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Clinical outcome of 42 patients treated with 81 immediately loaded zygomatic implants: a 12- to 42-month retrospective study

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Key words *immediate loading, zygomatic implants*

Aim: Rehabilitation of the edentulous atrophic maxilla by implants to allow placement of a fixed dental prosthesis remains a challenge, especially if immediate function is provided. The aim of this retrospective study was to evaluate the success rate of immediately loaded zygomatic implants placed in atrophic maxillae.

Materials and methods: Forty-two consecutively treated patients (19 men and 23 women), with a mean age of 57 years (range: 34 to 79 years) were followed for at least one year (range: 12 to 42 months, mean: 20.5 months). Thirty-seven patients were totally edentulous and five were partially edentulous. In total, 81 zygomatic and 140 conventional implants were inserted. The success criteria for the zygomatic implants were: (1) confirmed individual implant anchorage to the zygomatic bone by means of anteroposterior cranial radiograph; (2) the implant acting as an anchor for the functional prostheses; (3) no suppuration, pain, or ongoing pathological process at maxillary and zygomatic level; (4) confirmed individual implant stability. All patients had a fixed prosthesis screwed onto implants within 48 hours of implant placement. Descriptive statistics were used to analyse the data.

Results: After one year, there was no patient drop-out. None of the zygomatic implants were lost over the observation period (100% success rate). Four conventional implants were lost, resulting in a success rate of 97%. All the provisional prostheses were stable. Oroantral fistula and sinusitis was found in one patient, which was solved with antibiotics and meatotomy, with no further complications. Soft tissue swelling and pain at the zygomatic area were found in another patient after 10 days of surgery. This was solved with antibiotics, with no further complications.

Conclusions: Zygomatic implants together with conventional implants in severely resorbed maxillae appear to be a reliable technique for providing immediate function to patients. The time of treatment can be substantially decreased in a predictable way if zygomatic implants are loaded immediately after placement.

■ Introduction

The rehabilitation of the edentulous maxilla by means of implants to allow the placement of a fixed dental prosthesis remains a challenge, particularly in situations with atrophied sites, and especially if early or immediate function is provided[1,2]. Bone resorption, especially in the posterior maxilla, decreases the possibility for implant placement. For this reason, various techniques have been described to treat the atrophic maxilla, including the use of angled implants in the parasinus region, implants in pterygoid apophysis, grafting of the maxillary sinus floor, short and wide implants, and zygomatic implants[3-22].

Some recently published studies involve the use of short implants and tilted implants concomitant with immediate function[23-25]. To the author's knowledge, pterygoid implants and grafting procedures have not been studied with immediate function protocols[8-11].

The zygomatic implant is derived from the remote implant anchorage concept, developed by Parel et al[18]. After more than 12 years of follow-up, a survival rate of 97% has been demonstrated. Furthermore, 100% survival rates after 48, 36 and 60 months, respectively, have been reported in two retrospective and one prospective studies using machined-surface zygomatic implants with a two-stage protocol[20-22]. A multicentre prospective study has been performed, and survival rates of 98% and 96% were reported after a follow-up period of 1 and 3 years, respectively[26,27].

The possibility of anchoring more than one implant at the zygomatic bone has also been reported[28,29]. Furthermore, the use of machined-surface zygomatic implants with an immediate function protocol has been described[30-32]. In all these studies, 100% survival rates for zygomatic implants were reported.

The zygomatic implants are inserted in four cortical portions of bone of the maxillary alveolar process and the zygoma. In addition, the tip of these implants are inserted in a zygomatic area with a wider and thicker trabecular bone[33,34]. This allows for primary stability and the opportunity to load the implants immediately[32]. A three-dimensional finite elemental analysis of osseointegrated zygomatic implants suggested that stress due to occlusal force is mainly transferred to the zygomatic bone[35]. Nevertheless, no randomised clinical trial has been performed to assess advantages and disadvantages of this implant[36]. The aim of this retrospective study was to evaluate the success rate of immediately loaded zygomatic implants after 1 year or more in function.

