Title

Digital Workflow for Retrofitting a Surveyed Crown Using a Removable Partial Denture as an Antagonist

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Authors

Min-Soo Bae, DDS, MSD,[1] Won-suk Oh, DDS, MS,[2] Yeon-Hee, Park, DDS, MSD,[1] Jung-Jin Lee, DDS, MSD, PhD[1]

Affiliations

[1] Department of Prosthodontics, Institute of Oral Bioscience, School of Dentistry, Jeonbuk National University and Research Institute of Clinical Medicine of Jeonbuk National University-Biomedical Research Institute of Jeonbuk National University Hospital, Jeonju, Republic of Korea.

[2] Department of Biologic and Materials Sciences & Prosthodontics, University of Michigan School of Dentistry, Ann Arbor, Michigan

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Corresponding author:

Jung-Jin Lee

Department of Prosthodontics and Institute of Oral Bioscience

School of Dentistry, Jeonbuk National University

567 Baekje-daero, Deokjin-gu, Jeonju-si, Jeollabuk-do, 54896, Republic of Korea

Email: wjdwls04@gmail.com

ORCID: https://orcid.org/0000-0002-7381-5230

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Abstract

Digital workflow expedites the procedure of retrofitting a surveyed crown against an existing removable partial denture (RPD). This article describes a simple and straightforward technique of

digital workflow where an existing RPD is scanned as an antagonist to design the rest seat, guide plane, and height of contour of a surveyed crown.

Keywords

Digital workflow; Surveyed crown; Computer-aided design; Removable partial denture

Removable partial dentures (RPDs) play an important role in restoring oral functions and stabilizing the remaining dentition.[1-3] However, these prostheses may pose a risk of caries development and gingival inflammation when plaque accumulation is uncontrolled.[1,2] Direct abutments receive the clasp assembly for support, stability, retention of the prosthesis and are subject to occlusal loading. According to a clinical study,[3] the risk of abutment failure is more than double than that of indirect abutments receiving only occlusal rests and minor connectors.

A surveyed crown is the prosthodontic treatment of choice when the abutment tooth demonstrates a deficiency of coronal structure. The restoration is contoured to exhibit rest seat, guide plane and ideal height of contour to fit against the clasp assembly of the RPD. However, the procedure of retrofitting a surveyed crown to an existing RPD is a challenge because an error may occur with orientation of the RPD to the abutment tooth.[4-8] The RPD may demonstrate a positional change against the abutment during impression making.[9, 10]

The digital process may expedite the procedure of retrofitting a surveyed crown to an existing RPD by eliminating the need for impression making.[11] The digital workflow usually starts with scanning of intraoral structures to create the surface geometry into a 3-dimensional (STL) files using small triangles.[12,13] These files are imported into a computer-aided design (CAD) software or a

mesh editing tool to create a solid structure, and then a subtractive or additive manufacturing process is used to produce a model or a prosthesis. However, the common method of digital workflow requires multiple steps, including a need for a preoperative scan of the unprepared abutment teeth and/or acquisition of a crown pattern for the surveyed restoration.[12-14]

This article describes a simple and straightforward digital workflow for the fabrication of a surveyed monolithic zirconia crown to retrofit an existing RPD. This technique involves intraoral scanning of an existing RPD as an antagonist to design the rest seat, guide plane, and height of contour of a surveyed crown.

Technique

1. Determine the stability of an existing maxillary RPD and need of a surveyed crown for an abutment tooth (right maxillary canine). Reduce the abutment tooth using high-speed rotary instruments to create adequate occlusal and axial clearance for a monolithic zirconia surveyed crown (Fig 1).

2. Thinly coat an anti-reflective spray (CEREC Optispray; Dentsply Sirona, York, PA, USA) on the intaglio and cameo surfaces of the cobalt-chromium alloy RPD framework to avoid an error related to reflection of light emitted during the scanning procedure. Activate the scanning software to create the first scan order. Proceed to scan the prepared abutment tooth (Scan A) and the intaglio and cameo surfaces of the RPD framework (Scan B) as an antagonist, using an intraoral scanner (Trios 3 Color; 3Shape A/S, Copenhagen, Denmark). Obtain a virtual interocclusal record with the RPD placed in the mouth (Fig 2).

