Evaluation of Extra maxillary approach of the placement of Zygomatic implants in ZAGA-4 patients using the Zygomatic success code- A Case Series

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DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation titled **"Evaluation of Extra maxillary approach of the placement of Zygomatic implants in ZAGA-4 patients using the Zygomatic success code- A Case Series "** is a bonafide and genuine research work carried out by me under the guidance of **DrK.V.ARUN, M.D.S.,** Professor and Head, Department of Periodontology, Ragas Dental College and Hospital, Chennai.

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CERTIFICATE

This is to certify that this dissertation titled "**Evaluation of Extra maxillary approach of the placement of Zygomatic implants in ZAGA-4 patients using the Zygomatic success code- A Case Series**" is a bonafide record of work done by **Dr.MANIMALLA SHIVAAJI** under my guidance during the study period 2015-2018.

This dissertation is submitted to **THE TAMILNADU DR.MGR MEDICAL UNIVERSITY** in partial fulfilment for the degree of **MASTER OF DENTAL SURGERY, BRANCH II- PERIODONTOLOGY.** It has not been submitted (partial or full) for the award of any other degree or diploma.

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LIST OF ABRREVIATIONS

ABBREVIATION	EXPANSION
ZI	Zygomatic implants
ZB	Zygomatic bone
ZAGA	Zygomatic anatomy guided approach
OHIP	Oral hygiene impact profile
CBCT	Cone beam computer tomogram
CT	Computer tomogram

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Introduction

INTRODUCTION

Implant supported prostheses are expected to provide not only functional stability but also fulfill, aesthetic and phonetic expectations of the patient. In this regard, improving the overall quality of life through successful rehabilitation of atrophic posterior maxilla continues to be a therapeutic challenge for the clinician. [92,91]

Several clinical procedures such as Lefort I osteotomy, iliac crest grafts, maxillary sinus grafts have been advocated to increase the volume of load bearing bone on atrophic posterior maxilla.[88,134] The co-morbidity of such procedures like sinusitis and neuro sensory disorders, along with unfavourable post-operative sequale such as contamination or exposure of the graft and insufficient remnant bone after healing, continue to be a limitation in their use.[119,64]

Various graft-less solutions such as tilted implants in the para-sinus region, implants in pterygoid process, short and wide implants have been reported to increase patient acceptability and comfort. Another alternative to bone grafting in the atrophic maxilla is the use of zygomatic implants.[100]

The **Branemark (2005)**[41] zygomatic fixture was originally introduced for reconstruction of extensive defects of the maxilla caused by tumour resections, trauma and congenital defects. In an atrophied posterior maxillary ridge, the zygomatic implant (ZI) was meant to provide a steady anchorage for

the complete prosthetic rehabilitation with the addition of two to four standard implants in the anterior region.[112]

The original surgical protocol proposed by **Branemark**[41] was the Intra sinus approach, where a perforation was made through the maxillary sinus and implant was placed into the zygoma without elevating the sinus membrane. This was later modified into the sinus slot approach where the sinus membrane was preserved and zygoma approached by connecting a slot prepared on the outer wall of the maxillary sinus. However, in both the techniques, implant emergence was palatal to alveolar crest, thereby resulting in a prosthetic bulk that hindered with speech and oral hygiene maintenance. **Al-Nawas-2004**[9] reported that out of 37 zygomatic implants patients, 20 patients had increased probing depth >5mm in the palatal region, with severe resorption that have also been associated with the formation of oro-antral fistula.

Consequently a new classification system was introduced- "**ZAGA or Zygomatic Anatomy Guided Approach"** [13, 23]with five sub categories **(ZAGA-0 to 4)**. An extra maxillary approach was advocated in patients presenting with pronounced buccal concavities and deficiency in both horizontal and vertical dimensions (ZAGA-4). The merits of the extra maxillary approach were that the complications were minimised, buccal cantilevers were improved and the implant placement was guided by the anatomy of zygomatic bone. The resultant prosthetic components did not hinder with either speech or oral hygiene maintenance. A survival rate more than 90% and low incidence of

complications were reported using this approach, making it a predictable treatment plan in severely resorbed maxilla.[50]

The original zygomatic implant had threads engaging both the zygomatic bone (ZB) and alveolar bone.[16] Some of these implants have reported soft tissue recession and thread exposure when the alveolar process was severely resorbed in bucco-lingual direction. The exposed threads were reported to favour plaque accumulation that could lead to further tissue damage on an already recessed site. The next generation zygomatic implants were introduced with a smooth non-threaded surface engaging the alveolar bone and an apical threaded portion engaging the zygomatic bone[13].

There is a comparative paucity in literature regarding the use of the extra maxillary approach for the placement of smooth surface zygomatic implants and their long term success.

Several criteria have been individually used to record the long term success of zygomatic implant, but the zygomatic success code (ZSC) given by **Aparicio**[14] is widely accepted for its inclusivity, objectiveness and ease of use.

This study was aimed to rehabilitate atrophied maxillae using the extra maxillary approach of zygomatic implant placement in ZAGA-4 conditions and assess the success of the same using the zygomatic success code.

Aim and Objectives

AIM AND OBJECTIVES

AIM

To evaluate the extra-maxillary approach for zygomatic implant in severely resorbed edentulous maxillary arch with pronounced buccal concavities (ZAGA-4) using zygomatic success code.

OBJECTIVES

To evaluate the following parameters in zygomatic implants placed using the extra maxillary approach in ZAGA-4 using zygomatic success code:

- Zygomatic Implant Stability ;
- Associated Sinus Pathology;
- Peri-Implant Soft-Tissue Condition;
- Prosthetic Offset.

Review of Literature

REVIEW OF LITERATURE

Implants

Introduction of dental implants has been a great evolutionary change for replacing missing teeth, in spite of anatomical factors limiting the placement of implants in maxilla or mandible. Implant placement was observed to be difficult and compromised in atrophic maxilla in spite of numerous surgical techniques which were used for rehabilitation for the atrophic maxilla. [59]

Atrophy of maxilla

Dental implants are alternative treatment for replacement of partially or completely edentulous ridges. Atrophy of maxilla happens after traumatic extraction, periodontal disease, trauma, bone disease. Because maxillary resorption of the alveolar ridge occurs mainly on the buccal aspect. So, that buccal cortical bone of maxilla is thinner as compared to the palatal bone. There are many contraindications for the use of dental implants in atrophic maxilla there will be resorption of the buccal and palatal cortical plate for horizontal component deficiency and further resorption will take place in vertically also. Insufficient vertical dimension in the posterior maxillary alveolar ridge is due to pneumatization of the sinus resulting in deficiency of remaining alveolar bone; it will be difficult for the conventional implant placement.

Malevez C-2003[96] - reported that rehabilitation of patients with atrophic maxilla is a challenge for a clinician as there is a compromise of masticatory function and speech that can have a severe impact on the quality of life of the patient.

Stievenart M -2010[131] – reported that, poor bone volume in posterior maxilla makes it difficult for conventional treatment; fixed prosthesis as well as dental implants.

Classification-edentulous ridge can be classified in several methods as proposed by various authors[45,82,123]

Based on remaining bone volume available

- **Lekholm and Zarb 1985 :**

Based on remaining available bone -new classification for various degrees of atrophy for both mandible and maxilla were adopted

A: Virtually intact alveolar ridge

B: Minor resorption of the alveolar ridge

C: Advanced resorption of the alveolar ridge to the base of the dental arch

D: Initial resorption of the base of the dental arch

E: Extreme resorption of the base of the dental arch

- **Seibert's classification**: 1983 ridge defects were classified based on the location of the deformity and soft tissue deficiency

Class I- ridge defects it involves bone loss in the buccolingual width only.

Class II -ridge defects it involve a loss in the apicocoronal height only.

Class III -ridge defects It is a combination of both buccolingual and apicocoronal loss (both width and height).

Based on Completely edentulous maxillary arch

- **Misch**- classified edentulous arch into three types based on the region they are involved

Region - anterior and right and left posterior region

Type I- bone is symmetrical in all three segments with abundant bone

Type II- bone is similar in the posterior segments but differ from the anterior segment. Usually, the bone in the posterior segments is less as compared to the anterior segment.

Type III- bone present in posterior segments have different bone levels

Management of atrophic maxilla there are many surgical alternatives treatment to augment the resorbed ridge by iliac bone, Le Fort I osteotomy, onlay bone grafting, sinus floor augmentation, short implants, tilted implants, distraction osteogenesis procedure. [88]

Van der Mark EL et al 2011[49] reposted invasive techniques require long periods of treatment and are more prone to complications. The morbidity of these techniques includes the possibility of sinusitis, neurosensory disorders, contamination or exposure of the graft, post-operative pain, mobility, and insufficient bone after the healing period.

Raja SV -2009[21] **reported** most of the atrophic ridges that involve direct augmentation; numerous efforts have been made to pursue alternatives in achieving osseointegrated implant anchorage using the remaining native bone.

Pi urgell et al 2008[117] elaborated major reconstructions procedure using bone graft from the iliac crest associated with or without, sinus floor augmentation and onlay bone grafting which is been used most commonly with the goal of enabling placement of implant and integration of implants.

Ridge augmentation

The goal of hard tissue augmentation is to provide a foundation for ideal implant placement and also to support soft tissue for optimal esthetics. Various reconstruction procedure for the resorbed ridges using bone grafts as gold standard procedure were different types of grafts are used they autografts- block grafts, allograft-DFDBA, FDBA, alloplast-hydroxyapatite, xenograft-bovine bone.[2,82] After augmentation of bone, implants were placed

and it can be in staged procedure were implant placement can be done either one-stage, two-stage.[82]

Study done by **Chiapasco- 2009**[47] reported the mean survival rate of implants placed in conjunction with bone graft placement was 81.8% and with staged approach was 89.9%. In staged procedure implant had better stability and better osseointergration. Implant failure when the bone augmentation done with iliac grafts-17.5%, calvarial grafts (6 %) and intraoral grafts (5.5 %).

Sinus lift

Maxillary sinus pneumatization can occur after the age of 20 or after traumatic extraction of the posterior teeth so that remaining alveolar bone is lost, during healing phase also. The inferior wall of the maxillary sinus is closest to the teeth in the maxillary molar region, which is frequently causes the loss of the thin bone between the alveolar socket and the sinus during extraction, resulting in an expansion of the sinus. The results for sinus augmentation were more prevalent in molar sites (66.8%) than in premolar sites (33.2%). Maxillary sinus floor elevation procedures are indicated where insufficient bone height is available for implant placement.[1]

Types of sinus lift procedure[26]

- Direct sinus lift by Lateral wall approach (external sinus floor elevation ESFE)

- Indirect sinus lift by crestal approach (internal sinus floor elevation-ISFE)

Direct sinus lift- lateral window approach

This technique can be done when there is minimal residual bone and poor bone quality. It is also known as Tatum technique[26] and the sinus augmentation and implant placement can be done one-stage and a two stage technique, and the advantages is treating the teared membrane can be easily managed. Disadvantages it is post-operative pain, bruising and swelling.

Indirect sinus lift

This procedure is done by crestal approach in the residual maxillary alveolar bone and a bone grafting material is inserted into the area between the sinus floor and the residual maxillary bone. It is a less invasive procedure, shorter post-treatment waiting time. This procedure can be done in single or double stage procedure depending on the bone gain in the grafted region. Various modification in the technique is been done for ease of procedure.

- THE OSTEOTOME TECHNIQUE (SUMMERS TECHNIQUE**)** [132]
  The advantages are less invasive procedure, it improves the density of the maxillary bone, it has greater initial stability of implants. The disadvantages & limitation- expected higher elevation is not possible and there is higher chance of misaligning osteotome to the long axis during sequential osteotome.

- BALLOON SINUS ELEVATION[1]- This procedure is done by Zimmer Sinus Lift Balloon.
- HYDROPNEUMATIC SINUSLIFT - introduced in 2008 by **Troedhan.**[1]

Contraindications

Disorders and conditions that contraindicate the Sinus Lift procedure and they are generally known and recognized rules which was given by **Ten Bruggenkate CM- 1998**[71] purulent exudate, empyema it is a temporary contraindication. Patient with acute sinusitis history, hyperplastic mucosa, severe osteoporosis, Heavy smokers have a thin mucous lining of the maxillary sinus that is highly prone to perforation during the surgery.

The complication involved in this procedure is possibility of perforation of mucosa of the maxillary sinus during the surgery. Acute sinusitis is the most serious complication after surgery; Mild purulent, Postoperative hematoma is observed, primary failure (non-osseointegration) of the implant. **Chiapasco-2009**[17] in his study the frequent intraoperative complication as sinus perforation 4.8%-58% and post-op complication of 3% as infection and maxillary sinusitis.

Studies:

Boyne1980[36]- The amount of bone which can be gained using a crestal approach is usually less than that obtained with the lateral window technique, and a minimum of 3 mm crestal bone height is generally recommended to stabilize the implant at placement.

Pjeturson 2008[118]- proposed a sinus lift procedure In order to obtain simultaneous vertical bone augmentation with a combination of a sinus lift and an onlay graft. Implants are placed in the ulna, bone blocks containing the implants are retrieved with a trephine, inserted into the sinus via a crestal approach and left protruding occlusally for some millimeter in order to obtain simultaneous vertical bone gain.

Alveolar distraction osteogenesis:

Mcalister Bradley S-2003[101], Distraction osteogenesis (DO) is the process of bone generation between two bone segments in response to tensile stress. The technique was first described by **Codivilla** in 1905 and was developed by **Dr.Gavriel , Chiapasco-2009[46]** in his study complication rate of 75.7 % including soft tissue, tilting of the segments, change of the distraction vector, occlusal interferences and 21.6 % including fracture of basal bone or the transport segment, breakage of the distractor, and severe mechanical problems, leading to treatment discontinuation were reported

Short implants

An alternative procedure to sinus lift is the short implants. This implant is placed in the limited bone height to avoid invasive procedure like bone augmentation, sinus lift. **Renouard and Nisand**[86] defined short implants as an implant with a designed intra bony length of 8 mm or less. The posterior region of the jaws usually has the least height of existing bone because the maxillary sinus expands after tooth loss.

Disadvantages:

Short implants exhibit the following drawback of increased crown height, higher bite forces, less bone to implant contact after osseointegration. The functional forces after loading will be transferred to the crestal bone through this reduced surface of force distribution, which will lead to crestal boneless. The use of short implants ranging from 6.5 to 8.5mm has a low implant survival rate. **Goodcre.CJ, 2003**[72] in his study has observed that risk factor for implant longevity has emerged over the years, and short length implants may have lower survival rates.

Anitua-2010[10]-In this study short implant placed shows success rate after 1-8years, survival rate-99.3%&98.8%. but limitation of this implant lateral forces it cannot withstand the force increasing the number of implants and splinting them together can increase the area of forces applied to the prosthesis.

Misch, 2006[105] he has done a study how to compensate the multiple risk factors of increase stress, and the protocol followed in an attempt to reduce biomechanical stress to the bone implant interface. The methods to decrease stress for the short implants by avoiding cantilevers on the prostheses, angled forces to the posterior restorations, by Splinting multiple implants together.

Zygomatic implants

The use of zygomatic bone for anchorage of long oral implants was originally developed by **Branemark** and colleagues and first described by **Aparicio** and colleagues for rehabilitation of the atrophied maxillae who refuse the invasive procedure or have suffered a complication after bone grafting procedures.[8,99,90] **Chronovic-2016**[145] is his review paper he has observed that the high survival rates (higher than 90 %) and the low incidence of complications has been reported, so that it makes the zygomatic implant a good treatment option for the rehabilitation of severely resorbed maxilla.

Branemark developed a specific implant called the zygomaticus fixture to provide fixed solutions even when the conditions for implant insertion were poor in the posterior maxilla. This new technologic development offers alternatives to bone grafting or sinus-lifting procedures, which involve rather invasive surgery.

From his own experience based on animal research and human experiments, knowing that the introduction of an implant into the sinus would

not necessarily jeopardize sinus health. He considered using the zygomatic bone as an anchorage for prosthetic rehabilitation in hemi-maxillectomy patients as well as for other defects also. These reconstructions were successful and long-term stability of these implants was established.[112]

Historical Perspective

Zygoma implants were first introduced in 1998 by **Per Ingvar Branemark** widely acknowledged as the "Father of Dental Implantology".[87] After **Branemark, Malevez et al**[95] described zygomatic implants as self-tapping screws in commercially pure titanium with a well-defined machined surface. They are available in 8 different lengths, ranging from 30 to 52.5 mm. They present a unique 45 degree angulated head to compensate for the angulation between the zygoma and the maxilla. The portion that engages the zygoma has a diameter of 4.0 mm, and the portion that engages the residual maxillary alveolar process a diameter of 4.5 mm. At the maxillary level the angulated implant platform extremity offers the possibility to screw any kind of abutment from the **Branemark** system. However, for the newest generation of abutments a separate slightly shorter abutment screw must be utilized for the construction of conventional screwed prosthesis. Traditionally, these implants had a palatal emergence, crossed the maxillary sinus and were anchored in the zygomatic bone. Nowadays, the palatal emergence can be avoided by using the "extramaxillary" implants technique, where the zygomatic implant goes through the lateral wall of the maxillary sinus.[95] In

2011, Parel[112] and colleagues cited the use of implants in the zygoma as retaining elements after hemimaxillectomy. Subsequently**, Branemark**[42] and colleagues introduced a study with 77 patients and 156 implants, out of which 24 were called "zygomatic implants" (ZI) and presented lengths that were superior to the "standard model" and the rest responded to a specific implant design. The cumulative success rate of the Zygomatic implant was 96.8%. No data for the prosthesis outcome were reported. More recently, other authors have reported good results on the use of Zygomatic implant to stabilize a fixed prosthesis.

Anatomy of zygomatic bone

The zygomatic bone is small and quadrangular, and is situated at the upper and lateral part of the face; it is bilaterally present it forms the prominence of the cheek, part of the lateral wall and floor of the orbit, and parts of the temporal and infratemporal fossae. The zygomatic bone was compared to a pyramid, offering a solid anatomic structure for implant anchorage, and contains dense cortical and trabecular bone. A histological analysis of this area revealed the presence of a regular and dense bone with very high osseous density (up to 98 %). When occlusal forces are applied to the implant fixture, the load is transferred to the trabecular and cortical bone. According to an anatomical study, the mean length of useful bone in this region is 14 mm.[87]

Surfaces [74]

The malar surface, it is convex and perforated near its center by a small aperture, the zygomaticofacial foramen, for the passage of the zygomaticofacial nerve and vessels; below this foramen is a slight elevation, which gives origin to the Zygomaticus.