■ Materials and methods

This retrospective study included 42 consecutively treated patients (34 women and 19 men) with a mean age of 57 years (range 34 to 79 years) treated between June 2004 and December 2006 in the Department of Implantology and Maxillofacial Surgery, Medimar International Hospital, Alicante, Spain. The follow-up period ended in December 2007. All patients were followed for at least 1 year. The patients were consecutively 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.

A combination of zygoma and conventional implants was used to support fixed, screw-retained acrylic resin prostheses inserted 24 to 48 hours after surgery. Complete arch rehabilitations were accomplished in 37 patients. In 33 patients, two zygoma implants and six (two patients), five (three patients), four (16 patients), three (five patients), or two (seven patients) conventional implants were used. In two cases, one zygoma implant with five conventional ones was used. In two cases, four zygoma implants (two in each side) were used. Partial arch rehabilitation was accomplished in five patients, namely one zygoma implant in combination with two conventional implants.

The selection criterion for using zygoma implants was that the patients required complete or partial rehabilitation of the edentulous maxilla. While conventional implants could be placed in the premaxilla, the posterior maxilla could not be treated without using sinus grafting[10,11], wide implants[14,15] or pterigoid implants[8,9]. Tilted posterior implants were used for patients when they emerged at the level of the second premolar to avoid excessive prosthetic cantilevers. In all other situations, zygoma implants were used[3-7,32]. In two patients, there were no options for placement of implants in the anterior maxilla. In those cases, two zygoma implants were placed in each side. Most of the implants sites had type 2 bone quality and quantity of

Figs 1a to 1c 'Sinus slot technique' for placing zygomatic implants.

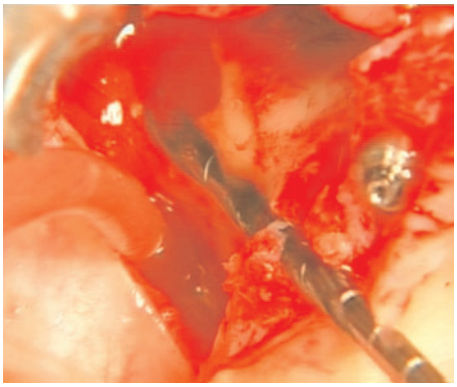

Fig 1a Drilling through a previously designed groove in the lateral aspect of the maxilla.

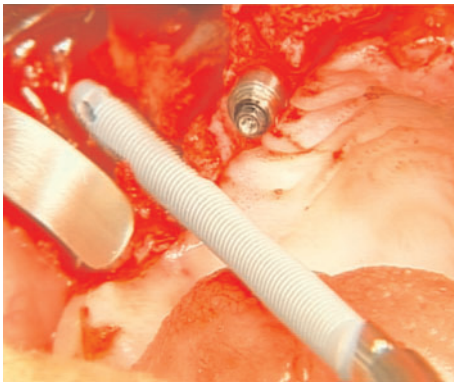

Fig 1b Placement of the implant.

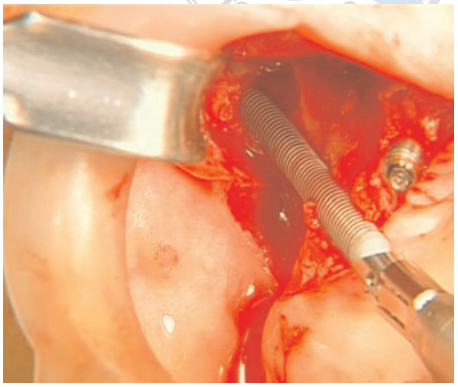

Fig 1c Anchorage at the level of zygomatic bone and maxillary alveolar process (crestal emergence).

types B or C according to the Leckholm and Zarb classification[37].

The exclusion criteria for use of zygomatic implants were acute sinusitis and heavy smoking (more than 10 cigarettes per day). Exclusion criteria for immediate loading of the implants were bruxism, uncontrolled diabetes and metabolic diseases.

A total of 81 zygomatic implants (Brånemark System, Nobel Biocare, Göteborg, Sweden) were placed. The distribution of the lengths of the implants is described in Table I. The implants had a 4-mm apical diameter and a 4.5-mm crown diameter, and a 45° pre-angulated head that emerges at the occlusal level as for standard implants of the Brånemark System. The implant surfaces were commercially pure titanium (machined) (44 implants), or porous titanium oxide (37 implants).

