

# Rehabilitation of severely resorbed maxillae with zygomatic implants: An update

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## ABSTRACT

Studies highlight the zygomatic bone as a suitable anatomical structure for implant placements since they cross four corticals.

Zygomatic implants were described by Branemark in 1998, since then zygomatic implants are indicated in maxillae with atrophy of the posterior area. They have been used in systemic diseases associated with bone loss in this area, and in patients who have suffered radical surgery for maxillofacial tumors.

Computed tomography is recommended before placement in order to discount any pathology of the maxillary sinus. The surgical technique has been slightly modified since its description with procedures such as the sinus slot technique.

The success rate obtained by different authors varies between 82% and 100%, indicating this technique as a valid treatment option. The objective of this study was to revise the literature with the aim of updating the subject.

**Key words:** *Zygomatic implants, anatomical buttress.*

## RESUMEN

Los estudios, destacan al hueso cigomático como una buena estructura anatómica donde colocar implantes, ya que se atraviesan cuatro corticales.

El procedimiento quirúrgico fue descrito en 1998, por Branemark, desde entonces, los implantes cigomáticos se indican en maxilares con atrofas del sector posterior; se han utilizado en enfermedades sistémicas asociadas a pérdida ósea en esta zona y en pacientes que han sufrido cirugía radical por tumores maxilofaciales.

Para su colocación, se recomienda el estudio previo con tomografía computerizada, para descartar patología en el seno maxilar. La técnica quirúrgica desde su descripción ha sido discretamente modificada con procedimientos como el de la ranura sinusal.

El porcentaje de éxito obtenido por los distintos autores, se sitúa entre el 82% y 100%, indicando que es una opción de tratamiento válida. El objetivo de este trabajo fue la revisión de la literatura con el fin de actualizar el tema.

**Palabras clave:** *Implantes cigomáticos, arbotantes anatómicos.*

## INTRODUCTION

The zygomatic fixture is an extended length (35 to 55 mm) titanium implant placed into zygomatic and maxillary alveolar bone. It was designed for situations where atrophy of the posterior maxilla complicates or prevents the placing of conventional implants (1-3). The original technique was first described by Branemark (4), who in 1998 published a follow-up over 10 years of 164 implants anchored in zygomatic bone, with a success rate of 97%.

The use of zygomatic implants avoids the need for bone grafting, shortens treatment and reduces morbidity. Widmark (5) in 2001 obtained a survival rate of 74% after 3-5 years follow-up in patients with bone grafts and conventional implants, while treatment with implants placed in unusual locations provided an 87% success rate.

Zygomatic implants have been used in atrophic posterior maxilla or in cases with pneumatization of the maxillary sinus with at least 3 mm of bone crest (6,3), avoiding the need for bone grafts in the posterior area (7). They have also been used in patients with maxillectomies resulting from tumors or diseases associated with atrophic conditions of the maxilla (8,9).

This study provides an update on zygomatic implants, via bibliographic searches in PubMed, Cochrane, and the manual review of various odontological journals from 1993 to 2006, using different combinations of the following key words: zygomatic implants, anatomical buttress.

## ANATOMY OF THE ZYGOMA

In 1993, Aparicio et al. (10) mentioned the possibility of inserting dental implants in the zygomatic bone; in 1997, Weischer et al. (8) cited the use of the zygoma as a support structure in the rehabilitation of patients subjected to maxillectomies.

Following Branemark's description, Uchida et al. (11) in 2001, measured the maxilla and zygoma in 12 cadavers, observing that the apex of a 3.75 mm-diameter implant requires a zygoma of at least 5.75 mm in thickness. With respect to implant placement, they advised that an angulation of 43.8° or less increases the risk of perforating the infratemporal fossa or the lateral area of the maxilla; if the angulation is more vertical, 50.6° or more, this increases the risk of perforating the orbital floor.

Nkenke et al. (12) used computed tomography and histomorphometry to examine 30 human zygoma, the study revealed that the zygomatic bone consists of trabecular bone, an unfavourable parameter for implant placement; however, the success of implants placed in the zygomatic bone was achieved by the implant crossing four portions of cortical bone.

Kato et al. (13) investigated the internal structure of the edentulous zygomatic bone in cadavers using micro-computed tomography, finding that the presence of wider and thicker trabeculae at the apical end of the fixture promotes initial fixation.

## INDICATIONS AND CONTRAINDICATIONS

The use of the zygomatic bone as an implant support structure is indicated both in partial and total maxillary edentulism with extreme resorption in the sinus area (3,9).

