Clinical Perspectives

Inside This Issue: Accelerated Patient Rehabilitation With Advanced Technologies

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Advanced Technologies

Patients today demand aesthetic tooth replacement with reduced treatment time. Technological advancements in computed tomography-based treatment planning, implant designs, surface treatments, provisional components and the precision of CAD/CAM technology, have afforded clinicians with the opportunity to provide implant therapy to meet these demands. This includes the ability to perform less invasive procedures and for the patient to leave the office with tooth-colored, implant-supported fixed provisional restorations on the same day as implant placement. The precision of CAD/CAM technology allows for the fabrication of a definitive Patient Specific Restoration®. Incorporation of these advanced technologies into everyday clinical practice provides benefits to patients and clinicians. These technologies include:

The NanoTite™ Implant
The NanoTite Implant starts with the microtopography of the OSSEOTITE® Substrate combined with a nanometer-scale Discrete Crystalline Deposition (DCD™) of calcium phosphate (CaP), which generate a more complex surface topography. This renders the NanoTite Implant a Bone Bonding® Surface by the interlocking of the newly formed cement line matrix of bone with the implant surface. NanoTite Implants may be used for immediate function in single- and/or multiple-tooth applications when good primary stability is achieved, with appropriate occlusal loading, in order to restore masticatory function.

The Navigator® System For CT Guided Surgery
Computed Tomography (CT) guidance technology has transformed conventional methods of dental implant treatment planning, surgery, provisionalization and definitive restoration, ultimately providing more consistent and predictable surgical and restorative outcomes. The Navigator System For CT Guided Surgery is used in conjunction with CT planning software and surgical guides to enhance treatment planning and improve the accuracy of placing BIOMET 3i Implants. Utilization of planning software programs allows clinicians to measure more precisely the locations of anatomic structures and the dimensions of underlying bone in order to plan and perform cases. The Navigator Surgical Guide also provides the opportunity to fabricate a master cast presurgically and subsequently an aesthetic, functional, laboratory-processed provisional restoration for immediate seating at the time of implant placement with minimal chairside adjustment.

QuickBridge® Provisional Restoration Components
Today, many clinicians prefer screw-retained definitive restorations but desire the simplicity and cost effectiveness of cement-retained immediate or delayed provisional restorations. QuickBridge Provisional Components offer an easier way to fabricate multi-unit, cement-retained implant-supported provisional restorations on Conical Abutments.

CAM StructSURE® Precision Milled Bars And Frameworks
Created with the technology to achieve a truly passive fit, CAM StructSURE Precision Milled Bars and Frameworks are milled from one solid piece of lightweight titanium, which eliminates the potential for weakness caused by soldering or laser welded joints. Both CAD/CAM and Copy Milled designs are available. With Copy Milled Frameworks, laboratory technicians can create unique bar designs with resin patterns, which are then scanned. Replicas of the patterns are milled from titanium or titanium alloy.

The Clinical Case Presentation to follow demonstrates the use of these multiple advanced technologies including: the placement of NanoTite Certain® Implants using the Navigator System For CT Guided Surgery; fabrication of a laboratory-processed fixed provisional restoration using QuickBridge Provisional Components placed immediately following implant placement; and a CAM StructSURE Copy Milled Framework for fabrication of a patient specific definitive prosthesis. The IN THE LABORATORY section provides Technical Tips to assist laboratory technicians with the successful application of porcelain to the titanium framework.

This clinical case presentation is representation of the individual experiences of the contributing clinician and laboratory technician. The outcomes obtained may not be indicative of other cases due to varying patient, clinician and laboratory scenarios.
Accelerated Rehabilitation Of The Edentulous Maxillae: A Case Presentation

Clinical Treatment By Pär-Olov Östman, DDS, PhD, MD (SWEDEN)

INITIAL PATIENT PRESENTATION

A 70-year-old male patient had been seen at the dental clinic regularly for ten years. During the last seven years, the patient was diagnosed and treated for severe periodontitis. During this time, implant therapy was presented to the patient who did not have any interest due to anxiety about the surgical procedure. Ten months before committing to implant therapy, an acute periodontal infection around the two maxillary central incisors (Fig. 1) led to the necessity to extract all the natural teeth in the maxillae, followed by placement of an immediate denture (Fig. 2). Wearing the removable appliance was not acceptable to the patient and therefore he requested a new treatment plan that would provide him with a fixed restoration supported by dental implants. The treatment plan accepted by the patient included a CT guided implant procedure, with immediate placement of a fixed provisional prosthesis on the same day as implant placement. This was to be followed by the placement of a patient specific CAD/CAM fixed definitive restoration in three months.