The conventional implants were Brånemark or Replace implants (Nobel Biocare). A total of 140 conventional implants were placed. Their length ranged from 11.5 to 15 mm, and they had a porous titanium oxide surface.

Full arch rehabilitation of the maxilla was accomplished in 37 patients. Of them, 22 were totally edentulous and 15 had remnant teeth. Partial rehabilitation of the maxilla was performed in five patients.

For all patients, the surgical procedures were performed under general anaesthetic. If there were any remnants of teeth present, they were extracted and, via an incision at the posterior maxilla, the entire antero-lateral wall of the maxilla was degloved as far as the body of the zygomatic bone. To obtain a visual control of the drills, a small lateral window was made in the bone. All implants were directed towards the zygomatic bone, anchoring them at level of the maxillary alveolar process and in the zygomatic bone itself, following the classic protocol for insertion[18-20]. For 15 implants, an improved crestal emergence was achieved by the 'sinus slot' technique, involving a groove in the lateral wall of the maxilla (Fig 1)[39].

In ten of the edentulous patients, a soft tissue punch was used at the level of the palatal mucosa and a small incision was made at the sulcus at the level of the zygomatic buttress, just large enough to secure a good visualisation of the entire lateral wall of the maxilla and the zygomatic area after degloving, and to allow the design of the lateral window. This small incision has been recently described for computer-guided zygoma surgery (Fig 2)[30]. The drilling and placement of the implants were performed following the classic protocol.

Table 1 Length of zygomatic implants placed in 42 patients.

Length (mm)	Number of placed implants
30	0
40	6
42.5	6
45	21
47.5	14
50	29
52	5
Total	81

Figs 2a to 2f 'Minimally invasive approach' for placeing zygomatic implants.

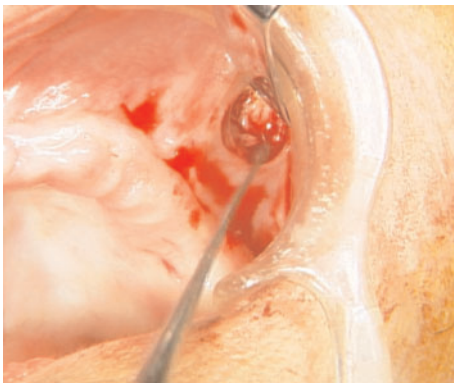

Fig 2a Incision at the level of the sulcus.

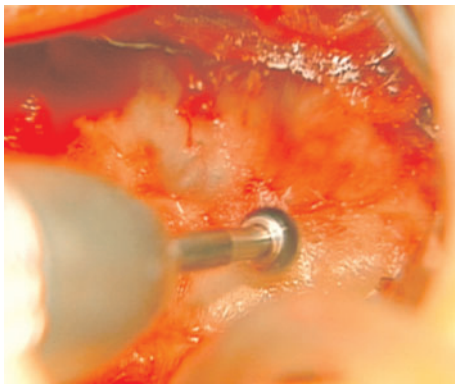

Fig 2b Degloving of the lateral wall of the maxilla, and design of the window at this level.

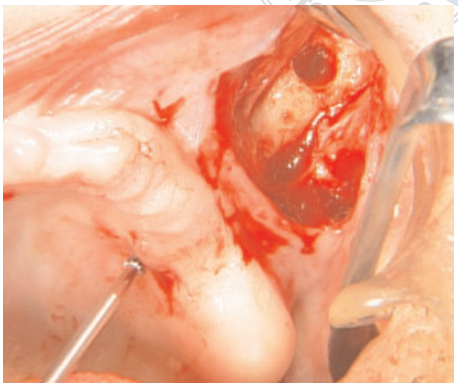

Fig 2c Drilling after small incision at the level of the palatal mucosa.

