THE JOURNAL OF PROSTHETIC DENTISTRY

DENTAL TECHNIQUE

A fully digital approach to fabricating a CAD-CAM ceramic crown to fit an existing removable partial denture

Diogo N. M. Gouveia, DDS,[a] Michael E. Razzoog, DDS, MS, MPH,[b] and Maria F. Alfaro, DDS[c]

ABSTRACT

The use of a fully digital approach to fabricate an anatomic contour crown to fit an existing removable prosthesis allows the dentist and the dental laboratory technician to work efficiently in a digital environment. This report presents a series of patient treatments involving the fabrication of an anatomic contour monolithic zirconia crown to retrofit an existing removable partial denture. A complete digital workflow comprises an intraoral digital scan and computer-aided design and computer-aided manufacturing (CAD-CAM) technology. (J Prosthet Dent 2019;121:571-5)

Replacing a crown on a tooth serving as an abutment for a removable partial denture (RPD) is considered one of the most difficult restorative procedures.[1] Various techniques have been reported, generally described as either direct or indirect.[2-5] The direct technique is where the outline of the restoration is fabricated intraorally as opposed to the indirect technique where all information is transferred to a gypsum cast, and the contour and design of the restoration are completed in the dental laboratory.[6,7]

The main advantage of the direct technique is that the patients can wear a functional RPD during the laboratory phase. However, increased clinical time is required to complete the intraoral waxing procedure, and inaccuracies could be incorporated because of the difficulty in manipulating the crown pattern in the oral environment. Conversely, the indirect technique permits the laboratory technician to work on the contour of the restoration with the existing RPD available. In this situation, the patient is deprived of the RPD, a typically unacceptable situation if an anterior tooth is replaced by the RPD. The disadvantages of this technique include reliance on the laboratory technician's experience, the shrinkage of the acrylic resin, and dimensional changes in the wax pattern that can lead to imprecisions in the contour of the definitive crown.[3,7]

The technique, direct or indirect, should be accurate and reasonably straightforward. The use of computer-aided design and computer-aided manufacturing (CAD-CAM) technology has become popular in fixed and removable prosthodontics, and its adoption has been associated with innovative, expedient, and precise methods of performing dental procedures. Different techniques have been described in which CAD-CAM technology is used to facilitate the fabrication of a surveyed crown, each with its own particularities and

Figure 1. Maxillary removable partial denture with metal-ceramic crowns on abutment teeth.

[a]Graduate Prosthodontics Resident, Department of Biological and Material Sciences, Division of Prosthodontics, University of Michigan, Ann Arbor, Mich.
[b]Professor, Department of Biological and Material Sciences, Division of Prosthodontics, University of Michigan, Ann Arbor, Mich.
[c]Graduate Prosthodontics Resident, Department of Biological and Material Sciences, Division of Prosthodontics, University of Michigan, Ann Arbor, Mich.

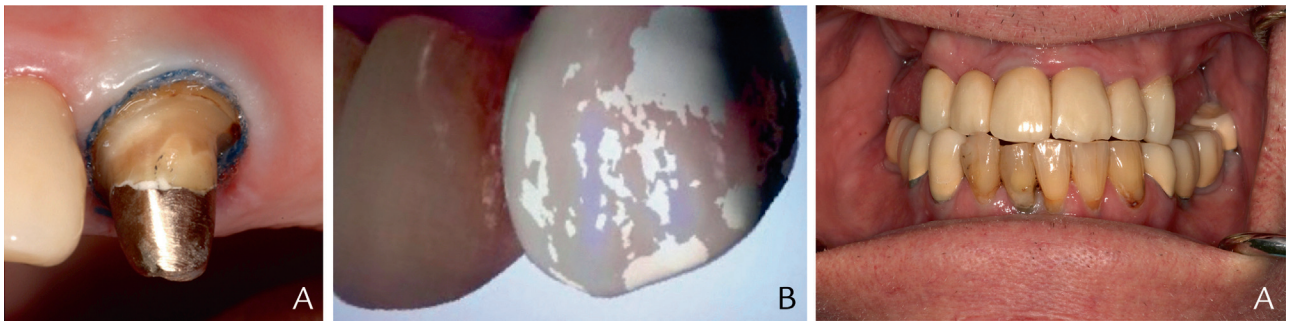

Figure 2. A, Prepared maxillary canine abutment crown for existing RPD. B, Software view of scan before preparation of crown (gray) merged with definitive scan (white). C, PMMA-milled interim restoration used for verification. PMMA, polymethyl methacrylate; RPD, removable partial denture.