Patients with systemic diseases associated with atrophy of the posterior maxilla have been treated with zygomatic implants. Balshi and Wolfinger (14), report a case of congenital ectodermal dysplasia successfully treated with bilateral zygomatic implants in combination with four conventional implants in the anterior region and two pterygoid implants. Peñarrocha et al. (15) published a case of ectodermal dysplasia in which two zygomatic fixtures were placed together with 3 implants in the anterior maxillary region; an upper complete prosthesis was screwed onto the implants, after 18 months of follow-up the patient reported significant improvement in oral function and self-esteem.

The reconstruction of maxillary defects following tumor resection is another situation in which zygomatic implants have been applied (9), they provide increased prosthetic stability and improved quality of life in these patients. In 1997, Weischer et al. (8) presented an obturator anchored to the zygoma. Tamura et al. (9), published a case of a maxillectomy with the placing of zygomatic implants; this method has several advantages: first, early detection of postoperative recurrence is easier than with closing the flap; second, when the implant is inserted into the midfacial region, zygomatic bone can be useful because of thickness. In addition, applying a maxillary prosthesis in the early stages avoids contracture of facial soft tissue.

Schmidt et al. (16) carried out a retrospective analysis of patients rehabilitated with zygomatic implants following maxillary resection, and presented 9 cases of partial or total maxillectomies rehabilitated using 28 zygomatic and 10 conventional implants. Although 6 zygomatic and 3 standard implants failed, they concluded that the combination of conventional and zygomatic implants could be used in patients with extensive resection of the maxilla. Landes (17) evaluated the level of well-being and indications for zygomatic implants in patients undergoing maxillary resection for a variety of defects; twelve patients received 28 zygoma implants and 23 dental implants with a follow-up of 14-53 months; the success rate was 71% and the quality of life comparable with fixed prostheses over natural dentition.

Pham et al. (18) rehabilitated a patient with unilateral cleft palate and generalized maxillary atrophy. They inserted two zygomatic implants and four anterior implants supporting an overdenture which filled the defect; and consider this to be an alternative technique for use in patients with cleft palate.

There are references to nasomaxillary reconstructions with the aid of zygomatic implants in patients with serious oronasal communications originating from tumor surgery. Bowden et al. (19) presented two cases of nasal reconstruction using implants anchored in the zygoma.

Contraindications to the procedure are the same as those applied to the placing of conventional implants, although it is worth mentioning those typical of intervention in the

maxillary sinus, such as absence of local infection (10). Patients with zygomatic implants may contract an upper respiratory tract infection, which might close the maxillary ostium, resulting in sinusitis; when this occurs the sinusitis can become chronic and it is necessary to surgically restore ventilation to the sinuses. There seems to be no increased risk of inflammatory reactions in normal nasal and maxillary mucosa in regions where titanium implants pass through the mucosa (20).

### EXPLORATION TECHNIQUES

Before undertaking the implant procedure, it is necessary to verify that the maxillary sinus is free of pathology. There should be no infection of soft or solid tissue, and the orodental condition should be healthy. A preoperative computed tomographic study is recommended, with axial cuts every 2 mm parallel to the palatal arch and conventional tomography with frontal tomograms perpendicular to the hard palate every 3-4 mm. Any anomalies should be detected, as well as estimating the amount of sinus penetration into the zygomatic bone (10).

Vrielinck et al. (1), presented a planning system for zygomatic implant insertion based on preoperative CT imaging; they calculated the position of the implants and fabricated a surgical guide. Using this system they obtained a success rate of 92% in 29 patients with zygomatic implants (two implants did not reach the zygomatic arch when using this surgical guide).

### SURGICAL AND PROSTHETIC TECHNIQUES IN ZYGOMATIC IMPLANTS

In 1993, the zygoma had already been reported as a possible implant-anchoring structure (10). The original procedure, defined by Branemark in 1998 (4), consisted of the insertion of a 35-55 mm-long implant anchored in the zygomatic bone following an intra-sinusal trajectory. Since this description, many authors have varied the technique slightly. Stella and Wagner (21) described a variant of the technique in which the implant is positioned through the sinus via a narrow slot, following the contour of the malar bone and introducing the implant in the zygomatic process. In this way, the need for fenestration of the maxillary sinus is avoided, and the implant is caused to emerge over the alveolar crest at first molar level, with a more vertical angulation. Peñarrocha et al. (22), detailed the use of this technique, presenting 5 clinical cases and discussing the advantages of the Stella and Wagner system over the original Branemark technique. Boyes-Varley et al. (7), disagree with the sinus slot technique, since perforation of the posterior antral wall is possible due to lack of visibility.

The zygomatic implant should be combined with implants in the anterior (canine buttress) or pterygoid areas, for the later fixing of fixed prostheses or overdentures (10). The reconstruction is made using bars that connect the zygomatic and anterior implants, finally a complete fixed prosthesis or overdenture is placed (23). Bedrossian and Stumpel (6) simplified the clinical protocol reducing the loading time.

