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DENTAL TECHNIQUE

# Workflow for a metal-resin-zirconia fixed complete denture: A dental technique

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## ABSTRACT

The hard- and soft-tissue replacement materials in the traditional workflow for an implant fixed complete denture are acrylic resin and conventional resin denture teeth supported by a rigid substructure. A novel technique is described combining a modified digital complete denture workflow with analog components and systems, allowing the use of multicolored zirconia and 3D-printed resin. In combination with an appropriate metal substructure, a high-quality prosthesis can be fabricated with reduced effort and cost. (J Prosthet Dent 2020;■:■-■)

The design of the first implant-supported fixed prostheses consisted of a gold alloy framework, which supported pink acrylic resin and conventional denture teeth.[1,2] Although today cast gold has mostly been replaced by alternative substructures, the basic concept remains.[3] High success rates have been reported for this nearly 50-year-old concept.[4-8] This article introduces an alternative workflow based on the concepts of digitally designed complete dentures.

As complete denture software is designed to generate removable complete dentures, modifications were needed to apply it to implant-supported fixed prostheses. Most noticeably, the software does not allow for the generation for screw access holes, although these can be generated manually or with additional standard tessellation language (STL) modifying software.

Two distinct files can be generated by the software, one for the denture base and the second for the denture teeth. If conventional denture teeth are to be used, the software will only generate the denture base. In the described technique, the generated file for the denture base is used as the pink tissue replacement midstructure base, and the second is the white tooth replacement. The software computes the precise meshing of the 2 files, creating a mid-substructure base in which the teeth are positioned on one side and the metal substructure on the opposing side. Digital design files can be sent to output devices, including a 3D printer or a milling machine for production, by using a selection of different materials and colors. The software includes a digital wax block out tool to allow space for the bonding resin between the metal substructure and the midstructure.

Selected areas around the screw access holes are left unaltered to allow precise placement of the metal substructure into the shell when the metal substructure and the midstructure are bonded together in the planned position. In the removable complete-denture workflow, the teeth replacement section is in resin, either prefabricated, milled, or printed. The zirconia is retained by mechanical retention and chemical bonding. Although studies on this specific application are lacking, excellent long-term data have been reported for bonding zirconia to composite resin.[9,10] The intaglio side of the prosthesis is formed in an analog fashion with an indirect or a direct technique. A sealed, smooth resin surface facing the soft tissue allows adaptability should the soft-tissue contours change over time.

## TECHNIQUE

1. Scan the cast with the metal substructure by using an intraoral scanner (TRIOS Move; 3Shape) or a laboratory scanner (Fig. 1).

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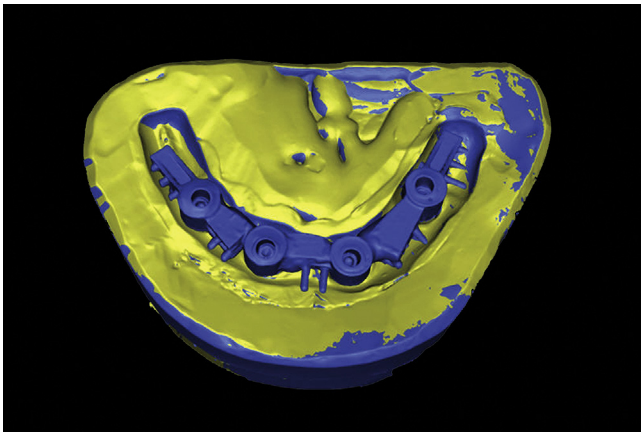

**Figure 1.** STL file of metal substructure on cast in dedicated removable denture software (Blue Sky Plan; Blue Sky Bio). STL, standard tessellation language.

