



IMMEDIATE FUNCTION IN THE ATROPHIC MAXILLA USING ZYGOMA IMPLANTS: A PRELIMINARY STUDY

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Statement of problem. Oral rehabilitation of the edentulous atrophic maxilla to allow placement of a fixed dental prosthesis remains a challenge, especially if immediate function is provided.

Purpose. The aim of this retrospective, preliminary study was to evaluate, after a period of a 6 to 29 months' follow-up of prosthetic loading, the survival rate of 36 immediately loaded zygomatic implants placed in 18 atrophied maxillae.

Material and methods. Eighteen consecutive patients (6 men and 12 women), with an average age of 58 years (range of 44-74 years), were followed up to 29 months (average of 14 months). The clinical criteria included stability of the implants and the prosthesis, resonance frequency analysis (RFA), and evaluation of swelling, pain, or discomfort. Radiographic analysis was completed for conventional implants, but not for zygoma implants. All patients had a fixed prosthesis screwed onto implants within 48 hours after implant placement. Descriptive statistics were used to analyze the data.

Results. No zygomatic implants were lost over the observation period. Survival rate was 100% over an average 14-month observation period. Three conventional implants were lost, resulting in a survival rate of 95.6%. All the provisional prostheses were stable, and no relevant complications were noted.

Conclusions. The use of zygoma implants, together with conventional implants, in severely resorbed maxilla, appears to be a reliable technique for providing immediate function to patients. (J Prosthet Dent 2007; 97: S44-S51.)

CLINICAL IMPLICATIONS

Based upon the results of this preliminary study, the use of zygoma implants is a predictable method to avoid apposition bone grafting and sinus grafts in the rehabilitation of patients with severely resorbed maxillae. Furthermore, the time of treatment can be substantially decreased if zygoma implants are loaded immediately after placement.

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Oral rehabilitation of the edentulous maxilla to allow placement of a fixed dental prosthesis remains a challenge, particularly in situations of atrophied sites, especially if early or immediate function is provided (Fig. 1). Immediate function of oral implants has been documented in edentulous mandibles, and studies have demonstrated predictability.¹⁻⁵ However, few studies on immediate or early function of fixed prostheses in the maxilla⁶⁻⁹ are available and only in jaws with slight to moderate resorption.

The conventional, 2-stage rehabilitation of edentulous maxillae with fixed prostheses supported by conventional implants has been shown to be predictable when sufficient volume of bone is available.¹⁰⁻¹² However, bone resorption, especially in the posterior maxilla, decreases the possibility of implant placement. Therefore, various techniques have been described to approach the atrophic maxilla, including use of tilted implants in the para sinus region,¹³⁻¹⁶ implants in pterygoid apophysis,^{17,18} grafting of the maxillary sinus floor,^{19,20} the use of short, wide implants,^{21,22} different types of grafts,²³⁻²⁵ and zygoma implants.²⁶⁻³⁴ Recently, Malo et al³⁵ demonstrated a technique for providing immediate function, applicable to edentulous maxillae with greater degrees of resorption, by tilting the 2 posterior implants. Use of posterior tilted implants has been documented by several authors.¹³⁻¹⁶ Success rates between 92% and 95% after 3-4 years, using classic, 2-stage protocols, have been reported.

Grafting of the floor of the maxillary sinus^{19,20} and other bone grafts²³⁻²⁵ are widely used techniques, but remain controversial. Unpredictability and the frequent need to use delayed protocols in which the graft is performed first, increase the waiting times and delay fabrication of the prosthesis. Furthermore, additional morbidity of the donor area must be considered. The introduction of wide implants, with a 5- to 6-mm diameter, has provided a treatment option for

situations in which the height of available bone is approximately 6 mm.^{21,22}

The zygomatic implant was developed as a result of Branemark's work,^{32,33} in which clinical studies of patients were conducted using zygomatic bone to place implants. Various studies have confirmed survival rates of almost 98%-100% for implants with few reported complications, using 2-stage protocols, with a 6-month healing period after surgery prior to loading the prosthesis. As a result, an increasing number of authors advocate the use of zygoma implants.²⁶⁻³²

Zygomatic bone is excellent for the anchorage of implants, as has been validated in several anatomical studies.³⁶⁻³⁹ The authors agree that the quality of zygomatic bone is superior to that of the posterior maxilla, and the importance of the cortical portion of the zygomatic bone for anchoring

implants³⁷ has been described. Furthermore, zygomatic implants display initial primary stability, since it has been demonstrated that the zygomatic bone area where the implant is inserted has wider and thicker trabecular bone.³⁸ Data related to the stability of the implants placed according to the classical protocol using resonance frequency analysis measurements have been published.⁴⁰ Furthermore, some authors have published modifications of the original protocol to improve the emergence of the implant at the palatal level and to simplify the technique.⁴¹ The purpose of this preliminary, retrospective study was to evaluate the survival rate of zygoma implants placed using an immediate loading protocol for 18 consecutively treated patients with atrophic maxillae.



