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Zygomatic implants placed with a 2-stage procedure: a 5-year retrospective study

Key words  long-term, sinus, two-stage, zygomatic implant

**Aim:** The zygomatic implant represents a non-grafting alternative for the oral rehabilitation of patients with extreme resorption of the maxilla. Nevertheless, there are few studies concerning their long-term prognosis. The purpose of this retrospective study was to evaluate the prosthetic rehabilitation success rate and the survival rates of machined surface zygomatic implants and conventional implants placed using a 2-stage protocol in 21 consecutively treated patients with atrophic maxillae after a 5-year follow-up period.

**Materials and methods:** A total of 24 consecutively treated patients (8 men, 16 women), with a mean age of 51.4 years (range 36 to 72 years) were included in this study. Rehabilitations were accomplished in 22 edentulous jaws, and two partially edentulous jaws. In total, 45 zygomatic and 109 conventional implants were inserted. A total of 21 patients had a screw-retained fixed implant-supported prosthesis within 6 months of implant placement and 3 had an implant-supported overdenture. Outcome measures were survival rates of the prosthetic rehabilitations, of the zygomatic and conventional implants, as well as complications.

**Results:** Three patients dropped out, 2 after one year and 1 after 3 years. Continuous stability of the prostheses was achieved in 20 out of the 21 patients throughout the study. Therefore, the success rate for the prosthetic rehabilitation after 5 years was 95.8%. One overdenture supported on two zygomatic implants was removed after one year of function. The patient is currently waiting for the installation of two more zygomatic implants or a grafting procedure. One zygomatic implant was lost giving a survival rate 97.4% after the 5-year follow-up period. A total of 11 conventional implants were lost, resulting in a survival rate of 89.9% after 5 years of follow-up. Sinusitis was observed in 5 patients throughout the study, which was solved with antibiotics, meatotomy, or Caldwell-Luc antrostomy with no further consequences.

**Conclusions:** Zygomatic implants together with conventional implants in the atrophic maxillae appear to have an acceptable 5-year clinical outcome.
Introduction

The zygomatic implant represents a non-grafting alternative for the oral rehabilitation of patients with extreme resorption of the maxilla1-3. Its potential advantages over grafting procedures have been described in different publications1-3. Nevertheless, no randomised clinical trials have been performed to assess these advantages, which may include improved predictability, less morbidity and better treatment acceptance from the patients1-4.

Furthermore, in two different studies involving a 10- and 12-year follow-up, a survival rate of 94.2% and 100% for these implants has been demonstrated1,2. Some clinical studies reported a 100% survival rate after 48, 36 and 60 months, respectively, using machined surface zygomatic implants placed with a 2-stage protocol5-7.

Recently, some clinical studies have described the use of zygomatic implants with machined and oxidised surface with immediate function protocols8-11. In all of these studies, 100% survival rates for zygomatic implants have been reported after 10 months, 12 to 34 months, 6 to 29 months, and 12 to 42 months, respectively8-11. Furthermore, some modifications from the original protocol, and a new design of the implant have been recently published, and a 100% and 98.5% survival rate for the zygomatic implant has been communicated12-13.

The sinus reactions to zygomatic implants have been evaluated. Sinuscopies performed in patients with these implants showed no signs of infection or inflammation in the surrounding mucosa14. Furthermore, in a recently published radiological study, it has been found that sinus reactions to zygomatic implants seem to lead to the adaptation and maintenance of normal physiology15. Nevertheless, some authors have reported a low rate of sinusitis associated with zygomatic implants, and the persistence of an oroantral fistula has been advocated as the main explanation for this complication1,15,16.

The long-term clinical outcome of zygomatic implants is largely unknown with only a couple studies presenting a follow-up longer than 5 years1,2. Therefore, the purpose of the present retrospective study was to report the treatment outcome of patients treated with zygomatic implants according a two-stage protocol with a 5-year follow-up.

Materials and methods

The STROBE (STrengthening the Reporting of OBservational studies in Epidemiology) guideline has been followed to perform the present retrospective study17.

