USING CAD-CAM TECHNOLOGY FOR THE FULL-MOUTH, FIXED, RETRIEVABLE IMPLANT RESTORATION: A CLINICAL REPORT

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Computer-assisted design (CAD) and computer-assisted manufacture (CAM) are technologic advancements used in dentistry today. These technologies have been developed to fabricate a complete arch substructure from a solid piece of titanium for a fixed, screw-retained implant-supported prosthesis. This clinical report demonstrates a treatment approach which uses CAD-CAM technology to incorporate a milled, titanium framework with retrievable metal ceramic crowns.

Key Words: CAD-CAM, retrievable restoration, implant prosthesis

INTRODUCTION

The original concept of the tissue-integrated prosthesis was a complete-arch, fixed implant prosthesis consisting of acrylic resin veneered on a metal framework that was secured to the implant abutments with screws.[1] This technique has been shown to be successful in long-term studies.[2–4]

The full-mouth, fixed, implant-supported prosthesis is a technically demanding treatment modality. When a treatment plan involves the re-creation of an esthetically pleasing, comfortable, stable masticatory system capable of nondestructive, efficient occlusion with unimpeded phonetics, the therapeutic intricacy is recognized. Since the maxillary and the mandibular fixed, implant-supported prosthodontic rehabilitation presents a list of inherent difficulties, restoring opposing arches in the same patient increases the complexity.

All implant prostheses supported by multiple implants, regardless of materials used, must have passive fitting metal substructures. This fact presents the clinician with a challenging situation since the intimate nature of the implant/prosthesis connection is critical to long-term success.[5] A poor fit of the metal casting has historically been addressed by sectioning of the framework with subsequent soldering of the component parts. This also has been shown to be an inexact procedure.[6] As more edentulous patients elect treatment with dental implants, the concept of retrievability must be a consideration due to the need for long-term maintenance of these prostheses.

Computer-assisted design (CAD) and computer-assisted manufacture (CAM) are technologic advancements used in dentistry today. Implant-supported prostheses are now made using the CAD-CAM technique, and recently technology has been developed to fabricate a complete-arch titanium substructure for a fixed, implant-supported prosthesis. This technology has been adapted for dental restorations by Nobel Biocare of Gothenberg, Sweden. The framework is milled from a solid piece of titanium resulting in a strong and lightweight restoration, free from defects and distortions.[7] The relationship to the abutments and/or the implants is also precision milled and becomes an integral part of the framework. The fit of the framework on the master cast has been shown to be more precise than frameworks fabricated with the conventional casting technique.[8,9] The precision fit of the titanium framework in the laboratory will mirror the fit clinically if the master cast has been developed with accuracy. For this reason, open-tray impression transfer copings luted together with a low-shrinkage autopolymerizing

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acrylic resin should be used because this technique has been shown to be an accurate method of reproducing dental implant position in a master cast.[10]

The manufacture of an accurately fitting titanium framework for the complete-arch, fixed, implant-supported restoration is possible; however, another issue remains. In the maxillary arch, implant placement may result in an angulation which prevents access openings for retaining screws from terminating neatly at the cingulum area. This complication may prevent retrievability through conventional screw retention. If cement is to be avoided, a technique of preserving the occlusal, facial, and proximal surfaces of the implant crown restorations is possible by placing the screw retention on the lingual surface of the crowns.[11] The lingual retaining screws are thread-tapped into the titanium substructure allowing assembly intraorally and resulting in a retrievable restoration for long-term maintenance.

This clinical report demonstrates a treatment approach which uses CAD-CAM technology to incorporate a milled, titanium framework with retrievable metal ceramic crowns.

