Use of digital data acquisition and CAD/CAM technology for the fabrication of a fixed complete dental prosthesis on dental implants

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The work flow in this report describes a metal-resin fixed complete dental prosthesis fabricated by using digital data acquisition at the implant fixture level with a computer-aided design and computer-aided manufacturing (CAD/CAM) fabricated tissue-colored anodized titanium framework. (J Prosthet Dent 2014;111:1-5)

Two different traditional implant impression techniques, pickup (open tray) and transfer (closed tray), are used to obtain impression at the implant fixture level.[1] Many studies have focused on the factors affecting the accuracy of implant impressions and definitive casts, including splinting or not splinting impression copings, modification of impression copings, time delay for stone pouring, dimensional stability of impression materials and stones, and the design and use of custom trays.[2] Digital data acquisition at the implant fixture level has become available and may offer some advantages over conventional impression techniques such as improved patient comfort and acceptance (especially from those with a strong gag reflex), reduced distortion of the resulting definitive cast, and potential cost effectiveness for both clinicians and dental technicians.[3-6] Digital data acquisition at the implant fixture level can be achieved by using a scannable impression coping (Scan Body; Straumann) and an intraoral digital scanner (Cadent iTero; Cadent Ltd).[7] The scanned data can be interpreted by the dental laboratory-based computer-aided design and computer-aided manufacturing (CAD/CAM) software (Straumann Cares 8.0; Straumann) for the design of customized anatomic abutments and/or transmitted to the modeling center (Cadent iTero; Cadent Ltd) for the fabrication of milled definitive polyurethane casts.

The passive fit of fixed dental prostheses on dental implants has been considered critical in decreasing the incidence of mechanical complications such as screw loosening, screw fracture, and occlusal inaccuracies.[8] Different approaches have been proposed to enhance the passive fit of frameworks. CAD/CAM fabricated frameworks demonstrate a more consistent and superior passive fit than conventionally cast frameworks.[9] The CAD/CAM process allows the omission of several steps used in the conventional casting technique, including waxing, investment, casting, and polishing. These procedures are considered to introduce inaccuracies and the inaccuracies may become more evident with more extensive frameworks.[10] A verification device has been proposed to confirm the accuracy of a definitive cast.[11] A retrospective study[12] suggested that the fabrication of a verification device and cast ensured the clinically passive fit of metal frameworks, which were verified using the 1-screw technique (Sheffield test).[13]

This article describes a work flow with digital data acquisition at the implant fixture level, a milled definitive polyurethane cast, and CAD/CAM fabricated tissue-colored anodized titanium framework for the fabrication of a metal-resin fixed complete dental prosthesis on dental implants.

TECHNIQUE

First clinical appointment

1. Evaluate the existing dental implants (Fig. 1A), and secure scannable impression copings (Scan Body RN; Straumann) to the implants with a 15 Ncm preload (Fig. 1B).

2. Complete the digital data acquisition at the implant fixture level with an intraoral digital scanner (Cadent iTero; Cadent Ltd) following the manufacturer's instructions. Obtain the scans of the impression copings (Scan Body RN; Straumann) and surrounding periimplant soft tissue areas (Fig. 1C). Send the approved scan data to the dental laboratory (Roy Dental Laboratory).

First laboratory procedure

1. Import the scan data into the corresponding CAD/CAM software (Straumann Cares 8.0; Straumann). Design, approve, and transmit the information to the manufacturer (Cadent iTero; Cadent Ltd) for fabrication of the milled polyurethane definitive cast.

