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No Bone Solutions for the Severely Atrophic Maxilla

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Minimally invasive surgery is defined as "the discipline of surgical innovation combined with modern technologies."[1] It is only during the past 10 years that prosthodontists, periodontists, and oral and maxillofacial surgeons have become interested in altering "maximally invasive" procedures with the use of novel, minimally invasive techniques. Consequently, immediately loaded dental implants have become an area of keen interest to dental health professionals and patients alike, offering expedited yet predictable and functional dentition in a matter of only one day or even one hour.

Typically, a patient who decides to pursue dental implant rehabilitation is suffering from poor overall dental health. In some cases, due to prolonged periods of edentulism, rehabilitation of the extremely atrophic edentulous maxilla is compromised, as the alveolar bone volume is often inadequate. Patients with advanced or severely resorbed alveolar crests present a daunting situation regarding bone harvesting and dental rehabilitation. Unfortunately, scenarios such as this occur all too often and may encourage practitioners to render these patients as "untreatable."

Typically, a patient who decides to pursue dental implant rehabilitation is suffering from poor overall dental health.

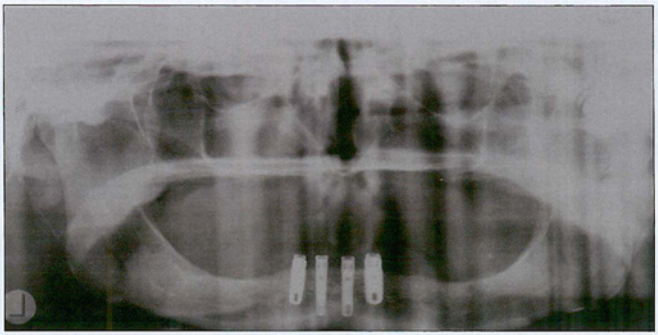

Figure 1. Pretreatment panoramic radiograph illustrates severe maxillary atrophy.

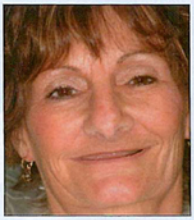

Figure 2. Initial patient presentation, facial view.

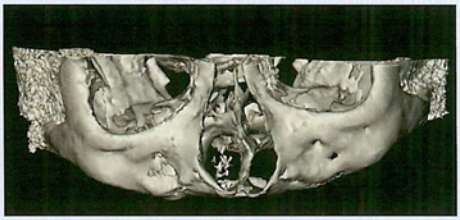

Figure 3. A 3-D reconstruction of patient's cranial structures illustrating a "No Bone" maxilla.

During the last 3 decades, several surgical procedures have been developed to increase local bone volume in deficient anatomical regions, including total/segmental bone onlays,[2,3] Le Forte[1] osteotomy with interpositional bone grafts,[4] and grafting of the maxillary sinus with autogenous bone and/or bone substitute.[5,6] If adequate bone volume allows, placing tilted implants[7,8] or implants in the pterygomaxillary region[9-11] have been predictable solutions for the edentulous maxilla.

This report discusses patient treatment of the atrophic maxilla using the zygoma bone for anchorage of dental implants. The zygomatic implant has been used in patients with moderate to severe resorption of the maxilla and has demonstrated success in supporting fixed prostheses.[12-17] In some reports, the zygomatic implant has been used under immediate functional loading and has demonstrated success.[15-17]

The development of cone beam CT scanning technology (i-CAT [Imaging Sciences International]) and 3-D treatment planning software (NobelGuide powered by Procera [Nobel Biocare]) have allowed patient treatment to be expedited and minimally invasive. Using these technologies, complex cases can be treatment planned virtually to produce a CAD/CAM surgical template to place the implants in a precise, predetermined position. This process, in conjunction with Zygomatic implants (Nobel Biocare) and the Teeth In A Day (Pi Dental Center) protocol,[15-16] allows all patients, no matter the severity of bone atrophy, to be treated with immediate functional loading in a single surgical procedure.