DIAGNOSIS

- Edentulous maxillae (ten months)
- Adequate bone quality and quantity for implant placement without the need for grafting prior to implant placement
- Adequate implant restorative and soft-tissue dimension
- Adequate interocclusal clearance with the opposing natural dentition

TREATMENT PLAN

- Denture duplication/fabrication of a CT scanning appliance; referral for a CT scan
- Placement of virtual implants in the proposed sites (Figs. 3-5); order Navigator® Surgical Guide
- Fabrication of a master cast, occlusal registration and a laboratory-processed provisional restoration
- Placement of implants using the surgical guide; placement of the immediate fixed-provisional prosthesis
- Fabrication and placement of the definitive prosthesis
PRESURGICAL TREATMENT
Upon acceptance of the treatment plan, the pre-existing denture was relined with Protemp™ 3 Garant (3M, ESPE, St. Paul, Minnesota, USA) to create a radiopaque border at the soft tissue level. The patient was sent for a CT study. A CT scan was obtained with 1mm thick axial sections and the occlusal plane at a zero degree gantry angle, following the radiographic protocol of Materialise Dental, Inc. (Glen Burnie, Maryland, USA).

The CT DICOM data was received electronically and processed using SimPlant Pro Interactive CT Planning Software from Materialise. Virtual implants were placed into the reformatted images according to the intended restorative tooth positioning. The relationship of the planned implants to the surrounding bone and anatomic structures can be seen in Figures 3-5. A tissue-borne surgical guide was fabricated by Materialise, which incorporated Master Tubes designed specifically for the Navigator® System For CT Guided Surgery (Fig. 6). The position of the Master Tubes in the surgical guide corresponded to the preplanned implant positions. A stereolithographic cast was also ordered from Materialise.

FABRICATION OF A PROVISIONAL RESTORATION
To fabricate a fixed provisional restoration for immediate placement at the time of implant placement, appropriate diameter and length implant Analog Mounts were selected from the Navigator Laboratory Kit as indicated by the Navigator Surgical Plan. The implant analogs were attached to the Analog Mounts and the thumb screws were tightened approximately two turns. The Analog/Analog Mount assemblies were placed through the Master Tubes and the rotational positioning pins were engaged into the notches in the Master Tubes to establish the proper alignment of the implant hexes from the cast to the mouth (Fig. 7). The thumb screws on the Analog Mounts were hand-tightened in the analogs.

In the dental laboratory, implant analogs were positioned in the stereolithographic cast using the surgical guide. These were placed through the holes made in the stereolithographic cast by Materialise based on the preplanned implant positions. The analogs were then fixated to the cast with acrylic resin (Fig. 8). The pre-existing denture was then placed on the master cast and articulated with the lower cast using the previously obtained occlusal registration (Fig. 9).
The prosthesis on the master cast was then duplicated in stone and articulated using the occlusal registration. A vacuum-formed template was made of the prosthesis (Fig. 10). The surgical guide was placed on the articulated master cast and an interocclusal record was made by a conventional wax index (Fig. 11), to be used intraorally to position the surgical guide. Conical Abutments of various heights (1-3mm), depending on the soft-tissue height, were placed on the master cast (Fig. 12, top). QuickBridge® Titanium Cylinders were placed onto the Conical Abutments and tightened (Fig. 12, bottom). The retention grooves on the Titanium Cylinders were blocked with wax. The vacuum-formed template was then filled with self-curing acrylic resin (ProTemp™, 3M ESPE), placed on the master cast and allowed to set (Fig. 13). Using a conical-shaped drill, indentations were created in the intaglio surface of the provisional prosthesis (Fig. 13, insert) to allow a 1mm circumferential space for the QuickBridge Caps, which would eventually be picked up intraorally. The provisional restoration was placed back onto the articulated master cast and an occlusal registration was made to position the provisional restoration intraorally (Fig. 14). The provisional fixed prosthesis was then trimmed and polished (Fig. 15).