limitations.[8-11] The purpose of this report was to describe and illustrate a series of patient treatments conducted in the Department of Graduate Prosthodontics, University of Michigan, in which a fully digital CAD-CAM approach was followed to fabricate an anatomic contour monolithic zirconia restoration to retrofit an existing RPD.

DENTAL TECHNIQUES

Patient 1

A 57-year-old patient presented with good oral hygiene and a maxillary RPD that had been fabricated 2 years previously (Fig. 1). On clinical and radiographic examination, the metal-ceramic maxillary left canine abutment crown was found to have distal caries. The treatment consisted of fabricating an anatomic contour zirconia crown by following the contours of the preexisting metal-ceramic crown.

Technique.

1. Assess the fit and function of the existing RPD and the prognosis of the maxillary left canine abutment.
2. Make a digital scan before cutting off the existing metal-ceramic crown and create a laboratory order for an anatomic contour zirconia crown with "pre-preparation" in the TRIOS software (TRIOS; 3Shape).
3. Remove the metal-ceramic crown, excavate the distal caries, and refine the margins.
4. Make a digital scan of the preparation (Fig. 2A), the antagonist arch, and the occlusion. The scanned order was outsourced to a commercial dental laboratory for crown design and manufacture.
5. Use design software (Dental System; 3Shape) to trace the margins and before treatment merge the scan into the new CAD crown using the mirroring tool (Fig. 2B).
6. Mill a polymethyl methacrylate crown (Temp Multi; Zirlux) as a crown pattern. As the fit of the pattern was clinically satisfactory (Fig. 2C), the zirconia (Katana; Kuraray Noritake Dental Inc) anatomic contour crown was milled, sintered, and glazed following the manufacturer's guidelines.
8. Lute the definitive restoration with glass ionomer cement (Fuji Plus; GC Corp) (Fig. 3).

Figure 3. Existing removable partial denture with definitive anatomic contour zirconia restoration

Patient 2

An 80-year-old white man presented to the prosthodontic clinic for a recall visit. The patient reported a history of hypertension controlled by medications. His dental history included restorations, extractions, implants, and a well-functioning, 5-year-old mandibular implant-supported RPD. Clinical evaluation revealed fair oral hygiene and recurrent caries under a mesial occlusal composite resin on the left mandibular first premolar (RPD abutment). Radiographic evaluation revealed caries at the margins of the tooth and adequate periodontal support. The treatment plan consisted of an anatomic contour zirconia crown on the left mandibular first premolar to be fabricated as a replica of the existing tooth.

