Zygomatic, Implant, Maxilla, success code, Zygomatic Anatomy Guided Approach, Zones of Maxilla

INTRODUCTION

A common clinical situation which encountered after tooth loss is edentulism and subsequent bone resorption, which is associated with various etiological factors such as dental caries, poor oral hygiene and advanced periodontal diseases. Edentulism is such a clinical scenario which can negatively affect the patient's outlook towards the life. Regardless of the severity of disease, injury, or atrophy present within the oral environment, the treatment molality should aim to restore the patient's mouth to normal esthetics, function and health. For this purpose Dental implants are considered as best treatment modality to replace missing teeth over other treatment modalities. Hence, the placement of conventional dental implants in severely resorbed ridges especially in maxillary arch with poor bone quality are associated with few restrictions [1].

Various surgical procedures have been described to overcome the limitations associated with the deficient bone volume such as onlay bone block grafts, Le forte osteotomy with interpositional bone graft and sinus augmentation with substitute bone graft materials [2].However these techniques are associated with few shortcomings, such as more than one surgeries are required in case of autogenous block grafting, donor site morbidity, prolonged healing time during which patient has to remain without rehabilitation. These factors intricate the patients acceptance for such treatment modalities [3].

The rehabilitation of many challenging patient situations is now a reality due to recent advances in dental implant techniques. In order to conquer such limitations, implants are designed to place in specific anatomical areas like the pterygoid region, the tuber or the zygoma is now introduced. These procedures require substantial surgical skills and are associated with its own advantages, dis-advantages, surgical risks and complications.

The placement of implants in the zygomatic bone is considered as graftless option for the rehabilitation of severely atrophic maxillae.

REGIONAL ANATOMY

Placing an Implant in an anatomical area require strong bony foundation. Apart from pterygoid bony plate, Zygomatic bone also provides a strong base for implant placement as this bone is pyramidal in shape and strong enough to provide bony anchor for implant. The conventional dental implants derive its initial stability through mechanical retention between the implant surface and the bone tissue. This is also considered as an important factor while placing zygomatic implants. The concept of placing implant in zygomatic bone was proposed by Aparicio *et al* in 1993 [4].

Nkenke et al conducted a study to evaluate the quantity and the quality of zygomatic bone and they arrived at a judgment that the zygomatic implants achieve anchorage and stability by engagement the four cortices (the palatal cortex of the maxillary alveolus, the cortical floor of the maxillary sinus at the crestal portion of the implant and the zygomatic bone cortices at the apex) [5].

In 2001 Uchida *et al.* evaluated the maxilla and zygoma in 12 cadavers and lead to observation that the 3.75 mm- diameter implant requires at least 5.75 mm in thick zygomatic bone. Regarding implant placement, they stated that there is a chance of perforating the infra-temporal fossa if an angulation of implant is equal to 43.8° or less; if the more vertical angulation that is 50.6° or greater is used, this will increases the risk of perforating the orbital floor [6].

INDICATIONS OF ZYGOMATIC IMPLANTS
- Patients with severe maxillary atrophy and complete edentulism [7].
- Lack of Posterior maxillary bone support due to significant sinus pneumatization [7].
- Severely resorbed maxillary posterior alveolar ridge [7].
- Maxillary arch rehabilitation after partial or total maxillectomy [8].
- To fix maxillary obturators as an alternative [8].

CONTRAINDICATIONS OF ZYGOMATIC IMPLANTS
A. Absolute Contraindications
- Acute sinusitis [9].

- Maxillary or zygoma pathology.
- Patients contraindicated to implant surgery because of underlying uncontrolled systemic diseases and malignant conditions [9].

B. Relative contraindications
- Chronic sinusitis
- Patients on bisphosphonates therapy
- Smokers (more than 20 cigarettes a day)

PRESURGICAL EVALUATION
After thorough clinical examination, radiographic examination should be carried out which allows for further appropriate treatment planning of the zygomatic implant. The zygomatic implant site and the sinus status, the implant path can be determined by using Computed tomography. The bone volume in the zygomatic arch and in the residual maxillary alveolar crest has to be explored. The implant angulation, probable emergence site and the relationship of the implant body to the maxillary sinus and the lateral wall of the maxilla are also considered.

