Combined Immediate Loading of Zygomatic and Mandibular Implants: A Preliminary 2-Year Report of 19 Patients

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Purpose: A retrospective study was performed to evaluate the feasibility of simultaneous use of immediately loaded zygomatic and mandibular implants for full maxillomandibular restoration.

Materials and Methods: A total of 40 zygomatic and 112 conventional implants were placed in 19 edentulous and partially edentulous patients and restored with full-arch acrylic resin prostheses within 3 hours of surgery. Implant insertion torque values were between 35 and 45 Ncm. Results: During the 1-year follow-up period, none of the 19 patients experienced implant or prosthesis failures. The patients did not experience any sinus infections or any other surgical complications from the performed procedures. Conclusion: Zygomatic and conventional implants can be simultaneously placed in the maxilla and mandible and successfully loaded with an acrylic resin prosthesis using the All-on-Four concept. Int J Oral Maxillofac Implants 2014;29:e22–e29. doi: 10.11607/jomi.te38

Key words: dental implants, immediate loading, insertion torque, zygomatic implants

Traditionally, reconstruction of the severely atrophic maxilla has included multiple grafting procedures to restore the lost hard and soft tissue complex.1,2 Iliac crest harvesting has been the mainstay for such procedures; however, the surgery has inherent risks and possible complications, as well as unpredictable success and resorption rates.3–7 The development of the zygomatic implant introduced a predictable graftless approach for treatment of the atrophic maxilla.8 Two to four zygomatic implants can be used, with or without standard anterior implants, and stabilized with a cross-arch fixed prosthesis.9–13 Using this technique, Malevez et al14 and Parel et al15 reported 100% zygomatic implant success rates up to 12 years postplacement. In a long-term study, Brånemark et al reported a 96% success rate using a delayed loading approach for zygomatic implants.16

The concept of immediate loading has readily progressed to zygomatic implants. Davo et al reported on a series of 36 zygomatic implants loaded within 48 hours of placement that demonstrated a 100% survival rate at 14 months.17 In two separate reports of immediately loaded zygomatic implants, Bedrossian and coworkers achieved 100% survival rates at 12 months and up to 7 years, respectively.18,19 Describing an “extramaxillary” approach to the zygoma, Maló et al reported an implant success rate of 100% at 12 months using an immediate loading technique.20 Treatment of the atrophic mandible has presented similar challenges, which have also been addressed with a variety of bone graft reconstructive procedures.20–23 Mandibular grafting procedures with or without immediate implant placement have been attempted to improve bone height, thereby allowing for longer implant placement.24–28 However, as with the maxilla, various complications can arise; these include sensory disturbance of the inferior alveolar nerve, wound dehiscence, graft infection, unpredictable graft resorption, and donor site morbidity.30–33 The use of tilted posterior implants can successfully circumvent many of these anatomical challenges and greatly reduce the need for significant bone grafting.34–43 Immediate loading in the mandible using four implants is a well-documented approach and has shown very high success rates in studies ranging from 3 to 10 years.44,45

The purpose of this paper is to show predictable implant placement with immediate loading in the severely atrophic maxilla and the compromised mandible using a simultaneous maxillomandibular protocol. The findings and recommendations of 19 patients treated with this technique will be discussed.
MATERIALS AND METHODS

The patients in this retrospective study were treated with maxillary zygomatic implants and conventional implants in both arches, which were all immediately loaded with full-arch acrylic resin prostheses. Selection criteria included severely atrophic maxillae with Zone I bone, as defined by Bedrossian et al., and either completely edentulous mandibles or mandibles with hopeless dentition. All patients underwent a complete medical and prosthetic evaluation prior to surgical intervention. They were followed for a minimum of 1 year, and 10 of the selected 19 patients have received their definitive prostheses. During this period, periapical radiographs and cone beam computed tomographic (CBCT) studies were obtained at fixed time intervals to monitor bone levels at all implant sites. This case series met the criteria for exemption from Institutional Board Review. Descriptions of two representative patients will follow.