The temporal surface- which is directed backward and medial ward it is concave, presenting medially a rough, triangular area, for articulation with the maxilla, and laterally a smooth, concave surface, the upper part of which forms the anterior boundary of the temporal fossa, the lower a part of the infratemporal fossa. Near the center of this surface is the zygomaticotemporal foramen for the transmission of the zygomaticotemporal nerve.

Anatomic landmark for zygomatic bone:[74]

The antero-superior or **orbital border** is smooth, concave, and forms a considerable part of the circumference of the orbit. The antero-inferior or **maxillary border** is rough, and bevelled at the expense of its inner table, to articulate with the maxilla; near the orbital margin it gives origin to the Quadratus labii superioris. The postero-superior or **temporal border**, curved like an italic letter f, is continuous above with the commencement of the temporal line, and below with the upper border of the zygomatic arch; the temporal fascia is attached to it. The postero-inferior or **zygomatic border** affords attachment by its rough edge to the Masseter.

Articulations —the zygomatic articulates with four bones: the frontal, sphenoidal, temporal, and maxilla.

Course of blood supply and nerve supply: Zygomatic Nerve[74]

Sensory fibers from the lateral aspect of the forehead enter the orbit through a foramen in the zygomatic bone as the zygomaticotemporal nerve. Fibers from the lateral aspect of the cheek and lower eyelid enter the orbit through a foramen in the zygomatic bone as the zygomatico facial nerve. These two nerves join to become the zygomatic nerve and course along the lateral orbital wall, exiting the orbit through the inferior orbital fissure and joining with the maxillary nerve.

The zygoma as an anchorage[77]

The zygomatic bone can be compared to a pyramid, offering an interesting anatomy for the insertion of the zygomatic implant.[85,135] Histologic analysis of the zygoma shows regular trabeculae and compact bone with an osseous density of up to 98%.[73] In a recent study on cadavers it could be established that the mean length of the zygoma was 14.1 mm, allowing the insertion of zygomatic implants.[135,95]

Nkenke E, 2003[108] did a Histologic specimen, which he sliced in the intended plane of the implant placement.

1. Anterior-posterior length- distance between the middle of the cortical layer of the maxillary sinus and the most peripheral point of the specimen
2. Medio-lateral thickness width of the zygomatic bones - distance between the medial and the lateral cortex tangent to the cortical layer of the maxillary sinus
3. Estimated implant length within the zygomatic bone - distance between the middle of the cortical layer of the maxillary sinus parallel to the crista zygomaticoalveolaris. it is the plane of the intended implant direction.

However, the study done by **Jensen et al. (1992)**[82] reveals the medio-lateral thickness of the patients, which they examined the zygomatic bones of Indian people and found average values of 4.4mm, which seem to be critical for implant placement

Kato et al-2005[87] did an analysis using Micro-computerized tomography (CT) of zygomatic bone revealed that the greatest thickness/density of trabecular bone was found in the **jugale region [jugale (Ju) which is the most concave point between the lateral margin of the upper zygomatic bone and the upper margin of the zygomatic arch]**. It was revealed that bone density in this region does not decrease as it does in alveolar process regions following the loss of teeth, because jugale region has insertion of masseter muscles, which provide adequate stress to continue

successful osteoblastic activation and bone turnover. Thus, adequate thickness of zygomatic bone is sufficient to provide anchorage and then load bearing for a zygomatic implant.

Indication

Severe maxillary osteomalacia, atrophy, surgical resection, complications of sinus disease and enlarged pneumatized sinuses or trauma.

Techniques

1. Intra sinus technique
2. Sinus slot technique
3. Extra sinus approach-Zygoma Anatomy Guided Approach (ZAGA)
4. Minimally invasive approach by the use of custom-made drill guides
5. Computer-aided surgical navigation system approach

Intra sinus technique – original

The classical approach was first introduced by **Branemark in 1998**[42] and was also used by many authors in their clinical studies.

The operative technique[42]

A vestibular Le Fort I incision, was made between both sides of first molar regions and a palatal flap is raised to expose the alveolar crest and the hard palate. The nasal mucosa is dissected to increase visibility of the local

anatomy. The dissection is continued along the infra-zygomatic crest towards the zygomatic bone (ZB). The infraorbital nerve was isolated and the zygomatic region exposed. The periosteum of the medial part of the zygomatic body and the zygomatic arch is then raised. A window is opened in the uppermost lateral aspect of the sinus wall to the extension of the infra-zygomatic crest, using a round bur. The sinus mucosa is then reflected (no special effort is made to keep it intact). The window provides direct visibility of the roof of the sinus and enables localization of the optimal point for entrance of the drill into the ZB. The entrance on the palatal side of the crest is marked, and a round bur (Ø 2.9 mm) is used to penetrate the crest and mark the entrance in the roof of the sinus. The entire site in the zygoma is then prepared with a twist drill (Ø 2.9 mm). A 3.5-mm pilot drill is then used to enlarge the site. To ensure that the wider drills do not deviate from the planned direction, it is has a non-cutting tip of 2.8 mm in diameter. The preparation continues with a 3.5-mm twist drill with a cutting apex. A depth indicator is inserted into the site to decide the correct length of the zygoma fixture. A 4-mm countersink drill may be used only when the palatal bone is thick or dense because of the risk of excessive widening of the palatal entrance. The ZI is inserted slowly until its apical portion is anchored in the alveolar crest, and it is manually inserted to adequate depth and positioned in an optimal way from the prosthetic point of view. The muscles that were released from the lower anterior aspect of the zygoma should be carefully repositioned to avoid the formation of a retrozygoma space. The submucous tissue should be reattached

with individual absorbable sutures that connect to the lateral horizontal incision over the distal aspect of the maxilla, so that tissue with periosteum provides a cover over the window in the upper anterior maxillary body. The initial incision is then closed with individual mattress non-absorbable sutures.

However, the great importance of the classic technique described by Branemark in 1998 was to be the pioneering technique. After this many alteration where done to improve the surgical technique.

Disadvantages:

In the study **Al-Nawas.B -2004** out of 37 zygomatic implant done in 20 patients had increased probing depth in the palatal region.[9] The morphological situation of the palate and the alveolar crest seem to influence probing depth as the palatal and mesial aspect showed significantly higher pocket probing depth. The study done by **Branemark**[37] the probing depth in 20 patient groups had 5 mm. It should be taken into account that bone resorption in the palatal region which might follow this clinical state leads to severe problems. Resorption of the thin palatal bone rapidly there was a oro-antral fistula followed by implant loss, which already was observed.

Sinus slot technique

The sinus slot approach was first introduced by **Stella and Warner in 2000**[129] and has been used by other authors in clinical studies

The operative technique

It is a surgical improvement from the classical one. The sinus slot is a guided window approach were sinus slot was made directly through the buttress wall of the maxilla, were by the zygomatic implant is guided through the maxilla to the apex insertion at the junction of the lateral orbital rim and the zygomatic arch. A slot is formed, which results in a smaller antrostomy**.**[129] This lateral window allows direct vision to the base of the zygomatic bone, helps control the implant position by direct vision, allows greater potential for bone-to-implant interface because of this lateral position, and it eliminates the sinus window and sinus lining elevation by the placement of the implant .[48,68,129] Less than half the amount of implant is exposed with the sinus slot method than with the classical approach, and therefore, a greater bone-to-implant interface exists with the sinus slot technique than with the classical protocol.[129] The dissection is narrower than the original **Branemark** protocol, and the palatal mucosa is reflected only to expose the crest of the ridge. Thus, minimizing dissection also facilitates recovery time by reducing postoperative edema and ecchymosis.[129] It is accomplished when crestal emergence of the implant is a priority, especially in patients with a well-preserved alveolar process**;** this technique allows a more vertical zygomatic angle and thus allows the position of the implant more bucally, bringing the head of the implant into better alignment with the resultant prosthesis (the implant platform stays directly over the crest of the ridge in the first molar region). The technique

had disadvantage ,**Boyes-Varley et al, (2003)**[35], who stated that the sinus slot does not provide adequate visualization of the base of zygomatic bone and argued that visualization of the entrance of the implant into the zygomatic bone is important to avoid complications.

Extra sinus approach

The exteriorized approach was first introduced by **Migliorança et al. in 2006**[103] and is also called of "extramaxillary implants" or "extrasinus zygomatic implants" [10]

The operative technique[103]

It begins with a supra-crestal incision joining both the side of the tuberosities, along with two vertical releasing incisions in the zygomatic pillar region. A mucoperiosteal flap is reflected, allowing the anatomical structures to be visualized. The zygomatic implants are placed outside the sinus, contacting the outer aspect of the lateral wall of the maxillary sinus, as it is distal to the second premolar or first molar region. No maxillary antrostomy is necessary. The osteotomies for the zygomatic implant begins with a spherical drill, which penetrates the residual ridge near to the top of the crest, from palatal to buccal, transfixes it, and emerges in the buccal aspect of the ridge, external to the maxillary sinus. The drilling continues toward the zygomatic bone along the outer aspect of the lateral wall of the maxillary sinus until it reaches the zygomatic bone in its lateral portion. With the same drill, the

zygomatic bone is perforated until the outer cancellous layer of the bone is surpassed. The depth indicator is then used to determine the length of the zygomatic implant, which is defined as 2 mm less than the obtained measurement. The osteotomy is progressively widened using these drills in sequence: twist drill, 2.9 mm; pilot drill, 2.9/3.5 mm; and twist drill, 3.5 mm. The implants are placed with an initial insertion torque of 40 Ncm, after which insertion is completed manually. The platform of ZIs emerges over or close to the top of the crest of the residual alveolar ridge.

As a result, the implant goes in an extrasinus path and sometimes engages the lateral sinus wall. Abutments were connected to the implants together with sterile impression copings, the wound were closed by suturing. The prosthetic steps are impressions of both jaws and bite registration were made immediately after surgery in order to manufacture a provisional fixed bridge to be connected within 24 hours. The patients were prescribed postoperative antibiotics and analgesics. Removal of sutures and check-up of occlusion were made 10 days after surgery. The provisional bridge was replaced by a permanent bridge 4 to 5 months after surgery

According to the authors of clinical studies [103,48,16], in which the exteriorized technique for placing zygomatic implant was exclusively used, this approach does not cause sinusitis, since the implant (or most part of it) is placed outside the maxillary sinus. Although these studies reported no

instances of maxillary sinusitis, studies placing zygomatic implant passing through the maxillary sinus also reported no instances of maxillary

Corvello et al. (2011)[52] evaluated the length of the holes drilled in the zygomatic bone of 18 dry adult skulls during the placement of zygomatic implants using the original Branemark and the exteriorized (extrasinus) protocols. The exteriorized technique produced significantly longer drilling holes than the Branemark technique, suggesting that the exteriorized technique may provide higher initial technical stability

Minimally invasive approach by the use of custom-made drill guides

In the minimally invasive approach the transfer of the preoperative plan to the patient is realized by custom-made drill guides. The technique combines preoperative computer tomography with the use of a customized drill guide produced by stereolithography, Computed tomography data for each patient are imported to planning software, allowing the surgical team to simulate implant placement on the 3D model[137] Once the implant is planned, its angulation can still be adjusted and its dimensions adapted to obtain the optimal position of the implant. The finalized treatment plan is then used to fabricate the maxilla model and a surgical drill guide with skeletal support, using stereolithography technology. The aim is to create an individualized drill guide that is suited to the patient's bone profile. A CAD/CAM program uses the shape of the bone and the 3D information of the planned drill paths to design the drill guide. The drill guide is then produced by stereolithography.

The drill guide consists of a resin backbone with cylindrical openings into which stainless steel tubes can be fitted. Each cylinder's position and direction corresponds exactly to the position and direction of the planned implants. This surgical drill guide is fitted onto the maxilla and is fixated with osteosynthesis screws. Then, the drilling procedures are performed with the use of appropriate drills. However, it is advisable to have the exit point prepared under direct vision to prevent the long ZI from coming too close or even perforating to the orbit.[46] Two studies[137,97] showed good precision with the technique for zygomatic implants (custom- made drill guides). However, one more recent study **Chrcanovic BR,(2010)**[50] demonstrated that the use of the zygomatic implant, in the context of the technique that uses customized drill guide produced by stereolithography, should probably be re-evaluated because some large deviations were noted. Thus, it is recommended that utilization of the sinus slot technique together with the CT-based drilling guide would enhance the final results.

Computer-aided surgical navigation system approach

The use of a computer-aided surgical navigation system to specifically place zygomatic impants was first introduced by **Schramm et al.**[14] Based on spiral computed tomography data, a navigation system uses tracking technology it is installed for the preoperative planning and intraoperative control of insertion of the implants. The preoperative planning is supported by 3D visualization of the anatomic sites and virtual positioning of the implants.

To compute a mathematical transformation that conveys the coordinate system of the CT scan to the patient, an LED emitter array can be attached to the skull or directly to the maxilla of the patient. All position data of surgical tools are reported relative to the position of this emitter array. Constant visualization of the drill trajectory on the computer screen can be seen, while deviation from the preoperative plan position is detected and displayed in real time. By guiding the drill in the intended direction, the clinical procedure of the implant placement can be carried out with an improved precision.

In contrast to the approach with drilling templates, a computer-aided surgical navigation approach offers constant intraoperative visualization of the tip of the drilling bur. This enables the surgeon to precisely guide the drill to control the implant axis and ensure optimum bone use, as well as feedback regarding the accuracy of the template or the position relative to the anatomic structures.

Studies:

Aparicio et al[14]. Were the first to use a navigation system for preoperative planning and intraoperative control of the insertion of zygomatic imppants, and he reported the use in three patients. One year later, it was assessed the precision of a computer-aided surgical navigation system dedicated to the placement of endosteal implants in the maxillofacial area. The accuracy of the implant position compared with the planned position was 0.8 mm for the external perforation of the zygoma and 1.7mm for the internal

perforation. This result is better while using drilling templates than the accuracy.

Corvello et al.[52] Aimed to compare the classical technique and the exteriorized technique in relation to the length of the drilling holes in the zygomatic bone for placement of zygomatic implants, the most frequently used zygomatic implant length, and the most frequent position where the implants emerged in the zygomatic bone. The length of the drilling holes in the zygomatic bone varied as a function of surgical technique.

The mean value of the exteriorized technique was significantly higher than that of the original classical technique. In the exteriorized technique, the lateralized placement of the zygomatic implant with the position where the implants emerging in the first molar region provides more penetration of the implant in the zygomatic bone, which may provide higher initial mechanical stability for zygomatic implants than the classical technique.

ZAGA-Zygomatic anatomy guided approach

When the patient has pronounced buccal concavities on the lateral aspect of the maxillary sinus, if intra-sinus approach- original techniques were used there will be excessive palatal emergence and bulky prosthesis on the palatal side which is difficult for the oral hygiene and speech also so that the modification from the original technique was given by **Aparicio-2011**[22,23] where he used zygomatic bone as the guide for the implant placement and it is

also used when there is intra-individual anatomic differences. The preparation of the implant site is guided by anatomy of the zygomatic bone, depends on the relationship between the zygomatic buttress and intra-oral starting point of the zygomatic implant, the placement of zygomatic implant is according to anatomy for every individual.

Classification for zygomatic implant placement planning[2]

- A general guide line was given by **Bedrossian et al (2010)[33]** according to which the maxilla can be divided into three zones:

Treatment recommendations based on the presence of bone in the different zones of the maxilla

- **Aparicio C in 2011[22,23]** proposed a classification for zygomatic implant patients based on the **Zygoma Anatomy Guided Approach (ZAGA**). The morphology of the lateral sinus wall, residual alveolar crest and the zygomatic buttress was taken into major concern. This classification was first introduced at the 3-I Spanish Annual Symposium held in Madrid January 2010.

1. Firstly, the coronal entrance point at the level of the alveolar process, for an optimal prosthetic outcome, is determined according to prosthetics, biomechanics and anatomical parameters.
2. Secondly, the apical zygomatic entrance point is identified based on the desired number and length of the implant(s) and the anatomy.

3. Thirdly, the implant trajectory is planned by joining the coronal of alveolar process and apical entrance points of ZB, which will determine the preparation and pathway of the implant body.

Intraoral coronal entrance point at the alveolar process is the key factor for a successful outcome of the ZAGA procedure. The implant head should be placed at or near the top of the alveolar crest, with a mesiodistal entrance at the level of the second premolar/first molar regions.

The five basic anatomical groups were named as ZAGA 0, ZAGA 1, ZAGA 2, ZAGA 3 & ZAGA 4 (Aparicio.C et al., 2011).[22,23]

- The general guidelines for zygomatic implants (**Lesley.D-2012**)[22]

1. When there is adequate bone in zone 1 and bilaterally lack of bone in zones 2 and 3. Typically, two to four conventional implants are distributed in the anterior maxilla plus one zygomatic implant on each premolar/molar side.
2. Adequate bone in zone 1 and lack of bone in zones 2 and 3 on either one side. One single zygomatic implant is placed and conventional implants are placed on the anterior maxilla and even on the side opposite to the zygomatic implant.
3. Inadequate bone in zone 1 and adequate pristine bone in zones 2 and 3. An anterior zygomatic implant, together with posterior conventional implants, can solve the problem.

4. When there is lack of bone in all three zones of the maxilla. Four zygomatic implants are to place for the rehabilitation.
5. Inadequate bone in zones 1, 2 or 3 in a partially edentulous patient. The placement of three implants to support a partial prosthesis is recommended; use of a zygomatic implant in partially edentulous patients requires more clinical validation before widespread use can be advocated.

ZAGA-0

The anterior maxillary wall is very flat, and the implant head is located on the alveolar crest. The implant body has an intra-sinus path. The zygomatic implant comes in contact with bone at the alveolar crest and zygomatic bone, and sometimes at the lateral sinus wall.

ZAGA-1

When the anterior maxillary wall is slightly concave. The implant head is located on the alveolar crest and the drill has performed the osteotomy slightly through the wall. Even if the implant can be seen through the wall, most of the implant body has an intra- sinus path. The implant comes into contact with bone at the alveolar crest, lateral sinus wall and zygomatic bone.

ZAGA-2

When the anterior maxillary wall is concave. The implant head is located on the alveolar crest. The drill has performed the osteotomy through

the wall. The implant can be seen through the wall and most of the body has an extra-sinus path. The implant comes into contact with bone at the alveolar crest, lateral sinus wall and zygomatic bone

ZAGA-3

The anterior maxillary wall is very concave. The implant head is located on the alveolar crest. When the drill has been done it goes from the palatal to the upper buccal alveolar bone, then the implant body leaves the concave part of the anterior sinus wall to penetrate into the zygomatic bone. Most of the implant body will be as anterior extra sinus path. The middle part of the implant body will not touch the most concave part of wall. The implant comes in contact with bone in the coronal alveolar and apical zygomatic bone.