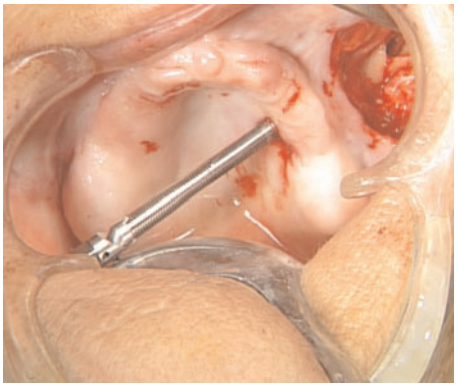

Fig 2d Placement of zygomatic implant.

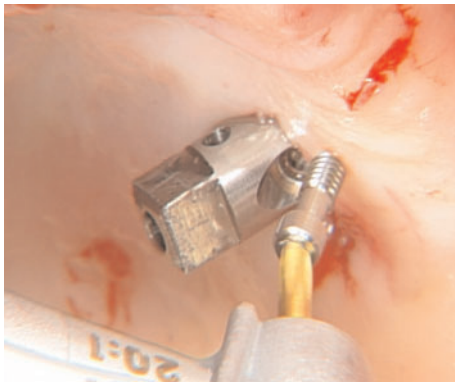

Fig 2e Fixture mount disconnection.

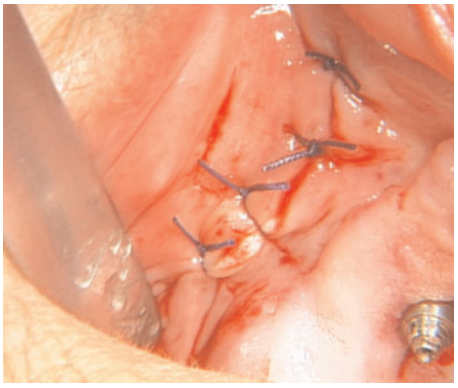

Fig 2f Suture at the level of the sulcus, and MultiUnit zygomatic abutment.

In order to place two implants in each zygoma bone, the sinus slot technique was used in two patients. The infraorbital nerve was carefully identified and special care was taken to avoid the orbital rim and orbital floor (Fig 3).

As soon as the abutments (MultiUnit, Nobel Biocare) were connected and soft tissues sutured, an impression was made using stock trays (Megatray, Megadenta Dental Product, Radeberg, Germany), standard impression copings (Nobel Biocare) screwed on the abutments, and silicone impression material (Aquasil Monophase Ultra, Dentsply, Konstanz, Germany).

The provisional prostheses of acrylic resin (Lucitone, Dentsply) reinforced with metal wire (Remanium, Dentaurum, Ispringen, Germany) were placed 24 to 48 hours after surgery (Fig 4). Mutually protected occlusion (MPO) with canine guidance was used in 40 patients. In seven patients with only two anterior implants placed, MPO with a group function occlusal scheme was used. According to the concept of MPO, 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 eccentric excursions, protecting the posterior teeth (or implants) from harmful lateral forces[40].

Once the provisional prosthesis was loaded, the patients were recalled after 1 week, 1 month, 3 months and 6 months. At 6 months, a new impression for the definitive prosthesis was made. After the

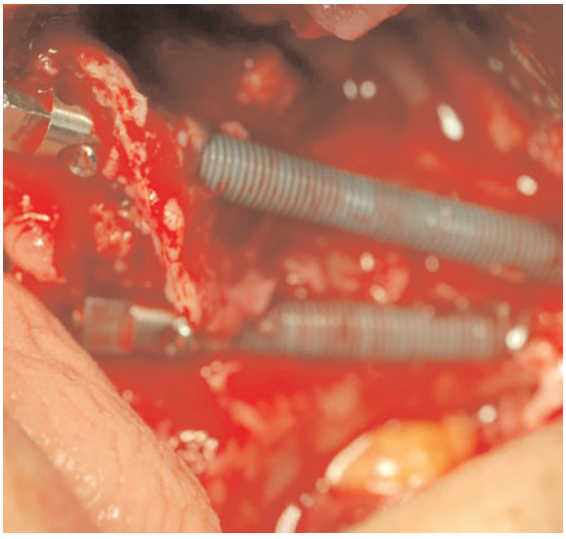

Fig 3a Two zygomatic implants are anchored in the same zygomatic bone.