Patient 1

A 75-year-old man presented with a chief complaint of broken maxillary and mandibular implant-supported dentures. Clinical and radiographic examinations revealed a maxillary subperiosteal implant device and four endosseous cylindrical implants in the mandible (Figs 1a and 1b). With the subperiosteal implant in place, the maxilla underwent significant bone resorption. The patient desired fixed immediate maxillary and mandibular prosthetic reconstruction without the use of significant bone grafting. His presurgical medical evaluation revealed the presence of a 4.6-cm abdominal aortic aneurysm, coronary artery disease, and hypercholesteremia. He had undergone an uneventful angioplasty in 2006. He indicated allergies to penicillin and tetracycline and was currently taking Censor and folic acid. He had ceased cigarette smoking approximately 12 years previously. The appropriate medical consultations were obtained, and the patient was cleared for surgery. The surgical plan included the removal of the existing maxillary and mandibular implants followed by immediate placement of two zygomatic implants and two conventional implants in the anterior maxilla and four mandibular implants using the All-on-Four protocol. In light of the planned surgical procedures, general anesthesia was requested by the patient. Immediate loading with provisional prostheses was planned for the same day.

The intraoral exam was significant for soft tissue inflammation surrounding the existing implants. The remaining soft tissues did not display any erythema, leukoplakia, or erosive lesions. The CBCT study (Fig 1a) demonstrated a severely resorbed maxilla, a subperiosteal implant, and hyperpneumatized sinuses without evidence of pathology. Four cylindrical implants were noted in the anterior mandible between the mental nerves. Evidence of hydroxyapatite was noted in both arches from previous grafting procedures (Fig 1b).

The maxillary subperiosteal implant was removed in multiple sections, and the maxilla was debrided of remaining inflammatory tissue and hydroxyapatite remnants (Figs 1c to 1e). The subperiosteal reflection was advanced to the zygomatic buttress until the zygomatic notch could be identified. Care was taken to avoid exposing and stretching the infraorbital nerve. The slot technique was used to access the maxillary sinus; however, several perforations through the lateral maxillary wall were already evident (Fig 1d). The membrane was reflected to provide unencumbered access to the superior portion of the lateral sinus. The zygomatic implant osteotomy was completed under direct visualization. The drill preparation sequence was completed with a 3.5-mm pilot drill. A 40-mm Bränemark System zygomatic TiUnite implant (Nobel Biocare) was placed under direct visualization with a torque above 45 Ncm. The same surgical sequence was followed for the left side, which also received a 40-mm implant with similar torque. The anterior implant sites were developed in the canine eminence, and both sites received 4.0 × 15-mm NobelSpeedy Groovy Regular Platform implants (Nobel Biocare) with insertion torque of at least 45 Ncm. Both zygomatic implants received straight 2-mm Bränemark System zygomatic multiunit abutments (Nobel Biocare), and the anterior implants received 4-mm 30-degree Bränemark System multiunit abutments (Nobel Biocare) (Fig 1f). The abutments were torqued according to the manufacturer’s instructions to allow for immediate prosthetic rehabilitation with fixed acrylic resin prostheses. The incision site was closed with 3-0 chromic gut (Ethicon, Johnson & Johnson) with watertight interrupted sutures.

The existing mandibular implants were removed via a trephine technique. The implant platform was prepared and the new osteotomy sites were prepared using the All-on-Four protocol. The four sites received 4.0 × 15-mm Nobel SpeedyGroovy Regular Platform implants (Nobel Biocare). Insertion torque values were all at least 45 Ncm. The anterior implants received 2-mm 17-degree Bränemark System multiunit abutments and the posterior implants received 30-degree Bränemark System multiunit abutments. The abutments were torqued to allow for immediate rehabilitation. Wound closure was achieved with 3-0 chromic gut sutures (Ethicon, Johnson & Johnson).
A postoperative CBCT scan was obtained to confirm appropriate positioning of all implants (Fig 1g).

The provisional maxillary and mandibular acrylic resin prostheses were seated within 3 hours of surgery. The patient was transitioned to the definitive fixed prostheses at 8 months post–implant placement.

