Zygomatic Implants as a Rehabilitation Approach for a Severely Deficient Maxilla

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A gunshot injury is one of the main trauma injuries that affect the head and neck region. Severe esthetic, functional, and psychologic deficiencies are consequences of gunshot injuries. The use of implants anchored in the zygomatic bone has been advocated as an approach to the prosthetic rehabilitation of a severely deficient maxilla. This approach provides the patient with an immediate, high-quality, esthetic, and functional complete fixed prosthesis and eliminates the need for bone grafting. In this case report, a patient with a severely deficient maxilla caused by a gunshot injury was rehabilitated by placement of four zygomatic and two pterygomaxillary implants, which were immediately loaded with a complete fixed all–acrylic resin interim prosthesis. The definitive CM Prosthesis (CM Prosthetics) was constructed using computer-aided design/computer-assisted manufacture (CAD/CAM) technology. Int J Oral Maxillofac Implants 2014;29 (7 pages). doi: 10.11607/jomi.3662

Key words: *dental implant, extramaxillary, gunshot wound, immediate loading, osseointegration, pterygoid, pterygomaxillary, teeth in a day, zygoma*

A gunshot injury is considered to be one of the most complex traumatic injuries that affect the head and neck region. When the resulting facial and oral defects cannot be repaired surgically, conventional maxillofacial prosthodontic treatment is indicated. The final decision about a definitive prosthesis usually depends on the extent and location of the facial defect, the type and amount of bone grafting that may be required, and the condition of the remaining teeth.[1,2]

Gunshot wounds of the midfacial region often result in a severely atrophic maxilla, which reduces the clinician's ability to place conventional dental implants and increases the complexity of bone grafting procedures.[3] There may also be significant bone loss in the posterior maxilla, which will limit the available volume for implant placement and may compromise the implant survival rate.[4,5]

The use of zygomatic implants and implants placed in the pterygomaxillary region can provide patients with an immediate, esthetic, and functional complete fixed prosthesis and can reduce the need for bone grafting in many cases. Brånemark introduced the use of the zygomatic bone as a source for anchorage for implants in the late 1990s.[6,7,8] Several studies have shown the viability of the cortical part of the zygoma in providing solid stability to the implants.[9]

Several clinical studies have confirmed the high survival rate of zygomatic implants with the immediate loading protocol. In a retrospective study, Davo et al[10] evaluated the survival rate of immediately loaded implants and found it to be 100% after a 29-month follow-up. Balshi et al[11] studied the survival rate of zygomatic implants with an immediate loading protocol for a 9-month to 5-year follow-up. The implant cumulative survival rate in that study was 96.37% with failure of only 4 of 110 zygomatic implants. The prosthesis survival rate was 100%. Maló and coworkers[12] evaluated the survival rate of zygomatic implants with immediately loaded prostheses and found the cumulative implant survival rate to be 98.5% after a 1-year follow-up and the prosthesis survival rate to be 100%.

The pterygomaxillary region has been used since the 1980s as a receptor site for endosseous dental

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Fig 1 Sagittal profile.

implants.[13] The survival rate of the pterygomaxillary implant has increased because of improved implant surfaces. Balshi et al[14] evaluated the survival rate of Ti-Unite-surfaced implants (Nobel Biocare) placed in the pterygomaxillary region and compared it to the survival rate of machined-surface implants. They found the cumulative survival rate of TiUnite implants to be 98.6%, an 8% greater success rate compared to the machined-surface implants.

CASE REPORT

Chief Complaint

A white male aged 45 years presented to a Postgraduate Prosthodontic Clinic (Rutgers School of Dental Medicine) with the chief complaint of "I am depressed, I cannot eat properly, and I cannot smile because of a defect in my mouth. I want to restore it."

History

Approximately 1 year earlier, the patient, under the influence of alcohol, attempted suicide by shooting upward from under the anterior border of the mandible. When he pulled the trigger, the gun slipped forward, and the bullet entered the anterior mandible, traveling upward through the premaxilla and exiting through the right side of the bridge of the nose, causing massive destruction of the bony structure in the mandible and maxilla. Extensive maxillofacial and plastic surgery was performed, which removed all remaining comminuted bony fragments, stabilized mobile bone segments with plates and screws, and attained soft tissue closure and skin grafting over the bridge of the nose (Figs 1 to 4).