3. Copy the first scan to create the second scan. Delete the scanned image of the opposing mandibular dentition taken in the first scan. Proceed to scan the opposing mandibular dentition (Scan C). Obtain a virtual interocclusal record with the RPD clasp assembly oriented against the abutment tooth (Fig 3).

4. Export both the first and second scan orders into a CAD software (Dental System 2018; 3Shape A/S, Copenhagen, Denmark) and create a laboratory order to design a surveyed crown. Import the Scan A as the abutment tooth and Scan B as antagonist. Proceed to design a surveyed crown for the existing RPD (Fig 4A). Assess the fit of the virtual crown against the scanned image of the RPD clasp assembly, using a distance color map or sectional view of the clasp assembly engaging the crown (Figs 4B and C). Refine the axial contour of the virtual crown and save the design.

5. Copy the laboratory order to open a new laboratory order folder. Replace the scanned image of the RPD (Scan B) with the opposing mandibular dentition (Scan C). Activate the "auto adjustment tool" of the CAD software to automatically adjust the occlusal contact relationship of the virtual crown against the opposing mandibular dentition. Verify the adequacy of the rest seat, guide plane, and height of contour characterized on the virtual surveyed crown (Fig 5). Note a limitation of automatic adjustment in creating an undercut area for retention. Adjust manually to reproduce the details of undercut area to match with the clasp arm. Save the design and export it as an STL file.

6. Import the STL file of the virtual crown into a computer-aided manufacturing (CAM) software (Hyperdent compact 8.2; FOLLOW-ME! Technology, Munich, Germany) to produce a monolithic zirconia surveyed crown (Upcera STML; Shenzen Upcera Dental Technology Co, Shenzhen, China), using a 5-axis milling machine (Arum 5X-100; Doowon ID, Daejeon, Korea).

7. Evaluate the fit of the surveyed crown to the abutment tooth and against the RPD clasp assembly and opposing mandibular dentition, using disclosing wax (Kerr Corp, Middleton, WI, USA) and

articulating strips (AccuFilm II; Parkell, Farmingdale, NY, USA). Adjust the fit and polish the surveyed crown using rotary instruments. Verify the intraoral stability of the RPD and lute the monolithic zirconia surveyed crown on the abutment tooth with an adhesive resin cement (RelyX U200; 3M ESPE, St. Paul, MN, USA).

Discussion

The conventional analog procedure of retrofitting a surveyed crown to an existing RPD involves making an impression with the prosthesis seated intraorally, and transferring the orientation of the RPD against the abutment tooth onto the master cast.[4,6-8] Various techniques have been published with a focus on keeping the positional stability of the RPD and accurate transfer of the orientation.[4-8,10] However, the conventional analog procedures require multiple steps and disrupt the patient's oral functions and comfort because of a need of the RPD for the fabrication of a surveyed restoration.

Adopting digital technology can expedite the procedure of retrofitting a surveyed crown to an existing RPD.[12-14] However, previous methods of digital workflow require multiple steps of scanning and alignment including baseline image of the unprepared abutment teeth and fabrication of resin or polyvinylsiloxane copings as an index against the prosthesis.[11,13-16] This new digital workflow of using an existing RPD as an antagonist eliminates the need for preoperative scanning of the abutment tooth and fabrication of the coping index. The patient can continue wearing the RPD during the fabrication process. Instead, the virtual image of the RPD is used to fashion the rest seat, guide plane, and height of contour of the surveyed crown.

This digital workflow involves dual function of the CAD software to ensure the fit of the surveyed crown against the clasp assembly using quantitative assessment of numerical values and qualitative evaluation of color maps. However, care needs to be taken while scanning the partially edentulous arch and removable prosthesis to ensure the correct relationship of the RPD against abutment tooth. The internal line angle of the rest seat may need refinement because of the limited capacity of the round end cylinder bur used in the milling procedure.

