Zygomatic Implants: A Boon For The Depleted Maxilla

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ABSTRACT:

Rehabilitation of the severely resorbed maxilla poses a dificult challenge for the clinician with inadequate stability with the use of removable dentures which also accelerate the resorption pattern as well. Placement of dental implants in the posterior maxilla is often jeopardized by the size and extension of the sinus cavities and inadequate amounts of bone. The next automatic choice for the rehabilitation turns out to be the placement of implants in the zygomatic bone with the help of Autogenous bone, harvested from the iliac crest. This article gives a review of the rehabilitation of severely resorbed maxilla with the placement of zygomatic implants and its advantages and disadvantages.

Key words: Zygomatic implants, Atrophic maxilla , Zygoma , maxillarysinus.

INTRODUCTION

The zygomatic implant, originated and developed by Dr PI Branemark, has been used as posterior anchorage for implant-supported prostheses in patients with atrophic maxillae since 1990. The original concept featured a single implant in the zygoma bilaterally, combined with at least two conventional implants in the anterior maxilla. Although the method has proved to be predictable, bone grafting to the region below the nasal aperture is sometimes required prior to implant placement.[1,2]

Treatment considerations for atrophic maxilla

Time: The length of time the patient has to spend without oral rehabilitation waiting for graft consolidation and healing is diminished.

Morbidity: The need for multiple surgeries; the use of extraoral donor areas (eg, iliac crest or skull), which involve extra morbidity is reduced.

Expenditure: Reduced expenditure is observed.[1]

History

In 1983 Aparatio et al mentioned the possibility of placement of zygomatic implants. In 1997,Welscher et al cited the use of zygoma as a support structure in rehabilitation of patients subjected to maxillectomies. In 2001 Uchida et

al,measured maxilla and zygoma in 12 cadavers observing that the apex of 3.75 mm implant requires a zygoma of atleast 5.75 mm in thickness.[3]

Indications

1. Resorbed posterior alveolar crest - Zygomatic implants are indicated for the treatment of severe maxillary atrophy, in combination with conventional implants in the anterior area. They are also an adequate solution for patients with maxillary resections and with systemic pathology causing severe maxillary atrophy such as cleft palate or epidermolysis bullosa.
2. Graft extension - Where an anterior onlay graft is required for implant placement and the need to extend the graft posteriorly can be eliminated by placing the Zygoma implant.
3. The partially edentulous maxilla with uni- or bilateral loss of premolars and molars - In such situations, a Zygoma implant, in combination with at least two regular implants, will offer adequate support for a fixed restoration.[3]

Biomechanical considerations

Number of implants: When compared to a standard implant, the Zygoma implant has an increased tendency to bend under horizontal loads.

This is related to two factors:

1. The greatly increased length of these implants (30-52.5 mm)
2. The fact that in some circumstances there is limited bone support in the maxillary alveolar crest. Consequently, these implants should be rigidly connected to stabilize conventional fixtures in the anterior maxilla.

Based on clinical experience and biomechanical theoretical calculations , a full arch restoration in the maxilla, supported by two Zygoma implants (one on each side), should be assisted by at least two stable regular Branemark System implants in the anterior maxilla.

Bending moments: Forces that cause bending moments are known to be the most unfavorable. These forces can potentially jeopardize the long-term stability of an implant-supported restoration. In order to decrease bending moments, the distribution of forces should be optimized by:

1. cross arch stabilization
2. decreased buccal lever arms
3. decreased cantilevers - mesial/distal and anterior/posterior
4. balanced occlusion
5. decreased cuspal inclination

Prosthetic design: General guidelines for prosthetic design when utilizing the Zygoma implant should include efforts to:

1. incorporate sufficient rigidity and precision in the restoration
2. decrease bending moments
3. balance functional, esthetic, phonetic, and hygiene requirements
4. facilitate maintenance

If the restoration is flexible, this may cause deformation and deflection of the Zygoma implant, resulting in implant loss or screw loosening.[3]

Implant texture: Self tapping titanium implant with a machined surface Available commonly in 8 different lengths extending from 32 mm to 52.5mm. Threaded apical part has diameter of 4 mm and a crestal part of 4.5mm. The implant head has an angulation of 45 degrees. Oxidized rough surface, smooth mid implant body,wider neck at the alveolar crest.[3]