Bedrossian *et al.* divided the maxilla into three zones Fig.1:
- Zone 1: the premaxilla
- Zone 2: the premolar area
- Zone 3: the molar area

Thus, it is easy to determine the availability of bone in all zones for clinician [10].
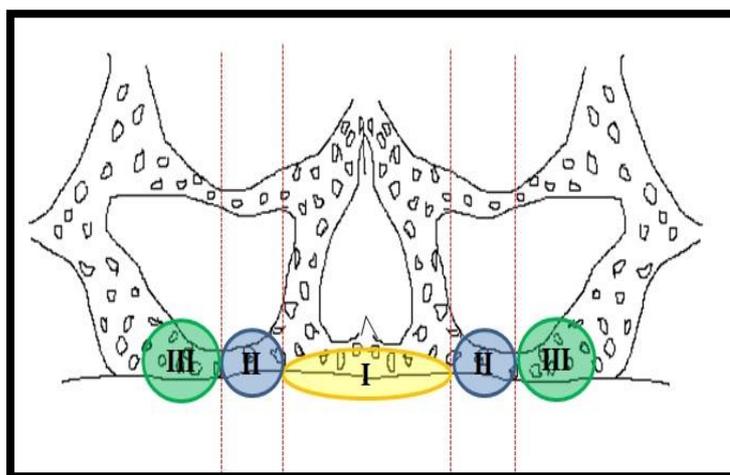

Fig−1 : Zones of the maxilla; dictates the availability of bone.

The availability of bone in these three zones as well as in zygomatic zone or any pathology in these areas can be determined by using cone beam computed tomography.

The guidelines for zygomatic implants placement [Table No2]
- Sufficient bone volume in Zone 1, 2 and 3. Typically four to six conventional axial implants are distributed in all over maxillary arch.

- Sufficient bone volume in Zone 1 with bilateral lack of bone volume in zone 2 and 3. Two to Four axial implant in zone 1 and one zygomatic implant one each zone 2/3 side can be placed.
- Enough bone volume in zone 1 and significantly less bone volume in zones 2 and 3 on only one side. One single zygomatic implant is placed in premolar/molar region and conventional implants are placed on the anterior maxilla and on the opposite arch of the zygomatic implant.

- Deficient bone volume in zone 1 with ample residual bone in zones 2 and 3. The zygomatic implant in zone 1 along with posterior conventional implants will solve the problem.
- Deficient bone volume in zone 1, 2 and 3 of the maxilla. Two zygomatic implants on either can be used.
- Lack of bone in all three zones in a partially edentulous patient. Partial prosthesis can be supported by placing three implants [11].

Table-2: Treatment recommendations based on the presence of bone in the different zones of the maxilla

Presence of bone	Surgical approach
Zones I, II and III	Conventional implants
Zones I and II	Four tilted implants
Zone I only	Zygomatic implants plus two or four traditional implants
Insufficient bone	Four zygomatic implants

Zygomatic Implant Design

A Branemark designed zygoma fixture which was inserted into zygomatic bone from palatal aspect of resorbed maxilla through maxillary sinus. It had features of conventional implants along with increased length and diameter. It is available in lengths ranging from 30 mm to 52.5 mm long which is self-tapping titanium implants [12].

The crestal part had a diameter of 4.5 mm and apical part had a diameter of 4 mm. At its crestal portion (implant head) implant was provided with the internal treads to which standard abutment can be attached/which provide junction for the standard abutment. A slight modification was done in which implant head was angulated to 45° [12].

At present, fixture surface had developed gradually to moderately rough oxidized surface and implant drive screw was included in implant which offers an inner thread for the connection of special 'zygomatic' multi- unit abutments.

Since decade, various companies offers the zygomatic implants with an oxidized rough surface at apex and crest along with a smooth mid-implant body, a wider diameter at the alveolar crest with a 55° angulated implant head.

Surgical Technique
Anesthesia

Previously, surgery was carried out under general anesthesia. Nowadays, local anesthetic solution with injections of lidocaine with epinephrine can be used to block the superior alveolar nerves (posterior, middle and anterior), the palatal nerves (posterior and naso-palatal), infra-orbital nerve, spheno–palatine ganglion through the greater palatine foramen and infiltration anesthesia around the zygoma area through the skin [13].

The original technique

Initially, a vestibular Lefort II type incision was used. Nowadays, mid-crestal incision and vertical releasing incisions along the posterior part of the infra-zygomatic crest which is anterior to the surgical site is placed to expose the underlying area. An attempt should be made to identify the vertical ridge/ anterior border of the zygomatic arch.