1 CT scan of zygoma from extremely resorbed maxilla.

MATERIAL AND METHODS

A combination of zygoma and conventional implants was used to support fixed, screw-retained, acrylic resin dentures inserted in the first 24 to 48 hours after surgery. To accomplish these complete arch rehabilitations, zygoma implants and 5 (2 patients), 4 (12 patients), 3 (2 patients), or 2 (2 patients) conventional implants were used (Fig. 2). The minimum time chosen for the follow-up of a patient in the study was 6 months. This time frame was based on histological studies for immediately loaded implants.^{42,43}

This retrospective study included 18 consecutive patients treated between June 2004 and May 2006 in the Department of Implantology and Maxillofacial Surgery at Medimar International Hospital in Alicante, Spain. The follow-up period extended until November 2006.

Eighteen patients were consecutively included, provided they met the inclusion criteria and provided written informed consent for the treatment. Approval from the hospital review board was obtained to use human data for the study.

The selection criterion for using zygoma implants was that the patients required complete rehabilitation of the edentulous maxilla, and while conventional implants could be placed in the premaxilla, the posterior

maxilla could not be treated without using 1 of the previously described techniques. These techniques included sinus grafting,^{19,20} wide implants,^{21,22} or pterygoid implants.^{17,18} Tilted posterior implants were used for patients when the implants emerged at the level of the second premolar, to avoid excessive prosthetic cantilevers,^{14,15,35} and in all other situations, zygoma implants were used. The exclusion criteria for use of zygomatic implants were acute sinusitis and heavy smoking (more than 10 cigarettes per day), and the exclusion criteria to immediately load the implants were bruxism, uncontrolled diabetes, and metabolic diseases.

Zygoma implants (Branemark System; Nobel Biocare AB, Goteborg, Sweden) were placed in all 18 patients. The distribution of implants is described in Table I. Conventional implants were regular platform implants (MK IV Branemark System; TiUnite, Nobel Biocare AB) (Table II). Rehabilitation of both dental arches (bimaxillary surgery) was accomplished during the same surgical procedure for 14 patients. Of these patients, 8 had periodontal disease in both arches, and all remaining teeth were removed. Maxillary and mandibular implants were placed during the same surgery. The remaining 6 patients requiring bimaxillary surgery had been completely edentulous for a long period of time. Complete arch rehabilitation using 4

immediately loaded implants (All-on-4; Nobel Biocare AB) was performed in the mandibles of all of these patients.⁵ In 4 patients, the maxilla was rehabilitated without operating on the mandible (3 patients with natural dentition and 1 with a previously placed implant-supported prosthesis in the mandible). The provisional prostheses were inserted within 24 to 48 hours after surgery.

A total of 36 zygoma implants were used. These implants are available in 8 lengths between 30 to 52.5 mm. They have a 4-mm apical diameter and a 4.5-mm crown diameter, and a 45-degree preangulated head which emerges at the occlusal level as for standard Branemark system implants. They have a commercially pure titanium (machined) surface. Sixty-eight conventional implants were placed, according to the classical protocol defined by Branemark.⁴⁴ All implants were from the regular platform system (4-mm-diameter MK IV, Branemark System; Nobel Biocare AB). The length ranged from 11.5 mm to 15 mm, and the implants had an oxidized surface (TiUnite; Nobel Biocare AB).

The surgical procedures were performed under general anesthetic for all patients. If there were any remnants of teeth present, they were extracted and, via an incision in the posterior maxilla, the entire antero-lateral wall of the maxilla was degloved as far as the body of the zygomatic bone. To control the movement of the drills visually, a small lateral window was placed in the bone. 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 insertion (Fig. 3).^{27,32,33} Care was taken to test the anchorage of the tip of the implant in the most superior cortical portion of the zygomatic bone and to obtain crestal emergence of the zygomatic implant (Fig. 4).