Anatomy: The Zygoma implants typically pierce the oral mucosa in the premolar region, and are in a slightly more palatal position compared to the implants in a standard maxillary restoration. It is important for the surgeon to carefully confirm the position of the implant head at the time of implant insertion. The direction and position of the screw attaching the implant mount to the implant represents the future position of the abutment screw.[3]

Pre-operative Radiographic Examination

- Panoramic image
- Intraoral radiographs
- Lateral cephalogram (profile radiograph)
- Tomography, conventional or computed tomography[3]

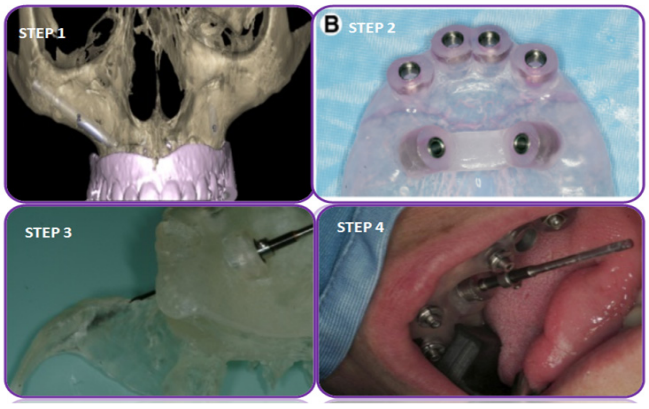

Figure 1: Stereolithographic Guides and Cad-Cam Technology. Step 1- Template planning, Step 2- Fabricated template, Step 3- placement experimented suing template, Step 4- placement of zygomatic implants using template. (Courtesy - A Protocol For A Predictable Zygomatic Implant Placement Using Stereolitography Guide and Customized Surgical Kit. Dr G. Schiroli - 2010)

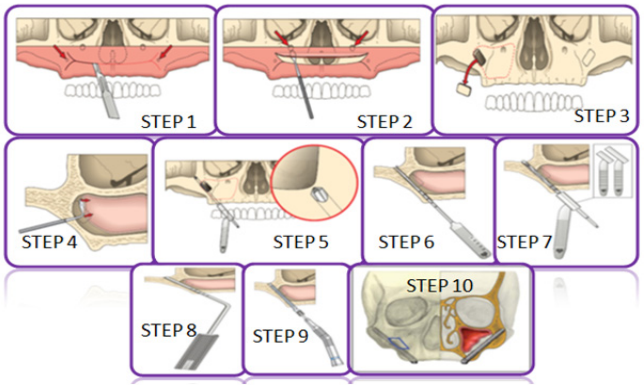

Figure 2: Classical Approach. Step 1 - Standard Le Fort 1 Incision, Step 2 - identification of infraorbital foramen, Step 3 - 10 by 5 mm window, Step 4 - lifting the sinus mucosa, Step 5 - Entrance mark in the posterior-superior roof of the sinus, Step 6 - straight depth indicator(depth indication), Step 7 - Widening the bone site, Step 8 - angled depth indicator (depth verification), Step 9 - implant insertion, Step 10 - zygomatic implants placed. (Courtesy - Reference Guide Branemark System)

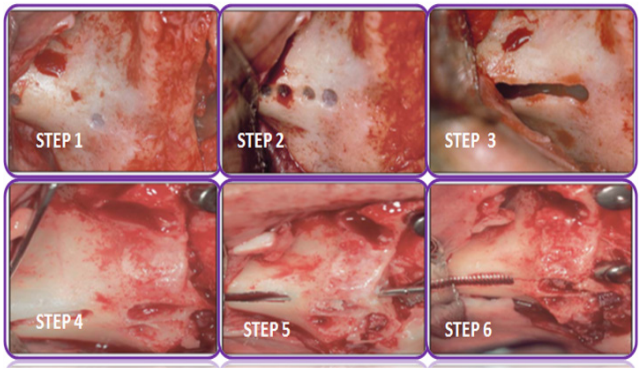

Figure 3: Sinus Slot Technique. Step 1 - thin long rectangular bone window planned, Step 2 - perforations, Step 3 - window being created, Step 4 - window, Step 5 - zygomatic implant placed, Step 6 - Zygomatic implant placed with proper buccal positioning of the implant head. (Courtesy - Zygomatic Implants Using the Sinus Slot Technique : Micheul Penarrocha: J Oral Maxillofac 2005;20:788-792)