ZAGA-4

The maxilla and the alveolar bone have vertical and horizontal atrophy. The implant head is located buccally to the alveolar crest. There is no or minimal osteotomy at the alveolar crest. The drill has arrived at the apical zygomatic entrance following a path outside the sinus wall. Most of the implant body has an extra-sinus/ extra-maxillary path. Just the apical part of the implant is surrounded by bone. The implant comes in contact with the zygomatic bone and part of the lateral sinus wall.

Rationale-

It is assumed that the only stability of the zygomatic implant is derived from the zygomatic bone. The remainder of the implant and the prosthetic components constitute a considerable cantilever. However, because these implants were never intended to be free-standing pillars, immediate, rigid, cross arch stabilization is recommended at stage II procedure to prevent micro-movement, and thus micro-fractures around the osseointegrated structures. Achieving such stabilization requires that the zygomatic implants be splinted to the other implants by a provisional rigid bar. **Brunski and Meredith**[32] suggested in their studies that this type of cross arch stabilization (splinting) appears to effectively reduce mechanical stress on the implants by reducing their movement. Fabricating a passive bar to connect the implants at phase II surgery may require 1 to 2 days. This approach saves considerable time over conventional techniques and allows for the restoration of severely resorbed maxillae in an efficient and routine manner.

Osseointegration

Branemark PI. -1983[2,37]-defined Osseointegration as the direct structural connection between bone and the surface of a load-carrying implant with no detectable soft tissue interface. Severely resorbed maxillae present a challenge for conventional osseointegrated implant installation.

Atraumatic surgical technique, avoidance of overheating from drilling and sufficient primary stability is still important factors in the success of osseointegration.

DETERMINANTS OF IMMEDIATE LOADING SUCCESS

In 1981, **Albrektsson and colleagues**[6] identified six factors as influences on osseointegration:

(1) Status of the bone, (2) Loading conditions; (3) Surgical technique; (4) Implant design (or macrostructure); (5) Implant finish (surface); (6) Implant material.

With conventional dental implants, initial implant stability derives from mechanical retention between the implant surface and the bone tissue. This concept is also important when using zygomatic implants.

Studies:

The quantity and the quality of zygomatic bone were studied by **Nkenke et al. (2003)**[108] they concluded that the trabecular bone of the zygomaticus arch was not favourable for implant placement and suggested that the success seen with zygomatic implants is probably a result of the engagement of four cortices (the lingual 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).

ZAGA success code[14]

A zygomatic success code describing specific criteria to score the success for a rehabilitation anchored to a zygomatic implant was proposed- **Aparicio-2013[14]**

The Zygomatic Success Code of a specific implant is represented by the outcome of the following variables:

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

Zygomatic implants can be scored by a code that includes four digits, each representing one specific criterion of success. A number is given depending on the condition of each criterion (e.g. 1/3/2/1).

Zygomatic implant stability- criteria A

When extra-sinusally placed implants are tested individually, slight mobility should be detected with no other associated pathological signs. Mobility of the implant comes from the elastic modulus of the anchoring zygomatic bone when they are bent by a remotely applied force. On the other hand, the movement must not be rotational, and it will disappear when

implants are splinted together. A rotational movement should be considered as a sign of implant failure.

Grade I- no mobility, no pain

Grade II-light clinical mobility, no pain

Grade III-clear clinical mobility, no pain (no evidence of disintegration of the apical part of the implant or rotation

Grade IV- clear clinical mobility, rotation and pain 9evidence of disintegration of apical part of the implant)

Diagnosis of associated sinus pathology: Rhinosinusitis- criteria B

Sinusitis in patients with zygomatic implants should be diagnosed in the same way as sinusitis in conventional patients, with some particularities. Rhinitis and sinusitis are among the most common medical conditions and are frequently associated. Therefore, many authors use the term rhinosinusitis. The vast majority of patients treated using zygomatic implant does not experience sinus pathology. It is not clear if sinusitis rates in patients with zygomatic implants are higher than in the general population. From the available data, the incidence of sinusitis is 6.6% for the classic two-stage protocol, 2.8% for immediate function protocols and 5.5% if both protocols are considered together.[57] The best way to avoid placing a zygomatic implant in patients with active sinusitis and this can be confirmed by CBCT all sinuses

and clinical examination of all patients prior to the placement of a zygomatic implant and after placement of implants. Patients with potential risk factors for the development of chronic rhinosinusitis should be identified, studied and, if necessary, treated by an otolaryngologist before implant placement.[121]

Scoring a CBCT scan- Lund-Mackay staging[102,111]

A CBCT scan of all sinuses must be performed to access Lund-Mackay staging system, a validated scoring system recommended by the Task Force on Rhinosinusitis. The radiological test included six regions: anterior ethmoid; posterior ethmoid; maxillary; frontal; sphenoid; and osteomeatal complex (OMC). Each region is given a score of 0, 1 or 2. Any scan with a score of >0 would be considered an abnormal or 'positive' scan, 0, 1 or 2-0 represents no abnormality; 1 represents partial opacification; and 2 represents total opacification for the sinus region. The osteomeatal complex can only be scored as 0 or 2

In a study **Aparicio et al[16]** compared the classical technique versus the ZAGA. The L-M score was statistically significantly lower for the ZAGA group (2.36 1 3.86 vs. 0.56 1 1.26, P = .042).

Questionnaire for sinusal reactions- Lanza-kennedy - Rhinosinusal clinical symptoms-1997

A patient questionnaire developed, in 1997, by Lanza & Kennedy[93] to identify the presence of rhinosinusal clinical symptoms, as specified by the

Task Force on Rhinosinusitis diagnostic clinical criteria, must be presented to each patient. After the zygomatic implant each symptom question is answered 'yes' or 'no'. Diagnosis of sinusitis requires a 'yes' answer in two or more major criteria, in one major and two or more minor criteria, or purulence on nasal examination.

Similarly, a statistically significant difference was reported by Aparicio and coworkers,[16] (P = .047) regarding the percentage of patients with no radiological signs or clinical symptoms of rhinosinusitis was observed between groups (54.55% for the classical technique vs. 76.25% with the ZAGA, P = .047).

Peri-implant soft-tissue condition- criteria C

Photographs are used to quantify the number of exposed threads. Standard periodontal parameters, such as bleeding on probing or probing depth, are not used because for different anatomic reasons, the zygomatic implant would be placed in different locations with respect to the residual crest, varying from a completely bone surrounded implant head to just a buccal soft-tissue relationship. Moreover, when placing zygomatic implants following the original technique, the palatal bone thickness surrounding the implant head is frequently extremely poor or even there will be no bone also. In those cases, probing may cause disruption of the soft tissue sealing and may cause oro-antral communication. In extra-maxillary approach there will be more soft tissue loss and bone involvement will not be there

Grade I – no recession

Grade II- light recession, implant is visible, no exposed threads

Grade III-recession up to seven exposed threads

Grade IV-recession, more than seven exposed threads

Specific criteria for zygomatic prosthesis success- criteria D

A bulky dental bridge at the palatal aspect sometimes leads to discomfort, speech problems and problems with oral hygiene. For precise reporting on prosthesis success, anatomic measurements to assess the position of the head of the zygomatic implant with regard to the middle of the crest of the alveolar ridge in the horizontal axial dimension should be included.

A positive value on this implant head position to the alveolar ridge relationship indicates a palatal position of the implant, whereas a negative value indicates a buccal emergency. An implant placed with no contact with the buccal bone at the head level will probably induce soft tissue dehiscence.

Grade I- 0mm≤D ≤6mm, -3mm ≤D ≤0mm

Grade II- 6mm≤ D ≤10mm, -4mm ≤D≤ -3mm

Grade III-10mm≤ D≤ 15mm, -5mm≤ D≤ -4mm

Grade IV- D> 15mm, D <-5mm

Visual analog scale-VAS

This scale has measured of 10 cm; each one cm gives a score. It been used to measure immediate post-operative complication of the procedure undertaken such as pain, swelling, odema etc. it is also used to measure one year after the procedure and prosthetic loading for the procedure undergone satisfaction level, implant fixed prosthesis does it have stability, oral hygiene maintenance, comfort of the prosthesis, self-esteem.

Macentee.MI-2005,[94] did a study where VAS are typically used to measure perceptions of subjective phenomena that are difficult to standardize from individual to individual. They used the following parameters used for scoring- 1.Considering the stability, 2.Comfort, 3.Ability to speak, 4.Cleaning ability, 5.Aesthetic, 6.Self-esteem, 7.Function of the prosthesis.

Patients answered questions giving values from 0cm (completely dissatisfied) to 10cm (completely satisfied) for each item.

Penarrocha et al 2007[114] did a study to evaluate the maxillary fixed prosthesis supported with conventional and zygomatic implants. In the evaluation on esthetic bases, zygomatic implant supported prosthesis was significant than the conventional implant group.

OHIP-oral health impact profile

Allen et al.[7] study done on Oral Health Impact Profile for assessing health-related quality of life in Edentulous adults

The satisfaction level and the masticatory capacity were evaluated by means of the questionnaire Oral Health Impact Profile Edentulous Patients (OHIP-EDENT). Patients answered questions regarding their ability or lack of ability to comminute hard and soft foods relating it to the discomfort and instability of the dentures, their perception of satisfaction in relation to the esthetics, pleasure when eating, and level of comfort, and to self-assurance. Patients answered nine questions about their dentures, the answer scale ranging from 0 to 4. 0-complete satisfaction, 4-complete dissatisfaction,

The highest scores represent the worst satisfaction levels and the minimum scores represent the best satisfaction levels. The maximum score is 36. Results were translated into percentage values of satisfaction, 0% representing worst possible satisfaction level and 100% best possible satisfaction level.

Satisfaction level questionnaire. [16]

Nine questions in a scale ranging from 0 to 4, (0 = never, 1 = hardly ever, 2 = occasionally, 3 = fairly often, 4 = very often).

Results were translated into percentage values of satisfaction, 0% representing worst possible satisfaction level and 100% representing best possible satisfaction level.

Carlos Aparicio, [16] in his study finally, regarding satisfaction level, no statistically significant differences were identified between the two cohorts of study. The maximum score is 36 and the minimum is 0, this representing the best satisfaction level and masticatory ability.

Patient satisfaction rate after oral rehabilitation. Comparison with sinus slot and conventional implants

Considering the hypothesis that the palatal emergency profile of zygomatic implants determines a less satisfactory prosthetic rehabilitation, compared the degree of patient satisfaction with ZAGA group.

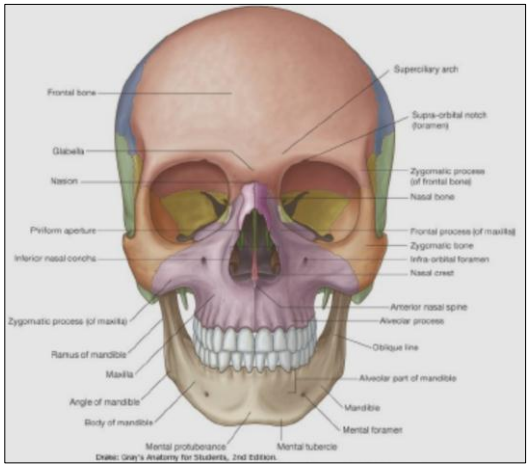
Individual parameters included the stability of the prosthesis, ease of cleaning, the ability to speak, aesthetics, self-esteem, and masticatory function after prosthetic rehabilitation [98]

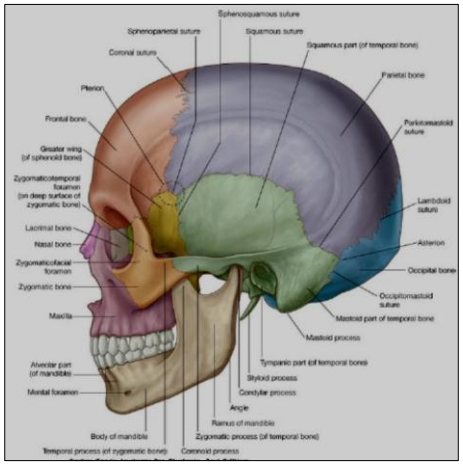
Survival Rate and Cumulative Survival Rate of Regular Implant and Zygomatic Implant

Zwahlen-2006[146] performed a study where the final 10 year cumulative survival rate (CSR) for regular implant was 97.71%. The final 10-year CSR for Zygomatic implants was 95.12%.

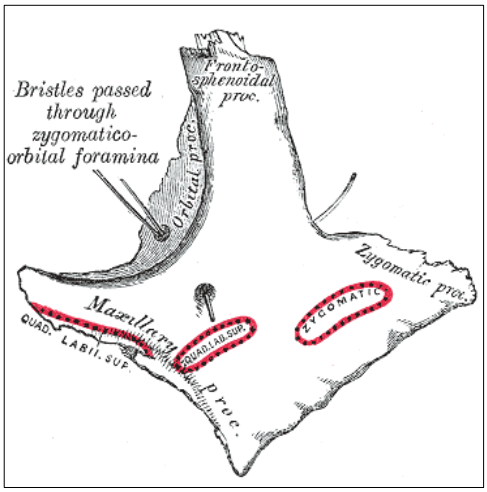
IMAGES

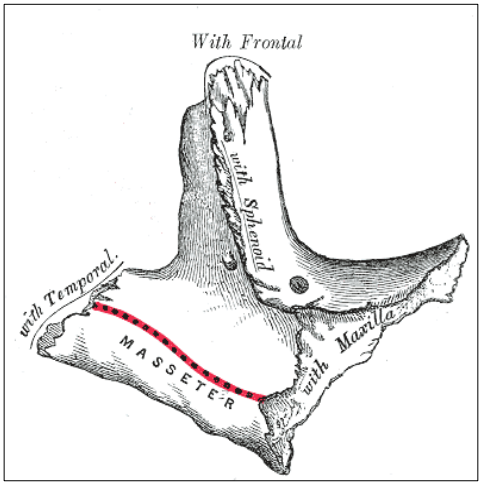
Skull Anatomy



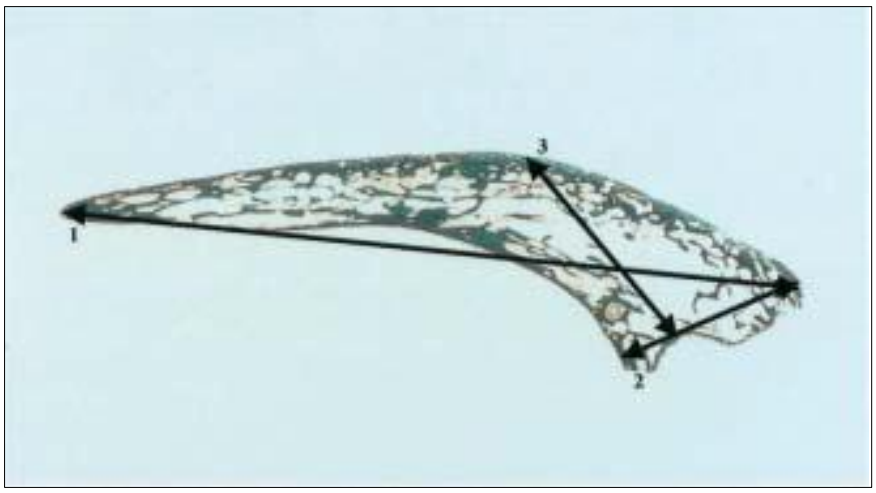


Surface

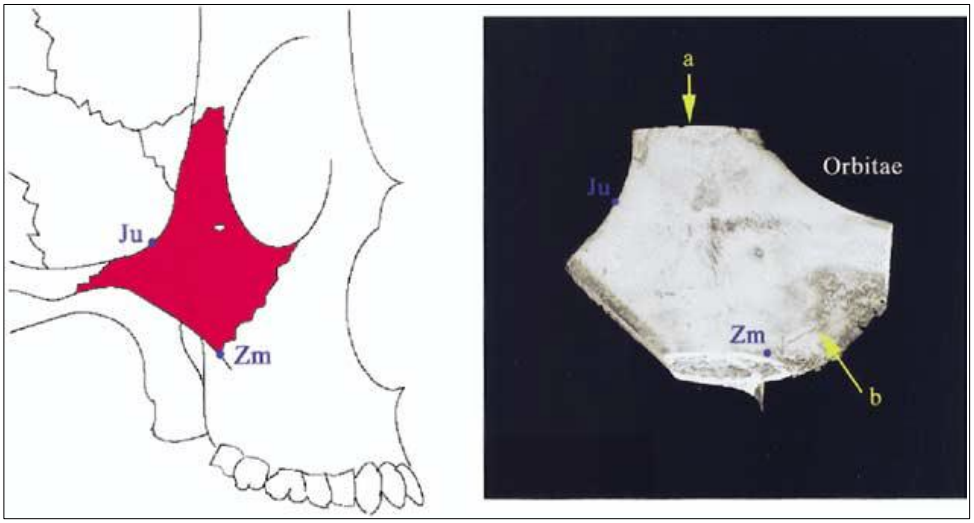




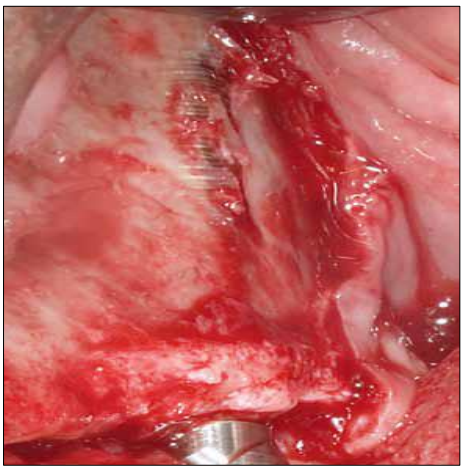
Histologic specimen analysis done by Nkenke E, 2003 for zygomatic bone anchorage

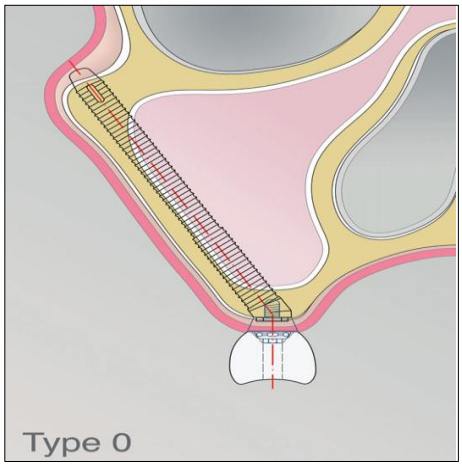


Micro-computerizedtomography (CT) of zygomatic bone by Kato et al-2005



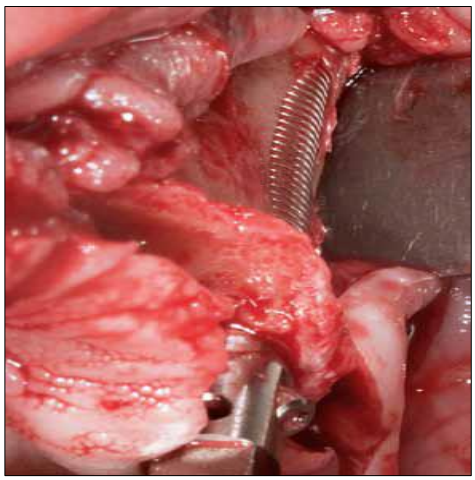
ZAGA-0

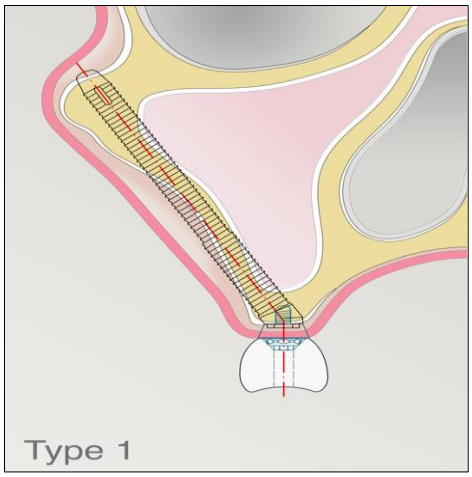




The anterior maxillary wall is very flat. The implant body reaches the zygoma bone following an intrasinusal path.