Clinical Report

A 67-year-old woman presented for consultation regarding complete mouth implant-supported prosthodontic rehabilitation. The maxilla was completely edentulous, fully healed, and atrophic. The maxillary ridge morphology was type C edentulism as described by the American College of Prosthodontists' classification based upon loss of anterior vestibule and a palatal vault offering minimal resistance to vertical and horizontal movement of a denture base. The mandible was partially edentulous with 6 carious, nonrestorable anterior teeth remaining (Figure 1). The patient reported that she was unable to comfortably wear any removable prostheses due to a severe gag reflex. The patient also had high expectations with several complicating factors. First, the patient was extremely phobic regarding dental treatment and requested intravenous sedation for all surgical procedures. Second, the patient requested both the maxilla and mandible be restored with fixed restorations only. Third, the patient hoped for a definitive solution with ideal esthetics, function, and comfort. After the situation was reviewed, a treatment plan for both the maxilla and mandible of fixed, retrievable implant prostheses was indicated. This determination was made, in part, because any subsequent complications with a cemented restoration would necessitate additional sessions with intravenous sedation. Although this alone was not a justification for the treatment provided, it was an important consideration.

Preoperative impressions were made and articulated on a semiadjustable articulator (Hanau Wide-Vu, Water-Pik Technologies, Newport Beach, Calif). A trial arrangement of artificial teeth (Portrait IPN, Dentsply International, York, Pa) was competed and evaluated intraorally to verify that the occlusal relationship, esthetics, and phonetics were acceptable. (Figure 2). With establishment of an acceptable tooth arrangement for both the maxilla and mandible and after obtaining patient approval, a computerized axial tomographic scan (Simplant, Materialise Clinical Services, Glen Burnie, Md) was done to properly plan the surgical phase.

In preparation for the first surgical session, the patient was sedated with intravenous fentanyl and midazolam. Eight 4.1-mm platform implants (Branemark, Nobel Biocare, Gothenberg, Sweden) were placed in the maxilla. In the mandible, all remaining teeth were removed with simultaneous placement of six 4.1-mm platform implants (Branemark). Wherever implants were immediately placed into fresh extraction sites, freeze-dried, mineralized, human bone allograft (Puros, Tutogen Medical Inc, Alachua, Fla) was condensed and covered with resorbable collagen membrane (Bio-Gide, Osteohealth, Shirley, NY) and primary closure was achieved.

Following a 6-month healing period the patient was again given intravenous sedation and all implants were uncovered. Since the patient had a severe gag reflex, at the same appointment open-tray impression transfer copings (Nobel Biocare) were attached to all implants, connected with autopolymerizing resin (GC Pattern Resin LS, GC Labs, Alsip, Ill) applied to the components with a powder and liquid brush technique. Maxillary and mandibular impressions were made using a polyether elastomeric impression material (Impregum, 3M Espe, St Paul, Minn). Master casts were poured in type V die stone (Glastone, Dentsply International) with soft tissue moulage (Soft Tissue Moulage, Kerr Corporation, Orange, Calif) and articulated on a semiadjustable articulator (Hanau Wide-Vu).

Denture tooth arrangement using artificial teeth (Portrait IPN) supported by maxillary and mandibular screw-retained, acrylic resin record bases were again evaluated and approved by the patient. The wax trial arrangements were duplicated in clear, heat-polymerized acrylic resin (Palapress vario, Heraeus Kulzer, Armonk, NY) and cut back to allow room for conventional crown restorations in both maxillary and mandibular arches (Figure 3). The acrylic resin was scanned at the manufacturing facility (Nobel

FIGURES 1–4. FIGURE 1. Pretreatment clinical presentation. FIGURE 2. Articulated wax trial arrangement. FIGURE 3. Clear acrylic resin cut back for crowns. FIGURE 4. Titanium frameworks ready for trial insertion.

Biocare) where the duplicate of the resin was milled from a solid block of titanium. After manual finishing the titanium substructures were ready for clinical evaluation (Figure 4).