TREATMENT PROTOCOL REVIEW

A 50-year-old white female presented with a completely edentulous and severely atrophic maxilla. Three teeth were present in the mandible (Nos. 17, 18, and 22), and levels of alveolar bone were minimally greater than the levels evident in the maxilla. The patient's chief complaints were of recurrent jaw pain, painful/ill-fitting dentures, unsuc-

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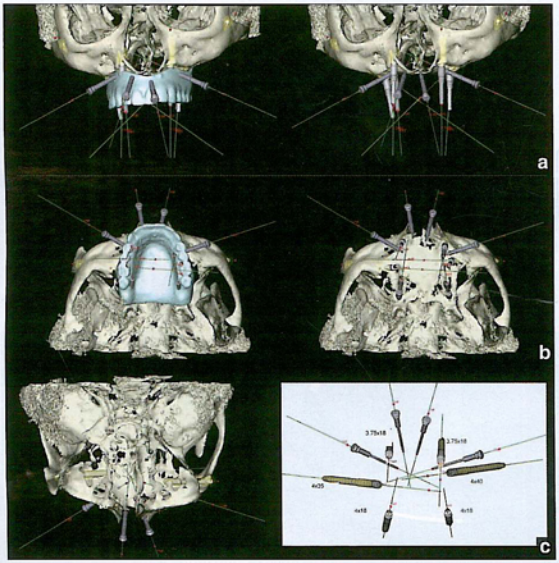

Figures 4a to 4c. Various virtual implant planning illustrations: (a) left - frontal view with the denture positioned, right - frontal view with denture removed, (b) left - occlusal view with denture positioned, right - occlusal view with denture removed, and (c) left - top view through nasal cavities and sinuses, right - implant sizes and spatial position.

cessful implants, and noticeable atrophy of alveolar bone in both the maxillary and mandibular arches. The patient's medical history included persistent depression and a 4-year episode with anorexia nervosa, for which she continues to seek professional assistance and has been prescribed Prozac (80 mg, Eli Lilly).

Her recent dental history included implant consultation at a local university hospital, where traditional implant placement was considered. However, she was denied full-mouth reconstruction at this time based on panoramic and periapical radiographic analysis, which suggested insufficient levels of alveolar bone.

The oral surgery department team then presented her with an iliac crest graft as a treatment option. When the patient declined the iliac crest graft procedure due to the potential risks, the treating clinicians decided to place root form endosseous implants in both maxillary canine eminences where bone levels appeared to be relatively higher.

The upper right implant failed, and the initial maxillary left implant was avulsed during a brief sinus infection and sneezing episode. This implant was replaced, but failed to achieve osseointegration.

The patient was then referred to another clinician who provided a CT scan to evaluate the bony structure in both of her zygomatic arches. During this time the 3 remaining mandibular teeth were extracted and 4 implants were placed in the mandibular anterior to support a removable prosthesis (Figure 1). Her upper denture was totally mobile and did not provide enough retention to withstand the mastication of a bolus of food. This denture had no labial or buccal flanges, and as a result had no lateral resistance to movement. It rested completely on the hard palate, anterior nasal septum (ANS), and eggshell-thick floor and lateral walls of the sinuses. The patient functioned with this prosthesis for another 3 years, wherein numerous modifications were made to accommodate her severely atrophic maxilla.

In 2005, the patient was referred to the Pi Dental Center at the Institute for Facial Esthetics in Fort Washington, Pa (Figure 2). Here, the patient's cranial structures were digitally recorded with a cone beam CT scan (i-CAT) and then processed through the Procera software to ultimately result in a virtual 3-D image of the patient's hard tissue and the relative position of the teeth. Upon

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Appropriate abutments were selected to accommodate the prosthetic reconstruction that would be immediately placed following the Teeth In A Day protocol.

image analysis, a marked loss of alveolar bone was indeed evident in the maxilla (Figure 3). However, clinicians were able to identify potential areas of bone bilaterally in the paranasal and pterygomaxillary regions, as well as in the area of the zygoma. A virtual planning of the patient's maxillary rehabilitation was executed, as illustrated in Figures 4a to 4c, with 6 Brånemark System implants (Nobel Biocare).

Once the virtual planning was complete, the computer files were transferred to the Procera manufacturing facility in Sweden, where rapid prototyping technology was used to create a surgical template designed to place the 6 implants in precisely predetermined positions (Figure 5). Following the traditional NobelGuide protocol,[18] a master cast was retro-engineered from the surgical template (Figure 6). Using a computer-generated duplicate of the patient's denture, the master cast was able to be articulated with the opposing model (Figure 7). An all-acrylic provisional fixed prosthesis was fabricated on this master model, following the overall aesthetic and functional arrangement of the patient's removable denture. This all-acrylic bridge would be connected to the 6 implants immediately after implant placement was complete.