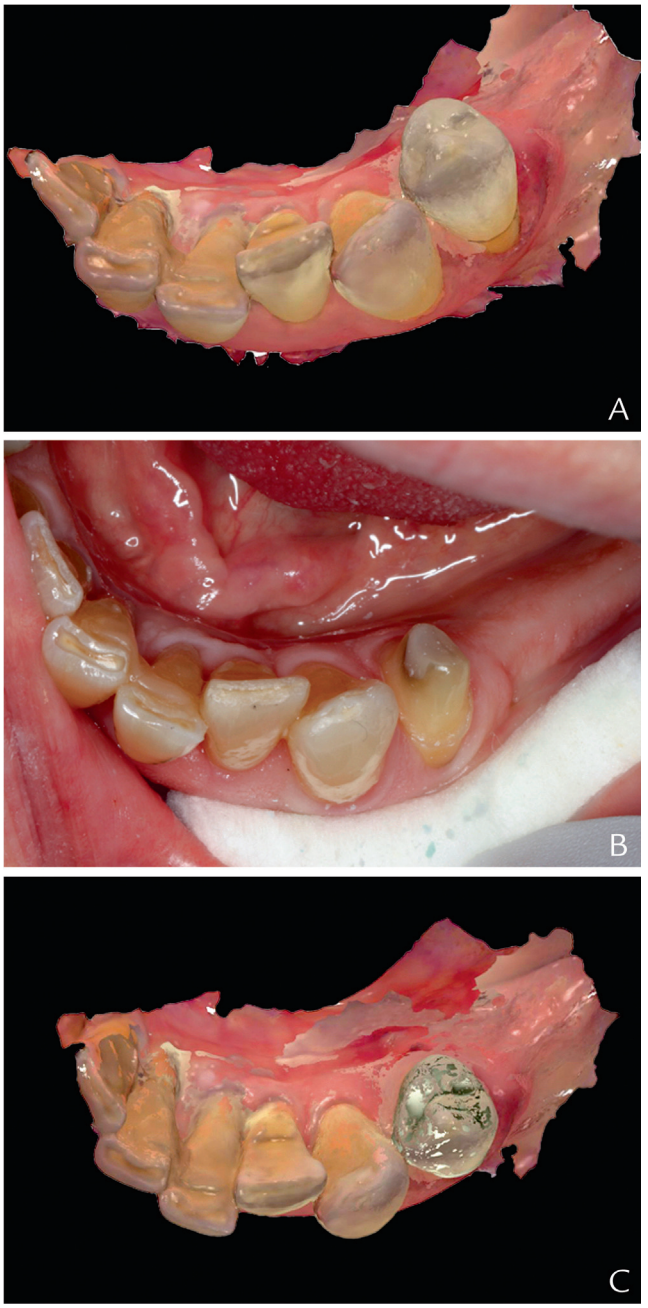

Figure 4. A, Digital scan of left mandibular first premolar before preparation. B, Abutment tooth preparation ready for digital scan. C, Scan (gray) before preparation merged with definitive design (white).

Technique.

1. Make a digital scan of the mandibular left quadrant with the TRIOS 3 intraoral scanner (TRIOS; 3Shape) before preparation (Fig. 4A).
2. Remove the composite resin and excavate the carious lesion, filling the cavity with a core foundation material (CompCore; Premier Dental).
3. Prepare the abutment tooth for a zirconia crown (chamfer design with a depth of 1.5 to 2.0 mm) with rounded angles and smooth contours (Fig. 4B).
4. Scan the preparation, antagonist arch, and occlusion using the TRIOS 3 intraoral scanner (TRIOS; 3Shape). Mark the margin and merge the scan before preparation to the final CAD design using the mirroring tool of the design software (Dental System; 3Shape) (Fig. 4C).
6. Send the CAD file to a milling center for the manufacturing and finishing of an anatomic contour zirconia restoration (Katana; Kuraray Noritake Dental Inc).
7. Evaluate the fit of the abutment crown clinically (Fig. 5A). Minimal adjustments to the occlusion were needed (Fig. 5B).
8. Lute the definitive restoration with glass ionomer cement (Fuji Plus; GC Corp).

Patient 3

An 86-year-old white man presented to the prosthodontic clinic with intermittent pain in the mandibular left canine. His medical history revealed compromised cardiovascular and renal status. He was functioning with a maxillary complete denture and a mandibular RPD that was in fair condition. The mandibular remaining teeth were periodontally stable, and the patient expressed his wish to maintain his existing dentition. The mandibular left canine had a ceramic crown fabricated 5 years previously (Fig. 6A) and was sensitive to percussion with an open distal margin. The patient was referred to the endodontic clinic for treatment. The treatment plan included the fabrication of an anatomic contour zirconia crown retrofitted to the existing RPD.

Technique.

1. Make a digital scan of the remaining teeth using the TRIOS pod (TRIOS; 3Shape) before preparation.
2. Complete the endodontic treatment, cut off the existing crown, and refine the margins (Fig. 6B).
3. Scan the preparation with the TRIOS 3 intraoral scanner. Trace the margins and merge the scan with the final CAD design before preparation (Dental System; 3Shape) (Fig. 7A).
4. Send the CAD file to a dental laboratory for the milling, sintering, and finishing of an anatomic contour zirconia crown (Katana; Kuraray Noritake Dental Inc) (Fig. 7B).
5. Verify the fit of the abutment crown and complete the seating of the RPD.
6. Lute the definitive restoration with resin-modified glass ionomer cement (Fuji Plus; GC Corp) (Fig. 7C).

