An Innovative Implant-Supported Treatment for the Edentulous Mandible: Case Report

Kenji Higuchi, DDS, MS¹/Glen Liddelow, BDS, MScD²

When surveyed, edentulous patients commonly state that they would prefer an implant-supported restoration to conventional removable dentures. However, acceptance of implant-supported restorations remains low, primarily due to the high cost of available solutions. To reduce cost and treatment time for patients with an edentulous mandible or failing mandibular dentition, an innovative treatment concept consisting of a standardized framework and time-efficient surgical and restorative protocols was developed. The prefabricated titanium framework is supported on three implants using an adaptive fixation mechanism that compensates for surgical misalignment of the implants to achieve passive fit. The definitive fixed, full-arch mandibular prosthesis can be delivered within 24 hours of implant placement. This patient presentation demonstrates the treatment of a man 82 years of age with complete edentulism. The entire treatment time from surgery to definitive placement was 3 hours over a single business day. After 2 years of function with immediate loading, the patient displayed favorable hard and soft tissue outcomes. Initial results indicate that treatment with this premanufactured device could potentially provide patients with a fixed full-arch implant-supported mandibular restoration with reduced clinical treatment time compared with other implant-supported treatments. INT J ORAL MAXILLOFAC IMPLANTS 2019;34:e13–e16. doi: 10.11607/jomi.6813

Keywords: cost- and time-efficient, dental implants, edentulous, failing, mandible, terminal dentition, Trefoil

Edentulism is a global public health problem that disproportionately affects aging and lower-income populations most severely.¹ Tooth loss in the mandible is particularly debilitating because it lacks the surface area to stabilize a conventional denture, and the musculature around the ridge frequently dislodges dentures and affects function.² While conventional dentures are most frequently prescribed for the treatment of edentulism, long-term outcomes are often superior for implant-supported prostheses.³,⁴ However, in the United States and Europe, less than 4% of edentulous adults had implant-supported prostheses,³ primarily due to cost.⁵,⁷

One way to provide an opportunity for decreased cost is to reduce the number of implants placed, because it reduces hardware costs along with laboratory and chair time.⁴ In 1977, Brånemark et al developed the first full-arch implant-supported prosthesis using four to six implants.⁸ Since then, full-arch prostheses secured with fewer implants have been shown to have a high survival rate in a clinical setting.⁹ Another cost-reducing measure is to use a premanufactured prosthesis.¹⁰ Standardized components require less complicated planning and eliminate the need to manufacture custom frameworks (both provisional and definitive).

A concern for fixed implant-supported prostheses is obtaining a precise fit between the superstructure and the supporting implants. Passive fit at the interface is a greater concern with premanufactured frameworks because of inevitable implant misalignment even with the use of guides or templates. These minor deviations in implant placement can exert undue mechanical stress on the prosthesis and components, which can result in prosthetic complications such as screw loosening and screw fracture.¹¹,¹² To address this issue, a standardized treatment system with innovative adaptive abutments (Trefoil, Nobel Biocare) was developed. The engineering of this fixed, full-arch...
implant-retained mandibular prosthesis sought to provide a time- and cost-efficient treatment, while ensuring passivity of fit, surgical flexibility, and esthetics. The system consists of three anodized parallel-walled implants with machined collars and conical connection abutment interfaces for optimal hard and soft tissue compatibility, a standardized single-piece framework milled from high strength titanium alloy, and adaptive fixation mechanisms at each implant-framework interface (Fig 1a). The adaptive fixation mechanism uses a series of articulating disks to compensate for implant placement deviations in the horizontal (±0.4 mm), vertical (±0.5 mm), and angular dimensions (±4 degrees) (Fig 1b). When supported on three implants, the fixation mechanism ensures that the full-arch framework is always stabilized securely on all implants; two implants could not provide the same stability, as they rely on soft tissue support in the posterior, and four or more implants could not be seated passively if a single implant deviates from its planned position. In an in vitro comparison study, this unique mechanism allowed the premanufactured prosthesis to achieve a passive fit comparable to that of a computer-aided design/computer-aided manufacturing (CAD/CAM)-designed prosthesis (Procera, Nobel Biocare) even when implants are not perfectly parallel or level.13 In addition to the engineering features, the system was developed with a time-efficient, template-guided clinical workflow and simplified laboratory protocol that can deliver a definitive full-arch mandibular prosthesis on the day of surgery or within several days postoperatively. Patients with a failing mandibular dentition or complete mandibular edentulism are potential candidates for this treatment.

CASE PRESENTATION

A male patient 82 years of age presenting with complete edentulism was previously treated with a pair of conventional dentures. After consultation, the restorative solution selected was replacement of the maxillary denture with a new conventional denture and placement of the standardized three-implant-supported system in the mandible. Axial and cross-sectional three-dimensional images of the anterior mandibular anatomy were used to confirm that the bony morphology allowed for placement of three implants between the mental foramina (Fig 2a). Jaw-relation records with the correct vertical dimension of occlusion were obtained prior to surgery and transferred to the articulator.