Past Medical History

The patient continues under the care of a psychiatrist for severe depression and loss of self-esteem due to the trauma and disfigurement and takes sertraline 25 mg/day (Zoloft, Pfizer).

Extraoral Examination

Scar tissue was present over the bridge of the nose, the exit site of the bullet. The lateral profile was concave as a result of midface deficiency and bone loss (Fig 1).

Intraoral Examination

The entire premaxilla and a portion of the hard palate were avulsed in the path of the bullet (Fig 2). The defect extended from the right first molar to the left first molar. There was no oronasal communication. There was severe crowding of the mandibular teeth, and the mandibular central incisors were missing because of loss of a huge segment of the anterior mandible. The right and left maxillary first and second molars were tilted palatally with almost complete loss of the facial bony plate (Fig 3). Mandibular posterior teeth were tilted lingually because of the collapse of the mandible with the loss of the anterior segment and soft tissue scarring of the lower lip.

Radiographic Examination

There is no bone present in the maxilla from the mesial surface of the right first molar to the mesial surface of the left first molar (Fig 4).

Prosthetically Driven Treatment Approach

The diagnostic maxillary and mandibular casts were articulated. The anterior teeth were arranged individually with the patient, and the posterior teeth were arranged into minimal occlusion with the lingually inclined mandibular posterior teeth. An interim maxillary partial denture was inserted. A radiographic stent was constructed from the diagnostic tooth arrangement for dual cone beam computed tomography (CBCT) scans. The patient was referred to the Pi Dental Center in Fort Washington, Pennsylvania, for definitive treatment.

Using the maxillary anterior tooth arrangement of the interim prosthesis and the data from the dual CBCT scans, the treatment plan was developed (Fig 5). The remaining posterior alveolar and basal bone were evaluated. The treatment plan was to provide implant support with remote craniofacial anchorage to restore facial support and dental function with a screw-retained fixed prosthesis. Computer analysis and virtual surgery greatly assisted the prosthodontist

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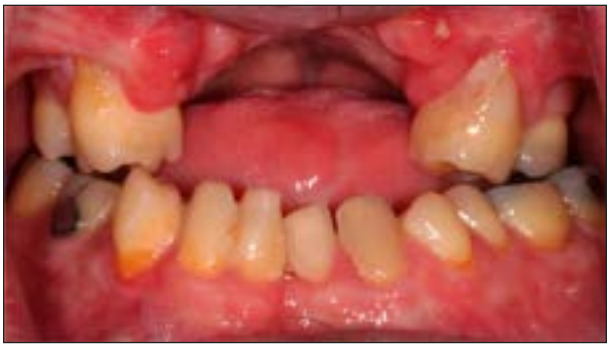

Fig 2 Intraoral maxillary deficiency.

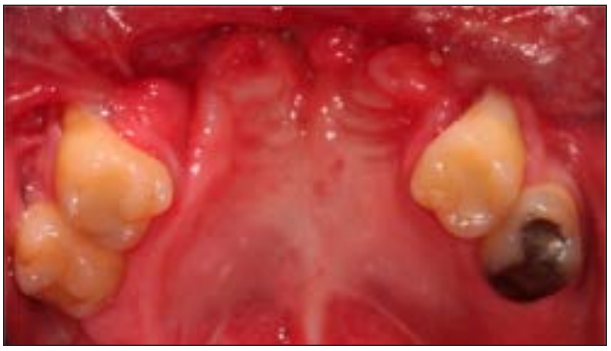

Fig 3 Maxillary arch, occlusal view.

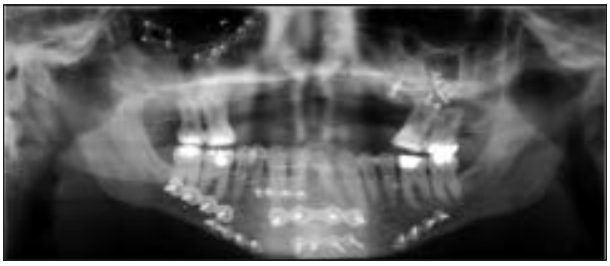

Fig 4 Panoramic radiograph: surgical plates and screws.

