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DENTAL TECHNIQUE

Fully digital workflow for the fabrication of polycarbonate-based resin diagnostic and interim flexible removable partial dentures: A dental technique

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ABSTRACT

This dental technique describes a fully digital workflow for the design and fabrication of interim removable partial dentures (RPDs) using a polycarbonate-based computer-aided design and computer-aided manufacture (CAD-CAM) material with custom-designed prosthetic teeth as an alternative to conventional interim RPDs with unesthetic metal clasps. (J Prosthet Dent 2025;133:1420-1423)

The digital workflow allows the creation of a virtual patient by integrating various digital technologies, enabling enhanced diagnostics, and facilitating treatment planning.[1] Within this workflow, the virtual patient is generated by superimposing the patient's digital data, such as cone beam computed tomography (CBCT), intraoral scans (IOSs) and extraoral scans (EOSs), in a computer-aided design (CAD) software program.[1–4] The goal of the digital workflow for creating a virtual patient in the dental laboratory is to improve diagnostics by providing the dental laboratory technician with as much information as possible to develop, with the dentist, an accurate diagnostic design. This approach reduces the number of clinical evaluations needed to achieve an optimal esthetic result, leading to a shorter treatment time with fewer patient appointments.[1,5]

After diagnostics, the new digital smile design can be milled or 3-dimensionally (3D) printed and presented to the patient as a trial restoration, allowing the visualization of potential improvements in esthetics and function specific to their situation.[6,7] In terms of diagnostics, the digital workflow has been reported to be successful.[1–3] Nevertheless, a method of fabricating computer-aided designed and computer-aided manufactured (CAD-CAM) removable restorations in partially dentate patients is lacking. In these situations, the dental laboratory technician must usually revert to the conventional workflow to fabricate interim RPDs from polymethylmethacrylate (PMMA) with conventional prosthetic teeth and stainless-steel clasps that may not match the initial diagnostic digital design.[8,9]

The main drawback of conventional interim RPDs is when metal clasps are visible. A common alternative is the use of nonmetal clasp dentures (NMCDs), conventionally fabricated using injection-molded thermoplastic denture base resins such as polyamide, polyester, or polycarbonate.[8–11] These provide a more pleasing esthetic outcome and are a suitable solution for patients with metal allergies.[8,10] However, the limitations of NMCDs also include the potential for redness of the mucosa area around the abutment teeth associated with the tendency of the denture to sink into the tissue during mastication, a reduction in retention over time, the occurrence of nonrepairable fractures, and discoloration.[8,12–15]

The present dental technique describes the fabrication of a flexible interim RPD from a polycarbonate-based CAD-CAM material with custom-designed prosthetic teeth by following a full digital workflow for a partially dentate patient for whom removable prostheses were planned.

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TECHNIQUE

1. Make scans of both jaws, including the interocclusal relation with and without the existing RPDs, using an intraoral scanning device (TRIOS 4; 3Shape A/S) according to the manufacturer's protocol. Register the extraoral situation through a face scan (Face Hunter and PlaneFinder; Zirkonzahn) or extraoral photographs (Fig. 1).
2. Design an occlusal device and mill it from a polyurethane-based resin (Try-in III; Zirkonzahn) to facilitate the recording of the maxillomandibular relationship. Adjust the occlusal device by building it up or grinding it down. If adjustments are necessary, scan (TRIOS 4; 3Shape A/S) the occlusal device to enable straightforward transfer to the software program (Fig. 2).
3. Create a virtual patient by matching the face scan or photographs, intraoral scans, and maxillomandibular relationship record using a CAD software program (Zirkonzahn.Software; Zirkonzahn). Design a digital diagnostic waxing and mill trial restorations from a polycarbonate-based material (Temp Premium Flexible A2-B2; Zirkonzahn) (Fig. 3).
4. Fabricate the interim RPD and interim crowns (if necessary) according to the approved diagnostic design. If a tooth presents some divergence, as in this situation, consider splinted interim crowns combined with a precision attachment for the divergent tooth (Temp Premium Flexible A2-B2; Zirkonzahn) (Fig. 4). For the fabrication of the interim RPD, mill the individual designed prosthetic teeth (Temp Premium Flexible A2-B2; Zirkonzahn) and the transparent framework in polycarbonate-based resin (Temp Premium Flexible Transpa; Zirkonzahn). Cement the prosthetic teeth on the framework with a dual-polymerizing luting cement (ESTECEM II PLUS; Tokuyama Dental) (Fig. 5).
5. Deliver the interim restorations and evaluate the situation and the initial condition and consider improvements for the definitive restorations (Fig. 6).

