A Novel Technique for Immediate Loading Single Root Form Implants With an Interim CAD/CAM Milled Screw-Retained Crown

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A technique is described where an interim abutment and crown are fabricated in the laboratory by utilizing computer-aided design/computer-aided manufacturing (CAD/CAM) technology and placed the day of dental implant surgery. The design and contours of the interim crown are designed by the computer software to be identical to the contours of the tentatively designed definitive prosthesis. The interim crown satisfies esthetics immediately after dental implant surgery while allowing the tissue to heal and obtain contours similar to the contours of the definitive prosthesis. The interim crown can be either cement retained or screw retained. The presented technique describes fabrication of a screw-retentive interim crown. After osseointegration is confirmed, a definitive impression is made with a CAD/CAM impression coping. The definitive prosthesis is then fabricated.

Key Words: immediate loading, immediate provisionalization, CAD/CAM implant crown, milled interim implant crown, guided tissue healing, custom impression coping, milled impression coping

INTRODUCTION

Dental implants have been established as a predictable treatment modality for the completely or partially edentulous patient. For the partially edentulous patient, it is important to provide interim restorations because they help confirm the diagnostic design, esthetics, and contours, which can be replicated in the definitive prosthesis. The healing response around the interim restoration can be evaluated, and the soft tissue around the fixtures can heal according to the contours of the tentatively designed definitive prosthesis. Regardless of the technique, various methods have been proposed and used to transfer soft tissue architecture to the laboratory so the definitive prosthesis can be fabricated in accordance to the acquired soft tissue morphology. In a recent publication, indicated that soft tissue has a tendency to collapse after removing the interim prosthesis, and exact duplication of the peri-implant soft tissue can be challenging when utilizing conventional prefabricated impression copings.

The purpose of the described technique is to introduce to the literature a method for immediately provisionalizing single-root form implants with a computer-aided design and computer-aided manufacturing (CAD/CAM) interim restoration, which is fabricated before performing dental implant surgery.

CLINICAL REPORT

A 56-year-old Caucasian male patient presented at the primary author’s private prosthodontic practice seeking treatment for his partial edentulism at the area of tooth #13. After evaluating different treatment options, the decision was made to place 1 root form implant along with an implant-retained single crown to treat his partial edentulism. The tissue around the edentulous area was evaluated and the determination was made that it was free of pathosis (Figure 1). Complete arch preliminary impressions were made preoperatively from the patient’s maxillary and mandibular arches with polyvinyl siloxane impression material (Silgimix; Sultan Healthcare, Anaheim, Calif). An interocclusal record was also made with polyvinyl siloxane occlusal registration material (Exabite II NSD; GC America Inc, Alsip, Ill) at the maximum intercuspation position. Radiographic evaluation included peri-apical radiographs and a cone-beam to confirm adequate bone volume for implant surgery. In addition, after providing local anesthesia, mapping of the alveolar ridge with an endodontic file with a rubber stop was performed (Figure 2). With this technique, the thickness of the soft tissue was measured around the area of the prospective implant surgery.

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The stone models that were produced from the preliminary impressions were scanned (D700; 3Shape, Copenhagen, Denmark) and the definitive prosthesis was simulated with the provided software. The computer software, which is incorporated into the scanner, allows the size and shape of each component to be designed digitally using precise measurements. After the suggested implant placement was performed digitally, a custom interim abutment and crown were digitally designed (Figure 3a) using the contours of the definitive prosthesis as reference. When the design process was complete, the interim abutment and crown were milled from a polymethyl methacrylate (PMME) block by utilizing a milling machine (TS150 Milling Solution; IOS Technologies, San Diego, Calif; Figure 3b). The position of the margins of the interim abutment was designed according to the thickness of the soft tissue measured during ridge mapping. The goal was to position the margins 0.5 mm subgingivally on the facial aspect of the restoration to satisfy esthetics, so that the interim abutment/crown transition line would not be visible. Therefore, the interim abutment and crown were fabricated in the laboratory before implant surgery was scheduled.