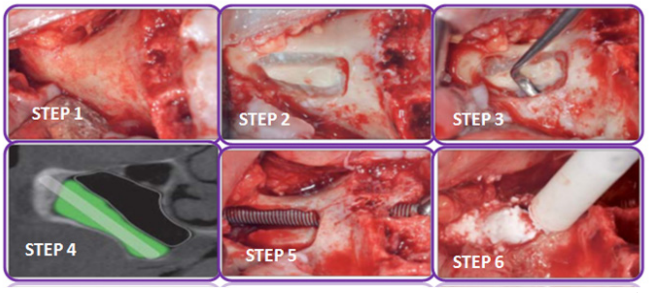

Figure 4: Extended Sinus Technique. Step 1 - visualization of the lateral antral wall, Step 2 - extended lateral window planned. Step 3 - reflection of the sinus membrane, Step 4 - Schematic drawing of the extended sinus elevation technique. The sinus mucosa (white line) is reflected beyond the proposed zygomatic implant position (bar). The green area represents the future implant site, ie, the augmented sinus cavity. Step 5 - extended lateral window, Step 6 - bone graft material placed. (Courtesy- Zygomatic Implant Placement in Conjunction With Sinus Bone Grafting: The "Extended Sinus Elevation Technique." A Case-cohort Study-marc Hinze Et Al, Oral Craniofac Tissue Eng 2011; 1:188-197)

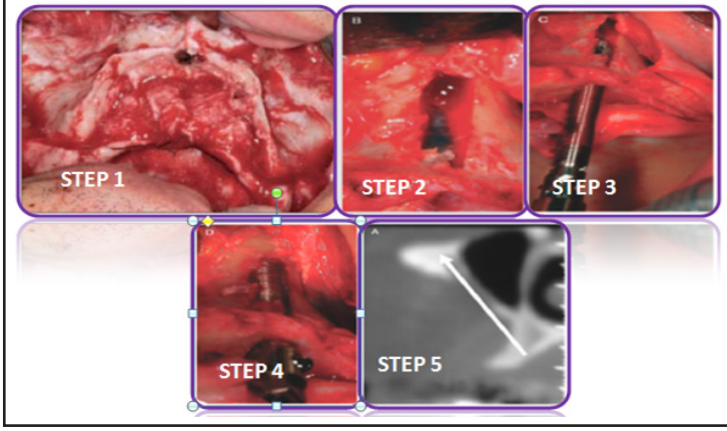

Figure 5: Extrasinus Technique. Step 1 - Reflection of the flap for the placement of implants, Step 2 - Clinical view showing preparation of the lateral sinus wall, Step 3 - insertion of the zygomatic implant, Step 4 - final seating of the implant, Step 5 - Tomographic section showing preoperative planning of an extrasinus zygomatic implant (Courtesy - Zygomatic Implant Placement in Conjunction with Sinus Bone Grafting: The "Extended Sinus Elevation Technique." A Case-cohort Study-marc Hinze et al, Oral Craniofac Tissue Eng 2011;1:188-197)

Table-1
Clinical case series of zygomatic implants

Authors	Patients	Number of Implants	Technique	Follow-up	Success Rate, %
Branemark et al[14]	28	52	Sinus window	60–120	94.3
Hirsch et al[16]	66	124	Sinus window	12	97.9
Ferrara and Stella[10]	16	25	Sinus slot	—	96
Becktor et al[12]	16	31	Sinus window	69	90.3
Davo et al[5]	18	36	Sinus window	29	100
Aparicio et al[9]	69	131	Sinus window	60	100
Kahnberg et al[13]	76	145	Sinus window	36	96.3
Peñarrocha et al[8]	23	44	Sinus slot	12	97.7
Boyes-Varley et al[11]	20	40	Sinus window	69	100
Peñarrocha et al[15]	21	40	Sinus slot	12–45	100
Aparicio et al[7]	25	47	Extrasinus	24–60	100
Aparicio et al[3]	20	36	Extrasinus	36–48	100
Pi et al[2]	54	101	Sinus window	72	96.1
Maló et al[1]	29	67	Extrasinus	18	98.5
Balshi et al[6]	56	110	Sinus window	60	96.4
Landes et al[4]	15	36	Sinus window	13–102	89
Johansson et al[17]	44	61	Sinus window	12–60	98.8
Stiévenart et al[18]	20	80	—	40	96
	552 patients	1082 implants			Weighted averaged success 96.7%