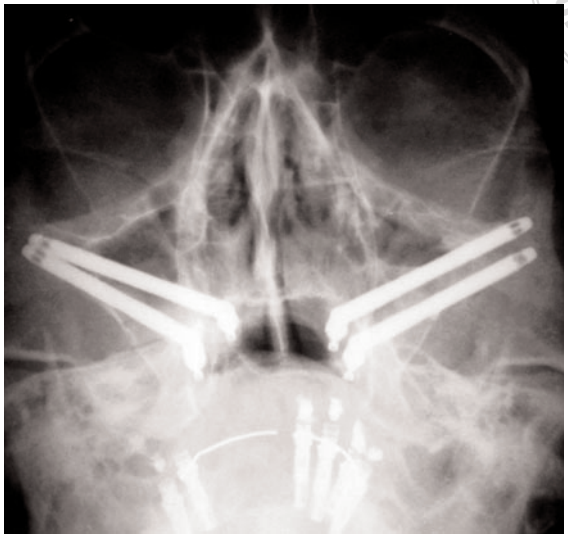

Fig 3b Cranial x-ray showing the four zygomatic implants.

Figs 3a to 3d Severe resorption of the maxilla.

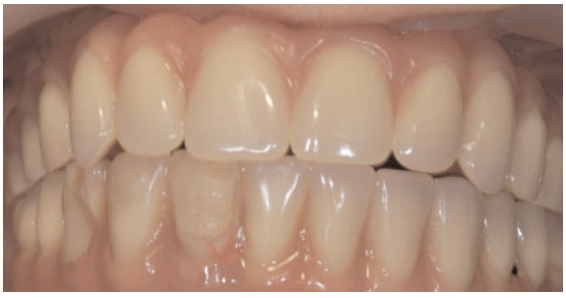

Fig 3c Provisional prosthesis (frontal view).

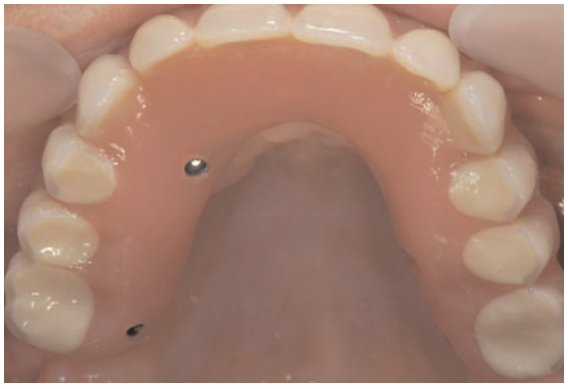

Fig 3d Provisional prosthesis (occlusal view).

definitive fixed, screw-retained, acrylic resin implant prosthesis was placed, patients were recalled every 6 months for 2 years, and once a year thereafter. The minimum follow-up was 12 months (two patients) and the maximum was 42 months (one patient). The mean follow-up period was 20.5 months.

The success criteria for the conventional implants were: (1) no radiolucent zone around the implant; (2) the implant acting as an anchoring for the functional prosthesis; (3) confirmed individual implant stability; and (4) no suppuration, pain, or ongoing pathological processes[41].

The success criteria for the zygomatic implants were: (1) confirmed individual implant anchorage in the zygomatic bone by means of antero-posterior (A-P) cranial radiograph; (2) the implant acting as an anchoring for the functional prostheses; (3) no suppuration, pain, or ongoing pathologic process at maxillary and zygomatic level; (4) confirmed individual implant stability, considering that when a zygoma implant is not connected to another implant, a slight mobility at the coronal aspect of the implant can be expected in some cases[42].

Panoramic radiographs were taken after surgery, at the 6- and 12-month follow-ups, and once a year thereafter. In all patients, A-P cranial radiographs were made to better visualise the anchorage of the zygomatic implants. For conventional implants, periapical radiographs were performed.

The data were analysed using descriptive statistics.

Figs 4a to 4c Severely resorbed maxilla.