Patients

The study included a cohort of 24 consecutively treated patients between May 1999 and December 2003 at the Department of Implantology and Maxillofacial Surgery at Medimar International Hospital in Alicante, Spain. A total of 45 zygomatic and 109 conventional implants were used. Of them, 21 patients with 39 zygomatic implants and 97 conventional ones, had been followed for 5 years after zygomatic implant insertion.

Full-arch rehabilitations were accomplished in 22 patients with 2 Brånemark zygomatic implants (Nobel Biocare AB, Gothenburg, Sweden) and 3 to 6 conventional Brånemark implants (Nobel Biocare AB) (6 implants in 1 patient, 5 implants in 8 patients, 4 implants in 11 patients, and 3 implants in 1 patient). One zygomatic implant and 6 conventional implants were used in one patient. Extensive bone grafting was performed in another patient who exhibited a total resorption of the maxilla (Fig 1). The graft was taken from the iliac crest and four conventional implants in the premaxilla and two zygomatic implants were installed during the same surgery.

Partial-arch rehabilitation was accomplished in 2 patients: 1 zygomatic implant was used in combination with 6 conventional implants in 1 patient and with 4 conventional implants in another patient. Rehabilitation of both dental arches (bimaxillary surgery) was accomplished during the same surgical procedure for 16 patients.

The selection criterion for using zygomatic implants was that the patients required complete or partial rehabilitation of the edentulous maxilla, and while conventional implants could be placed in the premaxilla, the posterior maxilla could not be treated without using one of the following techniques: grafting procedures including sinus grafting, wide and short implants, or pterygoid implants18-24. The exclusion criteria for use of zygomatic implants were acute sinusitis and heavy smokers (more than 10 cigarettes
Patients were included, provided that they met the inclusion criteria and gave their written informed consent for the treatment. Approval from the review board of the hospital to use human data for the study was obtained.

**Implants**

As previously described, a total of 45 zygomatic implants were used (Table I). These implants were available in 8 lengths between 30 and 52.5 mm. They had a 4 mm apical diameter and a 4.5 mm coronal diameter, and a 45-degree pre-angulated head that emerged at the occlusal level as for standard implants of the Brånemark system. They were made of commercially pure titanium with a turned (machined) surface.

The 109 conventional implants were placed (Table II) according to the classical protocol defined by...
All implants had a regular platform (3.75 to 4 mm diameter, Mk III; Bränemark System®, Nobel Biocare AB). The length ranged from 11.5 mm to 15 mm, and 79 implants had a machined surface and 30 had an oxidised surface (TiUnite®, Nobel Biocare AB).

**Surgical procedures**

All surgical procedures were performed under general anaesthesia. Non-retainable teeth were extracted and the entire anterolateral wall of the maxilla was exposed as far as the body of the zygomatic bone. To control the drilling procedure visually, a small lateral window was prepared to the maxillary sinus. All implants were directed towards the zygomatic bone, anchoring them at the level of the maxillary alveolar process and in the zygomatic bone itself following the classic protocol for insertion¹ (Fig 2). Patients wore dentures during the healing period. After 6 months, flaps were elevated and definitive abutments (Multi-unit abutments, Nobel Biocare AB) were connected.

**Prosthetic procedures**

Two weeks later, the definitive impression was made using stock trays (Megatray, Megadenta Dental Product, Radeberg, Germany), standard impression copings (Nobel Biocare AB) screwed on the abutments,
and silicone impression material (Aquasil\textsuperscript{TM} Mono-
phase Ultra, Dentsply, Konstanz, Germany).

A total of 3 patients were rehabilitated by means of an implant-supported overdenture and 19 were rehabilitated by means of a fixed metal-acrylic bridge. Fixed partial porcelain bridges were provided in 2 patients.

### Outcome measures

After delivery of the definitive prostheses, patients were recalled every 6 months for 2 years and once a year thereafter.