2. Upon receipt of the milled polyurethane definitive cast, use a drill press

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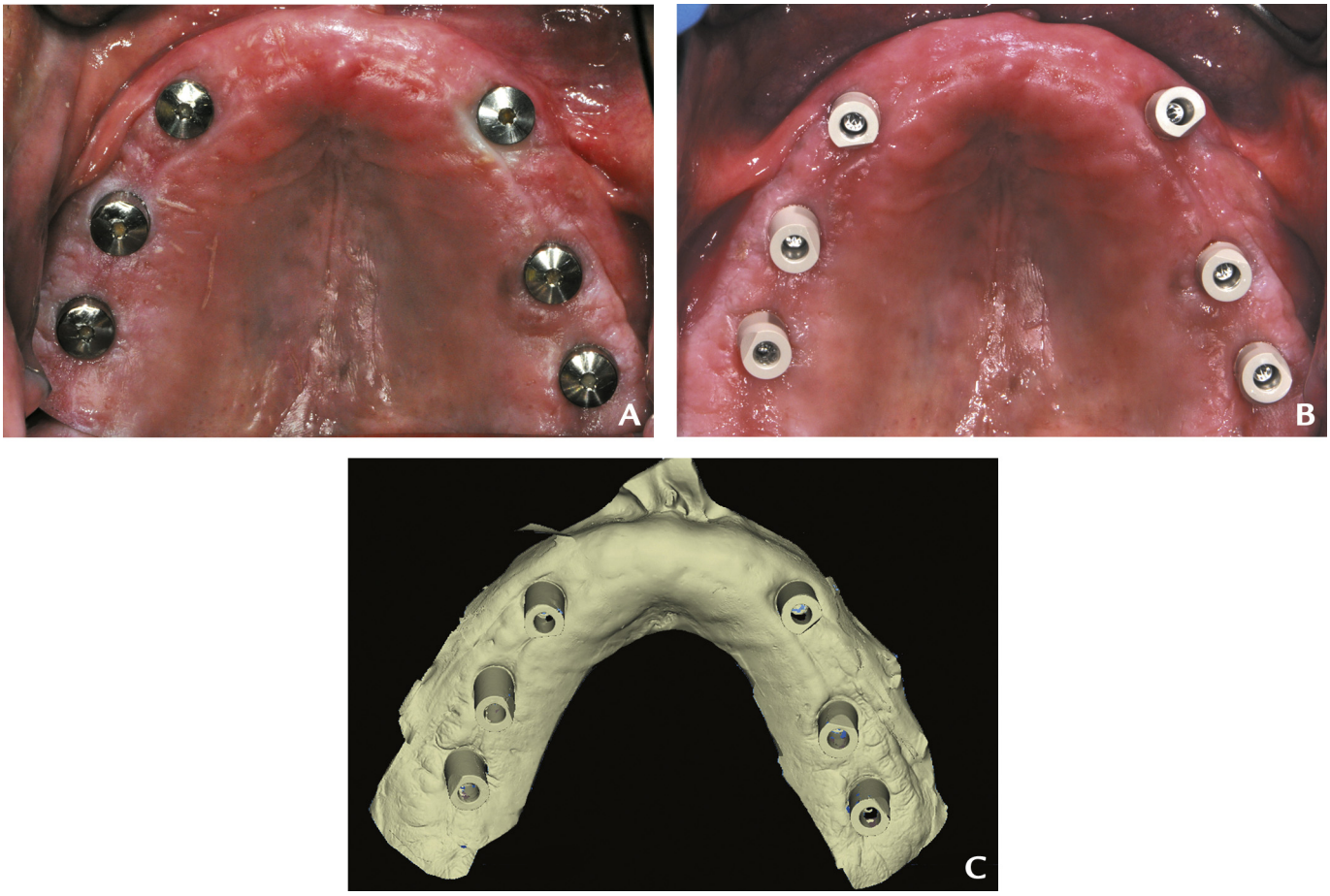
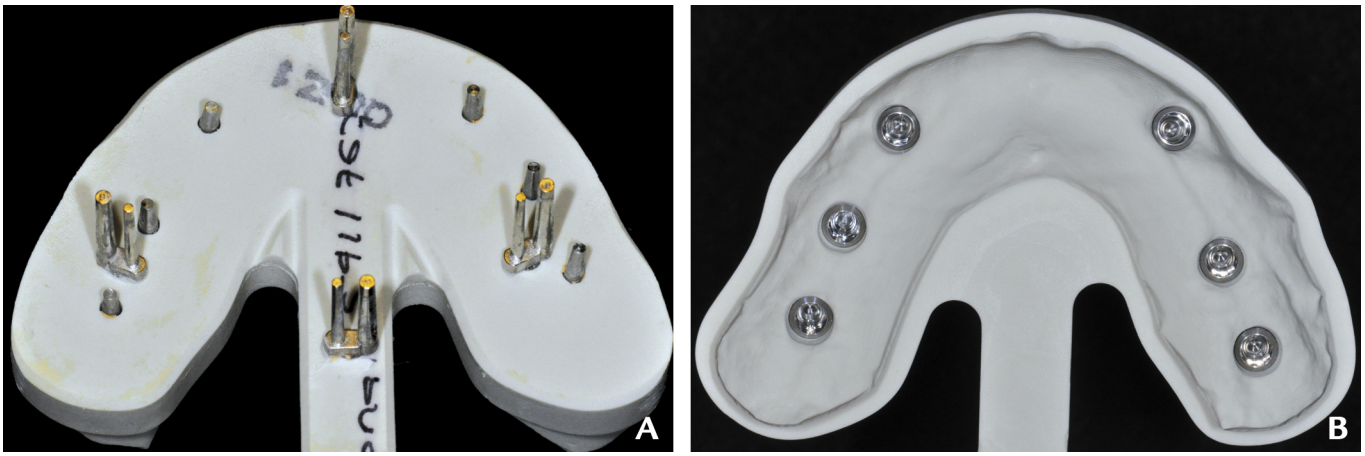