As soon as the abutments (Multi-Unit Abutments; Nobel Biocare AB)



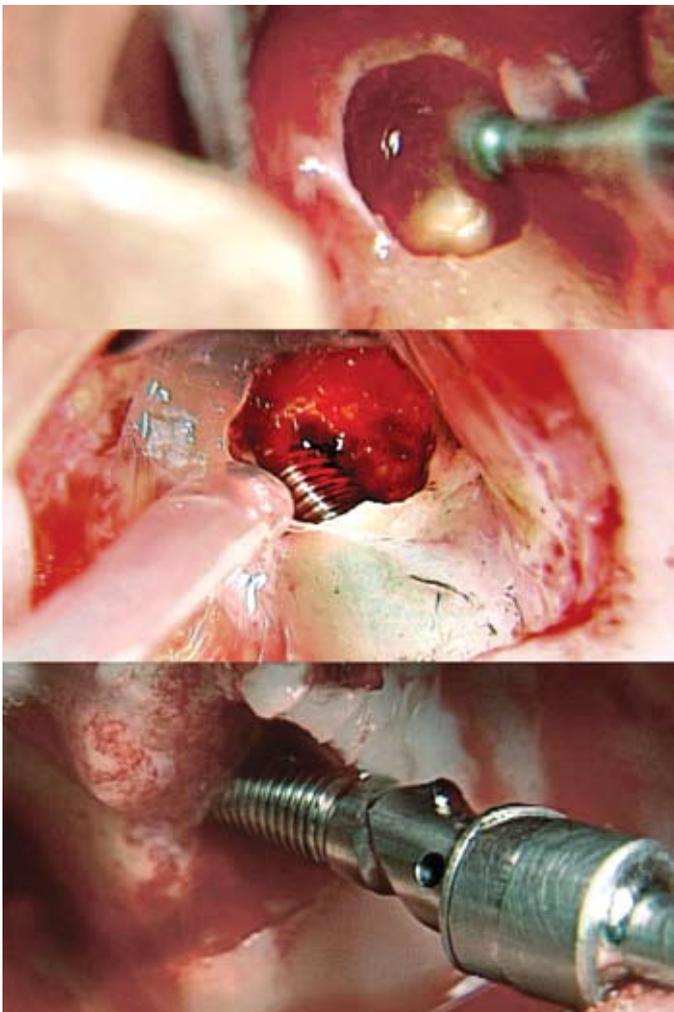
2 Surgical placement of conventional implants and zygomatic implant.

TABLE I. Size and number of zygoma implants placed in 18 patients

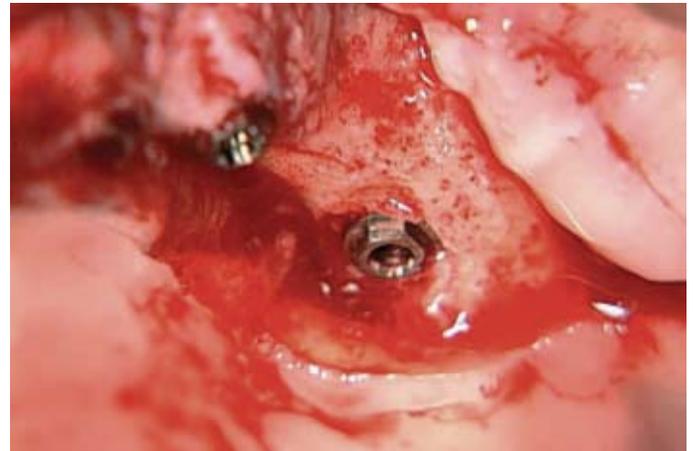
Size of Implants (mm)	Number of Implants Placed
30	0
35	0
40	4
42.5	1
45	13
47.5	5
50	12
52.5	1
Total	36

TABLE II. Size of anterior implants (Column 1: diameter x length)