A successful prosthesis was a prosthetic restoration that functioned as intended and was clinically stable and had not been removed for a substantial period of time (2 weeks or more) during the investigation\textsuperscript{3}. The success criteria for the zygomatic implants were: (1) confirmed individual implant anchorage in the zygomatic bone by means of anteroposterior (A-P) cranial radiograph; (2) the implant acted as an anchor for the functional prostheses; (3) no suppuration, pain or ongoing pathologic process at maxillary and zygomatic level; and (4) confirmed individual implant stability, considering that, when the zygomatic implant is not connected to another implant, a slight lateral mobility at the coronal aspect of the implant can be expected in some cases\textsuperscript{11}. Implant stability was examined by individual tapping or applying light force to the implant with a dental instrument. A failed zygomatic implant was an implant that presented increased mobility, had to be removed or was fractured.

The success criteria for the conventional implant were: (1) no radiolucent zone around the implant; (2) the implant acted as an anchor for the functional prosthesis; (3) confirmed individual implant stability and (4) no suppuration, pain or ongoing pathologic processes\textsuperscript{26}. A failed conventional implant was an implant that presented mobility, had to be removed or was fractured.

Panoramic radiographs were made for all patients after surgery, at the 6- and 12-month follow-ups, and once a year thereafter. Anteroposterior (A-P) cranial radiographs were made after surgery to better visualise the zygomatic implants. In 5 patients, who experienced sinusitis, a sinus CT scan was made to confirm sinusitis and to evaluate maxillary antrum anatomy.

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Fig 3 Orthopantomograph showing atrophy of the maxilla (A), 4 conventional and 2 zygomatic implants in place (B), facial profile without prosthesis (C) and facial profile with fixed bridge (D).
Results

The study ended in December 2008, at which time 21 out of 24 patients, with 39 zygomatic implants and 97 conventional implants had been followed for 5 years after the implant insertion. A total of 6 zygomatic and 12 conventional implants in 3 patients were not reviewed throughout the follow-up period, since one of the patients died after 3 years, and 2 more dropped out after one year because they moved to another country.

Prosthesis

Continuous stability of the designed prosthesis was achieved in 20 out of the 21 patients throughout the study. An overdenture designed using only 2 zygomatic implants was removed after 1 year of function to prevent further complications and the patient is now wearing a complete denture. Therefore, the success rate for the prosthetic rehabilitation after 5 years was 95.8%.

Implants

Stability of zygomatic and conventional implants was assessed in 18 out of 21 patients after 5 years of function. In three patients, the prosthesis was not removed at the 5-year follow-up, and the stability of each individual implant was not assessed. During the follow-up period, one zygomatic implant was diagnosed as a failure and removed, but not replaced. This failure occurred in one of the drop-out patients with a complete arch rehabilitation, with 2 zygomatic implants and 4 conventional ones. Right after the placement of the implants, the patient started experiencing pain at the level of the right zygoma, without swelling or any other symptoms. It was treated with antibiotic (amoxicillin/clavulanic acid 750/125mg every 8 hours) for 10 days, and analgesics for 1 month. After that, the implant was removed and the pain persisted two more months. A neurologist did not find a clear explanation of the symptoms and the diagnosis was “atypical facial pain”. Finally, the pain ceased and the patient was provided with an overdenture. The survival rate for zygomatic implants was 97.4%.
Of the 109 originally installed conventional implants, 11 were considered failures and removed. These failures were distributed in 6 patients. Three patients lost 1 implant each at the day of the abutment connection, with no further consequences. Two more patients lost two implants out of 4 at abutment connection. Four anterior implants were lost in the same patient at the abutment connection, while the zygomatic implants remain stable. Three additional implants were placed, but they failed again. Although, originally, an overdenture was designed using only 2 zygomatic implants, it was removed after 1 year to prevent further complications and the patient is now wearing a complete denture, as mentioned before. The patient is currently waiting for a grafting procedure or two more zygomatic implants, while the originally installed zygomatic implants are stable (Fig 4).

**Complications**

There were no severe complications during the implant surgery, implant-healing phase or at the abutment connection. Nevertheless, 5 patients suffered of sinusitis. In 2 of them it was resolved with conventional antibiotic therapy, 2 needed meatotomy (FENS, functional endoscopic nasal surgery) and one of them required a Caldwell-Luc antrostomy. In all patients, the problem ceased after treatment (Fig 5).