**SURGICAL TREATMENT**

After the patient was anesthetized, the surgical guide was placed intraorally using the interocclusal record to confirm accurate positioning (Fig. 16). The guide was fixated through the fixation tubes using 2mm diameter bone screws (BIOMET Microfixation, Jacksonville, Florida, USA) (Fig. 17). The Navigator® Surgical Plan provided by Materialise specified the instrumentation and drilling protocol to prepare the osteotomies and place the implants. The appropriate sized Tissue Punches were passed through the Master Tubes and rotated with the implant drilling unit set at low speed to the correct depth line as specified in the Surgical Plan. The Starter Drill was used in tooth sites 6 and 11 [13 and 23] to shape the bone crest and perforate the cortical plate to pilot the Twist Drill. Preparation of the osteotomies was done through the Master Tubes using the appropriate Drill Positioning Handles and Twist Drills with depth stops (Fig. 18). The Twist Drills used were 2mm and 3mm diameters for placement of 4mm diameter implants. The proper diameter and length Implant Mounts were selected from the kit; according to the Surgical Plan received, placed into the internal interface of the implants and connected by tightening the screws.
The implants were placed first in tooth sites 6 [13] (Fig.19) and 11 [23]. The Implant Mounts were left in place to provide bilateral fixation of the surgical guide.

The remaining osteotomies were prepared followed by placement of the additional four implants. All of the six implant sites received 4mm diameter NanoTite™ Certain® Implants in varying lengths, placed through the Master Tubes using the drilling unit on slow speed.

Final seating of the implants was accomplished using a hand ratchet to confirm vertical placement (Fig. 20). The rotational positioning grooves on the implant mounts were aligned with the grooves in the Navigator® Master Tubes to transfer the proper alignment of the hexes from the master cast to the mouth.

The fixation screws were removed from the surgical guide, followed by removal of the Implant Mounts by loosening the retaining screws and gently elevating the mounts from the Master Tubes. The surgical guide was removed from the mouth. Following evaluation of initial implant stability by radio frequency analysis (RFA), Certain Manual Bone Profilers were used to shape the bone coronal to the implant prosthetic seating surfaces.

The Conical Abutments previously selected for fabrication of the provisional prosthesis were placed into the implants and secured with abutment screws. A verification radiograph was taken and the prosthesis was tightened to 20Ncm of torque (Fig. 21, top). QuickBridge® Titanium Cylinders were placed onto each abutment and hand tightened to 10Ncm (Fig. 21, bottom). QuickBridge Caps were snapped onto the QuickBridge Titanium Cylinders intraorally (Fig. 22). The provisional restoration was tried-in to ensure an absence of binding over the caps for complete seating, then it was removed and the retention facets on the intaglio surface of the QuickBridge Caps were filled with self-curing acrylic resin. The provisional restoration was then seated and the patient was brought into centric occlusion using the interocclusal record while the acrylic resin set.

After setting of the acrylic resin, the restoration was removed. The QuickBridge Caps were picked up in the restoration. The
voids around the caps were filled with acrylic resin and the excess acrylic was removed (Fig. 23). The completed interim prosthesis was reseated intraorally and fit with minimal adjustment (Fig. 24). Chlorhexidine gel (2%) was placed into the caps and the restoration was snapped into place. The occlusion was verified by occlusion film. Care was taken to avoid lateral forces on the implants. A panoramic radiograph was taken to confirm the implant/abutment/prosthesis junction (Fig. 25). QuickBridge® Caps are made from a polymer (PEEK-polyetheretherketone) and therefore are not visible on the radiograph. The patient was released with instructions to maintain a soft diet and for optimal self care; and was seen for regular follow-up visits. At each visit, proper function, occlusion and oral hygiene were evaluated.

**RESTORATIVE TREATMENT**

Three months following implant placement and immediate provisionalization, the patient returned to begin fabrication of the definitive prosthesis. Healing was uneventful (Fig. 26). The provisional restoration was removed by disengaging the provisional prosthesis from the QuickBridge Titanium Cylinders (Fig. 27). Next, the Titanium Cylinders were removed from the Conical Abutments with a Large Hex Driver. Conical Abutment Pick-Up Impression Copings were seated onto each of the Conical Abutments and tightened by hand (Fig. 28). An abutment-level impression was made by selecting an open stock tray and by using heavy body polyvinylsiloxane impression material (Dimension™ Penta™ H Quick, 3M ESPE). Once set per the manufacturer’s instructions, the impression coping screws were loosened and the impression tray was removed from the mouth. The Conical Abutment Impression Copings were picked-up in the impression. An alginate impression was made of the opposing arch. The QuickBridge Titanium Cylinders were replaced and the vacuum-formed template was reused to make an occlusal registration by filling the template with polyvinylsiloxane occlusal registration material. With this technique, information about the interocclusal height, midline, shape of the teeth, etc., was provided to the dental technician for fabrication of a framework master (resin pattern) and a CAM StructSURE® Copy Milled Framework for a screw-retained porcelain restoration.