METHODS

Surgical Procedure

Following nasal intubation and the administration of general anesthesia, local anesthesia was administered intraorally using lidocaine hydrochloride (Lignospan Forte [Septodont]) with 1:50,000 epinephrine for regional hemostasis. The surgical template was placed into the mouth and stabilized using an occlusal index against the opposing prosthesis (Figure 8). Then, 4 horizontal anchor pins were used to help stabilize the surgical template to the bone while the implants were being placed. This in and of itself was challenging because of the limited bone volume where the pins could be surgically accessible (Figures 4a to 4c).

The paranasal implants and the implants in the pterygomaxillary region were placed following the standard NobelGuide protocol.[18] Template abutments (Nobel Biocare) were used in these 4 positions to help stabilize the surgical template further before the placement of the zygomatic implants. Then, using a series of guided zygoma drills of graduating diameters (Brånemark System Guided Zygoma Surgical Kit [Nobel Biocare]), the osteotomy sites were prepared. Generally, the zygoma bone has sufficient density to stall the drill machine using an insertion torque of 45 Ncm. The proper orientation of the zygomatic implant, which is predetermined during the virtual planning on the computer, was verified by visibility of the implant mount screw through the surgical template sleeve. When the implant mount screw was visible through the sleeve, the depth of the implant was checked digitally at the cheek. At this time, all implants were placed and the surgical template was removed.

Prosthetic Procedure

Appropriate abutments were selected to accommodate the prosthetic reconstruction that would be immediately placed following the Teeth In A Day protocol.[15-16] A prosthetic temporary cylinder with a short guide pin was installed on each of the 2 abutments that were connected to the zygomatic implants. The provisional prosthesis was prefabricated on the retro-engineered master cast with abutments placed on the paranasal and pterygomaxillary implants. This prosthesis was then positioned into place on the 4 abutments (2 paranasal, 2 pterygoid), and the mandible was closed to determine the alignment and occlusal relationship.

Next, the temporary cylinders on the zygomatic implants needed to be connected to the prosthesis. A rubber dam was marked, punched, and carefully positioned to protect the abutment collar and the implant. A thick mix of acrylic resin (Jet Tooth Acrylic [Lang Dental]) was loaded into a 50-cc monoject disposable syringe. It was then expressed circumferentially around both temporary prosthetic cylinders and in any area where a connection to the provisional prosthesis was intended. All the prosthetic screws were tightened in the previously placed prosthetic cylinders to anchor the prosthesis in the correct position.

When the acrylic polymerized completely, all guide pins and prosthetic screws were removed and the prosthesis and rubber dam were disengaged and removed from the patient. Final contours and polishing were immediately accomplished by the laboratory technicians (Figures 9a and 9b). The prosthesis was then reinstalled, and all prosthetic screws

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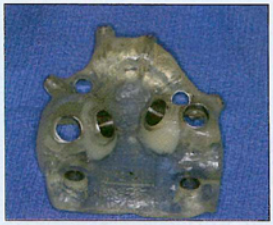


Figure 5. Surgical template for guided implant placement, occlusal view.

Figure 6. Master cast on which an all-acrylic provisional prosthesis is constructed.

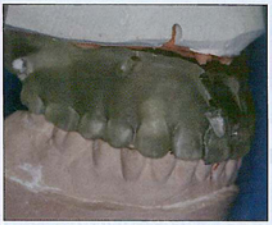


Figure 7. A computer-generated duplicate denture is used to articulate the maxillary master cast with the mandibular counter model.

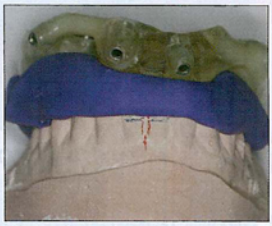
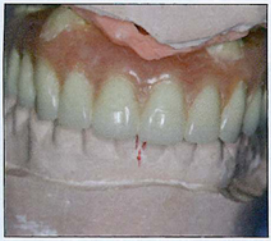
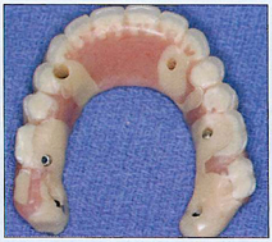
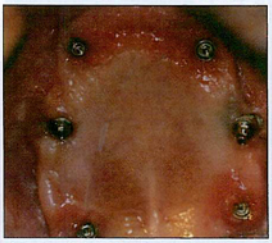


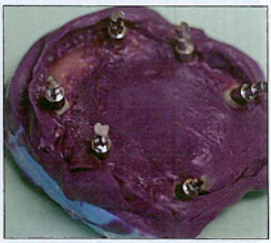
Figure 8. Occlusal registration used to position surgical template for placement of the horizontal anchor pins.