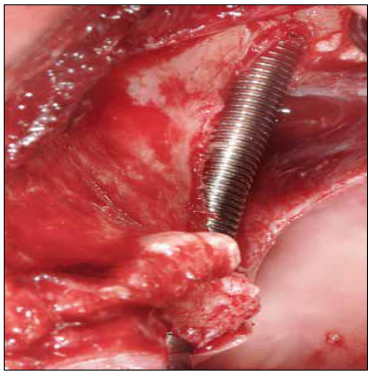
ZAGA-1

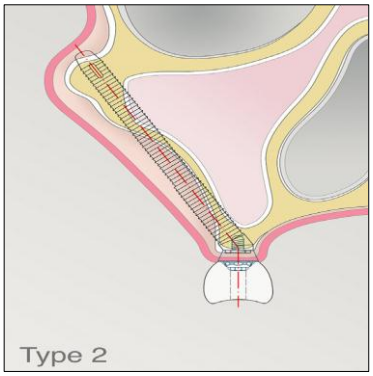




Mild concave anterior maxillary wall, implant osteotomy to perforate the maxillary wall. Implant body remained inside the maxillary oundaries.

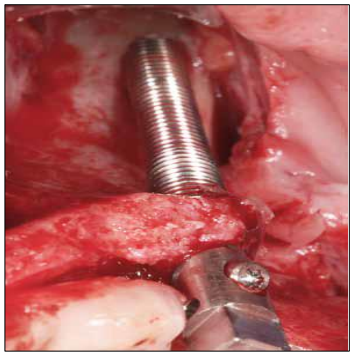
ZAGA-2

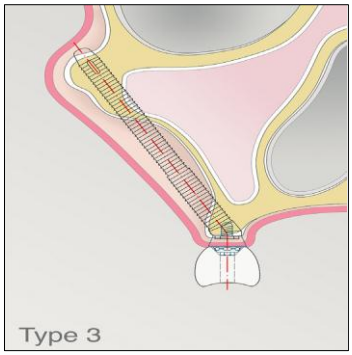




More concave maxillary wall, implant body to be placed extra-sinusally.

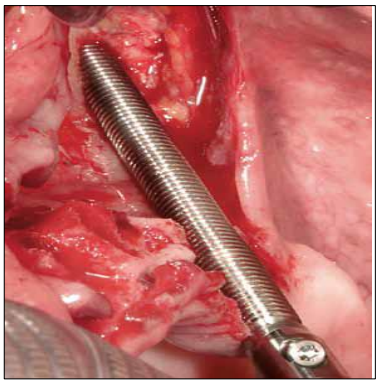
ZAGA-3

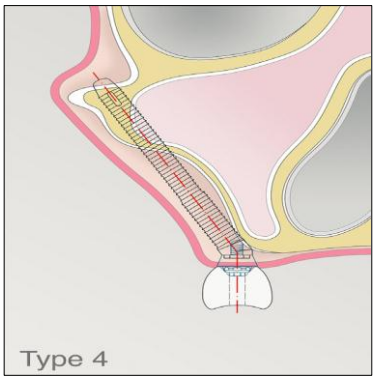




Very concave maxillary wall, implant head placed palatally

ZAGA-4

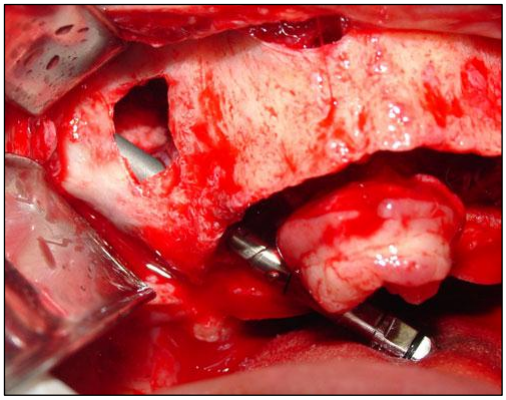


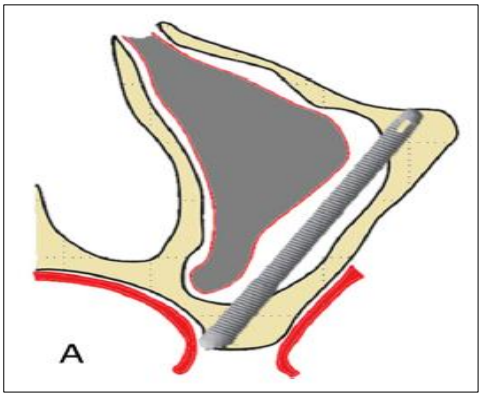


The maxilla presented vertical and horizontal resorption with buccal concavities. Placement of implant head to avoid perforation of a very thin palate. Extra-maxillary approach

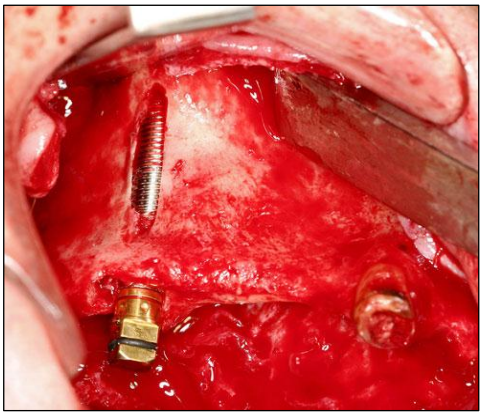
DIFFERENT TECHNIQUE

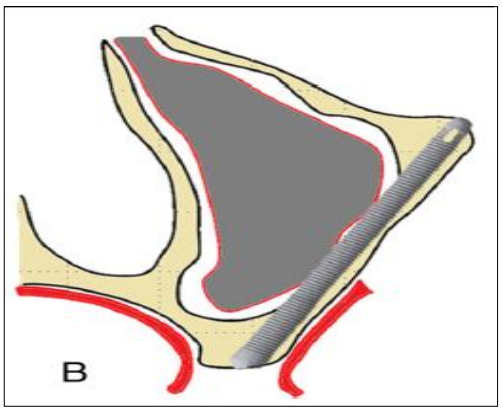
INTRA SINUS APPROACH



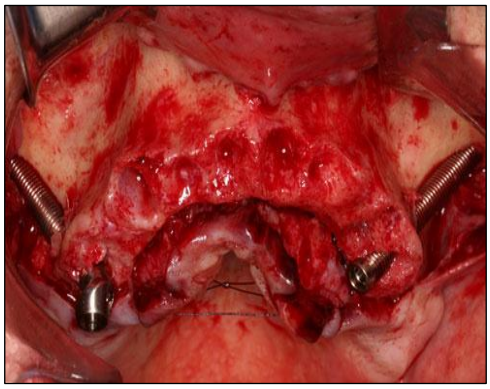


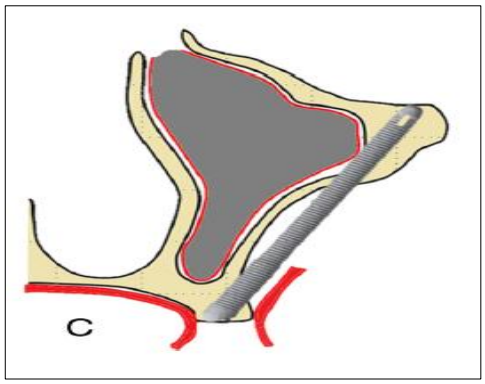
SINUS SLOT



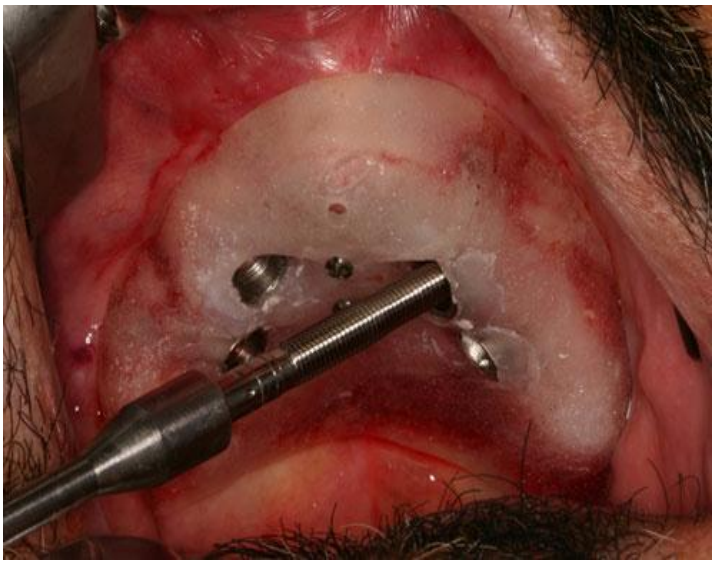


EXTRA MAXILLARY





MINIMALLY INVASIVE APPROACH



Zygomatic implant stability (Criteria A)

Success grade I	No mobility,	no pain
Success grade II	Light clinical mobility,	no pain
Success grade III	Clear clinical mobility- no evidence of disintegration of the apical part of implant or rotation	no pain
Success grade IV	Clear clinical mobility- evidence of disintegration of apical part of the implant	rotation and/or pain

Diagnosis of associated sinus pathology: Rhinosinusitis (Criteria B)

Sinus spaces		**No abnormality**	**Partial opacification**	**Total opacification**
Ant. ethmoid	R	0	1	2
	L	0	1	2
Post. ethmoid	R	0	1	2
	L	0	1	2
Maxillary	R	0	1	2
	L	0	1	2
Frontal	R	0	1	2
	L	0	1	2
Sphenoid	R	0	1	2
	L	0	1	2
Osteomeatal complex	R	Obstructed 2		not obstructed 0
	L			

Diagnosis on rhinosinusitis requires:0, 1 or 2-0 represents no abnormality; 1 represents partial opacification; and 2 represents total opacification,

The osteomeatal complex can only be scored as 0 or 2

Lanza-kennedy - Rhinosinusal clinical symptoms

Major criteria	**Yes/no**	**Minor criteria**	**Yes/no**
Facial pain or pressure		Headache	
Facial congestion or fullness		Fever (all non-acute)	
Nasal obstruction		Halitosis	
Purulent discharge		Fatigue	
Hyposmia or anosmia		Dental pain	
Purulence on examination		Cough	
Fever (acute only)		Otalgia or aural fullness	

Sinus pathology	
Success grade I	Lanza &kennedy (-), Lund-Mackay score =0
Success grade II	Lanza &kennedy (+), Lund-Mackay score =0
Success grade III	Lanza &kennedy (-), Lund-Mackay score >0
Success grade IV	Lanza &kennedy (+), Lund-Mackay score >0

Peri-implant soft tissue condition (Criterion C)

Zygomatic implant	
I	No recession
II	Light recession, implant head is visible (yuxta –gingival). No exposed threads
III	Recession upto seven exposed threads
IV	Recession. More than seven exposed threads

Prosthetic offset (Criteria D)

Implant position CT Anatomical Measurements Worksheet for Right and Left Zygomatic Implants		
A.1	Perpendicular distance between the tangent to the floor of the nose and sinus floor at the entrance of the zygoma implant level**.**	
A.2	Perpendicular distance between the tangent to the floor of the nose and the crest of the alveolar ridge at the entrance of the zygoma implant level.	
B.3	Distance between the midline of the palate and the center of the zygoma implant head.	
B.4	Distance between the midline of the palate and the center of the alveolar ridge.	

- 2-1= ; 4-3=

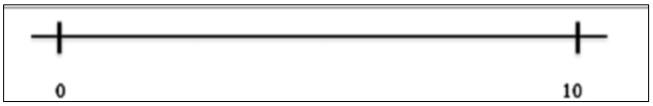
Prosthetic offset		
I	0mm≤ D≤ 6mm,	-3mm≤ D ≤0mm
II	6mm< D≤ 10mm,	-4mm≤ D <-3mm
III	10mm< D≤ 15mm,	-5mm≤ D <-4mm
IV	>15 mm	<-5mm

Zygomatic success code

Criteria	Condition & success	Score
A	Implant stability	1,2,3,4
B	Lund-Mackay staging system Lanza-kennedy	0,1,2 Yes/no
C	Peri-implant soft tissue condition	I,II,III,IV
D	Prosthesis	I,II,III,IV

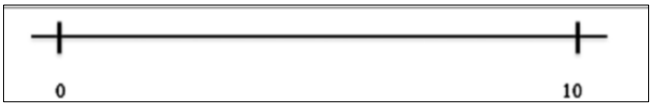
Visual analog scale-VAS

Post surgical



0 - there was no post-op difficulties and 10 with severe difficulties

Post-prosthetic



0 - complete dissatisfaction, and 10- complete satisfaction

Materials and Method

SUBJECT SELECTION

Subjects were selected from out-patient clinic, Department of Periodontics, Ragas Dental College & Hospital, Chennai. Subjects presenting with bilaterally edentulous atrophied maxilla, indicated for replacement with dental implants were included in this study.

SAMPLE SIZE:

The proposed sample size was 10 implants. Noris Medical Zygomatic implant™ were placed in the posterior region of completely edentulous maxilla in selected subjects

INCLUSION CRITERIA

Bilaterally completely edentulous maxilla fulfilling the following criteria was included in this study. The study comprised of participants of both gender. The patients were screened clinically and radiograpically.[14]

Only patients with Misch-Type III[124] edentulous maxillary arch (bone present in the posterior segment at different bone levels) and with Seibert's Class III ridge[124] (depicting ridge defect as a combination of both buccolingual and apicocoronal loss (both width and height) were taken up for further evaluation.

- CT scan and ENT evaluation was performed for these patients and they were classified according to **Aparicio**[14] ZAGA classification. Only

ZAGA-4 patients (pronounced buccal concavities of the maxilla) were included in this study.

EXCLUSION CRITERIA

- Any systemic illness/medications
- Radiation therapy to the head and neck region 12 months prior to the proposed therapy.
- Smoking
- Pregnant and lactating women
- Drug allergy
- Bisphosphonates medication
- Alcohol/ drug addiction
- Maxillary sinusitis

PRE-TREATMENT PROTOCOL

- Detailed medical and dental histories were recorded before patients were recruited in the study.
- Routine blood investigations
- Hard tissue parameters were assessed by dental radiographs, CT scan
- Clinical photographs were taken for documentation.

OBTAINING WRITTEN CONSENT FROM THE PATIENT

The college Institutional Review Board approved this study and an informed written consent was obtained from the study population. Patients who were enrolled in the study were given adequate instructions on oral hygiene maintenance and its role on the importance of success of implant therapy.

CLINICAL PARAMETERS

All clinical data regarding hard tissue dimensions were recorded using CT-scan by one independent dental examiner at baseline and one year after the prosthetic rehabilitation.

Zygomatic implant placement was planned according to guidelines proposed by **Lesley & Aparicio** based on **Bedrossian's** classification of maxilla into zone-1 and zone-2. In this study 2 conventional implants were placed in the anterior region for prosthetic rehabilitation.

SURGICAL PROCEDURE

Armamentarium

- Zygoma implants: (Noris Medical Zygomatic implant)
    - Implants with varying diameters and lengths ranging from 35mm to 57.5mm with 2.5mm increments
- Cover screw

- Zygoma healing abutments
- Multiunit abutment: (17°,30°,45° angulations)
- Zygoma drills:
  - Round bur
  - Zygomatic Burs for groove preparation- Fine, medium, course grit
  - Zygomatic Step Drills- D-2, 2.8, 3.2 mm, L-75,95
  - Long hex Driver-1.25mm, L- 14mm
  - Depth gauge- with 5mm of increments, 30-60mm
- Motor: Physio-dispenser with 20:1 hand piece
- Forceps: Gerald (toothed)
- Hemostats: long, curved (i.e., tonsillar)
- Hemostats: mosquito
- Needles: hypodermic 20 gauge, 1½-inch
- Pliers: crimping
- Retractors: beaver tails (Henahan), Army-Navy
- Scissors: Mayo
- Scalpel: long handle
- Suture: 2-0 black silk, Suture: 4-0 dyed Vicryl

PROCEDURE:

The operation was planned under general anesthesia (GA) with nasal intubation. Prior to administering GA, pre-operative investigations comprising

of Chest X-ray, ECG, Physician fitness & ENT evaluation were performed and anesthetist opinion was obtained.

Patients were given antibiotics prior to surgery. A throat pack and a gastric tube were used in each case. Local anesthesia (lignocaine and 2% adrenaline 15 ml) with 1:100000 adrenaline was injected into the maxillary buccal and palatal region. Sterile drapes, including the nasal area, were applied according to standard osseointegration procedures. However, the lateral part of the orbit was left uncovered so that it was possible to inspect and palpate during the operation.

OPERATIVE TECHNIQUE

A crestal incision was done from tuberosity to tuberosity. Vertical releases were placed posteriorly along the maxillary buttress and anteriorly within the midline region. A palatal flap was raised to expose the alveolar crest and the hard palate. The nasal mucosa was dissected to increase visibility of the local anatomy. Muco-periosteal flap elevation was done to expose the alveolar crest, the lateral maxilla, the maxillary antral wall, the infra-orbital nerve, the zygomatico-maxillary complex, and the lateral surface of the zygomatic bone.