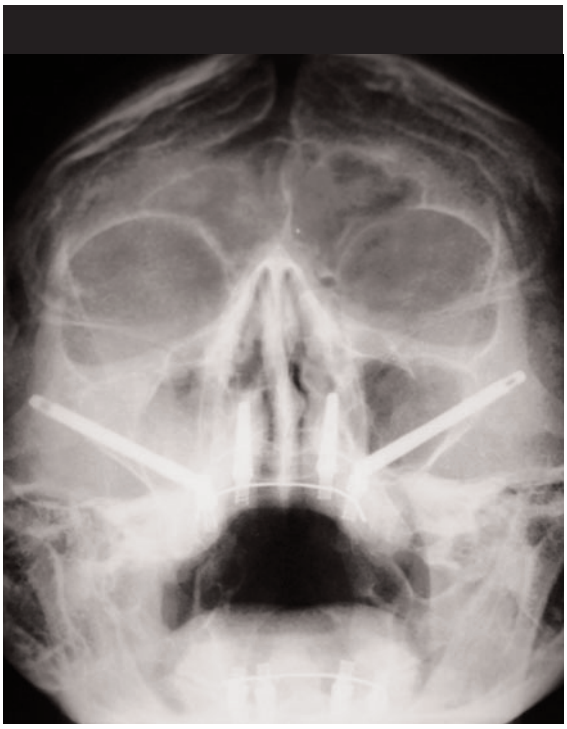

Fig 4a Cranial x-ray showing zygomatic and conventional implants.

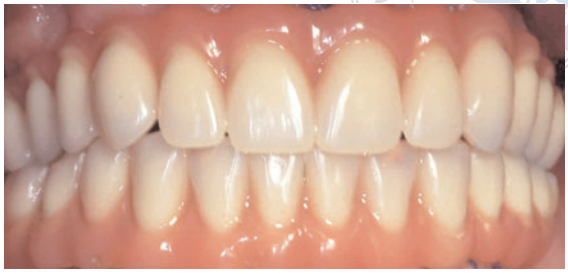

Fig 4b Provisional prosthesis (frontal view).

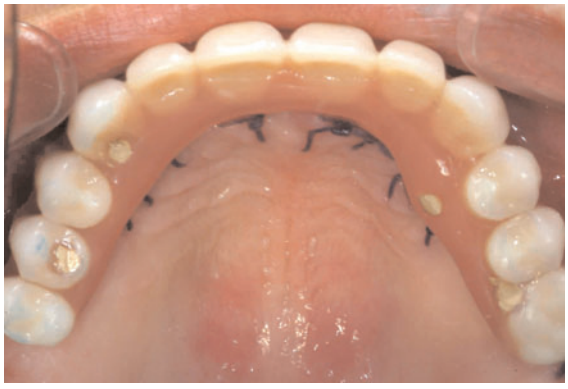

Fig 4c Provisional prosthesis (occlusal view).

■ Results

All zygomatic implants were anchored in the zygomatic bone and were acting as an anchoring for the functional prostheses without suppuration, pain, or ongoing pathological process at the maxillary and zygomatic level after the 3-month recall. The individual implant stability was confirmed, and five implants were characterised by slight mobility at the maxillary level without further consequences or findings. Mobility was observed in some implants that were placed using the sinus slot technique without the anchorage provided by the lateral aspect of the maxillary alveolar process. The success rate for the zygomatic implants was 100%.

A total of 136 of the 140 conventional implants were stable (97% success rate), Patients experienced no pain and there were no radiolucent zones around the implants. One anterior implant in two patients and two in another patient were removed due to mobility at the 3-month recall. All provisional prostheses were stable.

One of the patients suffered from swelling and pain at the zygomatic level during the immediate postoperative period (after approximately 10 days), which was resolved with antibiotic treatment (co-amoxiclav 750/125, 3 times daily for 10 days; Clamoxyl 750, GlaxoSmithKline, Madrid, Spain), and no further complications were observed. Macroscopic oroantral communication was found in a patient (one side), just after the placement of the zygomatic implant. This allowed for the transit of liquids from the oral cavity to the antrum and nose. It was followed by a sinusitis episode 4 months later. The sinusitis was successfully treated with antibiotic (co-amoxiclav 750/125, 3 times daily for 10 days; GlaxoSmithKline) and meatotomy (functional endoscopy nasal surgery, FENS). By doing so, sinusitis was resolved and oroantral communication spontaneously closed 1 month later. After 8 months of follow-up, the patient had not experienced any further complications.