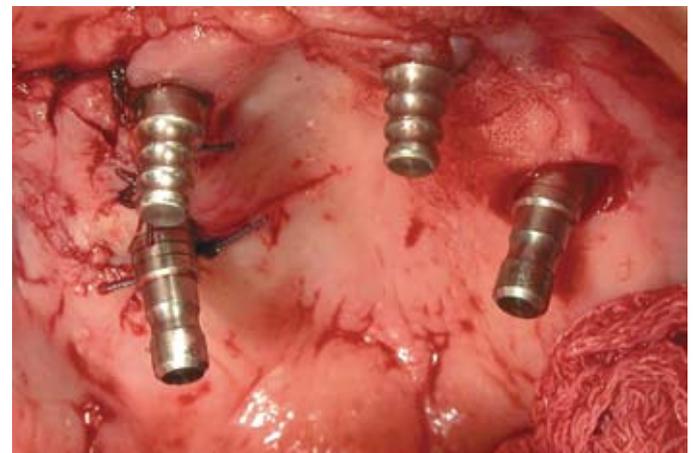
Size of Conventional Implants Diameter x length (mm)	Number of Implants Placed
4 x 10	1
4 x 11.5	6
4 x 13	34
4 x 15	27
Total	68



3 Top image: Window in antero-lateral wall of maxilla. Middle image: zygomatic implant as it passes through zygomatic bone. Bottom image: placement of zygomatic implant.



4 Zygoma implant emergence at crestal aspect of maxillary bone.



5 Impression copings screwed into abutments.

were connected and soft tissues sutured, an impression was made using stock trays (Megatray; MEGADENTA Dentalprodukte GmbH, Radeberg, Germany), standard impression copings (Nobel Biocare AB) screwed on the abutments, and silicone impression material (Aquasil Monophase Ultra; Dentsply DeTrey, Konstanz, Germany) (Fig. 5). The provisional prostheses, fabricated of acrylic resin (Lucitone; Dentsply DeTrey) and reinforced with metal wire (Remanium; Dentaaurum, Ispringen, Germany), were placed between 24 and 48 hours after surgery. Mutually protected occlusion (MPO) with canine guidance was used in 16 patients. In 2 patients with only 2 anterior implants placed, MPO with a group function occlusal

scheme was used. According to the concept of mutually protected occlusion, in centric relation there is only posterior tooth contact. The maxillary palatal cusps and mandibular buccal cusps occlude with the opposing occlusal fossae. Thus, anterior teeth positively disclude the posterior teeth in all excentric excursions, protecting the posterior teeth (or implants) from harmful lateral forces.⁴⁵

Once the provisional prostheses were loaded (Fig. 6), the patients were recalled at 1 week, 1 month, 3 months, and 6 months. At 6 months, a new impression was made to begin fabrication of the definitive prosthesis. After the definitive fixed, screw-retained, acrylic resin implant prosthesis was placed, patients were recalled

every 6 months for 2 years and once each year thereafter. The minimum length of follow-up was 6 months (2 patients) and the maximum was 29 months (1 patient), with the average length being 14 months. Clinical criterion for implant survival were stability of all implants (zygoma and conventional), based on the absence of pain or signs of inflammation or infection at palatine and/or zygomatic bone level, and no movement. Furthermore, panoramic radiographs (Fig. 7) were made for all patients after surgery, at the 6- and 12-month follow-ups, and once each year thereafter. In 14 patients, antero-posterior (A-P) cranial radiographs (Fig. 8) were made in order to better visualize the zygomatic implants. In 13 patients, a



6 Complete arch rehabilitation placed in immediate function using 2 zygomatic implants and 2 conventional implants. Top: emerging implants. Middle: palatal view of provisional prosthesis. Bottom: frontal view of provisional prosthesis.



7 Postoperative panoramic radiograph.



8 Postoperative A-P cranial radiograph.

sinus CT scan was made a minimum of 3 months after surgery to evaluate maxillary antrum.

For the conventional implants, periapical radiographs were made at the 6- and 12-month follow-up periods and once each year thereafter. The distance from the implant/abutment junction to the most coronal point of the marginal alveolar bone adjacent to the implant was measured on both sides with magnification, and radiolucent zones around implants were noted. All radiographs, except for the periapical radiographs, were made by an independent radiologist. Data was analyzed using descriptive statistics.

RESULTS

One of the patients suffered acute sinusitis during the immediate post-operative period (after approximately 10 days), which was resolved with antibiotic treatment (amoxicillin /clavulanic acid 750/125 mg every 8 hours for 10 days) (Augmentine; Glaxo-SmithKline, Madrid, Spain) without further complications. All zygomatic implants were stable when clinically examined, had no active inflammation or infection at the zygomatic bone or palatal level, no swelling, and no movement. Slight discomfort was found in 1 patient at the palatal aspect of the zygoma implant after 2 months of loading and no movement. The discomfort disappeared after loading was eliminated for 10 days. The survival rate for the zygoma implants was 100%.