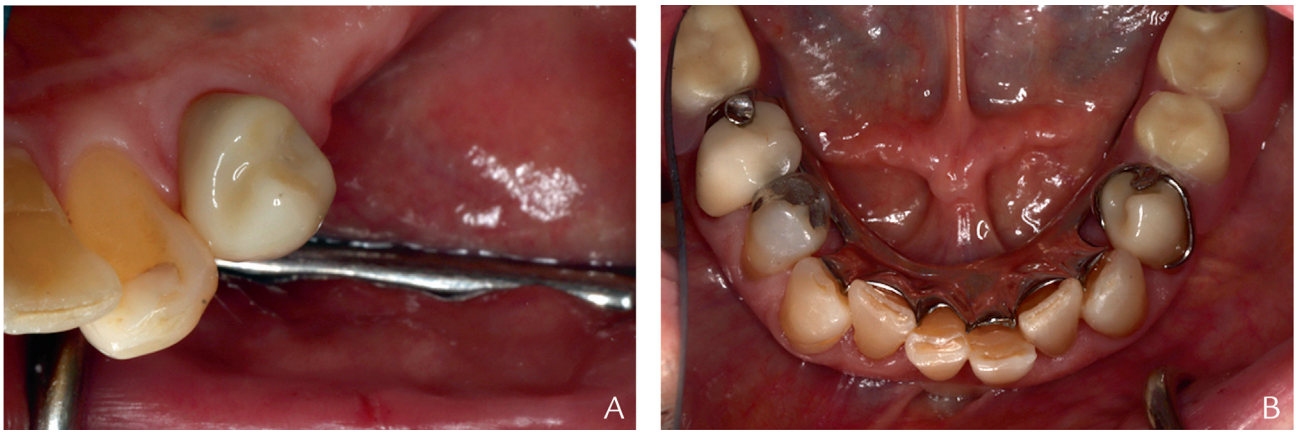

Figure 5. A, Intraoral evaluation of definitive restoration. B, Anatomic contour zirconia crown retrofitted to existing implant-supported removable partial denture.

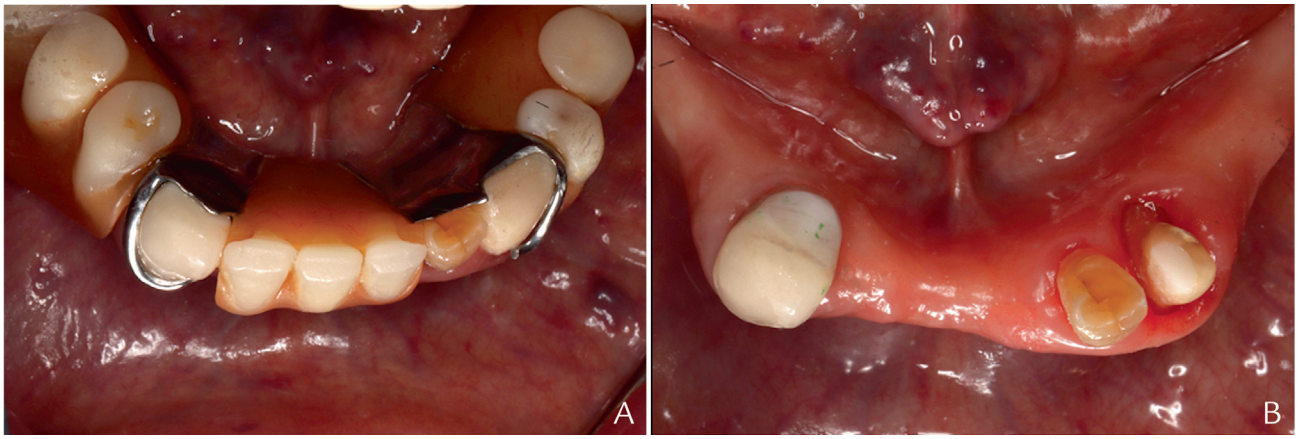

Figure 6. A, Existing abutment crown on left mandibular canine. B, Abutment tooth preparation ready for digital scan.