■ Discussion

The aim of this retrospective study was to evaluate the success rate of immediately loaded zygomatic implants. The remote implant anchorage concept applied with immediate function protocols using machined-surface zygomatic implants has been eval-

uated in some case reports and in two clinical studies[30-32]. A survival rate of 100% was reported in these studies. None of these previous studies offered a sample size of patients and implants as large as in the present study. Furthermore, to the author's knowledge, porous titanium oxide zygomatic implants have not been clinically evaluated.

Since this series of 81 immediately loaded zygomatic implants demonstrated a success rate of 100% after at least 1 year of function, the data imply that zygomatic implants can be used with immediate function protocols, confirming previous findings[32]. With immediate occlusal loading, the morbidity and time of treatment can be substantially decreased and the patient's acceptance increased[30,32].

A combination of zygomatic implants with conventional implants, using cross arch stabilisation from the prosthesis just after implant placement could alleviate the load on the anterior implants[18,32]. This has been confirmed by a recent three-dimensional finite elemental analysis study of stress distribution in the craniofacial structures around zygomatic osseointegrated implants[35]. It has been reported that stress due to occlusal forces is transferred predominantly through the infrazygomatic crest and is mainly supported by the zygomatic bone. Furthermore, when zygoma implants are connected with conventional implants, occlusal forces applied to the fixed prosthesis are transferred to the zygomatic bone and not to the anterior or posterior severely resorbed maxilla. This fact does not seem to be influenced significantly by anatomical structure of the maxilla[35]. This could be one of the reasons for the loss of only four immediately loaded anteriorly placed implants in the present patients. The success rate of immediately loaded conventional implants was 97%, which is higher than for other published data related to this combination of implants in atrophied maxillae using a two-stage protocol[20,21].

Very few data have been published about the placement of more than one implant in the same zygomatic bone[28,29]. Two patients of this series were successfully treated with four immediately loaded zygomatic implants, two in each side. Further investigations are suggested to evaluate this concept.

There are currently no clinical studies about the use of unilateral zygoma implants to accomplish partial arch rehabilitation. Four of the included patients were partially rehabilitated by means of two conventional implants and one zygomatic implant. Furthermore, one patient with a cystic-related absence of bone in the anterior maxilla was rehabilitated with two conventional implants and one zygomatic implant emerging in the canine region. In this way, an immediate rehabilitation from area 12 to 25 was performed (Fig 5). Further investigations are needed to evaluate this treatment procedure.

In the present series of patients, three different surgical approaches were used: the 'classical approach', 'sinus-slot technique', and a third one that can be designed as a 'minimally invasive approach'[3,19,38]. Sinus-slot was accomplished when crestal emergence of the implant was a priority, especially in patients with a well-preserved alveolar process[39]. Furthermore, if anterior emergence of zygomatic implant is desired (i.e. anterior implant in cases of two zygomatic implants in each side), the sinus slot technique facilitates the placement of these implants. If the patients were edentulous for a long period of time, a long crestal-palatal incision was avoided to respect the integrity of the palatal mucosa for facilitating the establishment of the soft tissue barrier at this level[30]. No differences were found with regards to success rates of implants, and the choice of the approach depends entirely on the preferences of the surgeon.

Slight mobility of the coronal part of the implant, with no further consequences, was observed in five implants when the anchorage at the level of the maxillary bone was not optimal. This slight mobility of the isolated zygomatic implant can be reduced by means of immediate cross arch stabilisation, and tends to diminish with time.

Macroscopic oroantral communication was found in one patient (one side), just after the placement of the zygomatic implant. It was followed by a sinusitis episode 4 months later. The sinusitis was successfully treated with antibiotics and meatotomy. The oroantral communication spontaneously closed 1 month later. After 8 months of follow-up, the patient had not experienced any further complications. These findings seem to confirm the oroantral communication could be the main reason for the low rate of sinusitis associated with zygomatic implants[42].