Exposure of the infraorbital nerve was identified as the anterior limit for implant placement in case of which quad zygomatic implants was planned. The dissection subsequently continued along the infra-zygomatic crest towards the ZB which aided proper placement of zygoma retractor and direct

visualization of the base of the zygomatic bone. After visualizing the zygomatic bone, osteotomy site was planned.

A 20:1 implant hand piece with preset torque of at least 35 Ncm, a round bur was used to enter the base of the zygomatic bone. A course, medium and fine grit drill was used to mark the residual maxillary bone, penetrating through the atrophic maxillary alveolus and then 2 mm, 2.8mm, 3mm final twist drill was used to penetrate both the cortices of the zygomatic bone till its desired length. This final drill provided the implant site with the final width of the zygomatic implant.

The osteotomy depth was measured using a specially designed depth gauge. The device utilized the small hook to engage the superior cortex, and depth measurements were made with the aid of 5 mm markings along the depth gauge. The implant body engaged the lateral bony wall of the maxillary sinus which entered the zygomatic bone. The zygomatic implant goes in an extrasinus path. No bone grafts or membrane was used to close the space between the zygomatic implant and the maxilla to avoid the soft tissue recession post-operatively. Instead autogenous buccal pad of fat was dissected from behind the opening of parotid gland and it was used as axial flap to cover the soft tissue and for the closure of exposed implant surface. Two conventional implants were been placed in the anterior region.

A multi angulated-17° abutment was connected to the zygomatic implant together with sterile impression coping, the wound was closed by suturing. Impressions of both jaws and bite registration were made

immediately after surgery in order to process a provisional fixed bridge to be connected within 24 hours.

Wounds were evaluated for hemostasis, copious irrigation was applied, and primary closure was performed with 3-0 Vicryl sutures.

The patients were prescribed postoperative antibiotics and analgesics. The two-stage approach was scheduled for abutment connection 6 months later for manufacturing a provisional bridge.

FOLLOW-UP

The patients were scheduled for check-up examinations at the following time intervals from the day of surgery:

- 10 days: for suture removal and checking for interim-denture occlusion,
- 1 month: checking of occlusion
- 4 to 5 months: replacement of provisional bridge to a permanent one.
- 12 months: radiographic and other post operative measurements

PROCESSING OF PROSTHESIS

Healing abutment was removed and impression copings for an open tray were connected to the multi-unit by abutment screws. Access holes are secured with cotton. A special tray was fabricated for an open tray impression technique. Self-cure acrylic resin was used to splint the impression coping in

order to maintain the angulations for passive fit. After the resin is set, putty material was loaded to the tray and the impression was made. Impression coping should project out of the tray to access the screw holes.

Implant replicas were connected to the transfer copings and a cast was made with gingival mask. After the cast was set the splinted transfer copings were retrieved from the impression which was oriented over the implant replicas in the cast and checked for passive fit, and the jig trial was done in patient's mouth and checked for passivity.

After this trail acrylic record base with wax occlusal rim was fabricated over the jig. The record base was attached to the abutment and the occlusal rim was adjusted to vertical occlusal plane orientation. Adequate lip support and facial contours and tooth shape and size were also were evaluated.

Preliminary tooth set-up was made using conventional prosthetic principles and tried on the patient and evaluated for the vertical dimension, occlusal relationship, cantilevers, cuspal inclination, tooth shade and shape, hygiene access, lip support, facial contour and phonetics.

The trial denture was then processed to final denture with heat cure acrylic resin using lost wax technique. The excess material was trimmed into fixed provisional bridge, the palatal portion was removed and buccal flanges were re-contoured. Any cantilevers that exist distal to the position of the zygomatic implant were trimmed. The palatal surface of the bridge was made

convex and smoothly polished to avoid food impaction and bacterial accumulation.

Finally bridge was placed on the abutments and tightened using prosthetic screws to 15 Ncm using hex drive and manual torque wrench, then the screw access holes were blocked out with cotton and self-cure acrylic resin.

POST-OPERATIVE PARAMETERS

A VAS rating was used for evaluation of immediate post surgical complication such as pain, swelling, odema etc where the reference score was 0 if there were no post-op difficulties and 10 with severe difficulties.

Patient were re-evaluated after final prosthesis and one year later for evaluating the Zygomatic Success Code for zygomatic implant, using CT scan and ENT evaluation which represented the final outcome of the following variables:

I. Zygomatic implant stability;
II. Associated sinus pathology;
III. Peri-implant soft-tissue condition;
IV. Specific criteria for zygomatic prosthesis success (prostheses bucco-lingual offset).

I. ZYGOMATIC IMPLANT STABILITY[13,14]

Implant stability was evaluated individually after one year of implant placement and prosthetic rehabilitation

II. ASSOCIATED SINUS PATHOLOGY

Frequently associated complication such as rhinitis and sinusitis were assessed by two scoring: Lund-Mackay staging and Lanza and kennedy score. (Annexure)

LUND-MACKAY COMPUTED TOMOGRAPHY STAGING SYSTEM-1993[79]

This system was used to score six sinus region: anterior ethmoid, posterior ethmoid, maxillary sinus, frontal sinus, sphenoid sinus, osteometal complex for sinus pathology. The score 0- represents no abnormality; 1- represents partial opacification; 2 -represents total opacification. For the osteomeatal complex the score is either 0 or 2. This score is done pre-op and post-op evaluation.

LANZA-KENNEDY - RHINOSINUSAL CLINICAL SYMPTOMS-1997[93]

It is patient related questionnaire to identify the rhinosinusal clinical symptoms. Each symptom question was answered by “yes” or “no”. The

diagnosis of sinusitis required a "yes" answer in two or more major criteria, one major and two or more minor criteria, or purulence on nasal examination.

III. PERI-IMPLANT SOFT TISSUE CONDITION[14]

Soft tissue around the zygomatic implant were assessed one year after the implant placement and prosthetic replacement where the exposed implant surface was measured from the implant head to the soft tissue recession area.

IV. PROSTHETIC OFFSET[14,16]

Prosthetic success depends on the anatomic measurements to assess the implant position of the head of the zygomatic implant.

Four anatomical measurements were performed to assess the following:

1. Perpendicular distance between the tangent to the floor of the nose and sinus floor at the entrance of the zygomatic implant level.

2. Perpendicular distance between the tangent to the floor of the nose and the crest of the alveolar ridge at the entrance of the zygoma implant level.

(i) The height of the alveolar ridge at the location of the head of the zygomatic implant (measurement 2 minus 1)

3. Distance between the midline of the palate and the center of the zygomatic implant head.
4. Distance between the midline of the palate and the center of the alveolar ridge.

(ii) The position of the head of the ZI with regard to the center of the crest of the alveolar ridge in the horizontal axial dimension (measurement 4 minus 3).

A positive value on this implant head position to the alveolar ridge relationship indicates a palatal position of the implant. The negative value indicates a buccal emergency.

The ZSC score was calculated by obtaining the mean of all the individual scores.

Twelve months post-operative review

The VAS scale was used 12 months post-op after the prosthesis is done for the following criteria - considering the stability and comfort of the prosthesis, ability to speak with the prosthesis, oral hygiene maintenance, aesthetic, self-esteem these are the parameters used for evaluating the implant.

Patients answered questions giving values from 0 (completely dissatisfied) to 10 (completely satisfied) for each item

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Phone: (044) - 24530003-06

DEPARTMENT OF PERIODONTOLOGY

CASE SHEET

Patient Name : **Date :**

Age / Sex: **Op No :**

Address : **Occupation:**

Contact No :

Chief Complaint:

History of Present Illness:

Past Dental History:

Past Medical History:

Family History:

Habits:

Clinical parameters

Hard tissue examination:

Soft tissue examination:

Investigations:

Radiological

- **Pre-operative – OPG**
- **Pre-operative- CT**
- **Post- operative- OPG**
- **Post- operative - CT**

Laboratory

- Routine blood investigations
- Blood pressure

Criterion A- Zygomatic implant stability (individually tested)

Implant number	**Success code**

Criteria B - Lund-Mackay Computed Tomography staging system

Sinus spaces		No abnormality	Partial opacification	Total opacification
Ant. ethmoid	R			
	L			
Post. Ethmoid	R			
	L			
Maxillary	R			
	L			
Frontal	R			
	L			
Sphenoid	R			
	L			
Osteomeatal complex	R	Obstructed	Not obstructed	
	L			

Criterion B- Lanza-kennedy - Rhinosinusal clinical symptoms-1997

Major criteria	Yes/no	Minor criteria	Yes/no
Facial pain or pressure		Headache	Yes
Facial congestion or fullness		Fever (all nonacute)	
Nasal obstruction		Halitosis	
Purulent discharge		Fatigue	
Hyposmia or anosmia		Dental pain	
Purulence on examination		Cough	
Fever (acute only)		Otalgia or aural fullness	

Criteria B : Associated Sinus Pathology

Implant number	Lund-Mackay Staging	Lanza-kennedy	Overall score

Criterion C-Peri-implant soft tissue condition

Implant Number	Soft tissue margin

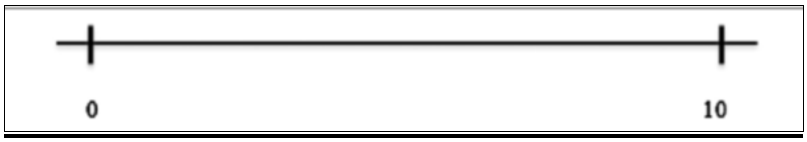
Criterion D-Prosthetic offset

Implant position	A.1	A.2	B.3	B.4
	2-1=		4-3 =	

Zygomatic success code

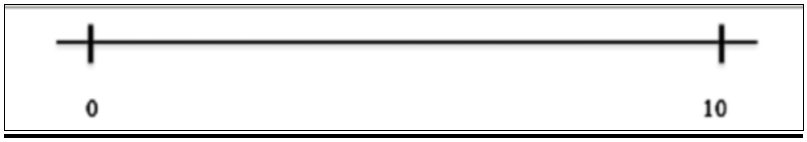
Criteria	Condition & success	Score
A	Implant stability	
B	Lund-Mackay staging system Lanza-kennedy	
C	Peri-implant soft tissue condition	
D	Prosthesis	

Post surgical VAS Score



0 - there was no post-op difficulties and 10 with severe difficulties

Post - prosthetic VAS Score



0 - complete dissatisfaction, and 10- complete satisfaction

RAGAS DENTAL COLLEGE AND HOSPITAL, CHENNAI.

DEPARTMENT OF PERIODONTICS

INFORMED PATIENT CONSENT

Patient Name: **Age:**

Sex:

I have been clearly explained and informed regarding the following surgical procedure to be performed on myself (*zygotic implants placed byextra maxillary approach for ZAGA-4*) in the language known to me (.....) and I have no objection for the treatment and if the treatment shows no anticipated results, I agree to undergo suitable/alternative method for the same. I give my consent for photographs and radiographs to be taken at the beginning, during, and at the end of the study.

PLACE:

DATE:

SIGNATURE OF PATIENT **SIGNATURE OF P.G STUDENT.**

SIGNATURE OF GUIDE **SIGNATURE OF H.O.D.**

ராகஸ் பல் கல்லூரி மற்றும் மருத்துவமனை, சென்னை.

ஈறு நோய் கண்டறிதல் துறை

ஒப்புதல் படிவம்

_____என்ற முகவரியில் வசிக்கும் திரு / திருமதி _____,வயது _____ வருடம், ஆகிய நான் என் சுய நினைவுடன் ,முழுமனதுடன்

கீழ்க்கண்டவைகளைக்கு சம்மதிக்கிறேன்.

1. நான் சம்பந்தப்பட்ட மருத்துவ ஆய்வு பற்றி விளக்கமாக எடுத்துகூறக் கேட்டுத் தெளிந்தேன்,
2. நான் இந்த மருத்துவ ஆய்வுக்காக என்னை பரிசோதனை செய்ய சம்மதித்து முழுமனதுடன் அவர்களுக்கு ஒத்துழைப்பு அளிக்கிறேன்.
3. நான் இந்த மருத்துவ முறை / ஆய்வு பற்றிய எனது சந்தேகங்களை விளக்கமாக மருத்துவரிடம் கேட்டு தெளிவு பெற அனுமதிக்கபட்டேன் / தெளிவுபெற்றேன்.
4. நான் முழுமனதுடன் மருத்துவர்களுக்கு இந்த பரிசோதனை முயற்ச்சிக்கு அனுமதியளித்து, அவர்கள் செய்முறைக்கு முழுஒத்துழைப்பு அளிப்பேன்.
5. இதன் பிறகு சுமார் _____ காலத்திற்கு தொடர் மருத்துவ ஆய்விற்கு ஒத்துழைப்பேன்.
6. எனக்கு இந்த ஆய்வு முறையில் விருப்பம் இல்லையென்றால் எப்பொழுது வேண்டுமானாலும் எழுத்து மூலமாக விண்ணப்பித்து விலகிக்கொள்ள அனுமதி பெற்றுள்ளேன்.

மேலே கூறப்பட்ட அனைத்தும் பயனாளிக்கு என்னால் எடுத்துக்கூறப்பட்டு அவர் தன் முழு சம்மதத்தை என் முன்னால் தன் சுய நினைவுடன் எழுதி வழங்கியுள்ளார்.

சாட்சிகள் : 1.

2.

ஒப்பம் முதுகலை மாணவர் ஒப்பம் பயனாளி / நோயாளி

ஒப்பம் பேராசிரியர் ஒப்பம் துறைத்தலைவர்

INFORMED PATIENT CONSENT- General Anaesthesia

I D/o, aged aboutyears residing at _____do hereby solemnly and state as follows:

I have been explained about the nature and purpose of the treatment (zygomatic implants) which I have to undergo surgery under General Anaesthesia. I give my consent after knowing full consequence during the surgery and post-op complication (post-surgical infection; bleeding; swelling; pain; sinus or nasal perforation; spasms; bone fracture; poor healing; paraesthesia of the lip, chin and tongue), which is usually temporary, but, on occasion, may be permanent. I have been given the opportunity to ask questions about the procedure. I was explained about the procedure and understood the same and I give my full consent. I sign this form.

Signature of the PG student

Signature of the Patient

Signature of the Attender

Signature of the Guide:

Signature of the HOD

ராகஸ் பல் கல்லூரி மற்றும் மருத்துவமனை, சென்னை.

ஈறுநோய்நோய்கண்டறிதல்துறை

பொதுமயக்கமருந்து-ஒப்புதல்படிவம்

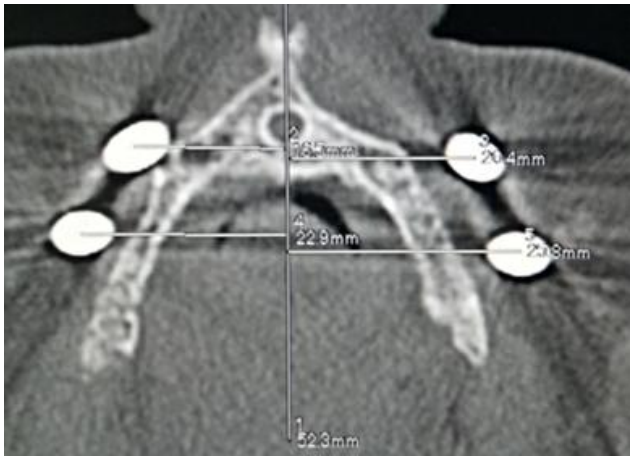
_____நான்,வயது _____ தந்தைபெயர் _____

நான் ஜெனரல் அனெஸ்தீசியாவின் கீழ் அறுவைசிகிச்சைக்கு உட்படுத்தப்பட வேண்டிய சிகிச்சையின் இயல்பு மற்றும் நோக்கம் (ஜிகோமடிக் உள்வைப்புகள்) பற்றி விளக்கப்பட்டுள்ளது. அறுவை சிகிச்சை மற்றும் பிந்தைய சிக்கல்கள் பின்தொடர்தல்போன்றவை, இரத்தப்போக்கு, வீக்கம், சினஸ் அல்லது நாசி துளைத்தல், வலிப்பு, எலும்புமுறிவு, ஒழுங்கற்ற குணப்படுத்துதல், உதடு, கன்னம் மற்றும் நாக்கு ஆகியவை) இது வழக்கமாக தற்காலிகமானது, ஆனால், சில சமயங்களில் நிரந்தரமாக இருக்கலாம். செயல் முறைபற்றிய கேள்விகளைக் கேட்க எனக்கு வாய்ப்பு கிடைத்தது. நான் செயல் முறை பற்றி விளக்கினார் மற்றும் அதே புரிந்து மற்றும் நான் என் முழு ஒப்புதல் கொடுக்கிறேன். நான் இந்த வடிவத்தில் கையொப்பமிடுகிறேன்.