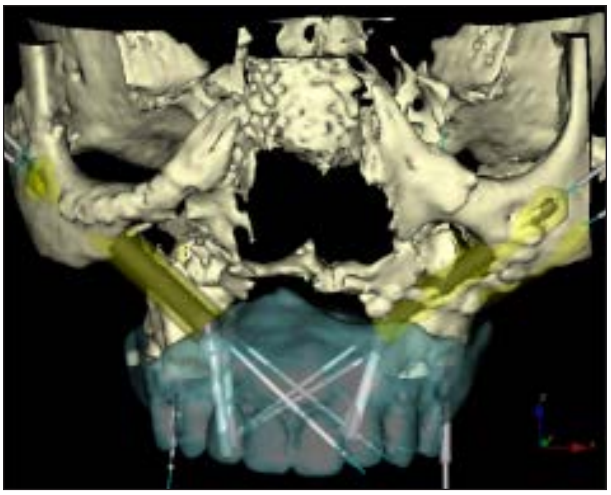

Fig 5 Frontal view of virtual implant planning.

in planning the surgical strategy for an immediately loaded all–acrylic resin screw-retained interim prosthesis (Fig 5).

The CBCT-scan planning gave a clear indication that six points of anchorage could be achieved once the remaining maxillary molars were removed.

An informed consent was reviewed and signed by the patient, prosthodontist, and staff. Sixty milliliters of blood was drawn for production of platelet-rich plasma (PRP) using a SmartPReP 2 Cell Separator (Harvest Technologies). General anesthesia via nasal intubation was administered with comprehensive full monitoring of vital signs. Full sterile draping of the patient and sterile gowning of all operating room staff was completed.

Surgical Treatment

Ten carpules of local anesthesia were administered (five 1:200,000 bupivicaine/epinephrine and five 1:50,000 lidocaine/epinephrine [Lignospan, Septodont]). Careful sectioning of the molar roots was performed to preserve interradicular bone during extraction of the right and left maxillary first and second molars. Full-flap elevation was performed bilaterally from the posterior aspect of the pterygomaxillary region, anteriorly to the end of the bone mesial to the first molars. Vertical releasing incisions were then made from the most anterior bone in the direction of the absent canine eminence. Several bone plates required removal for ideal positioning of the zygomatic implants. Mucoperiosteal flap elevation was further extended to visualize the body of the zygoma and the junction with the remaining maxilla at the lateral and inferior orbital rim. Screen captures from the scans were used to assist in identifying the anatomical positioning of the zygomatic osteotomy sites. Standard zygomatic drilling procedures, with copious saline irrigation, prepared the zygoma for reception of two implants bilaterally.[11] The implants, coated with PRP,[15] were inserted with a rotary drill; insertion was completed using a hand-tightening torque wrench exceeding 60 Ncm. An extramaxillary zygomatic implant was placed in the area of the maxillary left canine. The pterygomaxillary osteotomies were prepared in the standard fashion,[13,14] and the implants were coated with PRP and inserted. The implants were 15 to 18 mm in length to engage the dense bone in the pterygoid plates. Resonance frequency analysis (RFA)

Table 1 Implant Dimensions for Rehabilitation

Tooth position*	Implant type†	Implant dimensions (mm)	RFA (ISQ) at surgery (buccolingual/ mesiodistal)
18	NobelSpeedy Groovy RP TiUnite	4 × 15	62/62
15	Brånemark System Zygoma TiUnite	40	68/64
13	Brånemark System Zygoma TiUnite	40	46/39
23	Brånemark System Extra-Maxillary Zygoma TiUnite	45	30/41
25	Brånemark System Zygoma TiUnite	42.5	64/64
28	NobelSpeedy Groovy RP TiUnite	4 × 18	66/62

ISQ = implant stability quotient; RFA = resonance frequency analysis.
*FDI tooth-numbering system. †Nobel Biocare.