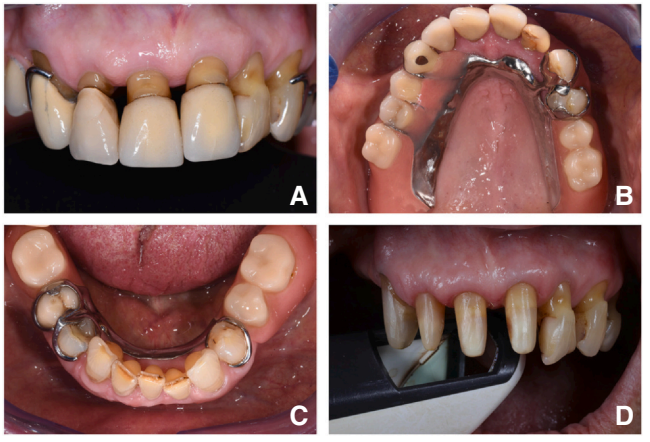

Figure 1. A, Frontal view showing initial intraoral situation. B, Maxillary occlusal view. C, Mandibular occlusal view. D, Maxillary anterior existing crowns removed to facilitate diagnostics, followed by optical scanning.

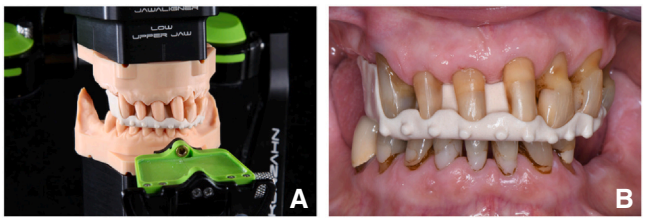

Figure 2. Occlusal device. A, Extraoral view. B, Intraoral view.

DISCUSSION

The present dental technique describes a fully digital workflow to design and manufacture interim CAD-CAM RPDs with transparent clasps and individual prosthetic teeth. This CAD-CAM technique ensures alignment between the diagnostic and interim phases, providing consistency in esthetics, function, and key parameters such as the vertical dimension of a fully digital workflow. From the patient's perspective, satisfaction is significantly enhanced by using custom teeth identical in form and size to those of the trial restorations and by the absence of unesthetic metal clasps. Furthermore, this workflow substantially reduces the laboratory manufacturing time compared with that of a conventional workflow. Another advantage is the digital storage of the RPD design, which facilitates the fabrication of a replacement denture in the event of loss or fracture.

The manufacturing process of an NMCD in a fully digital workflow has been demonstrated in clinical reports by using PMMA, polyamide, or polyester as denture base materials.[16–19] The NMCD materials have been evaluated, highlighting the benefits and limitations that must be considered.[8–15] Manzon et al[8] assessed the performance of polyamide RPDs, reporting improved patient satisfaction because of enhanced esthetic and acceptable functionality, with no fractures observed. However, polyamide RPDs exhibited a reduction in retention within the first year and were associated with mucosal redness around the abutment teeth.[8] Loss of retention, discoloration, and the inability to perform repairs are drawbacks of polyamide RPDs and can be partially attributed to the material's susceptibility to water absorption, which alters the retention areas and impairs RPD functionality.[12–15]

The limitations of the NMCD materials were considered in the design of the current RPD. The interim polycarbonate-based maxillary RPD was designed with

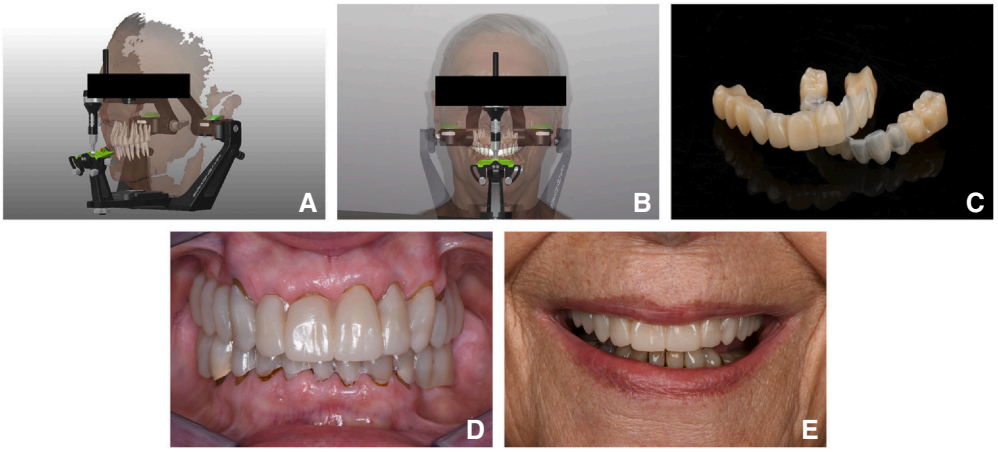

Figure 3. A, B, Three-dimensional virtual patient created by superimposing intraoral and facial digital scans. C, Milled trial restorations. Extraoral view. D, Milled trial restorations. Intraoral view. E, Facial photograph with trial restorations.