The anterior mandible was surgically exposed to the second molar region, exposing the mental foramina while assessing the extent of the anterior loop of the mental nerve. The bony platform of the residual mandible was leveled parallel to the maxillary occlusal plane and adjusted vertically to accommodate the space requirements of the implants, framework, wrap-around acrylic prosthesis, and soft tissue (22 mm, Fig 2b). Anatomical landmarks and a vertical verification guide pin confirmed that adequate amounts of vertical bone were removed. Analog drill guides and templates were used to place the implants in order to
ensure the implants were precisely placed in the correct location and direction between the mental foramina. The center implant site was prepared with a 2-mm twist drill aligned perpendicular to the maxillary occlusal plane and bony platform, and parallel and palatal to the long axis of the maxillary incisors. The final drill diameter was 4.2 mm. Using two separate templates and sequential drilling guides, the center implant was placed first, followed by placement of the right and left implants (Fig 2c). All three implants were tested manually to confirm that they exhibited initial primary stability capable of immediate or early loading (45 Ncm). A try-in framework was secured to the implants to verify fit and ensure there was adequate space between the distal framework cantilevers and bone level. Transfer abutments and a nonengaging temporary abutment were attached to implants and luted using light-cured resin to create the verification index (Fig 2d). The index was removed and used as the basis for fabricating a master cast that displayed the exact position and angulation of the three implants. Healing abutments were secured to the three clinical implants, and the soft tissue was closed. A silicone compression pad was placed to protect the tissues and limit swelling.

The master cast was constructed with an accurate die stone embedded with implant replicas to ensure the exact fit of the framework. The framework was seated to the master cast model utilizing the three compensating fixation mechanisms and tightened in place to 35 Ncm. Passive fit was verified visually under magnification on the master cast. To secure the compensation mechanisms during acrylic processing, the bar was laser welded. The substructure was subsequently silanated for acrylic bonding and opaqued. Denture teeth were arranged in wax based on articulation of the master cast with the opposing arch cast. The prosthesis was processed in acrylic using conventional wrap-around prosthesis technology to create an acrylic-titanium hybrid fixed prosthesis. After processing, the prosthesis was trimmed and polished to ensure a convex intaglio surface and improve plaque control.

The definitive prosthesis was secured on the day of surgery (Fig 2e). The total workflow took approximately active 3 hours. Following confirmation of clinical and radiographic fit, the clinical screws were torqued to 35 Ncm. Screw access was sealed with polytetrafluoroethylene (PTFE) tape and composite resin. The patient was provided with dietary and oral hygiene recommendations. The patient showed excellent bone and soft tissue health at the 12-month follow-up visit, and there were no prosthetic complications (Fig 2f). At the 2-year follow-up, peri-implant bone levels showed no discernible bone loss, as assessed by periapical and panoramic radiographs. The prosthesis was removed, and implants were individually assessed as immobile. Plaque control was excellent; therefore, no bleeding on probing or increased probing depths were observed. Some tissue shrinkage occurred as expected; however, the patient indicated that the spacing facilitated cleaning (Fig 3).

This approach has the potential to significantly reduce the overall restorative chair time and cost to the patient over other implant-supported solutions. This system eliminates the time to build and deliver a customized framework, which circumvents the need for
a provisional prosthesis and the associated intermediate steps. This workflow reduces the number of clinical visits and laboratory time required to deliver the definitive restoration, ultimately providing an opportunity for reduced costs for both patients and clinicians. The authors estimate the clinical time savings compared with conventional protocols to be approximately 3 hours.

This fixed, full-arch implant-retained prosthesis does have certain anatomical and technical considerations. First, the alveolar bone volume must accommodate three standard implants after ridge reduction, and patients with deep concavities in the anterior mandible may not be suitable for the treatment. Second, the undersurface of the acrylic wraparound may need to be refined following reduction of the initial soft tissue swelling and later with tissue shrinkage. Third, there is also the ever-present risk of implant failure; however, several corrective options are available, including the use of a removable overdenture until the bone heals and the implant can be replaced.

With the opportunity of lowering cost and duration of treatment, a new and expanded patient population may be able to benefit from this innovative fixed, full-arch implant-retained treatment alternative for patients with failing mandibular dentition or edentulous mandibles.

ACKNOWLEDGMENTS

Professional writing assistance was provided by Katherine H. Sippel, PhD, ELS at BioScience Writers, LLC. Dr. Higuchi and Dr. Liddelow have received consultation and speaking fees from Nobel Biocare during the design and development of Trefoil and are investigators in a 5-year multicenter clinical study supported by Nobel Biocare (clinicaltrials.gov, NCT02940353).

REFERENCES