Prior to the clinical visit complete-arch, acrylic-resin (Biolon Crown and Bridge Resin, Dentsply International) provisional restorations were made on the titanium substructures for verification of occlusion, esthetics, and phonetics. Trial evaluation of the titanium substructures exhibited a passive fit as demonstrated by alternate finger pressure and absence of screw resistance; therefore, the restoration could be completed. A barium-borosilicate, glass-filled, Bis-GMA composite resin (Cristobal, Dentsply International) was applied to the titanium substructure to simulate the gingival margin and attached gingival tissues. Metal ceramic crowns (Accu-Star/Heraceram System, Heraeus Kulzer) were fabricated in 3 sections for each arch (Figure 5). After final glazing and polishing, holes were drilled through the lingual collars of the crown sections and into the titanium substructure. These holes were then thread-formed (Tool set for individual screw connections, Bredent Corporation, Witzighausen, Germany) to accept lingual set screws which secured the crown restorations to the titanium substructure (Figure 6). The titanium substructures were inserted and torqued to a preload of 35 Ncm, and the crown restorations were again secured with lingual screws torqued to 20 Ncm (Figure 7). The patient was satisfied with the result and has been seen for follow-up maintenance with no complaints (Figure 8). Clinical findings at 1 year postinsertion included excellent peri-implant soft tissue health and maintenance of preload without complication of the lingual restorative-retaining screws.

DISCUSSION

The complete-arch ''tissue-integrated prosthesis'', as it has been termed, is a fixed, screw-retained restoration

FIGURES 5–8. FIGURE 5. Metal ceramic crowns prior to delivery. FIGURE 6. Finished prosthesis on master cast. Note lingual set screw holes. FIGURE 7. Definitive prostheses. FIGURE 8. Full-face view of completed case.

consisting of a cast framework veneered with denture teeth and gingival shade acrylic resin. Although still in use, this technique has its limitations, particularly in the materials used. The acrylic resin base supporting denture teeth exhibits excessive wear, discolors over time, and absorbs odors due to its porosity.[12] The high masticatory forces generated by fixed restorations on implants or implant abutments may result in acrylic resin fracture, with or without tooth dislodgement. For these reasons, clinicians have attempted to modify this restoration through the use of stronger dental materials better suited for continuous use intraorally. Fabrication of a passive-fitting metal substructure is difficult due to the multiple opportunities to introduce errors. Distortion from impression materials, gypsum products, waxes and casting alloys, together with manipulation of the restoration, all contribute to inadequate fit of the casting.[13]

Achieving passive fit of the metal casting is difficult in the fabrication of the complete-arch, implant-supported prosthesis; however, the problem may be exacerbated depending upon the materials used in veneering the metal substructure. If metal ceramic technology is used instead of acrylic resin, certain technical difficulties must be overcome. To begin with, the metal substructure must be fabricated to fully support the porcelain veneer for a complete-arch, implant-supported prosthesis. In the atrophic jaw, this results in a mass of metal that is impractical due to its excessive size, weight, and thermal expansion during the application of the porcelain. Repeated firings for porcelain application may further complicate the casting fit. For these reasons, complete-arch, metal-ceramic, fixed, screw-retained, implant-supported prostheses for the atrophic jaw may be ill advised when fabricated using the conventional, lost-wax casting technique.

To ameliorate the problem of achieving passively fitting complete-arch frameworks, implant restorations may be cemented to abutments. An absence of screw access openings improves esthetics, solves angulation problems, and permits development of occlusal surfaces devoid of screw access holes. Various cements are used that are purported to be releasable; however, unexpected dislodgement of the prosthesis due to weaker cement is an unwelcome complication for the patient. The use of stronger cements may avoid dislodgement but may prevent removal by the clinician, if necessary. Thus, the problem of retrievability of the complete-arch, fixed restoration continues to be a problem.

The technique described addresses the concerns of the complete-mouth, fixed, implant-supported restoration in atrophic jaws. The use of CAD-CAM milled titanium frameworks solves the technical problems associated with excessive interridge space and permits the use of retrievable metal-ceramic crowns.

Summary

The atrophic maxilla often precludes the use of metal-ceramic crowns in the complete-mouth, implant-supported restoration due to the mass of metal required to support the ceramic veneering material. Through the use of CAD-CAM technology, a complete-arch framework can be milled from one solid piece of titanium resulting in a lightweight, passive-fitting substructure upon which conventional-sized metal-ceramic crowns may be screw retained. This technique is indicated for patients with high esthetic demands while still maintaining retrievability of all components of the restoration.

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