Figs 5a to 5d Severely resorbed maxilla.

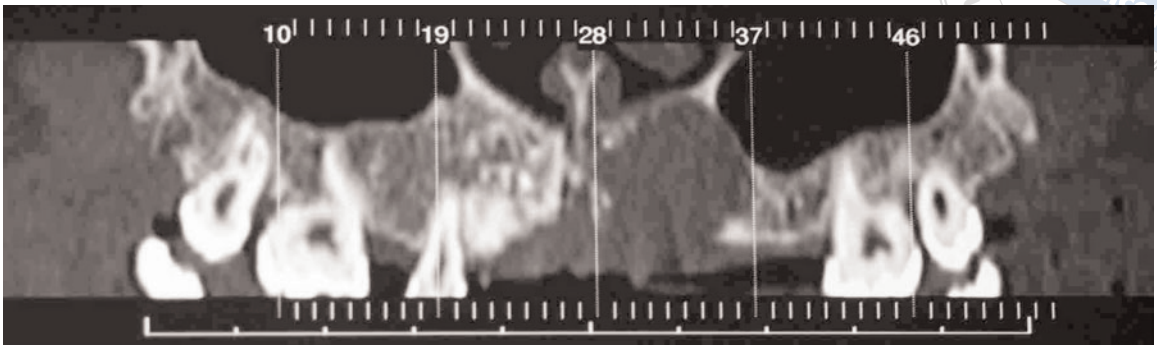

Fig 5a Provisional prosthesis (frontal view).

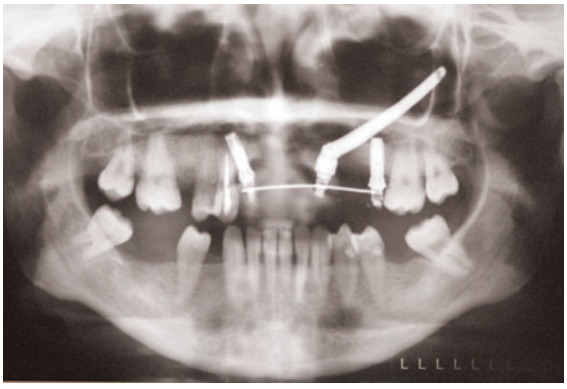

Fig 5b Provisional prosthesis (occlusal view).

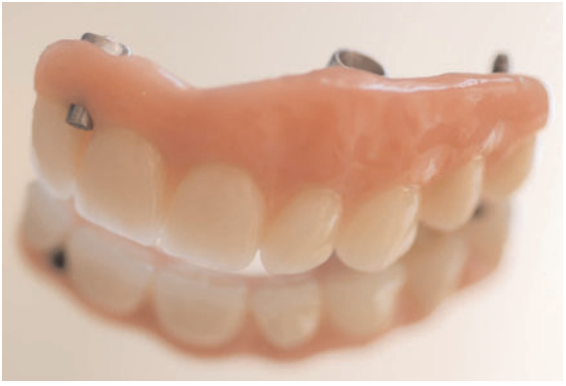

Fig 5c Provisional prosthesis (occlusal view).

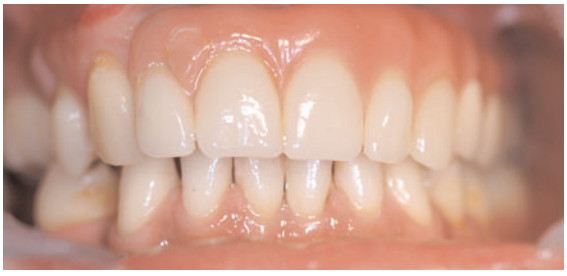

Fig 5d Provisional prosthesis (frontal view).

The limitations of this study include its retrospective design, and the relatively short follow-up period. Prospective studies and randomised clinical trials are needed to further evaluate immediately loaded zygomatic implants, the different approaches for their placement and the rehabilitation possibilities[36].

Conclusions

Within the limitations of this study, zygomatic implants can be successfully loaded immediately in combination with conventional implants to support screw-retained acrylic resin bridge.

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