Summary

The digital workflow of using an existing RPD as an antagonist expedites the procedure of retrofitting a surveyed crown. This process allows the patient use of the RPD while fabricating a surveyed crown. The virtual image of the RPD is used to fashion the rest seat, guide plane, and height of contour of a surveyed crown, and then the occlusal contact relationship is automatically adjusted using CAD software. This method of digital workflow is simple and straightforward for retrofitting a surveyed crown against an existing RPD.

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Figure 1 (A) Removable partial denture abutment tooth (right maxillary canine) prepared for surveyed crown, (B) Verification of clearance for designing of surveyed crown.

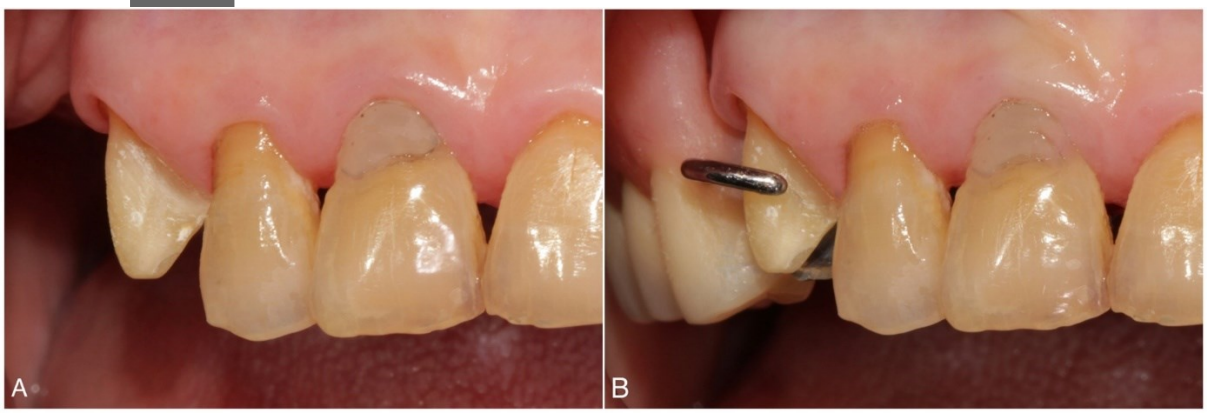

Figure 2 Scanned images: (A) Prepared abutment tooth (scan A), (B) Intaglio and cameo surface of existing RPD (scan B), (C) Interocclusal record obtained with alignment of scans A and B.

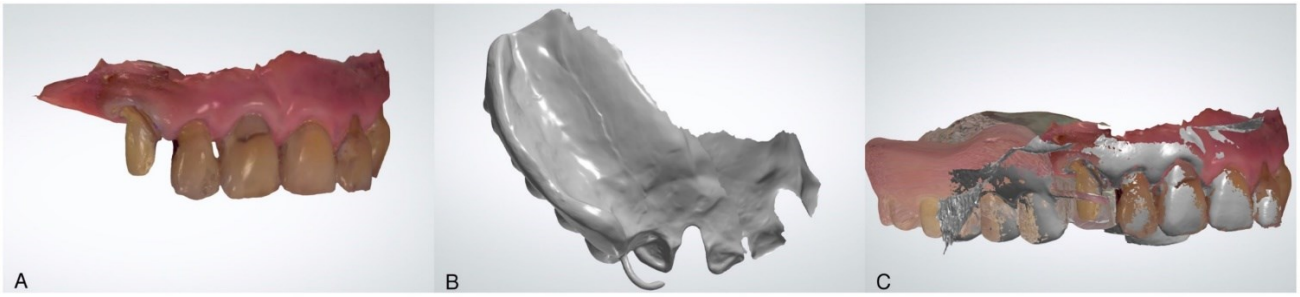

Figure 3 Scanned images: (A) Opposing dentition (scan C), (B) Interocclusal record obtained with alignment of existing removable partial denture and opposing dentition.