**NOTE:** See *IN THE LABORATORY* by Åsa Kärner, CDT on the pages to follow, to view the step-by-step protocol followed for
fabrication of the CAM StructSURE® Copy Milled Framework definitive restoration.

Following fabrication of the definitive prosthesis, the patient returned to the dental clinic. The provisional restoration was removed along with the QuickBridge® Titanium Cylinders. The Conical Abutments were confirmed to be tight and the definitive implant-supported, screw-retained prosthesis was placed with 10Ncm of torque applied to the retaining screws (Fig. 29). The screw-access openings were restored and occlusal equilibration was done. The patient received oral hygiene instructions and was released (Fig 30).

**CLINICAL OVERVIEW**

This clinical case presentation demonstrates the use of multiple advanced technologies for accelerated rehabilitation of an edentulous maxillae, which met the patient’s desire for immediate reduction of his oral handicap. The use of computed tomography guided implant surgery allowed for the placement of multiple implants using an atraumatic, flapless surgical protocol, followed by the immediate placement of an aesthetic, functional, prefabricated laboratory processed provisional restoration with QuickBridge Provisional Restoration Components. The simplicity of the QuickBridge Technique provided an efficient, cost-effective means for fabrication of the provisional prosthesis. The treatment planning and fabrication of the interim prosthesis occurred prior to surgery. The CAM StructSURE® Copy Milled Framework that was fabricated for the definitive screw-retained porcelain prosthesis provided several benefits in this case, including use of the same Conical Abutments that were placed on the day of implant placement and immediate provisionalization. By leaving the abutments in place, the potential for developing an inflammatory response and subsequent hard- and soft-tissue loss, was reduced. Additionally, the precision of the copy milled framework coupled with the retrievability of a screw-retained prosthesis provided the patient with an aesthetic, well functioning restoration.

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FABRICATION OF THE DEFINITIVE PROSTHESIS

The impressions, shade selection, occlusal registration and the laboratory prescription for fabrication of a CAM StructSURE® Copy Milled Framework were received from the clinician.

Conical Abutment Laboratory Analogs were mated to the Conical Abutment Impression Copings in the impression. A soft-tissue model was made by injecting soft-tissue material around the analog/impression coping junction (Fig. 1). The master cast was poured with Whip Mix® Silky-Rock Low Expansion Die Stone (Whip Mix Corporation, Dortmund, Germany/Louisville, Kentucky, USA) and articulated with the opposing cast per the occlusal registration. The QuickBridge® Provisional Restoration was placed onto the master cast (Fig. 2) and a silicone putty matrix was made. It was then removed and non-hexed Conical Abutment Temporary Cylinders were placed onto the Conical Abutment Laboratory Analogs. The putty matrix was filled with cold-cure acrylic resin mixed with a small amount of titanium oxide (TiO2) pigment. This step was done to aid in the scanning process.

The matrix was placed onto the master cast (Fig. 3). After curing, the framework master was then designed in a small anatomic shape for support of and to ensure an even layering thickness of the veneering (porcelain) material (Fig. 4).

**Technical Tip 1:** The framework master should be made as precise as possible with a smooth surface, as it will be scanned and milled into the definitive framework to those dimensions when it is submitted to the BIOMET 3i PSR® Department. The quality of the framework is dependent upon the quality of the framework master (Fig. 5).