**Discussion**

The purpose of the present retrospective study was to evaluate the long-term prosthetic rehabilitation success rate and the long-term survival rates of machined surface zygomatic implants and conventional implants placed according to a 2-stage protocol. This series of consecutively treated patients followed for 5 years showed a success rate for their prosthetic rehabilitation of approximately 96% and survival rates of approximately 97% for zygomatic implants and 90% for conventional implants, which are good results.

Zygomatic implants have been evaluated in different clinical studies as an option for the rehabilitation of the severely resorbed maxilla. High implant survival rates and few complications have been reported using two-stage and immediate function protocols. The advantages of zygomatic implants over other therapeutic methods, especially grafting procedures, may include more predictability, less morbidity and better acceptance of the treatment by patients. Nevertheless, the long-term prognosis of zygomatic implants remains unknown, since few studies offer a follow-up longer than 5 years. Brånemark and co-workers reported a 94.2% and 100% survival rate after 5 to 10 years and 12 years of follow-up, respectively. The long-term prognosis of conventional, screw-shaped titanium oral implants has been evaluated and it indicates a predictable treatment outcome. Furthermore, it is known that the long-term anchorage of an implant depends on the maintenance of osseointegration with adequate bone remodelling, and the persistence of marginal bone height. When implants in the zygomatic bone are considered, the intimate relationship between the implant and the zygomatic bone has not been elucidated, since a relevant radiographic analysis of bone apposition around implants in the zygomatic bone is technically impossible, and histologic evaluation has not been performed.

For these reasons, to evaluate osseointegration at the level of zygomatic bone, only clinical appreciation about the stability of the implant and about the presence or absence of inflammatory-infectious problems can be performed. Nevertheless, in a cadaver study using micro-tomography, Kato and co-workers showed that the area of zygomatic bone where implants are inserted, in which stresses are likely to be concentrated, has a wider and thicker trabecular bone. This could be one of the reasons that explain...
the good long-term clinical outcome for these implants. Furthermore, since zygomatic implants are inserted in 4 cortical portions of bone, they are expected to have a good prognosis. Nevertheless, further investigations are needed to evaluate osseo-integration at the level of zygomatic bone.

No fractures of zygomatic implants occurred after more than 5 years of follow-up, even though the middle point of the implant has been identified as a high stress point. This is coincident with other long-term data concerning these implants. A total of 11 conventional implants were removed due to the absence of osseointegration at the time of abutment connection. Nine of them had a machined surface. These failures may be related to the fact that they were placed in an area with large bony defects. This is in agreement with other data from clinical studies concerning the combination of zygomatic implants and conventional implants using a classical two-stage protocol. In all of these consecutive patients, a 2-stage procedure was accomplished with multiple connection/disconnection of transepithelial components. It has been hypothesised that it could imply a slow establishment of the soft tissue barrier and an increased risk of oroantral communication. Furthermore, machined surfaced zygomatic implants with a small hole at the top of the internal thread abutment screw chamber have been used. This hole is occupied by the tip of the screw once the abutment is connected. It has been suggested that this hole could lead to oral-sinus communication and an increased risk of sinusitis.

A classic, intra-sinus approach for placement of zygomatic implants has been associated with an emergence more palatal than natural dentition. Although the majority of the heads of the zygomatic implants were emerging slightly palatal, no problems for the construction of the prosthesis, including dis-
comfort for the patient, were found in the present series of consecutive patients. As Brånemark and co-workers described, ‘most patients did not even notice the position until the question was raised directly’.

The limitations of the present study include its retrospective design and small sample of implants and patients. Further prospective studies are suggested to evaluate long-term prognosis of this modality of treatment and to increase the possibility of generalisation of the results. However, based upon the results of the present study, the use of zygomatic implants together with conventional implants could be a predictable therapeutic alternative to grafting procedures in the rehabilitation of severely atrophic maxillae.

**Conclusion**

A success rate for the prostheses of 95.8% with a survival rate of 97.4% for zygomatic implants, and of nearly 90% for conventional implants were observed in the present study. These data indicate that zygomatic implants together with conventional implants placed using a two-stage protocol in atrophic maxillae, seem to be a reliable technique with a good 5-year clinical outcome.

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**References**