DISCUSSION

A fully digital workflow using CAD-CAM technology to replicate the contour of an existing crown to retrofit an RPD has been described. The main advantages of this efficient process are that patients can keep their well-fitting and fully functional RPDs while the definitive anatomic contour crown is being manufactured. Matching a direct or indirectly fabricated acrylic resin pattern is an arduous and skill-sensitive process and may be the weak link in the entire process.[7] In the described technique, a fully digital approach eliminates the need for the stone casts or acrylic resin patterns necessary in other described techniques to assess the fit or accuracy of the definitive restoration.[8-11]

The accuracy of the intraoral digital scanning technique in fabricating single-unit fixed restorations has been widely demonstrated.[12-15] In the reported patient treatments, the use of an intraoral scanner allowed the operator to capture and replicate effectively the existing retentive areas, guiding planes, and rest seats.[10,16] This eliminates the need for adjustments to the definitive zirconia restoration and reduces the risks of phase transformation that could decrease its mechanical properties.[17] Moreover, the use of a fully digital approach eliminates any distortion related to impression material, and all the steps involved in the process can be monitored with fewer appointments.[12]

The use of a fully digital CAD-CAM approach to match the existing contour of the abutment tooth and to manufacture the definitive restoration can provide excellent crown fit and improved retention for the existing partial removable prosthesis, particularly compared with conventional methods.[6]

SUMMARY

The use of CAD-CAM technology is a reality in fixed and removable prosthodontics. Three patient treatments were presented in which a fully digital workflow was used to retrofit a newly fabricated crown to an existing RPD with minimal adjustments and modification. This straightforward and reproducible technique helps both the dentist

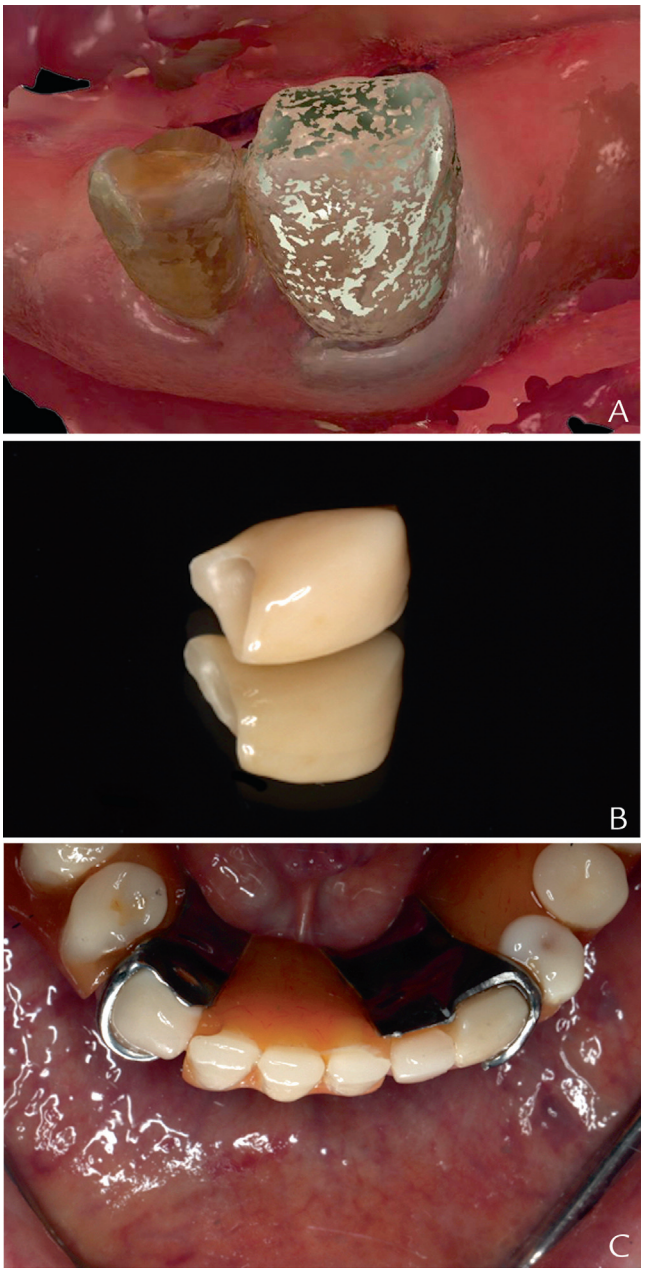

Figure 7. A, Scan before preparation (gray) merged with definitive crown (white). B, Anatomic contour zirconia crown ready for delivery. C, Definitive zirconia restoration retrofitted to existing removable partial denture.

and dental laboratory technician complete a complex laboratory procedure.