A care must be taken to avoid injury to lateral orbital border which is a second important landmark. Succeeding by which a mucoperiosteal flap is raised to expose the alveolar crest, the lateral wall of the maxillary sinus and the central/posterior part of the zygomatic complex.

A retractor is used for adequate visibility and to prevent the soft tissues laceration. To obtain proper drilling direction and starting point an indicator is used. 10 mm wide bone window is then prepared at the lateral aspect of the maxillary sinus. The sinus membrane is then elevated in the sinus cavity.

A sequential drilling should be carried out to prepare osteotomy sites at the alveolar process and the zygomatic bone b using series of drills. The depth gauge is used to detect the length of zygomatic implant. With the help of a motor or by manually the self-tapping zygomatic implant is placed, using an implant mount.

A cover screw is placed on the implant and the mucoperiosteal flap is closed. Abutment will be connected usually after a healing period of 6 months, using standard or multiunit Branemark abutments [9].

Modifications of the original protocol: the zygomatic anatomy-guided approach

In order to place the implant in more anatomical and prosthetically driven position, the

original position has been modified. These modifications in the original technique allow extra-sinus placement of zygomatic implants. Depending on the morphology of the lateral sinus wall, the residual alveolar crest and the zygomatic buttress Aparicio C *et al.* gave the concept called the zygomatic anatomy-guided approach (ZAGA) [14,15].

Five subsequent implant pathways has been identified namely, ZAGA 0–IV.
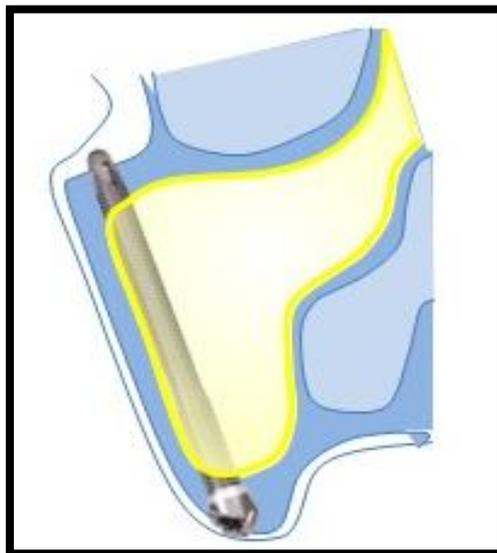
A zygomatic anatomy-guided approach (ZAGA) path type-0

Fig−2 :   The anterior maxillary wall is very flat. The implant body follows the intra-sinusal path to reach zygomatic bone.

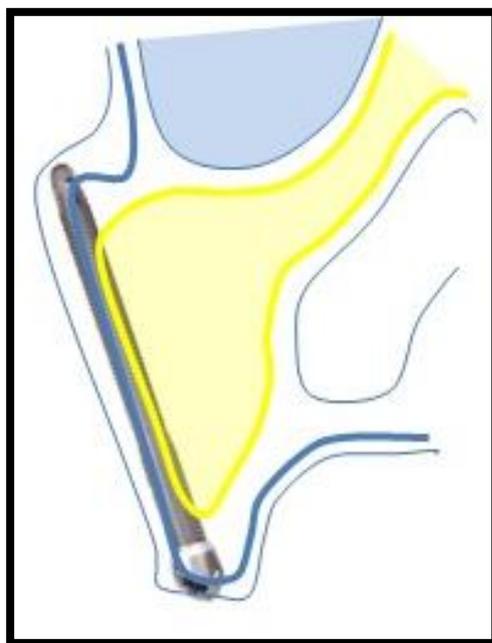**A zygomatic anatomy-guided approach (ZAGA) path type-1**

Fig−3 :   If slightly concave anterior maxillary wall is present, implant body perforate the maxillary wall most of the part remains inside the sinus wall

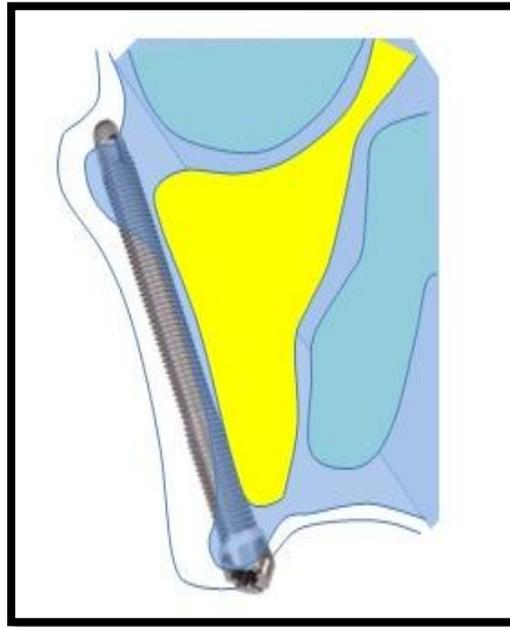**A zygomatic anatomy-guided approach (ZAGA) path type-2**