1 A, Occlusal view of existing implants. B, Scannable impression copings secured to implants. C, Digital data acquisition obtained with intraoral scanner.



2 A, Four dowel pins attached to base of definitive cast. B, Milled polyurethane definitive cast with removable implant analogs in place.

unit (Pindex; Coltene/Whaledent Inc) to place 4 parallel pin holes at the base of milled polyurethane definitive cast. Lute the dowel pins and sleeves (Dual Pin and Sleeve; Select Dental Mfg) into the parallel pin holes at the base of definitive cast with cyanoacrylate resin (3M Scotch Super Glue; 3M ESPE), and insert the corresponding removable implant analogs (RN Reposition Analog; Straumann) into the milled polyurethane definitive cast from the occlusal surface (Fig. 2A, B).

3. Spray separating medium (Super Sep; Kerr Corp) onto the base of the milled polyurethane definitive cast. Pour a stone base for the milled polyurethane

3 Milled polyurethane definitive cast with stone base.

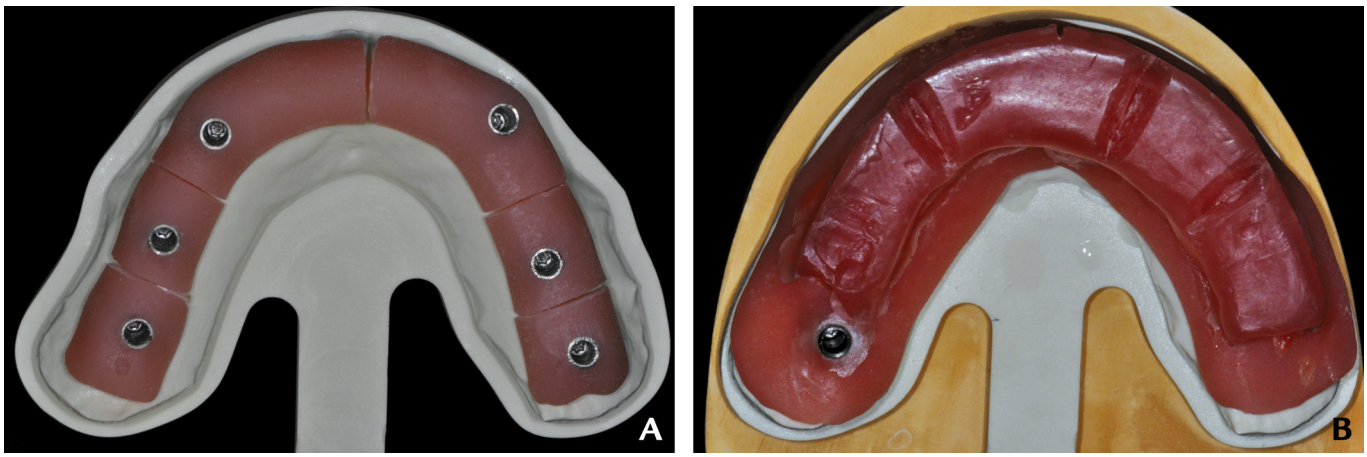
definitive cast over dowel pins/sleeves assembly with Type IV dental stone (Silky Rock; Whip Mix Corp) (Fig. 3).