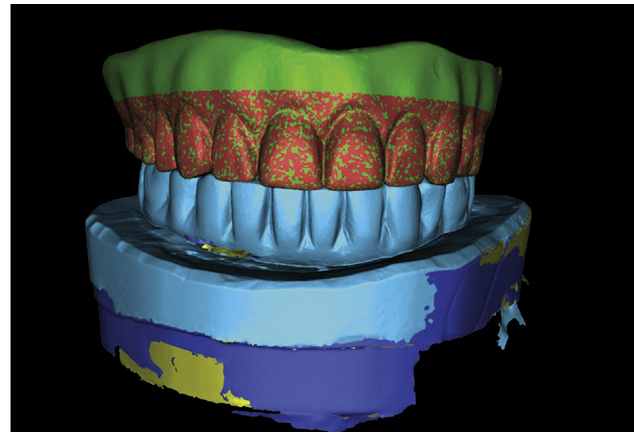

**Figure 2.** STL files displayed in different colors. STL, standard tessellation language.

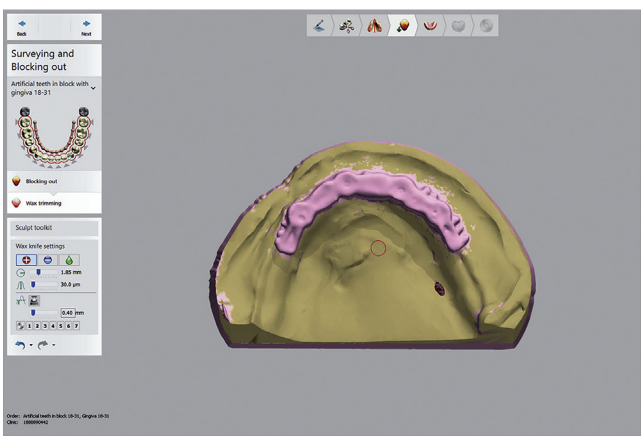


**Figure 3.** STL file of metal substructure on cast in dedicated removable denture software (Dental System; 3Shape). Note that substructure has been blocked out but that screw access areas have not yet been cleared. STL, standard tessellation language.