Table-2
Survival Rate of Zygomatic Implants

Authors	Complications
Branemark et al[14]	—
Hirsch et al[16]	1.5% sinus pain
	7.5% fistula
	12.2% gingivitis
	9.1% nerve abnormalities
	13.6% fracture prosthesis
Ferrara and Stella[10]	—
Becktor et al[12]	9.7% sinusitis
	56.3% local infection
Davo et al[5]	5.5% sinusitis
Aparicio et al[9]	4.3% sinusitis
	8.7% facial hematoma
	7.2% lip laceration
	8.7% paresthesia
	11.6% gingival inflammation
	9.2% fracture prosthesis
Kahnberg et al[13]	3.3% infection, redness, and swelling around the implants
	18.4% sinusitis
	3.9% fistula
	1.3% paresthesia
	13% fracture prothesis
Peñarrocha et al[8]	—
Boyes-Varley et al[11]	Complications for tumor removal
Peñarrocha et al[15]	9.5% sinusitis
Aparicio et al[7]	20% fracture prosthesis
Aparicio et al[3]	—
Pi et al[2]	1.8% sinusitis
	1.8% fracture prosthesis
Maló et al[1]	13.7 % sinusitis
Balshi et al[6]	—
Landes et al[4]	—
Johansson et al[17]	6.8% sinus membrane perforation
Stiévenart et al[18]	—

STEREOLITHOGRAPHIC GUIDES AND CAD-CAM TECHNOLOGY:

Computer-guided surgery provides a great benefit but its use for complete placement of zygoma implants is not yet predictable. The challenge of placing zygoma implants through a surgical template is related to the 45-degree angled head that not only makes the depth positioning of the implant critical, but also the timing pitch on the screw threads. There are also significant risks associated with drilling and placing an implant of that length in such close proximity to the orbit.[4,5]

Step 1 - template planning using the CAD-CAM technology

Step 2 - fabricated template

Step 3 - placement experimented using the template

Step 4 - placement of zygomatic implants using the template.[4,5] (Figure 1)

Procedures[3]

(1) The classical approach

(2) The sinus slot technique

(3) The exteriorized approach

(4) The minimally invasive approach by the use of custom-made drill guides

(5) The computer-aided surgical navigation system approach

(1) The classical approach: The classical approach was proposed by Dr. P-I branemark . The classic sinus window technique consists of exposing the frontolateral face of the zygomatic bone and creating a 10- X 5-mm window in the sinus to visualize the implant trajectory. The weighted average success was 96.6%.[6]

Step 1: Standard Le Fort 1 Incision - The reason for using this incision technique is to obtain coverage of the implant by the periosteum and a wide wound area to minimize the risk of dehiscence during healing. It is recommended to make vertical incisions along the infrazygomatic crest region and to continue the incisions in a downward direction, thereby facilitating the exposure of the maxilla and the

zygomatic bone and protecting the parotid gland duct.

Step 2: The lateral surface of the maxilla is exposed and the infraorbital foramen identified for the anatomic orientation of the area

Step 3: Make a 10 by 5 mm window on the lateral wall of the sinus close to the infrazygomatic crest.

Step 4: Ideally, the sinus mucosa should be kept intact during this process. Carefully lift the sinus mucosa away from the area where the implant will pass through the sinus, from the floor of the sinus to the roof, trying not to penetrate the mucosa.

Step 5: Make an entrance mark in the posterior-superior roof of the sinus before penetrating the outer cortical layer of the zygomatic bone at the incisura.