In addition, a custom impression coping was digitally designed and milled (Figure 4). The contours of the CAD/CAM impression coping were identical to the contours of the interim abutment and crown, and identical to the prospective definitive restoration as well. The custom impression coping was also milled from a PMME block through the same milling machine. A surgical stent was also fabricated based on the digitally planned implant position. The CAD/CAM interim crown was evaluated on the diagnostic stone cast to confirm ideal contours, contact areas, and esthetics.

Implant surgery was performed with local anesthesia with the aid of the surgical stent and copious saline irrigation. A threaded root form of resorbable blast media surfaced, dental implant was chosen (Inclusive; Glidwell Corp, Newport Beach, Calif) and full thickness labial and lingual flaps were reflected. Whereas the surgical stent was used for guided osteotomy, final implant positioning was performed freehand. The implant was inserted with adequate torque 50 Ncm while the primary stability was confirmed through the Periotest device (Periotest; Siemens, Munich, Germany) by placing a 5-mm-long healing abutment before testing. For this patient this recorded $C_0$, which was consistent with adequate implant stability.26

The interim crown was placed intraorally to confirm proper contours and contact points. After these parameters were
evaluated, the interim abutment was placed intraorally (Figure 5) and the interim crown was adjusted along the internal area to ensure proper fit on top of the abutment. The internal relief space between the interim abutment and crown provided by the designing software was 30 microns. After confirming proper fit, the occlusal aspect of the interim crown was opened with the use of a diamond bur and a high speed. Light-cured composite resin cement (RelyX Luting Plus; 3M ESPE Inc, St Paul, Minn) was applied along the internal aspect of the crown and along the external surface of the abutment as well. Applying the composite resin on both surfaces reduces the possibilities for air entrapment. After positioning the crown on top of the abutment, an extension screw was inserted to avoid the flow of composite resin cement around the hex of the crown. The extension screw was secured on an implant analogue and was subsequently light-cured. After removing the excess composite resin cement, the screw-retained interim prosthesis was complete (Figure 6).

The interim prosthesis was then inserted intraorally (Figure 7). The occlusal screw was hand-tightened and light-cured and a cotton pellet with composite resin cement was placed on top. Occlusal clearance was confirmed at approximately 40 µm with 4 layers of 10µm shim stock (occlusal registration strips; The Artus Corp, Englewood, NJ). The proximal contacts were evaluated with a single layer of the shim stock before sealing the occlusal access hole.

Four months postsurgery the soft tissue around the implant demonstrated no sign of pathosis (Figure 8a). The implant stability was reevaluated with the Periotest device. The Periotest measured −2 whereas radiographic evaluation revealed no pathosis confirming successful osseointegration. No probing greater than 4 mm was detected around the implant, and no bleeding upon probing was recorded.

The screw-retentive CAD/CAM interim crown was removed and the tissue was evaluated (Figure 8b). The tissue appeared to have obtained contours compatible with the contours of the prospective definitive prosthesis. The CAD/CAM custom impression coping was hand-tightened and a definitive impression with polyvinyl siloxane impression material (Exafast NDS; GC America Inc) was made.

The definitive restoration was then fabricated. The original design of the definitive prosthesis was retained by the software and was duplicated after the soft tissue obtained contours similar to the contours of the definitive prosthesis (Figure 9). A zirconia occlusal screw retentive crown with a bonded titanium insert was fabricated as the definitive prosthesis (Figure 10a). After confirming proper contours, esthetics, occlusion, and contact points, the occlusal screw of the definitive prosthesis was torqued to 35 Ncm, according to the manufacturer’s recommendations. Light viscosity polyvinyl siloxane impression material (Exafast; GC America Inc) was in the occlusal access hole with light-cured composite resin on...
Patient was reevaluated 18 months after placing the definitive prosthesis (Figure 10b). During the reevaluation examination, no probing depth exceeding 3 mm was detected around the implant, and no bleeding on probing was observed whereas the soft tissue appeared to maintain its integrity. Radiographic examination revealed no pathosis or bone loss exceeding 1.5 mm.