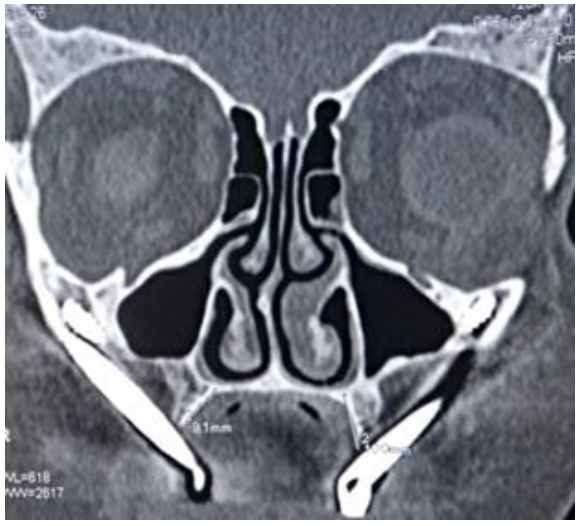
ஒப்பம் முதுகலை மாணவர் ஒப்பம் பயனாளி / நோயாளி

ஒப்பம் பேராசிரியர் ஒப்பம் துறைத்தலைவர்

Anatomical measurements for the right and left zygomatic implants for prosthetic offset by CT evaluation



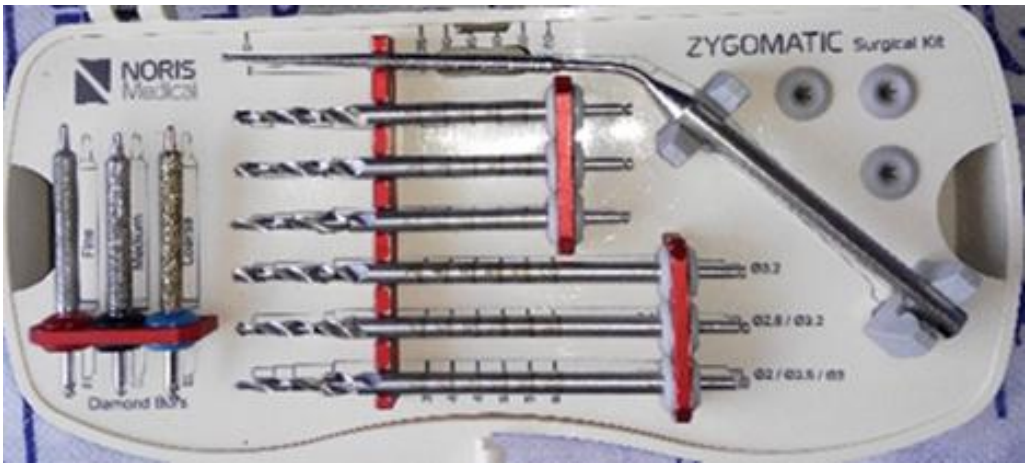
The position of the head of the Zygomatic implant with regard to the center of the crest of the alveolar ridge in the horizontal axial dimension



Height of the alveolar ridge at the location of the head of the Zygomatic implant