**Patient 2**

A 65-year-old woman who had been edentulous in the maxilla for 30 years and had a macerated mandibular dentition presented with the desire for maxillomandibular reconstruction using dental implants and fixed prostheses. She did not specify any health concerns or chronic medications and indicated an allergy to penicillin. The CBCT exam demonstrated an extremely atrophic maxilla, sinuses that were free of pathology, and multiple decayed mandibular teeth (Figs 2a and 2b).

Because of the lack of bone in the posterior maxilla, the surgical treatment plan called for the placement of two zygomatic implants, as well as two traditional implants in the anterior maxilla. In the mandible, four implants would be placed using the All-on-Four technique. Immediate delivery of provisional prostheses was planned for both arches.
The intraoral exam was significant for multiple missing and decayed mandibular teeth and a severely atrophic edentulous maxilla. Soft tissue inflammation accompanied the remaining teeth; however, there was no evidence of clinical infection. The surgical procedure was completed under intravenous anesthesia.

The maxilla was exposed via a midcrestal incision from the bilateral tuberosities to the midline. The subperiosteal reflection was extended superiorly to the piriform rim and to the base of the zygoma bilaterally. The posterior reflection was extended further superiorly to the zygomatic notch. The right lateral sinus wall was found to be extremely thin and concave. A standard slot osteotomy was completed with a no. 4 round bur. The sinus membrane was reflected from the lateral and superior walls of the sinus. The implant osteotomy was prepared under direct visualization and with ample sterile irrigation. Because of the significant concavity of the lateral wall, the inferior portion of the implant body was in an extramaxillary position. A 35-mm Brånemark System zygomatic TiUnite implant (Nobel Biocare) was placed under direct visualization, and insertion torque of more than 45 Ncm was obtained (Fig 2c).

On the left side, the same procedure was performed and a 35-mm zygomatic implant was placed with a similar torque value. To accommodate implant placement in the anterior maxilla, the nasal membrane was reflected off the lateral wall on the piriform rim. The implant osteotomy was directed toward the canine eminence bilaterally. Sequential drill preparation was completed under sterile irrigation, and two 4.0 × 10-mm NobelSpeedy Groovy Regular Platform implants (Nobel Biocare) were placed with torque values of at least 45 Ncm. The zygomatic implants received 3-mm 17-degree Brånemark System multiunit abutments (Nobel Biocare) and the anterior implants received 4-mm 30-degree Brånemark System multiunit abutments (Nobel Biocare). Closure was achieved in an interrupted fashion with 3-0 chromic gut (Ethicon).

The hopeless mandibular teeth were removed using a periotome technique. Incisions were made from the retromolar pads bilaterally to the midline, and full muco-periosteal flaps were reflected lingually and buccally. The mental foramina were identified bilaterally; this was followed by preparation of the implant shelf. The distal implants were placed 2 to 3 mm distal to the mental nerve, with the anterior implants in the lateral/canine positions. The posterior implants were 4 mm in diameter and 18 mm long, and the anterior implants were 4 × 15-mm (Nobel Speedy Groovy Regular Platform, Nobel Biocare). All implants achieved 45 Ncm of torque. The anterior implants received 2-mm 17-degree Brånemark System multiunit abutments and the posterior implants received 30-degree Brånemark System multiunit abutments (Nobel Biocare). Soft tissue approximation and closure were completed with 3-0 chromic gut (Ethicon, Johnson & Johnson). A postsurgical CBCT was obtained to confirm correct implant placement (Fig 2d). The same prosthetic procedures described previously were followed for the fabrication of the definitive prostheses.
Success Criteria

Implant success was quantified with several indicators based on criteria described by Albrektsson et al and Babbush et al: (1) no associated radiolucency; (2) absence of infection (including the maxillary sinus for zygomatic implants), soft tissue inflammation, or pain; (3) functional loading of implants with a fixed prosthesis.46,47

RESULTS

A total of 40 zygomatic and 112 conventional implants were placed in 19 edentulous and partially edentulous patients and restored with full-arch acrylic resin prostheses in both arches within 3 hours of surgery. All conventional and zygomatic implants met the criteria for success at all subsequent postoperative exams. At 4 months postplacement, they did not exhibit any movement or pain at torque values above 35 Ncm. The survival rate for both conventional and zygomatic implants was 100% (Table 1). CBCT scans were taken at 4 months to evaluate the sinus cavities for any pathology or fluid levels. None of the patients in this series demonstrated any radiographic evidence of pathology at the 4-month appointment. All provisional prostheses were stable throughout the provisional treatment phase.