Table 2 Abutment Selection for Immediate Loading Protocol

Tooth position	Abutment*	RFA (ISQ) at surgery (buccolingual/ mesiodistal)	RFA (ISQ) at delivery (buccolingual/ mesiodistal)
18	4 mm Multi-unit	46/39	58/67
15	17° Zygoma Multi-unit 2 mm	57/59	65/65
13	17° Zygoma Multi-unit 2 mm	46/46	49/41
23	30° Multi-unit 4 mm	28/48	69/72
25	17° Zygoma Multi-unit 2 mm	57/55	63/63
28	4 mm Multi-unit	51/46	60/61

*Nobel Biocare.

(ISQ, Osstell) was performed to obtain a baseline for stability at implant level at insertion and to provide a numerical value to primary stability[16] (Table 1). Table 2 shows the various transmucosal abutments that were attached to the implants along with the abutment-level RFA measurements.

Prosthodontic Treatment ("Teeth in a Day" Protocol)

A complete acrylic resin denture was constructed to provide optimal lip and facial support. A silicon putty interocclusal matrix (Lab Putty, Coletene/Whaledent) was made to the opposing stone cast to function as a guide for the orientation of the maxillary prosthesis to the mandibular cast. Triad Gel (Dentsply) light-cured resin occlusal matrices were made to assist in positioning the molar teeth bilaterally. Titanium prosthetic cylinders (Multi-unit Temporary Coping, Nobel Biocare) were placed on all six abutments using guide pins. Holes were cut into the palatal aspect of the provisional denture to permit seating of the denture over the prosthetic cylinders and to ensure that the cylinders did not interfere when the mandible was closed against the silicone matrix. The top of each guide pin was marked with an ink stick (Dr Thompson's Color Transfer Applicators, Great Plains Dental Products). An extra-heavy rubber dam was then impressed against the ink-laden guide pins to clearly mark the abutment position. The second smallest hole on the rubber dam punch was used to punch holes in the rubber dam at the guide pin mark. The rubber dam was inserted over the prosthetic cylinders to the level just occlusal to their junction with the abutments. Jet acrylic resin (Lang Dental) was mixed to a thick fluid consistency, loaded into a 50-mL syringe, and injected over the rubber dam connecting all cylinders. The immediate denture was positioned over the cylinders with the guide pins protruding through the palatal side of the prosthesis. Additional acrylic resin was injected into visible voids in the connection of the prosthetic cylinders to the denture. The mandible was closed into centric relation position against the occlusal matrix and held motionless until the acrylic had polymerized.

The guide pins and the prosthesis were removed, and the prosthesis was cleaned of any coagulum. Excess acrylic resin was removed from the labial aspect of the intaglio surface, and abutment analogs were inserted with guide pins. Denture base acrylic (Hi-Impact, Fricke International) was mixed and injected into the voids between the acrylic resin and the denture flange. The prosthesis was immediately immersed in warm water in a pressure pot at 40 psi for 5 minutes.

While the acrylic was polymerizing in the pressure pot, surgical flap closure commenced. The surgical site was cleansed and irrigated with a tetracycline (250 mg) antibiotic solution. PRP was applied to the exposed bone and under the periosteal flaps. Interrupted 4-0 Vicryl FS-2 sutures (Ethicon) were used to obtain primary closure of the soft tissue flaps. The surgical area was reinjected with four additional carpules of bupivicaine and 50 mL of dexamethasone to reduce postoperative swelling and discomfort. Cold therapy was applied to the patient's face while antibiotic-moistened gauze was used to compress the surgical site.

The guide pins and analogs were removed from the prosthesis. Excess facial and palatal acrylic resin was

removed, and the intaglio surface was contoured to be convex in a labiopalatal dimension. The entire prosthesis was polished. Twenty-millimeter guide pins and abutment analogs were reinserted in all six positions. All surfaces of the all–acrylic resin interim prosthesis were painted with a denture sealant (Palaseal, Heraeus Kulzer) and polymerized in a rotating curing unit for 2 minutes. The guide pins and analogs were removed and any excess sealant that had extended onto them was carefully trimmed with a ceramic acrylic cutting bur (K251ACR, Komet).