Sixty-five of the 68 conventional implants were stable, patients experienced no pain, and there were no radiolucent zones around the implants found in the radiographs. One anterior implant in a patient and 2 implants in another patient were removed, as they were mobile at the 3-month recall. The provisional prostheses remained stable.

DISCUSSION

The aim of this study was to evalu-

ate the survival rate of immediately loaded zygomatic implants used in combination with immediately loaded standard implants to provide immediate function in complete arch rehabilitation with fixed, acrylic resin, screw-retained implant prostheses. Immediate and early function of oral implants have been documented in different studies, both in mandibles¹⁻⁵ and maxillae.⁶⁻⁹ However, severely resorbed maxillae remain a problem, since the applicable techniques have not been evaluated in immediate loading protocols. One clinical trial validates the use of tilted posterior implants placed in immediate function in the edentulous maxilla.³⁵ However, additional clinical trials and longer follow-up periods are required to evaluate this protocol. Pterygoid implants,^{17, 18} wide implants,^{21, 22} and grafting procedures,²³⁻²⁵ including sinus lift,¹⁹⁻²⁰ have not been evaluated using immediate function protocols.

The zygomatic implant is derived from the remote implant anchorage concept developed by Parel et al.³³ After more than 12 years of follow-up, a high survival rate of 97% for the zygomatic implant has been demonstrated.^{32,33} Furthermore, Malevez²⁷ and Bedrossian³⁵ report a 100% survival rate after 48 and 36 months, respectively, using 2-stage protocols, and a 98% survival rate was reported in a multicenter study at 16 clinics,²⁸ after 1 year of follow-up. For these reasons, zygomatic implants represent a good alternative for the rehabilitation of the atrophied maxilla.

Until now, immediately loaded zygomatic implants have not been evaluated with a follow-up at 29 months. Since this series of consecutive patients demonstrated a success rate of 100% for zygomatic implants followed over a mean of 14 months, the preliminary data imply that they are a good alternative for providing immediate function for patients with severely resorbed maxillae. The remote implant anchorage concept can be applied with immediate function protocols. It is a predictable method

not only to avoid bone and sinus grafting, but to provide immediate function in this population of challenging patients. Immediate function decreases the time of treatment and increases acceptance of the treatment by the patients.

Zygomatic implants are inserted in 4 cortical portions of bone from the maxillary alveolar process and zygoma bone.³⁷ The tip of the implant is inserted in a zygomatic area with wider and thicker trabecular bone.³⁸ This allows for primary stability and the opportunity to immediately load the implant.

Furthermore, using a fixed prosthesis to connect all implants with adequate antero-posterior spread provides cross-arch stabilization and allows masticatory forces to be transmitted to the zygoma bone.³² Thus, cross-arch stabilization from the prosthesis, just after placement of the implants, could alleviate the load on the anterior implants, and could be 1 of the reasons to explain the loss of only 3 implants in such atrophied sites. This loss of implants may be related to the fact that they were placed in an area with a large bony defect, since immediate loading itself does not seem to preclude osseointegration.^{42,43} In fact, the survival rate for these immediately loaded anterior implants was almost 96%, which is higher than other published results for this combination of implants in atrophied maxillae using a 2-stage protocol.^{27,35} Further investigations are suggested to evaluate this concept.

In the present study, only the survival rate for zygomatic implants was reported since clinical evaluation methods such as a radiographic analysis are not possible in this area,²⁷ and there is not enough literature regarding other diagnostic methods.⁴⁰ New diagnostic methods are needed to evaluate bone apposition around zygoma implants and to assess whether zygoma implants have achieved an intimate bone-to-implant contact. The limitations of this preliminary study include the relatively short follow-up

periods and small sample size of both patients and implants. Prospective studies are needed to further evaluate immediately loaded zygomatic implants, which can also be described as the remote implant anchorage concept with immediate function protocols.

CONCLUSIONS

Within the limitations of this preliminary study, these data indicate that zygoma implants, in combination with 2 to 5 anterior conventional dental implants placed in atrophic maxillae, can be loaded immediately to support a fixed screw-retained, acrylic resin implant denture.

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