Fig−4 : If a more concave maxillary wall is present, implant body is placed extra-sinusally in close contact with lateral aspect of the anterior maxillary bone

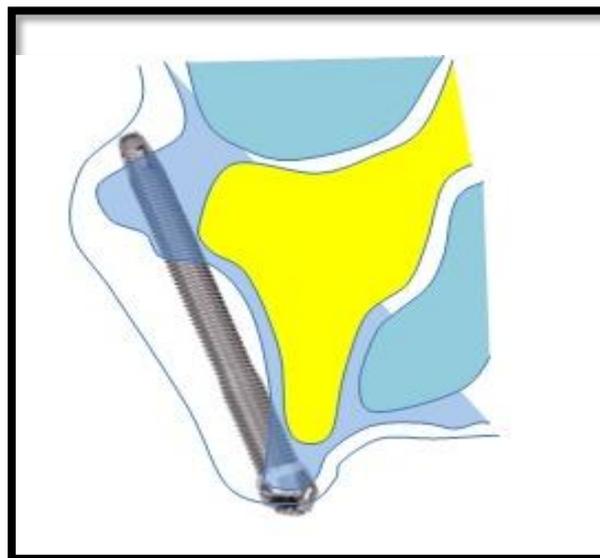**A zygomatic anatomy-guided approach (ZAGA) path type-3**

Fig−5 : If very concave maxillary bone is present, middle part of implant body does not touch the bone

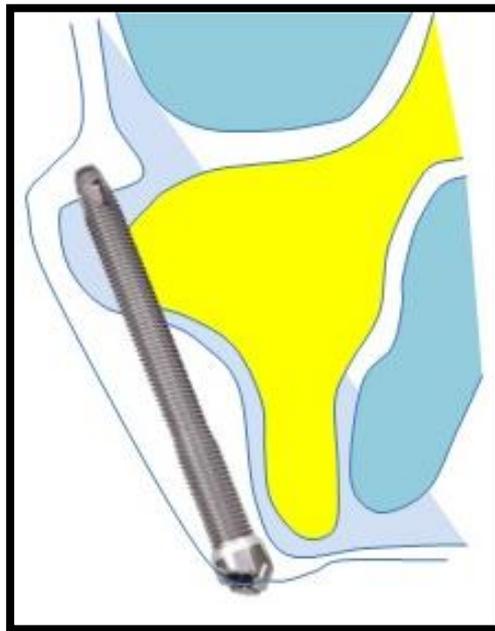**A zygomatic anatomy-guided approach (ZAGA) path type-4**

Fig−6 : **If severely atrophied maxilla with both vertical and horizontal bone loss is present, extra-maxillary path has to be chosen**

Advantages of zygomatic implants
- Use of bone grafts to reconstruct the atrophic maxilla can be avoided.
- No second donor surgical site or morbidity
- Zygomatic implants placed with the conventional implants can be loaded immediately or after a 6-month of healing period.
- Zygomatic bone provides good anchorage and stability to prosthesis
- Reduces the number of patient visits.
- Treatment is more economic as fewer implants are required to support a prosthesis compared with bone grafting and implant placement.
- The overall laboratory fees are equal to or slightly less than those for conventional implants [16].

Disadvantages of zygomatic implants
- Difficulty to place implant in severely resorbed maxilla as it increases the palatal emergence of implant head.
- Patient may experiences difficulties while phonetic, speech and deglutition due to increase bulk on palatal aspect of the final prosthesis.
- The anatomy of zygoma may limit the placement of the implant.
- The thorough anatomical knowledge of Zygomatico-facial complex and surgical skills are required to place the zygomatic implant [17].

Prosthetic procedure
The zygomatic implant tends to bend under horizontal a load which is related to two factors: the increased implant length that is raging from 30 to 52.5

mm and is deficient or no bone support in the maxillary alveolar crest. To overcome these scenarios zygomatic implants should be connected to conventional implants in anterior premaxillary zone [18].