The all–acrylic resin interim prosthesis was tightened on all six abutments with multiunit prosthetic screws to 15 Ncm of torque. Teflon tape was densely packed into each screw access channel 2 mm short of the surface. The last 2 mm of the screw opening was sealed with a light-cured flexible resin material (Telio CS, Ivoclar Vivadent). The protective throat pack was carefully removed, and the airway suctioned clear of coagulum and fluids. The anesthesiologist then extubated and recovered the patient.

Postoperative Care

Postoperative care instructions were given to the patient prior to treatment, and reviewed with the accompanying adult, both verbally and in printed form. The patient returned 9 days later for suture removal and postoperative radiographs. Following 5 months of uneventful healing, the patient was appointed to begin construction of the definitive prosthesis.

Final Impressions

At the final impression appointment, a vinyl polysiloxane (Regisil 2x, Dentsply) occlusal registration was made as well as initial alginate impressions of the maxillary provisional prosthesis in situ and the mandibular arch. Clinical photographs were taken of the patient as a reference for future laboratory procedures. The all–acrylic resin interim prosthesis was removed, and all abutments were retightened and implants checked for stability. The interim prosthesis was reinserted using long guide pins, and an open-window impression tray was fitted to permit access to the six guide pins. Alginate impression material was mixed and loaded into the tray with additional material applied to the junction of the prosthesis and soft tissues using firm finger pressure on a tongue blade applicator. The impression tray was inserted into the mouth with finger pressure over the wax window to identify the location of all six guide pins. After 1½ minutes, the guide pins were removed. The impression containing the all–acrylic resin interim prosthesis was removed from the mouth, sprayed, and disinfected. Long guide pins and pristine stainless steel abutment analogs were inserted. The laboratory technician applied a separator (Separator, Zhermack) to the alginate and the intaglio surface of the prosthesis. A gingival replication silicone material (Gingifast Rigid, Zhermack) was injected over the intaglio surface to a height above the collar of the abutment analogs. Once set, the silicone material was trimmed around the periphery with a sharp scalpel to create tapered inlay-like margins. The impression was boxed and poured in type 4 die stone.

When the stone was set, the guide pins were removed and the impression separated from the master cast. The interim prosthesis was retrieved from the alginate impression and attached to the master cast with prosthetic screws. The master cast with the interim prosthesis in place was articulated against a stone cast of the mandibular arch with a new centric relation record. The stone cast of the maxillary interim prosthesis was also articulated using the same occlusal registration. The master cast, with the interim prosthesis still securely fastened, was indexed with a laboratory bur in three locations at the midline and left and right molar areas. A silicone lab putty matrix (Lab Putty, Coltene/Whaledent) was made to record the relationship between the interim prosthesis and the maxillary master cast.

The interim prosthesis was reinserted into the patient's mouth. Confirmation of esthetics and phonetics was noted. CM Prosthetics gingival shade and Vita tooth shades (Vident) were selected and recorded. The patient was scheduled for definitive prosthesis delivery 6 weeks later.

The production of the maxillary CM Prosthesis[17] (CM Prosthetics) began. Using the silicone matrix made with the interim prosthesis, a resin framework pattern was designed to support individual porcelain crowns. The framework pattern was then optically scanned, and a computer numeric controlled (CNC)–milled titanium framework was fabricated. Individual lithium disilicate crowns (IPS e.max CAD, Ivoclar Vivadent) were made and, after appropriate refinement, were cemented onto the opaqued titanium framework with RelyX Unicem 2 resin cement (3M ESPE). The acrylic resin (Classico, Classico) gingival veneer was layered onto the crowns. The final curing of the acrylic resin was accomplished in a microwave oven.