4. Attach 1 temporary abutment (RN synOcta post for temporary restoration, Bridge; Straumann) to all implant analogs and connect them by using light polymerizing acrylic resin (Triad Denture Base; Dentsply Prosthetics) to fabricate a verification device.[11,12] Section the verification device with a diamond disk (911.11.220 DS DIAM DISC; Brasseler USA) (Fig. 4A).

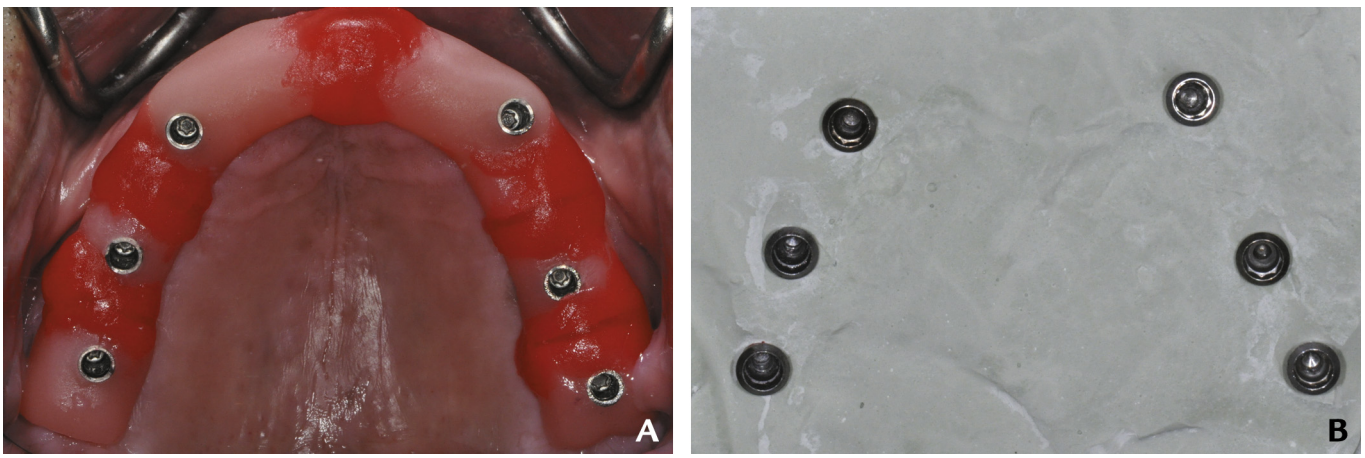
5. Attach 1 temporary abutment (RN synOcta post for temporary restoration, crown; Straumann) on the definitive cast and block out the remaining implant analog areas with wax (Truwax Baseplate Wax Regular; Dentsply Prosthetics). Fabricate an implant-retained trial base with light polymerizing acrylic resin (Triad Denture Base; Dentsply Prosthetics) and wax (Truwax Baseplate Wax Regular; Dentsply Prosthetics) (Fig. 4B).