REFERENCES

1. Hill GM. Construction of a crown to fit a removable partial denture clasp. J Prosthet Dent 1977;38:226-8.
2. Helvey GA. Retrofitting crowns to an existing removable partial denture clasp: a simple technique. J Prosthet Dent 2002;87:399-402.
3. Macpherson JR, Evans DB. Fabricating crowns to fit existing removable partial dentures: an illustration of two techniques. J Prosthodont 1993;2:199-205.
4. Lubovich RP, Peterson T. The fabrication of a ceramic-metal crown to fit an existing removable partial denture clasp. J Prosthet Dent 1977;37:610-4.
5. Burns DR, Unger JW. The construction of crowns for removable partial denture abutment teeth. Quintessence Int 1994;25:471-5.
6. Ozawa D, Suzuki Y, Kawamura N, Ohkubo C. Fabrication of crown restoration retrofitting to existing clasps using CAD/CAM: fitness accuracy and retentive force. J Prosthodont Res 2015;59:136-43.
7. Tran CD, Sherraden DR, Curtis TA. A review of techniques of crown fabrication for existing removable partial dentures. J Prosthet Dent 1986;55:671-3.
8. Marchack BW, Chen LB, Marchack CB, Futatsuki Y. Fabrication of an all-ceramic abutment crown under an existing removable partial denture using CAD/CAM technology. J Prosthet Dent 2007;98:478-82.
9. Paek J, Noh K, Pae A, Lee H, Kim HS. Fabrication of a CAD/CAM monolithic zirconia crown to fit an existing partial removable dental prosthesis. J Adv Prosthodont 2016;8:329-32.
10. Yoon TH, Chang WG. The fabrication of a CAD/CAM ceramic crown to fit an existing partial removable dental prosthesis: a clinical report. J Prosthet Dent 2012;108:143-6.
11. El Kerdani T, Roushdy S. The use of CAD/CAM technology for fabricating cast gold survey crowns under existing partial removable dental prosthesis. A clinical report. J Prosthodont 2017;26:321-6.
12. Gjelvold B, Chrcanovic BR, Korduner EK, Collin-Bagewitz I, Kisch J. Intraoral digital impression technique compared to conventional impression technique. A randomized clinical trial. J Prosthodont 2016;25:282-7.
13. Shimizu S, Shinya A, Kuroda S, Gomi H. The accuracy of the CAD system using intraoral and extraoral scanners for designing of fixed dental prostheses. Dent Mater J 2017;36:402-7.
14. Chan DC, Chung AK, Haines J, Yau EH, Kuo CC. The accuracy of optical scanning: influence of convergence and die preparation. Oper Dent 2011;36:486-91.
15. Brawek PK, Wolfart S, Endres L, Kirsten A, Reich S. The clinical accuracy of single crowns exclusively fabricated by digital workflow-the comparison of two systems. Clin Oral Investig 2013;17:2119-25.
16. Lee JH. Completely digital approach to fabricating a crown under an existing partial removable dental prosthesis by using an intraoral digital scanner in a single appointment. J Prosthet Dent 2016;115:668-71.
17. Park C, Vang MS, Park SW, Lim HP. Effect of various polishing systems on the surface roughness and phase transformation of zirconia and the durability of the polishing systems. J Prosthet Dent 2017;117:430-7.

Corresponding author:
Dr Michael E. Razzoog
Department of Biological and Material Sciences
Division of Prosthodontics
University of Michigan
1011 N University
Ann Arbor, MI 48109-1078
Email: merim@umich.edu

https://doi.org/10.1016/j.prosdent.2018.09.009