A conventional protocol has been followed for prosthetic procedure. A two-stage procedure was recommended for the zygoma technique, however, over time, the original protocol has been replaced with immediate loading.

The provisional prosthesis is important in the patients treated with the zygomatic implants in order to provide acceptable esthetics, masticatory and speech during the healing period. Provisionalisation is also helpful in determining the occlusal and esthetic position of the teeth and soft-tissue substitutes in final prosthesis. Screw retained provisional and final prosthesis is considered as best option as in case of any complications it is easy to remove [19].

Reported zygomatic implant outcomes
The Branemark et al gave the concept of zygomatic implant.
In his study, he reported no implant had lost out of 65 zygomatic implants placed in 27 patients over the 1– 12 years of follow up [20].

Aparicio C et al conducted a review of 32 studies on clinical outcomes with a zygomatic implant which included 1031 patients and 2131 zygomatic implants with a follow-up period of 6 months to 12 years. Study concluded that the zygomatic implants had showed over all 98.1% of survival rate [13].

Zygomatic success code

Zygomatic Success Code is the criteria used to score the success of zygomatic implants anchored rehabilitation. Following variables are considered while evaluating the Zygomatic Success Code of a specific implant [Table No.1] [9]

- Zygomatic implant stability (individually tested)
- Associated sinus pathology
- Peri-implant soft-tissue condition
- Specific criteria for zygomatic prosthesis success (prostheses bucco lingual offset).

Individual Zygomatic implants can be scored by a four digits code; each number in four digit code represents one specific variable. The overall code will determine the Zygomatic implant success [Table No.1] [9].

Table−1 : Zygomatic Success Code [Aparicio *et al*.]

Criteria	Condition I Success grade I	Condition II Success Grade II	Condition III Success Grade III	Condition IV Success Grade IV
Criteria A: Individual Zygomatic Implant Stability	Absence of Mobility and Pain	Slight clinical mobility and no pain	Evident clinical Mobility and no pain	Evident clinical mobility with rotation and/or pain
Criteria B: Corresponding Sinus Pathology	Absence of clinical and radiographic findings of sinus pathology	Presence of clinical but absence of radiographic findings of sinus pathology	Absence of clinical but presence of radiographic findings of sinus pathology	Presence of both clinical and radiographic findings of sinus pathology
Criteria C: Peri-implant soft tissue Condition	No recession	Slight Recession. Visible implant head with no exposed threads	Presence of Recession. Up to seven threads exposed	Presence of recession. More than seven reads exposed
Criteria D: Prosthetic Offset	≤ 6 mm palatally & 0-3 mm buccally from the center of the alveolar crest	> 6 mm and ≤ 10mm Palatally & up to 4 mm buccally from the center of the alveolar crest	> 10 and ≤ 15 mm palatally & up to 5 mm buccally from the center of the alveolar crest	> 15 mm palatally and > 5 mm buccally from the center of the alveolar crest

Complications of zygomatic implants
Transient neurosensory disturbances

It occurs due to injury to the zygomaticofacial nerve while reflecting a soft tissue over the lateral aspect of the zygoma. It resolves over 1- 2 months postoperatively [21].

Difficulty with Speech and Deglutition

The posterior maxilla tends to resorb more palatally, which allow the placement of the zygomatic implant head in close contact with palatal plate. Usually palatal contour is well tolerated with minimal or no disruption of speech [21].

Sinus infections

The commonly occurring clinical complication in patient undergone zygomatic implant placement with intra-sinus approach is sinusitis. Signs and symptoms include occasional discharge from the nose, pain, head ache and slight pressure over the anterior maxillary wall. It can be treated by administering antibiotic regimen. Sinusitis which is refractory to the antibiotic therapy can be treated with a functional endoscopic sinus surgery (FESS) [22].

Zygomatic implants Failure

It can be occurred due to difficulties in implementing appropriate oral hygiene because of the position of implant head and abutment and prosthesis design. Signs and symptoms include peri-implant bleeding, increased probing depths and increased implant mobility [22].

CONCLUSION

Zygomatic implant serves as rescue treatment modality in severely resorbed maxilla where conventional treatment modalities usually remain unsuccessful. Zygomatic implant has shown improved clinical results compared with the sinus grafting and ridge augmentation procedures. Pre-surgical evaluation of sinusal and zygomatic pathology is considered as an utmost important factor to determine the Zygomatic implant success criteria.

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