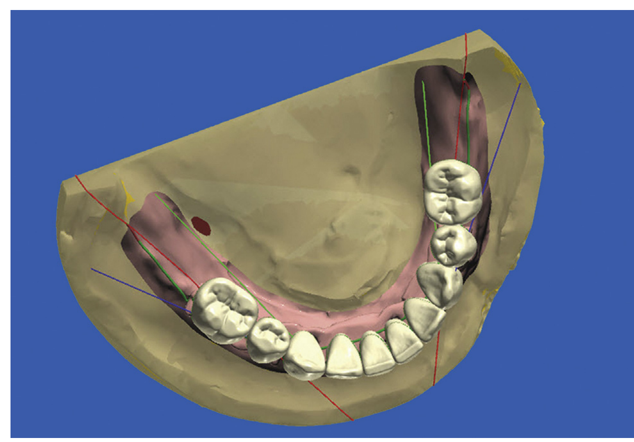

**Figure 4.** Tooth arrangement in removable denture software module.

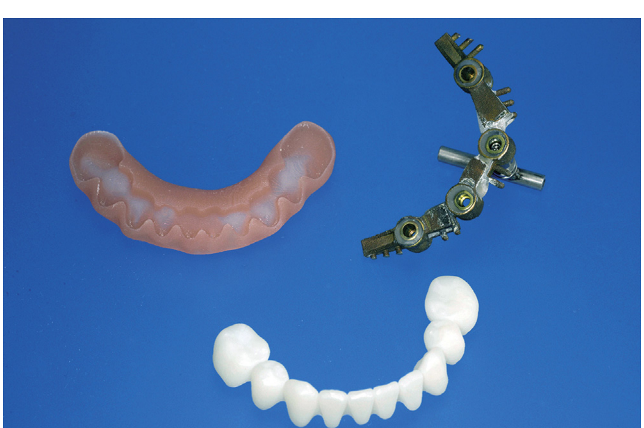

**Figure 5.** Metal substructure, midstructure base section, and white teeth arch section.

**Figure 6.** Metal substructure bonded into midstructure base section. Note no screws placed.

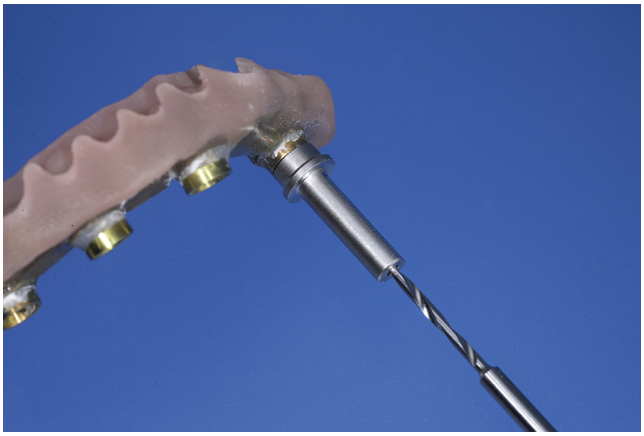

**Figure 7.** Midstructure base perforated opposite screw channel.

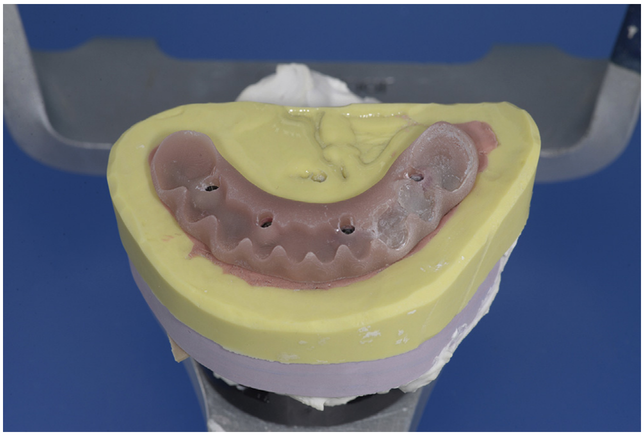

**Figure 8.** Screw access channels enlarged.

**Figure 9.** Prosthesis sintered and glazed.

**Figure 10.** Zirconia section fits passively into midstructure base section.

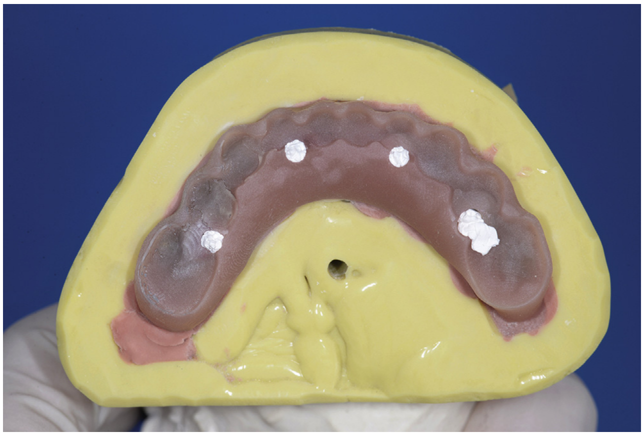

**Figure 11.** PTFE tape placed to prevent blocking screw access holes with luting composite resin. PTFE, polytetrafluoroethylene.

**Figure 12.** Dual-polymerizing luting composite resin bonding zirconia to resin midstructure base.

2. Scan the opposing arch, interim restoration, occlusal vertical dimension, and centric relation. Enter these scans into the removable denture software (Dental Systems; 3Shape) (Fig. 2).
3. Block out the metal substructure with digital wax. Allow 5 mm around the screw access holes (Fig. 3).
4. Design a complete denture following the workflow indicated by the software and generate the STL files (Fig. 4).

**Figure 13.** Intaglio waxed to desired contour.

**Figure 14.** Waxed for investment in clear polyvinyl siloxane material.

**Figure 15.** Casting of polyvinyl siloxane material. Note air inclusions eliminated by pressurized polymerization.

**Figure 16.** Clear polyvinyl siloxane material with channels to introduce light-polymerizing composite resin.

5. Print the STL file of the midstructure base by using a 3D resin printer (5100 3D Systems; Nextdent) in denture resin (Denture 3D+; Nextdent). Postprocess according to the manufacturer's instructions (Fig. 5).
6. Secure 1 laboratory analog onto the metal substructure as an interim holder and fit the metal substructure into the midstructure resin base. Confirm complete and positive seating. Remove the metal substructure and unscrew and remove the laboratory analog.
7. Place wax (Utility Wax Strips; Patterson Dental) in the screw access holes of the metal substructure. Note no screws are placed at this time.
8. Airborne-particle abrade the intaglio of the midstructure resin base and place a small quantity of denture resin (Denture 3D+; Nextdent) inside. Position the metal substructure into the base, being careful not to overflow resin onto the implant abutment mating surface of the metal substructure. Light polymerize (Fig. 6).

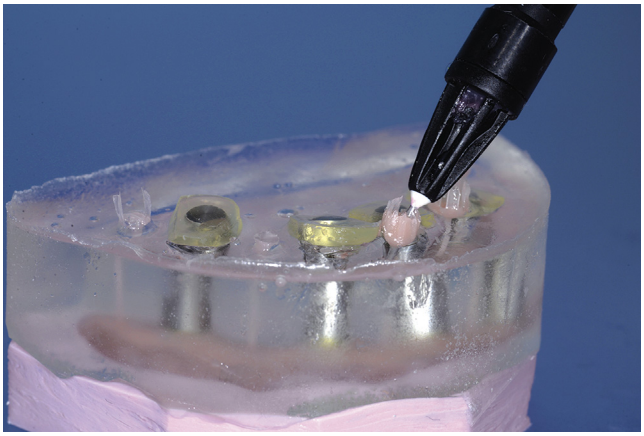

**Figure 17.** Injection of composite resin.

9. Place a guided laboratory analog (Drill Guide Multi-unit Abutment Plus; Nobel Biocare) into the implant abutment mating surface and perforate the resin base by using a guided laboratory drill (Apical Drill Temporary Snap Abutment;