Figures 9a and 9b. All-acrylic screw-retained provisional restoration delivered the day of implant placement: articulated frontal view (a) and occlusal view (b) .





Figures 10a and 10b. Five months after implant placement, the construction of the final prosthesis commenced: tissue healing around abutments (a), and TIAD open-tray master impression with provisional prosthesis enclosed (b) .

No Bone Solutions.....

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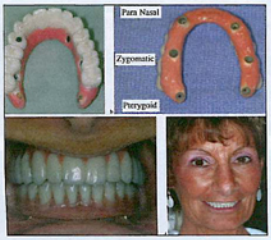
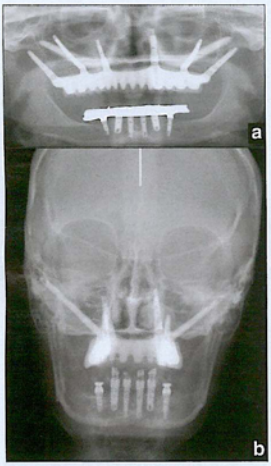


Figures 11a to 11d. Definitive prosthesis constructed of porcelain-fused-to-gold: occlusal view (a), intaglio view (b), retracted frontal view (c), and patient final presentation (d).



Figures 12a and 12b. Radiographic confirmation of definitive prosthesis delivery: panoramic (a), and A-P cephalometric (b).

were uniformly tightened to 10 Ncm. The occlusion was adjusted and verified.

The screw access holes were then sealed, beginning with a firmly packed cotton pellet followed by a light-cured temporary resin (Fermit LC [Ivoclar Vivadent]). The patient was then extubated and recovered from the general anesthesia. When the patient was fully conscious, the occlusal guard was delivered and postoperative panoramic, lateral, and A-P cephalometric radiographs were made.

The provisional prosthesis remained securely fastened for 5 months to provide an undisturbed period of healing with the immediate loading protocol.[19] Following 20 weeks of healing, the patient returned to initiate the construction of the definitive prosthesis (Figures 10a and 10b). The final prosthesis was constructed as a porcelain-fused-to-gold restoration (Figures 11a to 11d). The same series of radiographs were made following the delivery of the definitive prosthesis (Figures 12a and 12b).

DISCUSSION

Denture treatment and many other traditional methods of restoration are falling out of favor with the majority of patients who now expect to experience a higher standard of living and improved quality of general and dental health throughout the later years of their life. Dental implants, which have quickly become the new standard of care for the partial or fully edentulous patient, are viewed by many as a means to this end. In treatment of edentulous patients with adequate volume of bone, the use of titanium implants has led to successful treatment during the last 2 decades, both in the maxilla and the mandible. When resorption of the alveolar crest is advanced, conditions for implant surgery are more challenging. The severely resorbed maxilla poses difficulties in placement of implants, and the insufficient bone mass often does not permit the use of conventional implant surgery anterior to or below the sinuses. In patients with severely resorbed maxillas, different bone grafting procedures have been used for augmentation of the alveolar crest as a preprosthetic measure. These grafting procedures often require significant healing times for patients and drastically increase the treatment time to obtain the intended final result.[20]

The introduction of cone-beam technology and CAD/CAM guided implant placement has made it possible to develop new methods for treatment. Even patients with severe bone loss can be treated in a minimally invasive, expedited fashion that results in a fixed implant-supported prosthesis at the time of implant placement. Using a combination of implants in the zygomatic and pterygomaxillary positions has allowed for the treatment of the posterior maxilla and has eliminated the need for any bone grafting and sinus augmentation procedures.

CONCLUSION

The development of cone-beam CT scanning technology and 3-D Procera treatment planning software has allowed patient treatment to be expedited and minimally invasive. Using these technologies, complex cases can be treatment planned virtually to produce a CAD/CAM surgical template to place the implants in a precise predetermined position. This process, in conjunction with zygomatic implants and the Teeth In A Day protocol, allows all patients, no matter the severity of bone atrophy, to be treated with immediate functional loading in a single surgical procedure. This systematic approach to treating patients with severely atrophic maxilla is a highly predictable "No Bone Solution" (a trademarked term) therapy that offers new hope for a large population of edentulous patients. ✦

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