Step 6: Now use the straight depth indicator to determine the desired length of Zygoma implant to be used.

Step 7: Widen the bone site successively

Step 8: Verify the depth of the prepared bone site with the angled depth indicator to ensure that the selected implant length can be fully seated without apical bone interference

Step 9: Use slow speed on the drilling unit while engaging the implant apex in the prepared bone site. Confirm the correct insertion angle of the implant while continuing through the sinus until the implant apex engages the zygomatic bone.

Step 10: zygomatic implants placed[6] (Figure 2).

(2) The sinus slot technique: In 2000, Stella and Warner developed the sinus slot technique. This technique improves visualization of the implant positioning, reduces sinus complications and postoperative symptoms, and allows a more buccal positioning of the implant head, thus facilitating prosthetic restoration. The weighted average success was 97.8%.[7]

Step 1: After the flap was raised and retracted, a thin long rectangular bone window was planned to be cut according to the level of the sinus floor and sinus roof.

Step 2: Make perforations along the the area planned to be drilled

Step 3: Create a window along the planned area

Step 4: Window created and is ready for the placement of zygomatic implant

Step 5: Zygomatic implant placed in the created window

Step 6: Zygomatic implant placed with proper buccal positioning of the implant head[7] (Figure 3).

(3) The Exteriorized approach: The Extended sinus technique or the Exteriorized technique is a modification of the sinus slot technique. To decrease the risk of sinus infection, a modified technique was developed to preserve the integrity of the sinus membrane and to regenerate bone around zygomatic implants using an extended sinus grafting approach. To increase biomechanical stability over the long term, the development of an extended implant site surrounding the entire zygomatic implant seems to be favorable. Therefore, a treatment method to provide a bony housing around the zygomatic implant simultaneous with implant placement would be preferable.

According to Boyes-Varley et al, preparation of a buccal access window allow direct visualization of the access point of the implant into the body of the zygoma, and perforation of th posterior antral wall can be avoided because of visual control. Hence, the extended lateral window minimizes the risk of operative complications and enhances intrasurgical control. Furthermore, the visually controlled implant placement facilitates easier and more reproducible implant positioning, enabling prosthetically ideal orientation of the implant platform.[8]

Step 1: Crestal incision, elevation of a mucoperiosteal flap, and visualization of the lateral antral wall.

Step 2: An extended lateral window is prepared from the sinus floor to the superolateral aspect of the maxilla.

Step 3: Controlled reflection of the sinus membrane is accomplish with sinus elevation instruments.

Step 4: Schematic drawing of the extended sinus elevation technique. The sinus mucosa (white line) is reflected beyond the proposed zygomatic implant position (bar). The green area represents the future implant site i.e., the augmented sinus cavity.

Step 5: Clinical view after preparation of an extended lateral window, sinus membrane reflection, and zygomatic implant placement in the right maxilla.

Step 6: The intrasinusal and lateral portions of the zygomatic implant are augmented with bone graft material [8] (figure 4).

(1) Extrasinus technique: The extrasinus placement of the zygomatic implant was proposed by Aparatio et al, was intended to simplify surgical procedures and to improve prosthetic outcomes. The success rate obtained is (98.7%). The extrasinus technique for placement of zygomatic implants is simpler than the original technique proposed by Branemark and coworkers and the slot technique proposed by Stella and Warner. The extrasinus approach eliminates the need for maxillary antrostomy, sinus elevation, or the creation of a slot. It also results in the emergence of the zygomatic implant next to or on the top of the alveolar ridge crest, improving prosthesis design and biomechanics. In contrast, the palatal implant emergence that is typically seen with intrasinus techniques increases the risk of occlusal overload and makes oral hygiene more difficult.[9]

Step 1: Reflection of the flap for the placement of implants

Step 2: Clinical view showing preparation of the lateral sinus wall. Note intact sinus membrane in the bottom of the preparation

Step 3: Showing insertion of the zygomatic implant

Step 4: Showing final seating of the implant.