Definitive Prosthesis Delivery

The interim prosthesis was removed and all abutments were checked for stability and tightness. RFA measurements were rerecorded at abutment level to compare with the initial measurements taken at implant placement (see Table 2). The final CM Prosthesis was inserted with prosthetic screws and torqued to 15 Ncm. The occlusion was checked and adjusted. Postoperative radiographs confirmed the accurate fit of the milled titanium framework (Figs 6 and 7). Postoperative photos

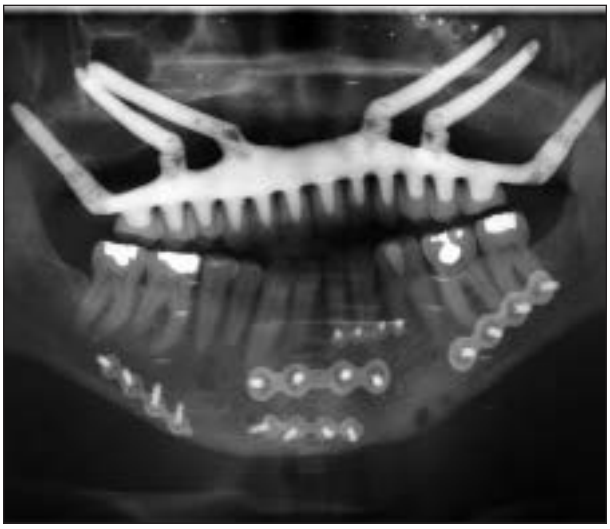

Fig 6 Panoramic radiograph showing maxillary definitive prosthesis.

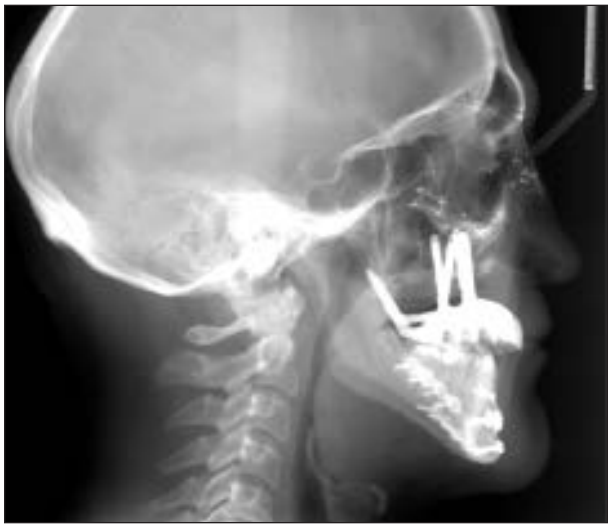

Fig 7 Lateral cephalometric radiograph.

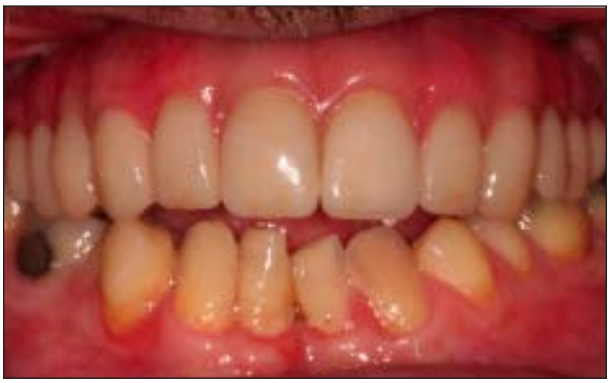

Fig 8 Definitive prosthesis inserted.

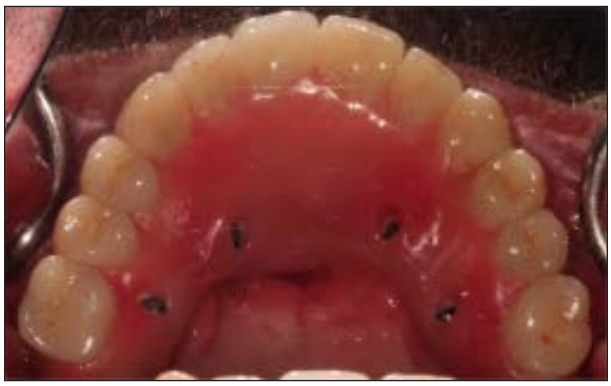

Fig 9 Occlusal view of maxillary implant-supported prosthesis.