ARMAMENTARIUM

Zygomatic implant kit



Zygomatic implant

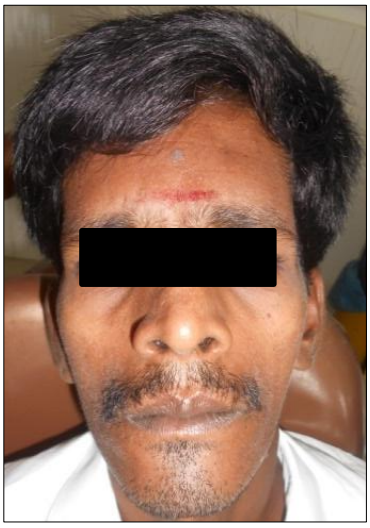
Coarse bur

Photographs

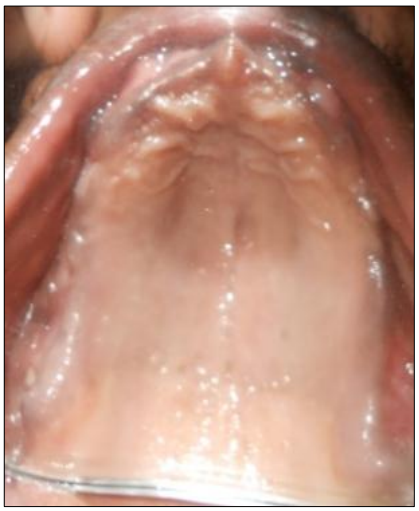
CASE I

Pre-operative

1.A. Facial view

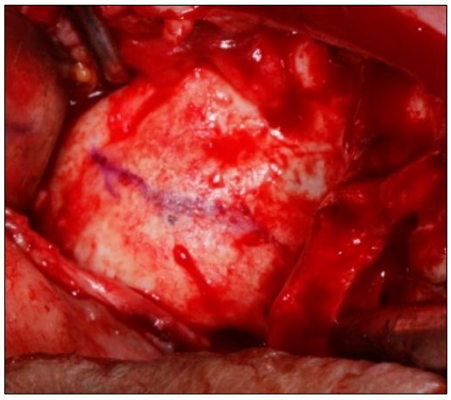


1.B. Intra oral view

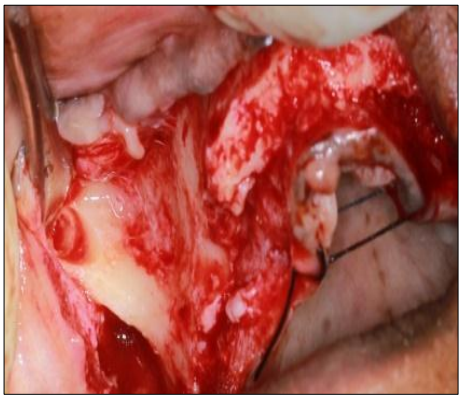


PROCEDURE

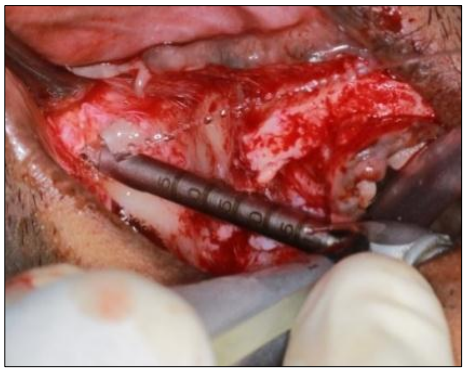
2.A. Locating the zygomatic bone



2.B. Initial osteotomy

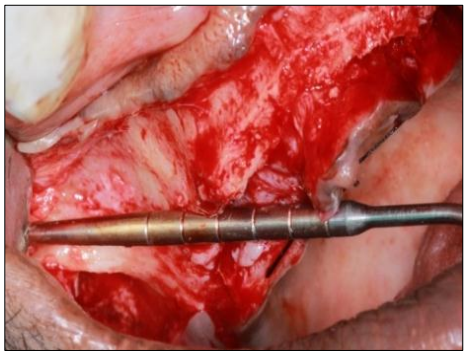


2.C. Step drills in zygomatic bone

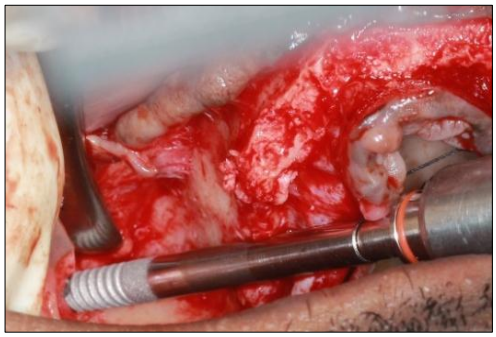


2.D. Coarse bur

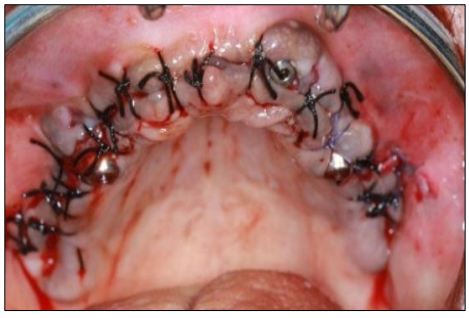
2.E. Depth gauge



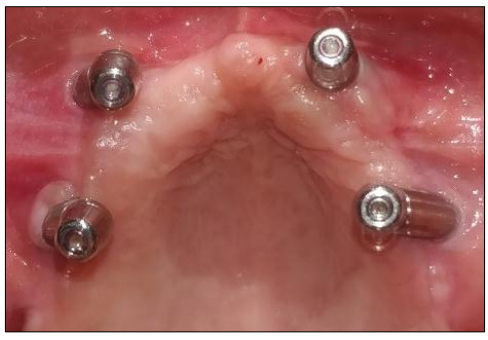
2.F. Zygomatic implant placed



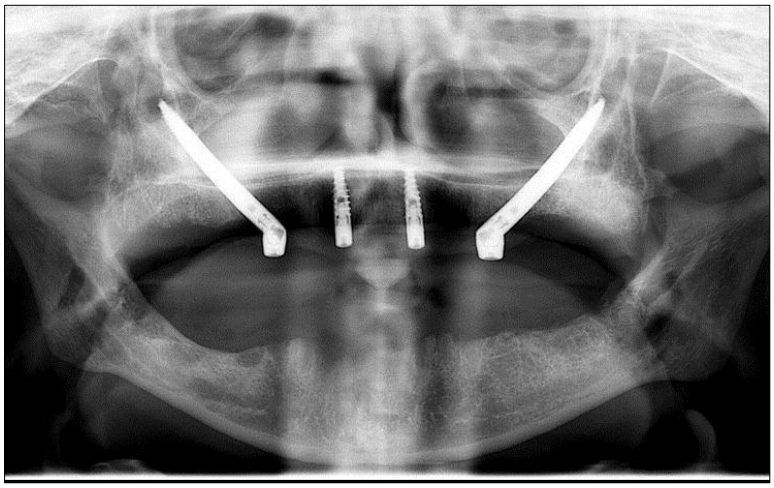
2.G. Sutures



2.H.Multi-unit with healing abutment

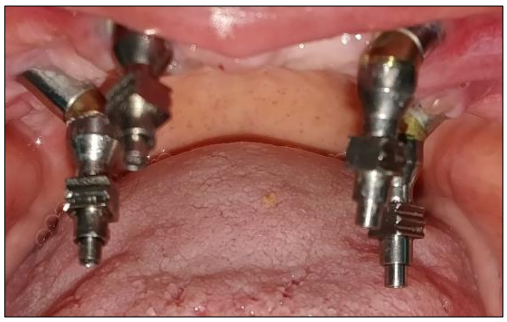


3.A.Immediate post-operative

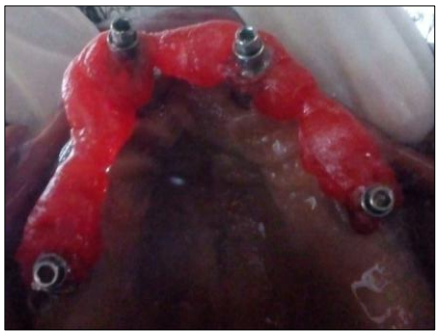


4. Prosthetic procedure

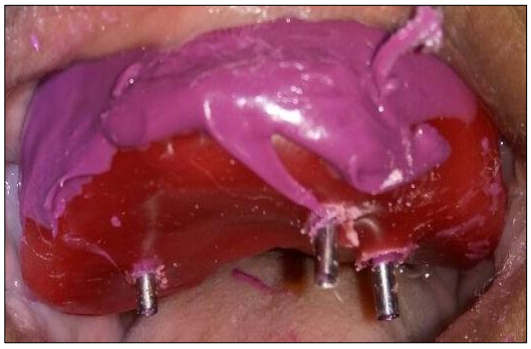
4.A.Transfer coping



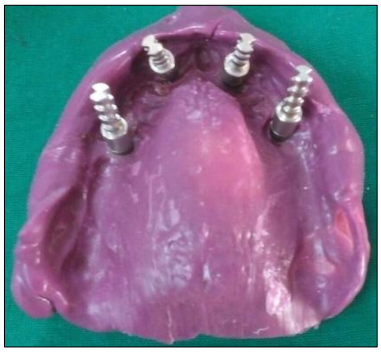
4.B. Acrylic splinting



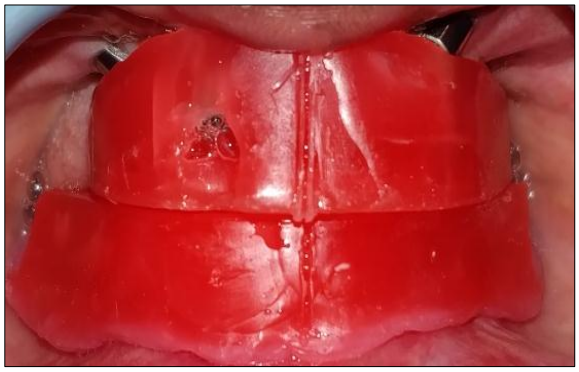
4.C. Putty impression



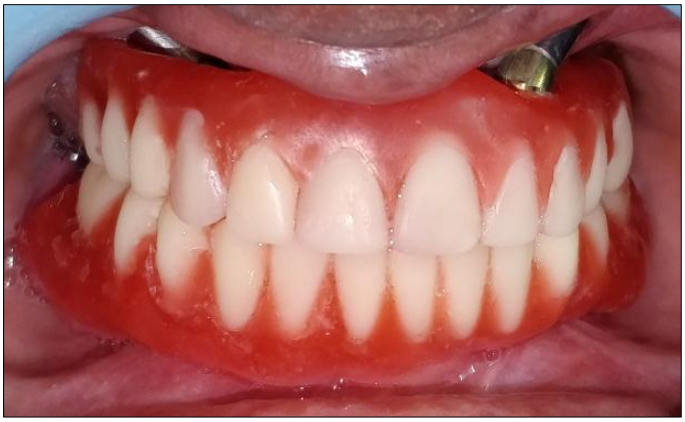
4.D. Pick up impression



4.E. Jaw relation

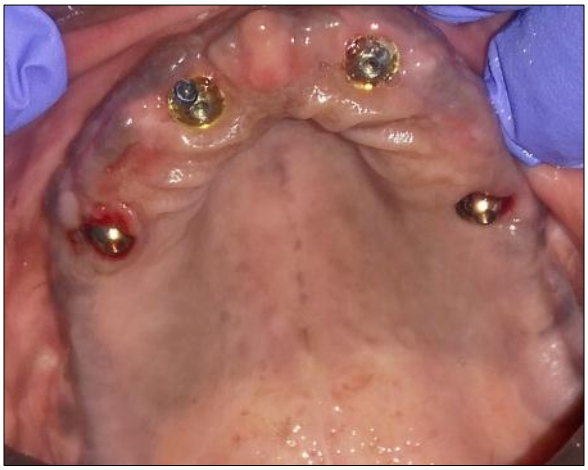


4.F. Wax trial



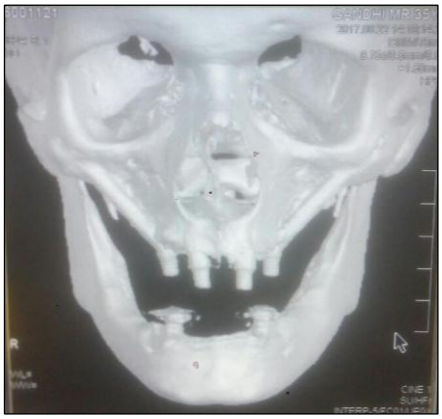
5.A. Post prosthetic view

5.B. Post-operative after one year prosthetic loading

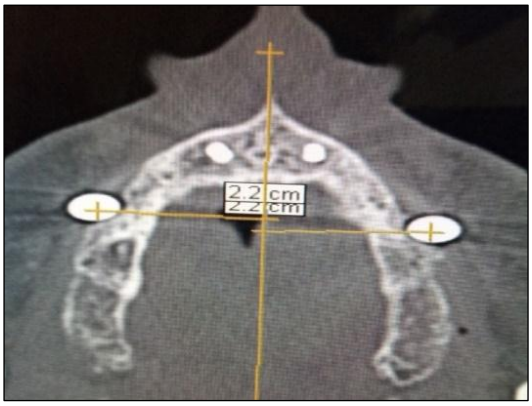


6. CT scan

6.A. Post- operative CT evaluation



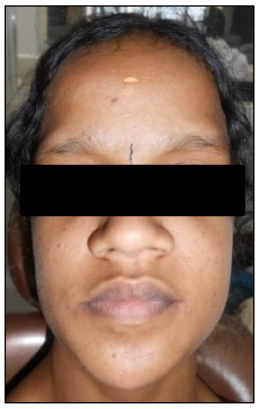
6.B. Post- prosthetic evaluation



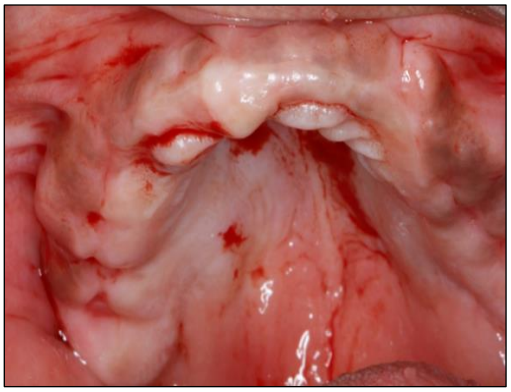
CASE II

Pre-operative

1.A. Facial view

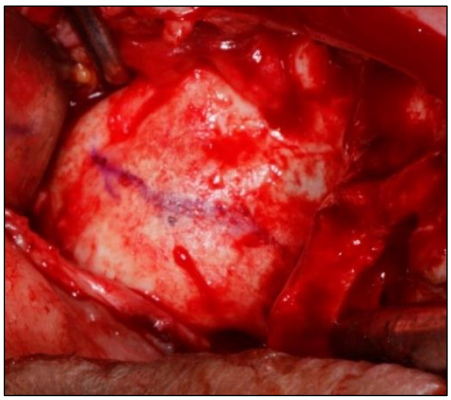


1.B. Intra-oral view

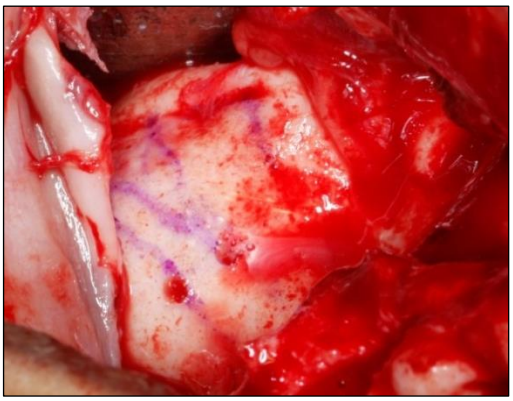


PROCEDURE

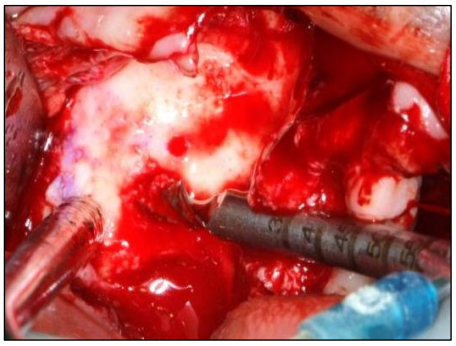
2.A. Locating the zygomatic bone



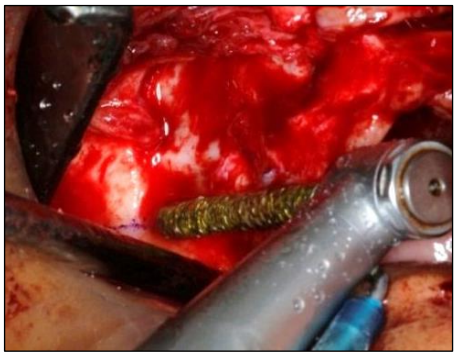
2.B. Initial osteotomy



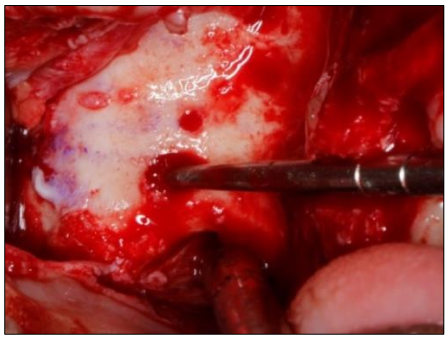
2.C. Step drills



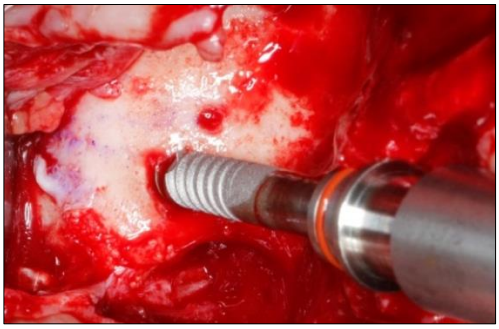
2.D. Coarse bur



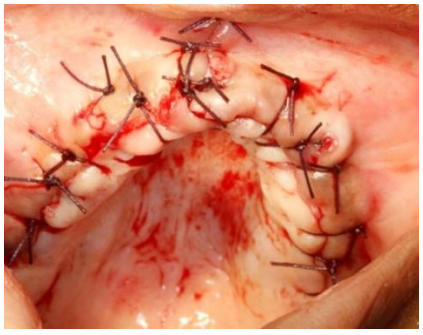
2.E. Depth gauge



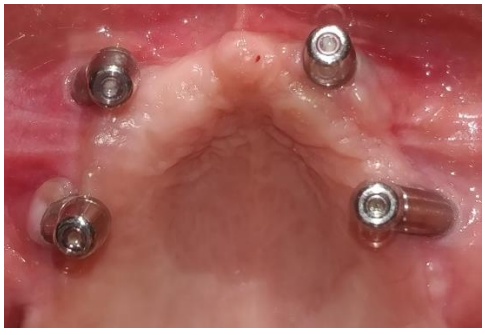
2.F. Zygomatic implant placed



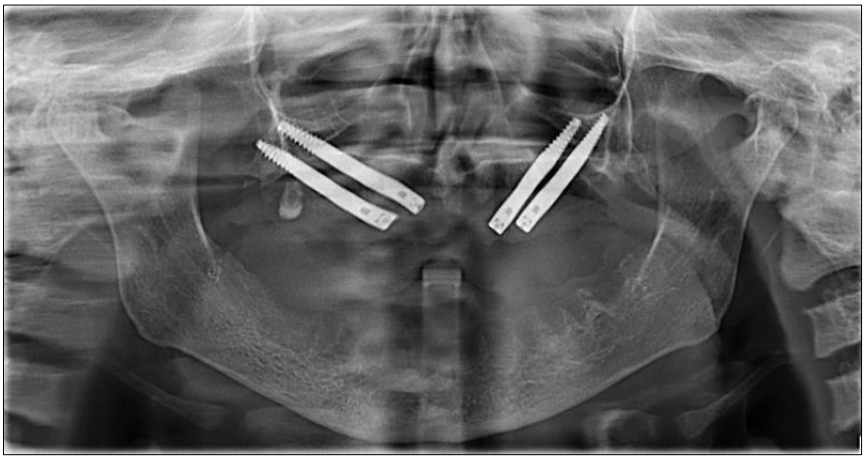
2.G. Sutures



2.H. Multi-unit with healing abutment

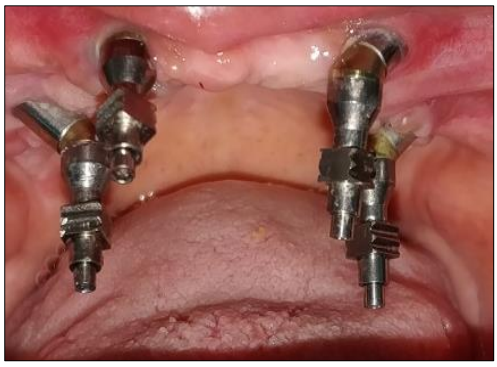


3.A. Immediate post –operative

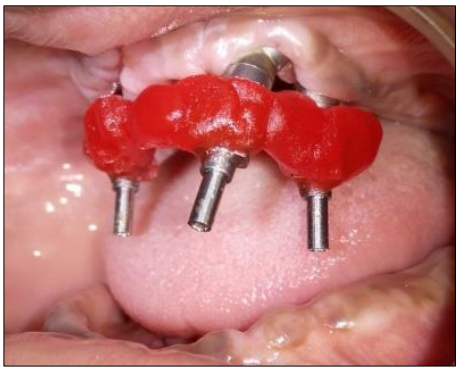


4. PROSTHETIC PROCEDURE

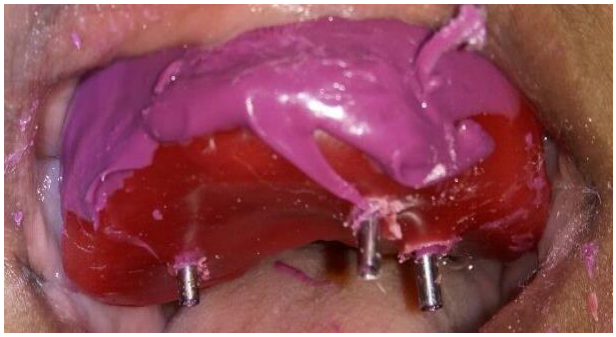
4.A. Transfer coping fixed



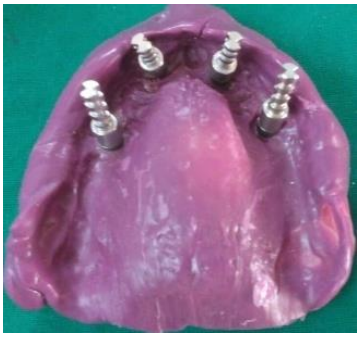
4.B. Acrylic splinting



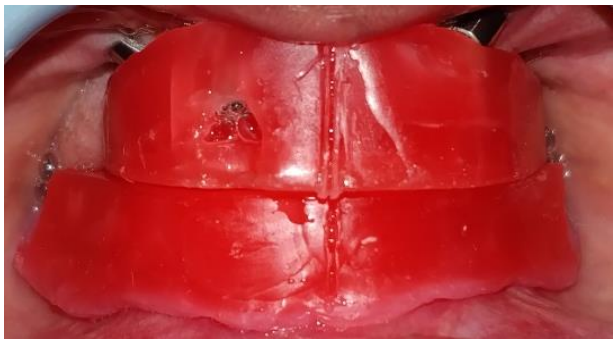
4.C. Putty impression



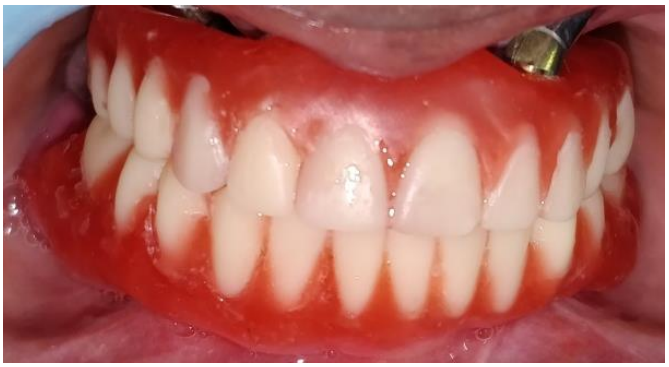
4.D. Pick up impression



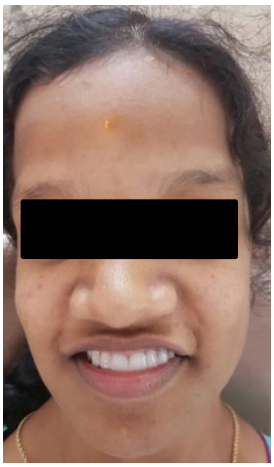
4.E. Jaw relation



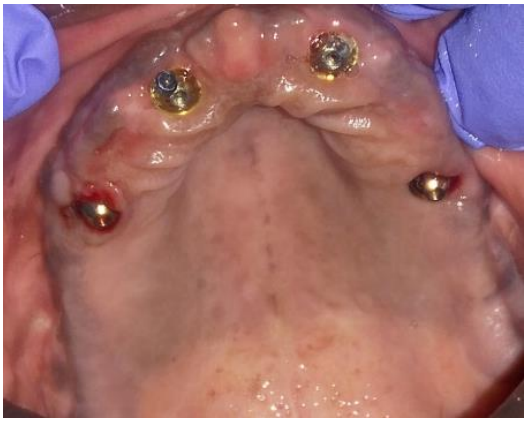
4.F. Wax trial



5.A. Post-prosthetic view

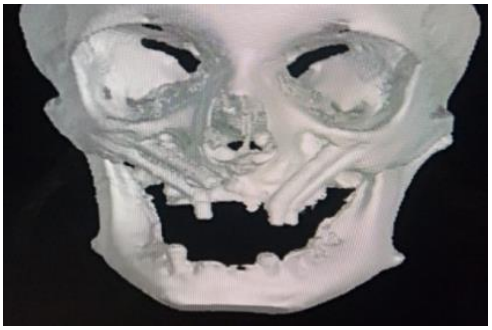


5.B. Post- operative after one year Prosthetic loading

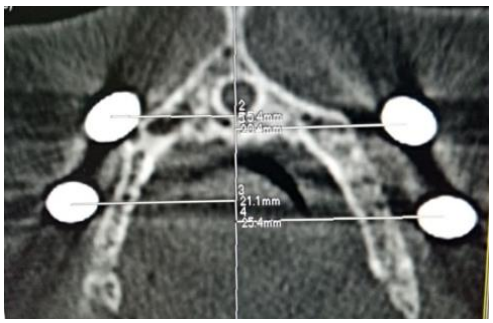


6. CT Scan

6.A. Post- operative CT evaluation



6.B. Post -prosthetic evaluation



Results

RESULTS

The present clinical study was done to evaluate ten zygomatic implants placed on ZAGA-4 patients by the extra maxillary approach. Subjects were evaluated pre and post operatively and parameters were recorded at baseline and one year after surgery. Implant related soft and hard tissue changes were assessed using zygomatic success code (ZSC) one year after the procedure and prosthetic rehabilitation was done. ZSC was evaluated using select parameters and specific criteria need to be met for measuring success/survival of zygomatic implants. ZSC is represented by the following criteria-

Criteria A-Zygomatic implants stability;

Criteria B-Associated sinus pathology;

Criteria C-Peri-implant soft-tissue condition;

Criteria D-Specific criteria for zygomatic prosthesis success (prostheses bucco- lingual offset).

DIMENSIONS OF ZYGOMATIC IMPLANT

A standard diameter of 4.2mm implant was placed on all ten sites with varying range of lengths with a minimum length of 35mm and maximum length of 45mm.

VISUAL ANALOG SCALE (VAS)

Immediate post-surgical VAS scoring was done to evaluate the pain, swelling, oedema (post-op complication), and two implant had score of 1, five implants had score of 2, three implants had score of 3. The mean VAS score was 2. Table-3, graph-2.

ZYGOMATIC SUCCESS CODE (TABLE-2, GRAPH-1)

Zygomatic success code was based on the following criterion.

Criteria-A: recording implant stability was evaluated after one year post-op period. All ten implants placed exhibited no pain, no mobility or any associated pathology. All implants were given a success code of 1 (no pain/mobility), hence a **mean value of 1** was derived. (Table-2, graph-1)

C**riteria-B:** diagnosed associated sinus pathology. This criterion was scored based on two parameters. Task Force Questionnaire developed by Lanza & Kennedy was evaluated based on clinical symptoms and Lund-Mackay (L-M) staging system was assessed for rhinosinusitis.

Diagnosis of rhinosinusitis was based on a 'yes' answer in two or more major criteria, in one major and two or more minor criteria or purulence on nasal examination. There was no purulent discharge or any rhinosinusitis symptoms for all the questions. Hence Lanza & Kennedy test was scored negative (-) for all ten implants.

Lund-Mackay score when analysed by an independent ENT specialist using CT-scan images, revealed no abnormality or any changes in opacification in the sinus region in all the implants placed.

L-M score of'**0**'was designated to all ten implants. When both Lanza & Kennedy test and L-M score were evaluated together the associated sinus pathology for Criteria B was and the success code for the sinus associated pathology was scored 1 for all ten implants, with a **mean value of 1**. (Table-2, graph-1)

Criteria-C: was based on peri-implant soft tissue condition. Among the ten zygomatic implants placed, three zygomatic implants revealed no soft tissue recession, and were scored 1, five zygomatic implants exhibited recession where the implant head was visible (scored 2) and two zygomatic implants exhibited recession up to 7mm and were scored 3 with a **mean score of 1.9**.(Table-2, graph-1)

C**riteria-D:** evaluated prosthetic offset using axial and coronal sections on the CT scan. The value which was derived from the CT scan by using the (Anatomical Measurements Worksheet for Right and Left Zygomatic Implants- Annexure)and was found to be negative, indicating that prosthetic offset of ZI is buccally placed and thus a score of 1 was given. All ten zygomatic implants had ZSC of 1 and with a **mean was 1**. (Table-2, graph-1)

Success grade of the implant was determined by the highest number (representing worst condition) scored among the four criterion. Thus the ten zygomatic implants were given the success grade depending on the worst success code (eg-1/3/2/1- classified as success grade III) Table-2.

Thus among the ten zygomatic implants, three implants were given ZSC of Grade I, five implants were given ZSC of Grade II and two implants were given ZSC of Grade III.

Overall ZSC is 1/1/3/1

VISUAL ANALOG SCALE (VAS)

After 12 months of post-prosthetic assessment was done to evaluate the implant fixed prosthesis. A minimum score of 7 and maximum score of 9 was obtained and the mean value of 8 which indicated good patient satisfaction Table-3,graph-3.

The overall survival rate of the all the ten implants was 100% for a 12 months follow-up.

Tables and Graphs

TABLES 1: DIMENSIONS OF ZYGOMATIC IMPLANT

Implant number	Implant size(mm)	
	Diameter	**Length**
1	4.2	45
2	4.2	45
3	4.2	37.5
4	4.2	40
5	4.2	35
6	4.2	35
7	4.2	40
8	4.2	40
9	4.2	40
10	4.2	40

TABLE 2: ZYGOMATIC SUCCESS CODE

Implant number	Implant stability	Associated sinus pathology	Peri-implant soft tissue condition	Prosthetic offset	Success code	Success grade
1	1	1	1	1	1/1/1/1	I
2	1	1	1	1	1/1/1/1	I
3	1	1	2	1	1/1/2/1	II
4	1	1	2	1	1/1/2/1	II
5	1	1	2	1	1/1/2/1	II
6	1	1	2	1	1/1/2/1	II
7	1	1	1	1	1/1/1/1	I
8	1	1	2	1	1/1/2/1	II
9	1	1	3	1	1/1/3/1	III
10	1	1	3	1	1/1/3/1	III
Mean	1	1	1.9	1	1/1/3/1	II

A Zygomatic Success Code scored by a code that includes four digits, each representing one specific criterion of success. A number is given depending on the condition of each criterion (e.g. 1/3/2/1). The success grade of the implant is determined by the worst condition of the four criteria (e.g. 1/3/2/1 would be classified as success grade III).

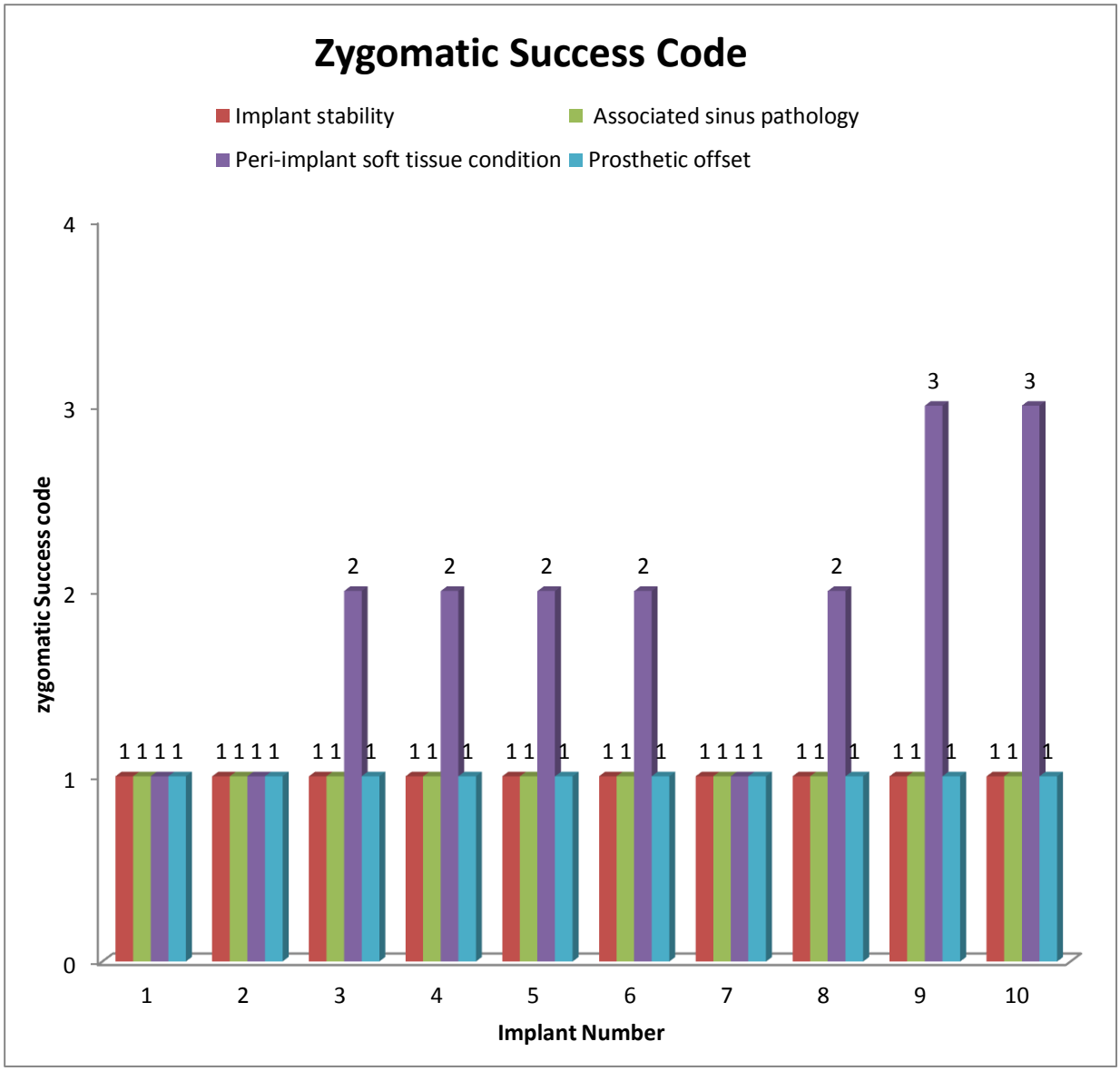
TABLE 3: VAS-VISUAL ANALOG SCALE

Implant number	**VAS[#] immediate post-surgical (0-10)**	**VAS[*] 12-month post-prosthetic (0-10)**
1	2	8
2	1	8
3	2	7
4	2	9
5	3	7
6	2	8
7	3	9
8	2	8
9	1	7
10	2	9
Mean	**2**	**8**

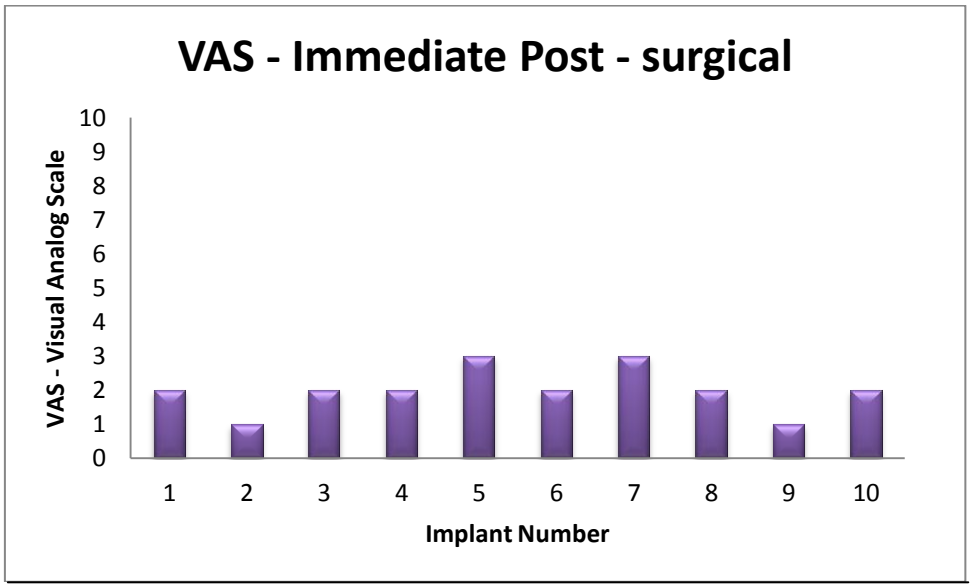
In VAS[#]: 0 indicates no post-operative difficulties and 10 indicates severe difficulties post surgically after placement of Zygomatic implant.