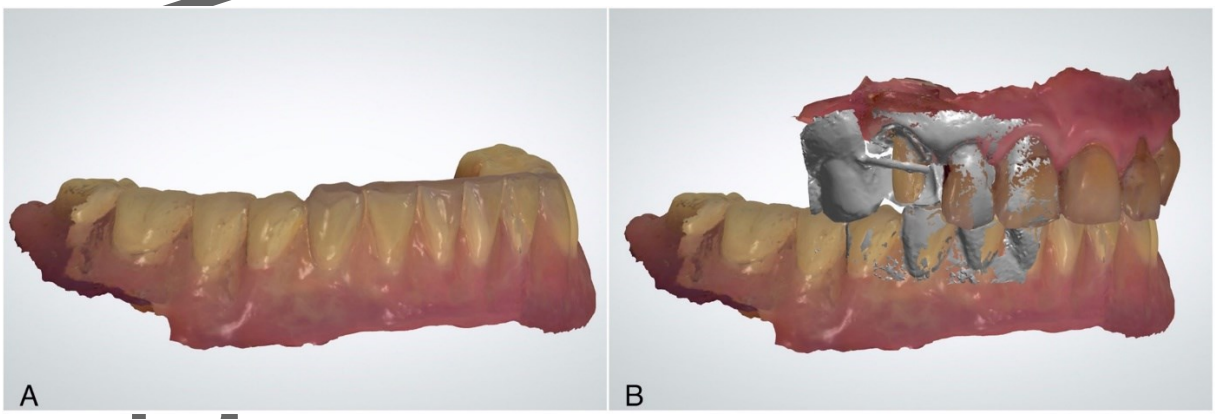

Figure 4 (A) Surveyed crown designed to fit against existing RPD, (B) Visual assessment to evaluate fit of crown against RPD with color difference, (C) Cross-sectional view to verify precision of fit of crown against RPD. RPD: removable partial denture.

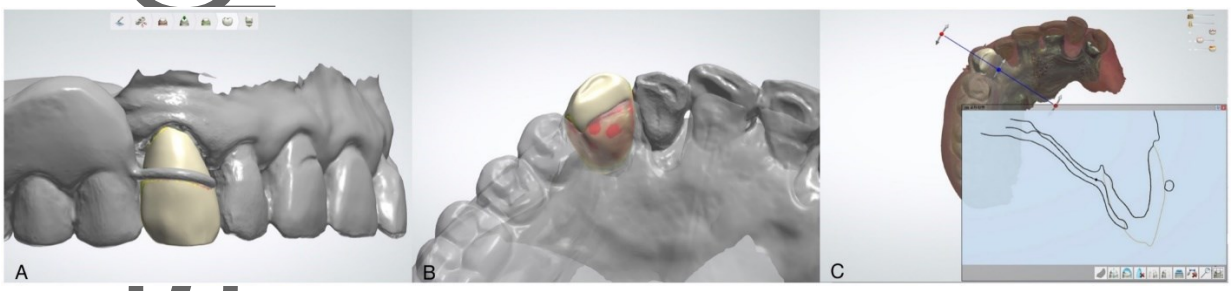

Figure 5 Surveyed crown revealing occlusal contact relationship against opposing dentition (scan C).

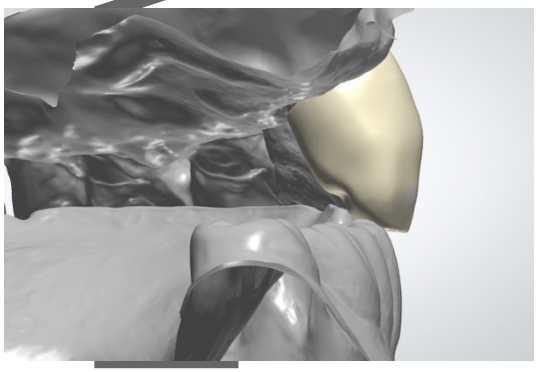

Figure 6 (A) Milled monolithic zirconia surveyed crown demonstrating rest seat, guide plane and ideal height of contour for existing RPD, (B) Verification of intraoral fit of surveyed crown against

RPD, (C) Occlusal view of surveyed crown with existing RPD placed in mouth. RPD: removable partial denture.