Aparicio (10), using 29 clinical cases, described the characteristics of this technique in relation to the surgical indications and the prosthetic fabrication procedure. Bothur et al. (24) presented an alternative, fixing 3 implants on one side, and 2 on the other in the zygoma in order to accommodate a fixed prosthesis. Boyes-Varley et al. (7) contributed a series of 77 implants in 45 patients, reporting that by using a placement appliance to place the implant as close as possible to the crest of the alveolar ridge and an implant with a 55° head, the emergence of the restorative head and resultant buccal cantilever was reduced by as much as 20%.

### PROGNOSIS AND SUCCESS RATE IN ZYGOMATIC IMPLANTS

In 1998, Branemark published a study presenting the technique for zygomatic implants after following a series of 164 zygomatic implants in 81 patients over an average 1-10-year period, obtaining a success rate of 97%.

Parel et al. (2) made a retrospective study of 65 zygomatic implants placed in 27 patients (24 after maxillectomy, and 3 with cleft palate). After a 6-year follow-up, no implants were lost. A series of 22 patients was presented by Bedrossian et al. (25), in which 44 zygomatic implants and 80 premaxillary implants were located. After 34 months follow-up there was 100% success for the zygomatic and 91.25% for the conventional implants.

In 2004, Branemark et al. (26) presented a series of 28 patients with a 5 to 10-year follow-up, the survival rate was 94% for the 52 zygomatic and 73% for the 106 conventional implants.

In a retrospective study, Malavez et al. (27) evaluated the survival index of 103 zygomatic implants inserted in 55 maxillae after a 6-48 month follow-up of prosthetic load, no zygomatic implant was considered fibrously encapsulated and functionality was satisfactory. Hirsch et al. (28) in a multicenter study of 124 zygomatic implants, found a survival rate of 97.9% at one year of follow-up, 80% of patients were satisfied with the treatment and the condition of the periimplant mucosa was normal in 60% of the locations; when plaque was present the palatal surface was the most affected.

Al-Nawas et al. (29) verified the survival of 37 zygomatic implants in 24 patients and found 97% success. They evaluated the incidence of periimplantitis in the zygomatic implants, carrying out clinical examinations and DNA tests. Of the 24 patients, only 14 with 20 zygomatic implants were included in the study; nine of the 20 implants showed bleeding on probing; four of which had positive microbiologic results. In nine out of the 20 implants both, bleeding on probing and pocket probing depth  $\geq 5$  mm indicated soft tissue problems resulting in a success rate of only 55% (Table 1). Nakai et al. (30), invited the opinion of patients treated with zygomatic implants after 6 months loading with the aim of analyzing the prosthetic functionality. Problems with articulation and difficulty in hygiene in the posterior area were present in some cases. Computed tomograms showed no alterations in the maxillary sinus in any patient.

**Table 1.** Success rate obtained by the different authors.

AUTHOR	N° PATIENTS	N° ZYGOMATIC IMPLANTS	N° CONVENTIONAL IMPLANTS	FOLLOW -UP	SUCCESS RATE ZYGOMATIC I.	SUCCESS RATE CONVENCIONAL I.
Brånemark <sup>4</sup> 1998	81	164	–	1 to 10 years	97%	–
Bedrossian et al. <sup>25</sup> 2002	22	44	80	34 months	100%	91.25%
Nakai <sup>29</sup> 2003	9	15	–	6 months	100%	–
Brånemark <sup>26</sup> 2004	28	52	106	5-10 years	94%	73%
Hirsh et al. <sup>27</sup> 2004	76	124	–	12 months	97.9%	–
Malevez et al. <sup>27</sup> 2004	55	103	194	6-48 months	100%	91.75%
Al-Nawas et al. <sup>29</sup> 2004	24	37	–	12 months	97%	–
Landes <sup>17</sup> 2005	12	28	23	14-53 months	82%	–
Peñarrocha et al. <sup>22</sup> 2005	5	10	16	12-18 months	100%	–

Becktor et al. (31) studied 16 patients over an average period of 46.4 months. Of 31 zygomatic implants placed, 3 (9.7%) were lost due to recurrent sinusitis. Of 74 conventional implants, 3 (4.1%) failed during the osteointegration period, poor hygiene was identified on the majority of the zygomatic implant surfaces (10/16). Few long-term studies exist of extensive series of zygomatic implants, and there are no random controlled studies comparing zygomatic implants with bone grafts.

## CONCLUSIONS

The zygomatic implant is an alternative procedure to bone augmentation, maxillary sinus lift and to bone grafts in patients with posterior atrophic maxillae. After almost 8 years evolution since Branemark developed the technique, the success rates obtained by the diverse authors vary between 82% and 100%. It should be taken into account that the lowest success rates correspond to studies in oncological patients.

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