**DISCUSSION**

The significance of the presented technique is related to the ability of the operator to have a CAD/CAM interim crown fabricated before dental implant surgery from a milled PMME block. The presented technique offers the option to have a milled PMME interim abutment and crown fabricated instead of
a chairside acrylic resin crown that is typically connected to a prefabricated temporary abutment. According to the manufacturer's recommendations, milled PMME has compressive strength in the range of 110–130 MPa. This is similar to the compressive strength of a definitive metal-ceramic restoration. Santing et al28 in a laboratory study reported that the use of chairside-fabricated PMME implant-supported crowns does not have sufficient mechanical properties to withstand laboratory simulated occlusal wear. On the contrary, interim restorations made in the laboratory had superior mechanical properties and the ability to better withstand mechanical forces during simulated mastication circles.

An advantage of the proposed technique is that it offers the clinician an option to contour the soft tissue in a way that will passively accommodate the definitive prosthesis since the digital contours of the CAD/CAM healing abutment are saved in the designing software and are identical to those of the definitive prosthesis. The assumption can be made that when the soft tissue acquires contours similar to the contours of the definitive restoration, the definitive restoration will be placed with minimal, if any, pressure on the tissue. This minimal or no pressure placement of the definitive prosthesis may lead to better long-term tissue stability; a clinical study is needed to confirm the validity of this hypothesis.

In the described technique, a CAD/CAM impression coping was used to transfer soft tissue anatomy to the laboratory before fabricating the definitive prosthesis. The contours of the CAD-CAM milled PMME impression coping were identical to the contours of the interim and definitive crown as well. Other authors have suggested using the interim prosthesis while making the impression,17,23 or fabricating a custom impression coping by placing autopolymerized acrylic resin around the impression coping.18,21,23 To the author's best knowledge, there is no consensus regarding which technique better transfers soft tissue architecture in the laboratory before fabricating a definitive prosthesis. The described technique might offer the advantage of reduced chairtime by having the custom impression coping fabricated in advance before implant surgery. The CAD/CAM impression coping may have an advantage in transferring soft tissue architecture since it is predesigned exactly as the interim prosthesis, so when secured on the implant with a retentive screw, it applies minimal or no pressure on the surrounding tissue. Joda24 reported 21.7% shrinkage of the periimplant soft tissue within 10 minutes after removing the interim restoration. The described milled custom impression coping is designed preoperatively based on the contours of the tentatively designed definitive prosthesis, and not on the contours of the soft tissue when the final impression is being made. A clinical study is needed to validate a potential advantage of utilizing a CAD/CAM impression coping.
A limitation of the described technique is that the CAD/CAM interim abutment and crown are digitally designed with the assumption that one of the flat surfaces of the implant hex is parallel to the tangent of the mid-buccal surface of the adjacent teeth. The final rotational position of the implant during surgery is critical in order to have reproducible fit of the prefabricated abutment and crown. The quest for this specific rotational implant positioning imposes an additional variable to the implant surgeon who needs to be well aware of the design methodology of the interim prosthesis.

Another disadvantage of the presented technique may be associated with the increased cost of the milled abutment, crown, and impression coping. The reduced chairtime to place the interim restoration and the superior mechanical properties, which may be associated with reduced incidences of failure, may justify the additional expense.

**SUMMARY**

The described technique offers an alternative method to fabricate interim restorations on dental implants the day of implant surgery. In addition, a digitally designed and milled custom impression coping may offer better accuracy in duplicating the periimplant soft tissue contours before fabricating the definitive prosthesis. The superior mechanical properties and reduced chairtime may justify the additional cost of having a milled interim abutment, interim crown, and custom impression coping. A prospective clinical study is needed to validate the use of the described technique.

**ABBREVIATIONS**

CAD/CAM: computer-aided design/computer-aided manufacturing  
PMME: polymethyl methacrylate

**REFERENCES**