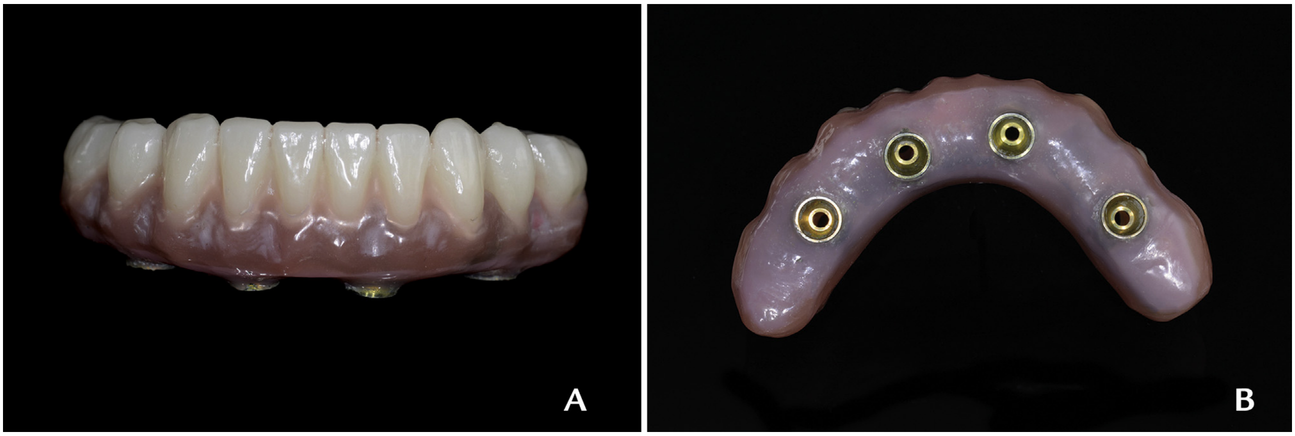


**Figure 18.** Finished prosthesis. A, Anterior view. B, Intaglio as copied from waxing.

Nobel Biocare). Enlarge the perforation sites to access the screw access holes. Clean out residual wax (Figs. 7, 8).

10. Send the STL file of the tooth arch section to a dry mill (DWX51D; Roland) loaded with a multicolored zirconia disk (STML; Katana) and mill out the section in approximately 2 hours.
11. Cut screw access holes and retentive features by using a rotary instrument into the zirconia (DCB5 HP 220; Komet Dental) while still in its green state. Remove supports and sinter for approximately 9 hours in a furnace (Sintra Plus; Shenpaz). Stain and glaze (Cerabien ZR; Kuraray Noritake Dental) (Figs. 9, 10).
12. Place polytetrafluoroethylene (PTFE) tape (Thread Seal Tape; Uline) into the screw access holes (Fig. 11).
13. Airborne-particle abrade the intaglio of the zirconia with aluminum oxide at 0.25 MPa and apply ceramic primer (Clearfil Ceramic Primer; Kuraray Noritake Dental).
14. Mix primer (ED Primer; Kuraray Noritake Dental) and apply to tooth section receptacle area of the midstructure section. Mix dual-polymerization 10-methacryloyloxydecyl dihydrogen phosphate (10-MDP)-containing luting resin (Panavia F 2.0; Kuraray Noritake Dental) and apply to the same area. Place the zirconia tooth section into the midstructure receptacle section and remove extruding luting resin. Initiate polymerization with visible-light polymerizing unit (Bluephase 20i; Ivoclar Vivadent AG) (Fig. 12).
15. Apply pink-colored composite resin (Anaxgum; Anaxdent) to create desired contours and papillae.
16. Create ideal contour of intaglio in wax (Beauty Wax Soft; Miltex) (Fig. 13).
17. Place laboratory analogs onto the metal substructure. Position metal tubes in the wax and box to receive clear polyvinyl siloxane (PVS) duplicating material (Matrix Cast Clear; Anaxdent) (Figs.;14, 15).
18. Mix PVS, pour, and polymerize in a pressure pot (Adjustable Temperature Pressure Pot; Great Lakes Orthodontics) at 140 kPa for 20 minutes. Remove the metal tubes.
19. Remove the prosthesis from the PVS base, remove the wax, airborne-particle abrade the intaglio, place bonding resin (Optibond Solo Plus; Kerr Corp), and light polymerize. Secure the prosthesis again onto the PVS base and inject flowable pink composite resin (Anaxgum Flow; Anaxdent) into the access channels created by the metal tubes, filling negative space previously occupied by wax. Light polymerize (Figs. 16, 17).
20. Finish the composite resin by using rotary instruments and apply a nanofiller glaze (Nanovarnish; Dreve) to eliminate porosities. Polish with composite resin polishing material (Pasta Grigia I; Anaxdent) (Fig. 18).
21. Deliver the metal-resin-zirconia implant fixed complete denture, secure the implant screws, and verify the occlusion, esthetics, phonetics, and contours. Tighten each prosthetic screw to the manufacturer's recommended settings and place PTFE tape (Thread Sealing Tape; Uline) into the screw access holes. Place composite resin (Filtek Supreme Plus; 3M) on top to seal the access channels (Fig. 19).