In VAS[*]: 0 indicates complete dissatisfaction and 10 indicates complete satisfaction after prosthetic rehabilitation.

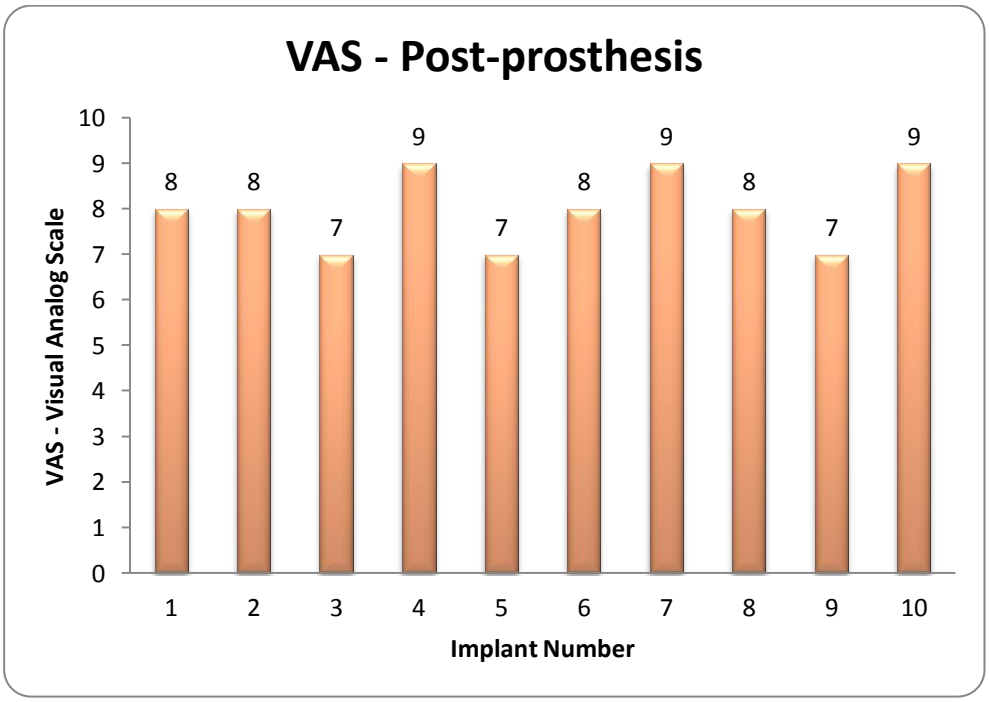
GRAPH 1: ZYGOMATIC SUCCESS CODE



GRAPH 2: VAS# (0-10)



GRAPH 3: VAS* (0-10)



Discussion

DISCUSSION

The zygomatic implant was initially used to rehabilitate the maxillectomy defects that occurred as a result of surgical excision following malignancies or other major defects.[77, 117] The limitations associated with procedures such as sinus augmentation and inlay-onlay bone grafts for ridge augmentation lead to the more widespread use of zygomatic implants in the atrophic posterior maxilla. In addition to overcoming the graft related problems, these implants resulted in a much shortened treatment time because of possibility of loading immediately after placement. [126]

Several investigators have evaluated the suitability of using the zygomatic bone for implant placement. The highly cortical nature of the zygoma makes it possible to obtain very high insertion torque and presumably good primary stability.[87] The importance of primary stability for osseointegration and the long term success of implants have been too well documented to need any further elaboration.

Conversely, other reports have suggested that zygoma with its minimal cancellous content does not provide enough osteoblast/osteoclast coupling that is required for the remodelling that is integral to osseointegration.[108,82] These authors have therefore questioned the use of zygomatic bone for implant placement.

In clinical practice however several studies done using all-on-four[97] have reported predictable results after engaging cortical bone such as nasal buttress and lower border of the mandible, both of which exhibit a similar lack of cellular activity. These results would suggest that a very cortical zygoma may provide a predictable site for placement of dental implants. Regardless of presence or absence of adequate cellular activity, several authors have investigated on the long term results following the placement of zygomatic implant and reported survival rates ranging from 95to 100%.[66,64,115]

This study was undertaken in accordance with these previous results.

The use of zygomatic implant however necessitates a thorough understanding of the anatomy of zygoma and its related structures to avoid iatrogenic injury to important structures such as orbital plate, infra orbital nerve and the zygomatic arch.[76]

It has also been suggested that sufficient volume of body of zygoma at the "Z point" is an essential pre-requisite for implant placement. [77] Previous reports have indicated that a minimum dimension of 14mm anteroposteriorly and 5 mm mediolaterally is required for safe implant placement in the zygoma.

In accordance with these reports, we have included only those patients who fulfill these dimensional criteria in this study.[31, 56]

An additional advantage of zygomatic implants over graft based solutions is shortened treatment time due to the possibility of immediate loading after placement. **Bedrossian et al (2006)**[31,50] reported a 100% survival rate in a total of 28 zygomatic implants, with prosthetic loading done immediately after surgery. Following this there has been increased acceptance for this protocol and several authors had reported survival rates ranging from 95.8 % to 100%.[66, 60,115]

The immediate loading treatment protocol adapted in this study was in accordance with these studies.[32,48]

Following surgical and prosthetic difficulties encountered with zygomatic implants, **Aparicio** introduced the ZAGA approach that was based on the anatomy of the zygomatic bone. (**Aparicio-2011)**[23] ZAGA-4 exhibited both vertical and horizontal resorption of the alveolar bone and pronounced buccal concavities of the maxilla.

Only patients who were in the ZAGA-4 category were included in this study.

The severe resorption on the buccal cortices of the maxilla meant that zygomatic implants placed using the intra sinus approach exhibited pronounced angulations leading to undesirable prosthetic offset in the palate. This led to a bulky prosthetic component resulting in difficulties in both oral hygiene maintenance and phonetics**.**[9,30,35]

In order to overcome these difficulties, an extra-maxillary approach was suggested by (**Aparicio-2006**)[16,23] where the zygomatic implants are placed with an anatomy guided approach. In this approach the zygomatic implants engaged the alveolar process only on the buccal aspect, staying completely exterior to the body of the maxilla and maxillary sinus.

This approach avoided the prosthetic offset and its resultant complications. Due to these advantages, the extra maxillary approach was used in this study.

There has been considerable debate in literature regarding the type of implants suited for the zygoma. The original **Branemark** implants **(Branemark-2004)**[13] were threaded, so as to engage both the zygoma as well as the alveolar bone on the palatal aspect.

As the extra maxillary approach did not necessitate engaging the alveolar bone as much as the intra nasal approach, the need for threads was somewhat diminished.[100] Further the use of threads lead to greater plaque accumulation than smooth surface implants. Second generation zygomatic implants have threads, therefore, only on the portion that engages the zygoma while the area in the alveolar bone has a smooth surface.

In this study, smooth surface implants have been utilized because of these reported advantages.[15]

In this study a total of ten smooth surfaces zygomatic implants were placed using the extra-maxillary approach. All the patients included in this study were otherwise systemically healthy and with no history of malignancies or any other disease. In other words every patient included in the study exhibited severe atrophic posterior maxilla as a result of long standing extraction and pneumatisation of the maxillary sinus. All the patients were examined using clinical and radiographic techniques and only those whom fell under the classification system of Misch-grade III, and Sieberts- class-III were taken up for further evaluation.[105]

CT evaluation and ENT opinion was sought pre-operatively for categorizing into ZAGA-4 and ruling out any otolaryngeal pathology which would contraindicate placement of the zygomatic implants

All the implants were placed under general anaesthesia for patient comfort and safety. This is in accordance with studies by **Aparicio, (2012)**[11] and **Aparicio,(2010)**[17] who have used general anesthesia during surgery. Although authors have suggested that zygomatic implants can be placed under local anesthesia, the large area involved and the prolonged time duration for the procedure will necessitate administration of local anesthesia at a dosage that will stretch the limit of its safety, Oral/IV sedation (with LA) a method developed by **Naoki Hatsons**, is recommended only if surgeon is experienced and if the procedure takes <1.5 hours. Further, the presence of anatomically important landmarks like the infraorbital nerve, zygomatic arch and orbital

plate require careful and extensive flap management, a procedure that is best suited to general anesthesia.

After anesthesia was administered, crestal incisions and vertical release incision were placed from the tuberosities area as per previously established protocol.[20] Careful flap elevation was performed to obtain clear visibility of the zygoma and lateral border of orbital plate. The infra orbital nerve was careful isolated and preserved in all cases. The placement of zygomatic implants began with the use of precision drill at Z point of the zygoma and sequential drilling was performed closely adhering to manufactures recommendation. A very high insertion torque > 40 newton, indicative of good primary stability was obtained in all the implants at the time of placement.

As the extra-maxillary approach resulted[106] in an exteriorized placement, several bone replacement grafts, collagen membrane, platelet rich fibrin, have been used to cover the exposed implant surface prior to flap closure. There is no universal agreement in literature regarding the material of choice for this purpose.

In this study we have used Buccal pad of fat (BPF) which was obtained using a well-established surgical protocol to cover the exposed implant surfaces for the following reasons. [65]

1. The autogenous nature of BPF will, avoid any graft related delay in healing.

2. BPF it is obtained from non-keratinized lining (buccal) mucosa and has been used to cover the implant surface only in the area of alveolar mucosa and that superior to it, not as a substitute for keratinized tissue
3. It has been suggested that adipose tissue may be a source for stem cells that may differentiate into bone forming osteoblasts/ fibroblast depending on the cues received from ECM.[62]

To the best of our knowledge there is no previous literature that has used BPF to cover the exposed implants in the extra-maxillary approach for zygomatic implant.

In this study we documented both the immediate and long-term results obtained after placement of zygomatic implant.

There was no evidence of iatrogenic injury in any of the zygomatic implants placed in our study. None of the patients reported with adverse outcomes such as sub-conjunctival ecchymosis, zygoma fractures or paresthesia in the infra orbital region etc. Immediate post-op assessment was done using visual analog score which is an objective assessment for subjective phenomena such as pain and swelling. All patients reported with only mild to moderate pain and swelling, and the mean VAS was two. This value is well within normal limits as experienced with other reasonably extensive surgical procedures. [115,8,63]

After the flap approximation, immediate impression was taken and interim dentures were given. The prosthesis occlusion was re-evaluated one month and three months post-operative. At six months post-operative final prosthesis was fabricated and fixed to zygomatic implant. Post-operative evaluation was done after 12 months for its long term survival without any complication.

According to zygomatic success code proposed by **Aparicio,**[14] various criteria have been listed for the post-op evaluation done for the zygomatic implants placed. The four important criteria are criteria-A, B, C, D.

Criteria-A was assessed for zygomatic implant stability where the head level of the zygomatic implant had no anchorage at the alveolar bone level. In this study, stability of the zygomatic implant was grade I for all the ten zygomatic implants placed as the zygomatic implants did not have mobility, pain or any other associated pathology.

The mean of ZSC-1, indicating no signs of pain, mobility or other implant related pathology compared favorably with previous studies done by **Farzad et al,(2006)** [66]

The sinus associated pathology **(criteria-B)** was assessed using two scoring systems; the Lund-Mackay (L-M) staging system[14] using CT scan imaging, **Task force rhinosinusitis** criteria (TFR) subject based questionnaire, by **Lanza-Kennedy 1997.**[93]

There was no evidence of sinus involvement or associated pathology in any of the implant assessed in the study. The mean L-M score of 0 obtained in this study was therefore indicative of successful rehabilitation with zygomatic implants without any iatrogenic sinus related pathology. When compared with previous results our study compares favorably with those studies using the intranasal approach.[102,111]

The TFR is an assessment of symptoms exhibited by the patient as result of any maxillary sinus involvement. Previous studies[13]have used these criteria as an effective way of assessing involvement of maxillary sinus following zygomatic implant placement.

The TFR scoring in our study (with all the patients reporting negative for sinus associated symptoms) was similar in all the ten implants.

The mean ZSC for criteria-B therefore was 1. These results compared favorably with previous studies showing considerable improvement with the extra maxillary approach.[102,79]

In this study the peri-implant soft tissue (**criteria-C**) was evaluated quantifying the exposed implant surface. Only two out of ten implants placed had soft tissue recession upto seven mm and were given a ZSC of 3. Five implants had exposure of only implant head, for which a ZSC of 2 was given. Three implants had no per-implant soft tissue recession and hence ZSC of 1was given.

Overall mean ZSC-1.9 was obtained, which indicated a good soft tissue response in relation to zygomatic implant placed. It must be mentioned that it is only two out of ten implants exhibited significant soft tissue recession. Both the implants were placed considerable buccal to the midcrestal level as a result of severe resorption in the maxilla of that area, which could have led to the result obtained in this study.

Our results did not compare favourably with **Lekholm,(1996)[38]**, who exhibited no peri-implant soft tissue recession in a five year follow up, following placement using the intrasinus approach.

Our results are more in line with that of **Al-Nawas[9]** who have reported that soft tissue recession is almost invariable following the extra maxillary approach.

The results of our study indicate the BPF may be a suitable option for covering the exposed smooth surface of the zygomatic implant that are placed using extra ,maxillary approach.

The mean ZSC obtained for this study for prosthetic offset (**criteria-D**), was 1, which indicated that it ranged between (-3mm-0mm). This favorable prosthetic offset meant that all the zygomatic implant were restored without bulky prosthesis. This would translate to improved phonetics and oral hygiene maintenance for the patients, the fact that was underscored by the implant comfort related assessment.

At end of the first year, the visual analog scale was used for assessing the stability and comfort of the implant fixed prosthesis and a mean score of 8 was obtained. The score 8 indicated that patient were satisfied with their speech, masticatory ability, esthetics, stability of the prosthesis.

Our reports are in accordance to similar studies by **Farzad,[66] DeBruyn,[60] and Penarrocha,[115]**

The overall survival rate of the ten implants in our one year study is 100%. These results are superior to **Zwahlen et al,[146]** who reported survival rate of 95%, but was somewhat similar to that of **Aparicio,[15] Chrcanovic.[50]**

However it must be noted that long term assessment is required for improved understanding of the extra maxillary approach.

The cumulative ZSC with a mean of grade II indicated that the zygomatic implants placed in our study were successfully rehabilitated with good satisfaction and no unfavorable sequale.

This study are in accordance with **Aparicio[11,13,14,20,23]** and his recommendation for the success of zygomatic implants.

The small sample size and the short duration one year of the study are some of the limitations of the study.

A larger sample size with a follow-up of eight to ten years will produce a greater clarity on the success and predictability of the procedure.

Summary and Conclusion

SUMMARY AND CONCLUSION

The extra maxillary zygomatic approach has been advocated for smooth surface zygomatic implants placed in patients with severely resorbed maxilla exhibiting pronounced buccal concavities (ZAGA-4).

Ten zygomatic implants were placed in the study and were evaluated one year post operatively for their performance using the zygomatic success code proposed by Aparicio.

All 10 implants have been successfully rehabilitated and there was no evidence of immediate post-operative complication such as neural damage, fracture of zygomatic bone or subconjunctival ecchymosis. At one year post-operative evaluation period the survival rate was 100% for the 10 implants examined. An overall zygomatic success code of 1/1/3/1 established, with no evidence of unfavorable implant sequence or rhinosinusitis pathology.

The extra maxillary approach (smooth surface implants) can be used for successful rehabilitation of severely resorbed maxilla with pronounced buccal concavities. (ZAGA-4)

Further long-term studies with larger sample size are required to obtain greater clarity.

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Annexures

ANNEXURE I

RAGAS DENTAL COLLEGE & HOSPITAL
(Unit of Ragas Educational Society)
Recognized by the Dental Council of India, New Delhi
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TO WHOM SO EVER IT MAY CONCERN

Date: 20.12.2017

Place: Chennai

From

The Institutional Review Board

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Uthandi,

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The dissertation topic titled **"EVALUATION OF EXTRA MAXILLARY APPROACH OF THE PLACEMENT OF ZYGOMATIC IMPLANTS IN ZAGA-4 PATIENTS USING THE ZYGOMATIC SUCCESS CODE-A CASE SERIES"** submitted by **Dr. MANIMALLA SHIVAAJI** has been approved by the Institutional Ethics Board of Ragas Dental College and Hospital.

DR. N.S.AZHAGARASAN, MDS.,

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ANNEXURE II

URKUND

Urkund Analysis Result

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