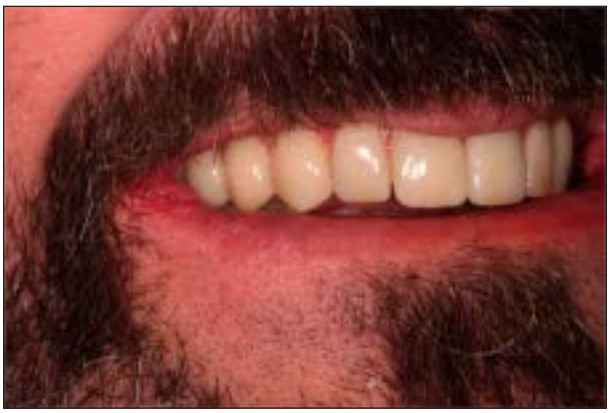

Fig 10 Patient smile with prosthesis.

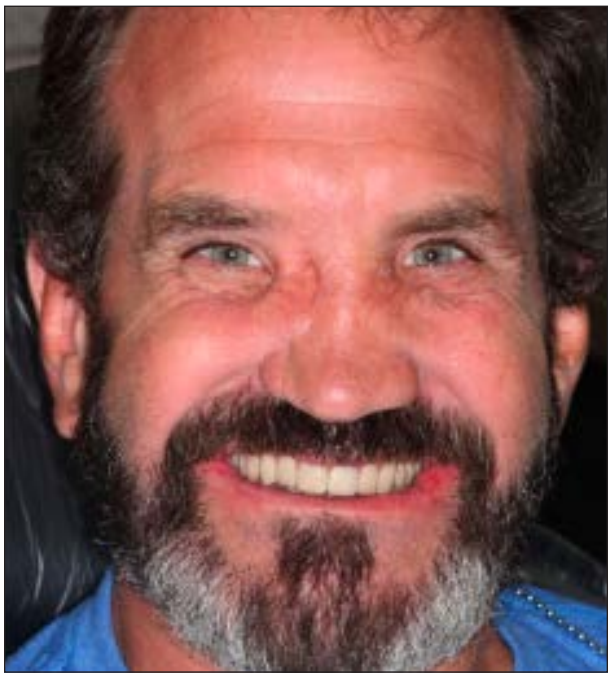

Fig 11 Postoperative patient smile.

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were taken (Figs 8 to 11). The patient was instructed in hygiene maintenance and scheduled for oral hygiene and reevaluation in 6 weeks.

DISCUSSION

The bullet entered through the inferior border of the mandible and destroyed a small area of the incisor region. When the bullet entered the maxilla, it diffused over a large area, causing the massive destruction in the maxilla. The lateral profile of the patient clearly identified severe deficiency of the maxilla compared to the mandible. A complete fixed prosthesis, using a conventional endosseous implant protocol, would have required significant bone grafting procedures.[18,19] Extensive grafting would have taken at least 8 to 12 months to mature, if it was at all possible.[11]

Eighteen weeks following implant placement, the definitive complete fixed prosthesis was delivered. This prosthesis provided the patient with acceptable function and esthetics and has an excellent long-term prognosis.[17] The milled titanium framework and individually cemented IPS e.max crowns provided optimum esthetics and function, and if repair is required, an individual crown can be replaced.[17]

Postoperative instructions were given to the patient, and he was shown how to use the Oral B Pro-Health Clinical Pro-Flex Toothbrush and Oral B Super Floss (Procter & Gamble) beneath the prosthesis. The recall maintenance schedule began at 24 hours after the insertion of the final prosthesis, and then 1 week, 1 month, and every 3 months for 1 year. The mandibular arch will be restored when patient finances permit.

The patient and his family were extremely pleased with the esthetics and function of the prosthesis. As the patient stated, his confidence has been restored, and he anticipates a more normal life and will begin actively pursuing employment.

The patient was seen at the 12-month recall and all is functioning well. The oral tissues remain healthy and all abutments and prosthesis were secure. Oral hygiene procedures were performed and home care was again reiterated. The patient will continue on a 3-month hygiene recall schedule.

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