## SUMMARY

A workflow is presented that combines the efficiency of customized treatment with computer-aided design and computer-aided manufacturing (CAD-CAM) denture fabrication software and the use of dental materials in a nonconventional manner. The hard- and soft-tissue

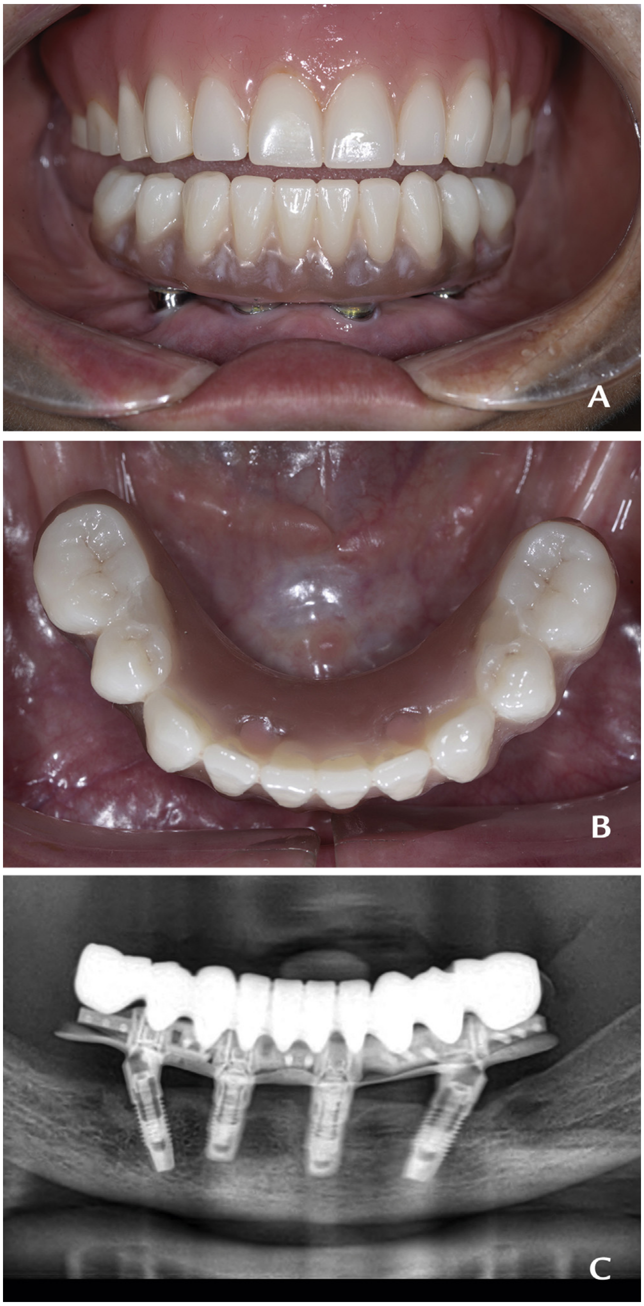


**Figure 19.** Delivered prosthesis. A, Anterior view. B, Occlusal view. C, Radiographic view.

replacement sections are split in the digital removable complete denture software, allowing for different output selections. The midstructure base is 3D printed in composite resin, while the tooth replacement section is milled from a multicolored zirconia disk. These sections are bonded together, supported by an appropriately designed and fabricated metal substructure. The analog finishing of the intaglio completes the combination of digital and analog workflows. An improved prosthetic outcome can be obtained with less effort and cost than the conventional workflow.

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