Second clinical appointment

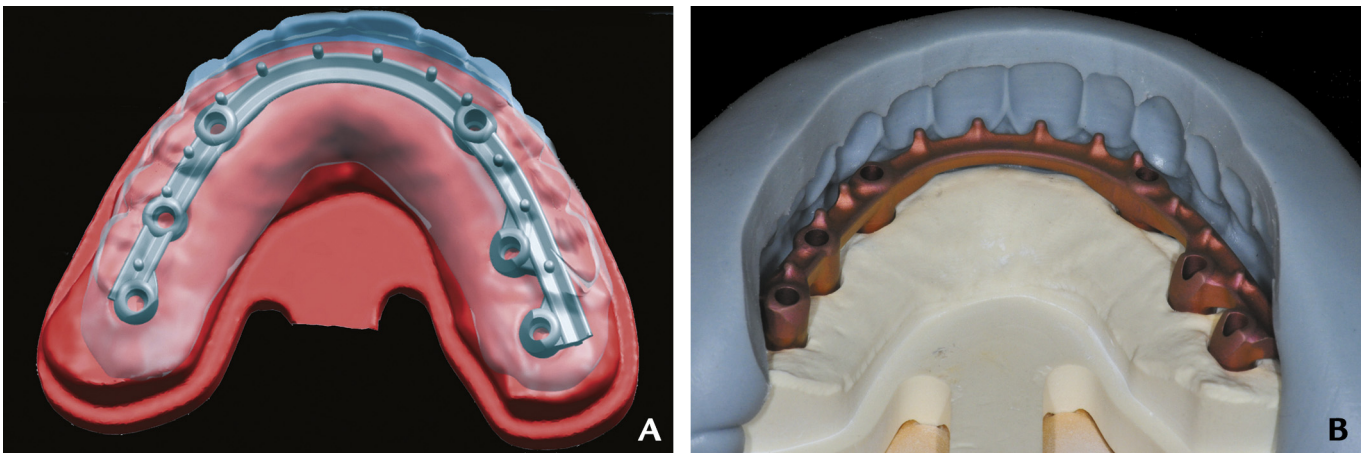
1. Evaluate the verification device intraorally and connect all the segments with autopolymerizing acrylic resin (Pattern Resin LS; GC America) (Fig. 5A). Remove the verification device and connect the corresponding implant analogs (RN synOcta Analog; Straumann) with the verification device. Place



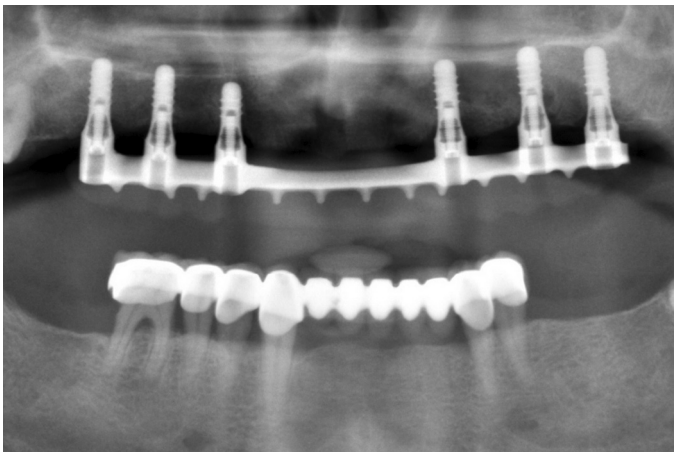
4 A, Completed segmental verification device on definitive cast. B, Completed implant-retained trial base and wax rim on definitive cast.



5 A, Verification device luted as 1 piece intraorally. B, Verification stone cast.



6 A, Digital design of custom-milled titanium bar. B, Completed tissue-colored anodized titanium framework with milled polyurethane definitive cast and facial matrix assembly.



7 Panoramic radiograph of definitive prosthesis.

the assembly into the Type IV dental stone (Resin Rock; Whip Mix Corp) to obtain a verification cast (Fig. 5B).