The framework master was sent with the CAM StructSURE Work Order to the BIOMET 3i PSR Department specifying fabrication of a CAM StructSURE Copy Milled Framework for porcelain. The PSR Technicians scanned the framework master and the analogs in the master cast. The framework master was milled from a solid blank of commercially pure titanium, as specified on the Work Order for porcelain application, then finished, polished and returned with the retaining screws to the dental laboratory for porcelain application (Fig. 6).
Technical Tip 2: Because of the high flexure (rigidity) of titanium, the wall thickness of the porcelain veneering material should be at least 0.5mm. To avoid localized stress concentrations in the porcelain, it is important to round all sharp corners and line angles of the framework. A tungsten carbide bur (Fig. 7) for titanium is recommended to adjust the framework. It is important to grind the entire surface to ensure removal of the a-case layer. Stones and wheels used on ceramic materials, as well as diamond burs or separating discs are not suitable for finishing titanium. The binders may contaminate the titanium surface during porcelain firing, which may lead to bubble formation in the porcelain.

The titanium framework was blasted with aluminum oxide (110-150 m) at 40psi (Fig. 8). If the pressure had been lower, the surface conditioning would not have been sufficient.

Technical Tip 3: Sparks should be completely absent or at least occur very rarely during the blasting process. A greater number of sparks may be indicative of an a-case layer, which must be removed using a tungsten carbide bur and then the blasting process has to be repeated.

The framework was steam cleaned, then allowed to rest for ten minutes for passivation. This procedure of grinding, blasting, cleaning, and ten minutes resting, is important for optimal bonding between titanium and porcelain. Following steam cleaning and passivation, Triceram® Bonding Paste (Dentaurum Group, Ispringen, Germany/Newton, Pennsylvania, USA) was mixed with bonding liquid and was applied in a very thin layer to the entire surface of the framework that was to be covered in porcelain (Fig. 9). It was then fired following the manufacturer’s recommendations for time and temperature. After the bonding step, the surface appeared dark grey with a little shiny sheen and no visible white spots (Fig. 10).

Technical Tip 4: If the bonding layer is too thick, it may cause bubbles in the porcelain. The bond is the most important component between the framework and the veneering ceramics, as it ensures a strong long-term bond between the titanium framework and the veneering.

After the bonding medium was fired, the opaque powder was mixed with opaque liquid and applied to the framework. Due to the darkness of the oxide layer of the titanium framework, a lighter shade of opaque porcelain was applied for the first firing. In this case, three opaque porcelain applications were required (Fig. 11 and 12).
Technical Tip 5: It is important to avoid creating a thick layer of opaque material as this may crack. The opaque porcelain should have a homogenous layer without specific surface characterizations.

PORCELAIN BUILD UP
The framework was placed back on the cast in the articulator and incisal and dentin (body) porcelains were built-up in the desired shade. First, a thin layer of opaque dentin was added onto the entire surface with a darker color on the cervical area. Anatomic contours were then built up with dentin, incisal and translucent porcelains, following the manufacturer’s instructions (Fig. 13). (Porcelains have different firing temperatures.) Prior to placing the framework into the oven, a sharp instrument was used to separate each of the dental units down to the opaque layer. This was done to allow for porcelain shrinkage without damage to the framework by avoiding increased stress concentrations within the porcelain.

For the second firing, dentin and incisal porcelains were added as needed to compensate for shrinkage, which occurred in the first firing and to create the desired anatomic forms. In this case, a third dentin firing was necessary prior to finishing the restoration (Fig. 14). Before the glaze firing, the occlusion and the surface characterizations were adjusted with diamonds or ceramic stones. The last step in the process was the glaze firing. This step may be performed with or without the application of extrinsic stains for special tooth characterizations.

Technical Tip 6: The porcelain surface should not be adjusted after glaze firing, as this may have affected the strength of the porcelain (Fig. 15).

Technical Tip 7: After firing, oxides are present on the exposed titanium. These oxides can be easily removed after glaze firing by blasting with 50μm glass beads.

Finally, the exposed titanium was polished and cleaned. The patient specific CAM StructSURE® Copy Milled Framework screw-retained porcelain prosthesis was returned with the retaining screws to the clinician for delivery to the patient.

‡ Åsa Kärner graduated from Umeå University Sweden with a degree in Dental Technology in 1983. She is Manager of Dentalgruan Dental Laboratory in Falun, Sweden.
Advanced Technologies Available From BIOMET 3i

Nanotile™ Implant

Navigator® System For CT Guided Surgery

QuickBridge® Provisional Restoration Components

CAM StructSURE® Precision Milled Bars And Frameworks

For information about these technologies from BIOMET 3i, please contact your local BIOMET 3i Representative or visit the BIOMET 3i Website at www.biomet3i.com

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