DISCUSSION

Maxillary bone grafting with delayed implant placement has been shown to have successful results; however, the lengthy treatment period and the inability to utilize existing complete removable prostheses during the healing period have led to low acceptance by patients. Keller and coworkers reported on the reconstruction of compromised maxillary arches with 118 inlay grafts and 248 Brånemark System implants. They reported an implant survival rate of 87% and a prosthetic survival rate of 95%.47 Rasmusson and colleagues presented a study of patients who had received autogenous inlay grafts, onlay grafts, combined inlay/onlay grafts, and/or Le Fort I procedures.49 The implant survival rate at 3 years was 80%. When implants were placed at the time of bone grafting into grafted bone, the implant survival rate was lower, with a 23% failure rate. The failure rate of implants placed in native bone was only 11% in the same group. Survival of implants in conjunction with augmentation procedures was studied at the 1996 Sinus Consensus Conference, which concluded that the material was multifactorial that it was difficult to draw definitive conclusions50(41–32) and that controlled prospective studies were needed.

Nontraditional implant anchorage sites have been developed to circumvent compromised maxillary bone anatomy and volume. Such sites have included the pterygoid plates, the zygoma, and the vomer.51,52 Brånemark has demonstrated that the zygoma is a reliable site for implant placement, and, with the ability to control the occlusal platform, immediate loading can be predictably achieved.16 Currently, biomechanical data are not available for immediately loaded zygomatic implants; however, the placement of angled implants results in greatly reduced cantilever length without sacrificing the anteroposterior stability of the prosthesis. Testori et al were able to decrease the posterior maxillary cantilever length by tilting the most distal implants.53 The angulation of the distal implant was found to reduce the tensile stress placed on the prosthetic superstructure, and two-dimensional finite elemental analysis demonstrated that the use of cantilevers results in higher stress in the marginal bone around implants.54 The elimination of the cantilever arm by the use of an apically tilted implant mitigated the observed stress pattern on bone.55 In a biomechanical comparison of 30-degree angled and axial distal implants supporting a fixed prosthesis, Kim and coworkers reported a 5-mm decrease in cantilever length, along with a 17% decrease in crestal bone stress around the axial implants.56 In that case study, the use of zygomatic implants led to a decreased cantilever length in both the provisional and definitive prostheses. Immediate loading (within 3 hours postplacement with a fixed full-arch prosthesis) stabilized the zygomatic implants, and the occlusal forces were evenly distributed between the anterior maxilla and the zygomatic bone.

For this patient group, primary stability was the sole determining factor that led to the decision to load the implants immediately. The need to limit micromotion to less than 100 µm has been established as a crucial factor in promoting functional bone-to-implant contact.54,57,58 Thus, implant site preparation was modified to increase insertion torque values and implant stability. Previous studies have shown that an insertion torque of at least 30 to 32 Ncm was needed at implant placement to predictably allow for successful immediate loading of a splinted prosthesis.59,60 In animal studies, an insertion value of > 35 Ncm was shown to increase bone-to-implant contact.61 For the present patient series, implant insertion torque values were kept to an upper limit of 45 Ncm and a lower limit of 35 Ncm (Table 1).

This report describes the successful combination of immediately loaded zygomatic implants placed in atrophic maxillae with immediately loaded conventional mandibular implants using the so-called All-on-Four technique. The use of zygomatic implants allowed...
Table 1 Patient and Implant Data

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*Insertion torque of 35 Ncm; all other implants were placed with insertion torque of 45 Ncm.

Edent = edentulous; 1–3 = one to three teeth remaining in arch; 4–6 = four to six teeth remaining in arch; > 7 = more than seven teeth remaining in arch; RP = right posterior; RA = right anterior; LA = left anterior; LP = left posterior.

for decreased distal cantilever length, and judicious implant site preparation enabled high insertion torque values for immediate loading. This study observed a preliminary 2-year 100% implant and prosthetic survival rate.

REFERENCES