Step 5: Tomographic section showing preoperative planning of an extrasinus zygomatic implant.[9,10] (Figure 5)

PROSTHETIC REHABILITATION:

Cemented or screwed fixed prosthesis. Immediate loading has shown success rate of 96.4% to 100% and Delayed loading has shown success rate of 89% to 100%.[3]

PROSTHETIC PHASE:

Only Zygoma abutment Multi-unit (RP) or Zygoma 17° abutment Multi-unit (RP) are recommended to be used together with Zygoma implants.[8]

Clinical procedure

The prosthetic procedure includes the following steps:

1. **Impression:** A rigid impression material and impression coping Multi-unit open tray is recommended. An impression of the lower jaw is also recorded, as well as a preliminary registration and jaw relation records.
2. **Adjustment and relining of removable prosthesis:** It is imperative to carefully adjust the patient's existing denture during the course of the prosthetic treatment. This entails an extensive relief of the palatal base. It is important to ensure that the healing caps do not interfere with the hard acrylic of the denture.
3. **Master cast fabrication:** The impression is delivered to the dental laboratory and a master cast is made. An acrylic record base with a wax occlusal rim is fabricated on this cast.
4. **Registration of jaw relations:** The record base is attached to the abutments and the occlusal rim is adjusted to the correct vertical height and occlusal plane orientation. Adequate lip support and facial contours are also evaluated and appropriate adjustments are made to the occlusal rim. Tooth shape and shade are selected.
5. **Tooth set-up in wax:** A preliminary tooth set-up is made according to conventional prosthetic principles.
6. **Try-in of preliminary tooth set-up:** The wax set-up is tried in the patient. Evaluation of vertical dimension, occlusal relationships, cantilevers, cuspal inclination, tooth shade and shape, hygiene access, lip support, facial contours, etc. is made.
7. **Framework fabrication:** A rigid framework with adequate volume and precision is made. Cast gold-alloy or precision-milled titanium frameworks) are recommended. A passive fit of the frame-work on the master cast is imperative.
8. **Try-in of framework:** The passive fit of the framework is verified intra-orally. Use of magnification loops facilitates the procedure.

9. **Processing and delivery of final restoration:** The passive fit of the final restoration, once fabricated, is verified intra-orally and the retaining prosthetic screws are tightened to 15 Ncm. The occlusion is carefully checked and, if necessary, adjusted.
10. **Post-insertion visit:** The patient should be seen one to two weeks after delivery for a check-up. The stability of the restoration is checked, and a general evaluation of function, phonetics and esthetics is made. The stability of the bridge retaining gold screws are also tested and, if necessary, the screws are re-tightened. The screw access holes can be permanently sealed. A soft, easily removed material is placed over the screw head and a hard filling material, e.g. composite resin, is placed on top to completely seal the holes.
11. **Re-call schedule:** A re-call schedule is established based on an individual evaluation of each patient's needs and circumstances. Annual clinical check-ups are recommended, with intraoral radiographic examinations after one, three and five years.[8]

IMMEDIATE LOADING

There are 2 different ways of performing immediate occlusal loading: 1-stage and 2-stage methods. Examples of the 1-stage method are the Brånemark Novum and the Teeth-in-an-Hour techniques. Examples of the 2-stage method are All-on-4. No matter which method is used, the critical factor for immediate occlusal loading is initial implant stability. Initial implant stability of the individual implant is important but not as critical as in a single implant situation. Once the implants are linked together with a rigid connector, the individual implant will become part of an integrated system to distribute and share the occlusal loading. Because most of our patients require extraction of their remaining teeth prior to implant placement, it is very difficult to deliver a definitive prosthesis at the time of surgery. It is advantageous to perform the 2-stage method to accommodate any soft tissue shrinkage before making the final impression for the definitive prosthesis. The preliminary reports shows the good potential to load the zygomatic implants immediately with a provisional prosthesis. This immediate loading protocol is beneficial to the patients by being minimally invasive. However, further study should be conducted to investigate the long-term results of immediate occlusal loading of the zygomatic implants.[11]

Complications (Table 2)

- Maxillary sinusitis-1.85% to 18.42%
- Minor sinus- membrane perforation.
- Gingival infections
- Oro-antral fistula
- Paraesthesia
- Fracture of prosthesis[1]

Conclusion

Zygomatic implants are a suitable alternative for the treatment of severe posterior maxillary atrophy.

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