2. Evaluate and adjust the implant-retained trial base for esthetics, function, and occlusal vertical dimension. Select the prosthetic teeth (BlueLine DCL; Ivoclar Vivadent) and obtain the facebow transfer and interocclusal record with trial base and registration material (Regisil Rigid; Dentsply Prosthetics). Articulate the definitive cast and the opposing cast in a semi-adjustable articulator (Hanau Modular Articulator System; Whip Mix Corp).

Second laboratory procedure

1. Arrange the selected prosthetic teeth (BlueLine DCL; Ivoclar Vivadent) on the implant-retained trial base with wax (Truwax Baseplate Wax Regular; Dentsply Prosthetics).

Third clinical appointment

1. Evaluate the trial arrangement on the implant-retained trial base for esthetics, function, and occlusion intraorally. Make necessary adjustments to achieve optimal clinical outcome.

Third laboratory procedure

1. Make a facial matrix with polyvinyl siloxane putty (Sil-Tech; Ivoclar Vivadent) around the facial surface of the trial arrangement and milled polyurethane definitive cast assembly to preserve the spatial orientation of the prosthetic teeth as determined at the trial insertion appointment.

2. Send the trial arrangement, milled polyurethane definitive cast, and verification stone cast to a CAD/CAM facility (Cagenix; Cagenix Inc). Have the dental laboratory technician fabricate a custom-milled CAD/CAM titanium bar (AccuFrame Plus; Cagenix) using the trial arrangement for the restorative space assessment and the verification stone cast to obtain accurate interim-plant spatial relationships during the process (Fig. 6).

3. Arrange the prosthetic teeth on the custom-milled CAD/CAM titanium bar as determined at the trial insertion appointment by using the facial matrix.

4. Process the definitive tooth arrangement with heat polymerizing acrylic resin (SR Ivocap High Impact; Ivoclar Vivadent). Finish and polish the definitive prosthesis.

Fourth clinical appointment

1. Verify the fit of the definitive metal-resin fixed complete dental prosthesis intraorally with the 1-screw technique (Sheffield test)[13] and a radiograph (Fig. 7). Adjust the intaglio surface and occlusal contacts of the definitive prosthesis with a laboratory tungsten carbide cutting instrument (Carbide Cutter; Brasseler USA) as necessary.

2. Secure the definitive metal-resin fixed complete dental prosthesis to the implants with a 35 Ncm preload (Fig. 8). Instruct the patient as to the home care regimen and schedule periodic maintenance appointments.

DISCUSSION

There are many advantages associated with digital data acquisition at the

8 Definitive prosthesis. A, Smile. B, Frontal view.

implant fixture level,[3-6] and patients with strong gag reflexes may significantly benefit from this work flow because the intraoral scanner does not touch the soft palate and allows the patients to rest during data acquisition if necessary.[5] There are some disadvantages of the digital data acquisition at the implant fixture level, such as higher initial investment of required intraoral digital scanner and CAD/CAM software; further, additional system-specific training and experience are required for both clinicians and dental technicians. Furthermore, the large size of the intraoral digital scanner tip may prevent the scanning in the posterior region for patients with small openings.[6]

The proposed laboratory procedures included placing dowel pins/sleeves onto the base of the milled polyurethane definitive cast and creating a stone base for the milled cast. The dowel pins and sleeves can provide flexibility for the laboratory process when there is a need to remove and reposition the milled polyurethane definitive cast from the stone base, as when replacing damaged removable implant analogs. The stone base provides a stable surface for the articulation of milled polyurethane definitive cast in a semi-adjustable articulator.

Summary

This article presents a work flow for obtaining digital data acquisition at the implant fixture level with an intraoral scanner for a metal-resin fixed complete dental prosthesis on dental implants. It provides an alternative to obtain a definitive cast. To ensure the passive fit of the definitive prosthesis, a verification device and cast were used in the work flow. With the further development of intraoral scanners and CAD/CAM systems, the verification device and cast may be omitted.

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