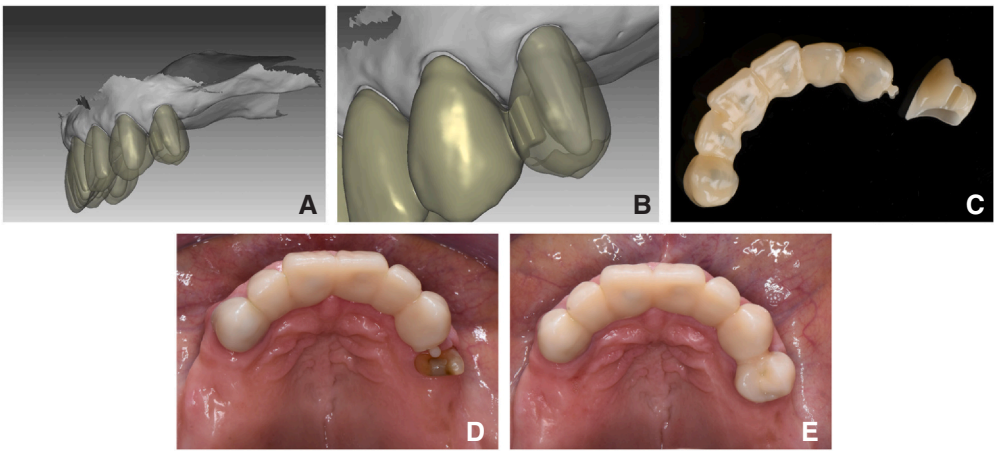

Figure 4. A, Digital design of interim crowns. B, Digital design of precision attachment. C, Interim crowns. D, Splinted maxillary incisor interim crowns. Intraoral view. E, Attached first premolar single crown bonded with resin to precision attachment.

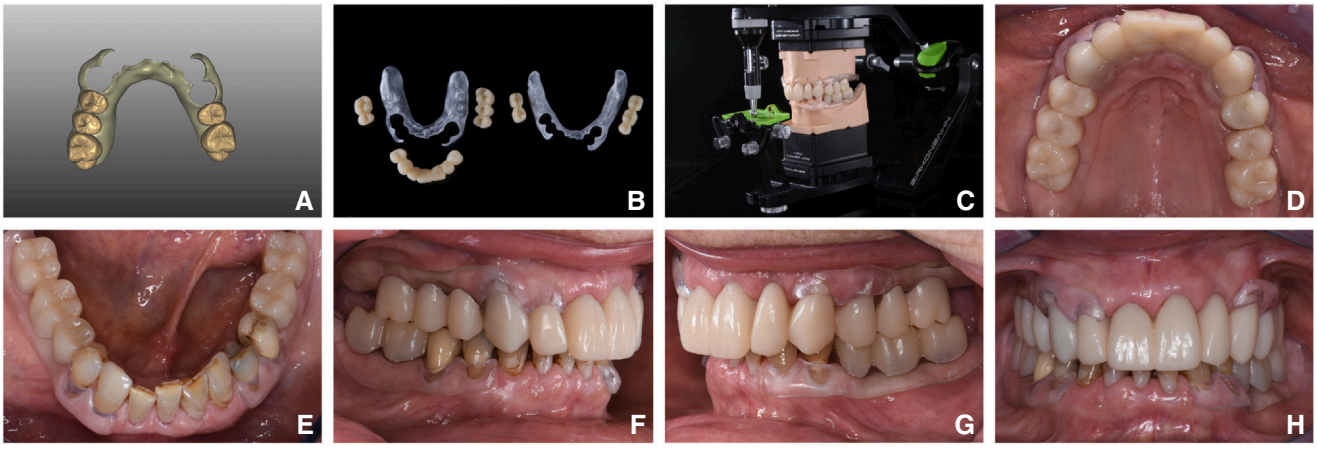

Figure 5. A, Digital maxillary interim RPD design. B, Milled resin framework with transparent clasps and milled custom teeth before cementation. C, Articulated maxillary and mandibular interim prostheses. D, Maxillary interim crowns and interim RPD. Intraoroal view. E, Mandibular interim RPD. Intraoral view. F, Lateral right view. G, Lateral left view. H, Frontal view. RPD, removable partial denture.

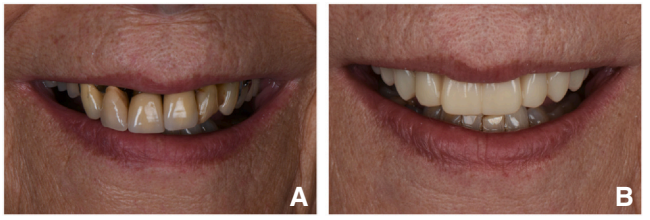

Figure 6. Extraoral images. A, Initial situation. B, With interim prostheses.

palatal coverage and occlusal rests to alleviate mucosal pressure. Retention was enhanced by increasing the size of the clasps and extending them to 2 adjacent teeth, minimizing the risk of fractures. While this design proved effective in the present treatment, fractures remain a risk, particularly in patients with parafunctional habits.

The CAD-CAM material used in this dental technique was a pigment-containing thermoplastic resin with polycarbonate resin as its main ingredient. It has been reported that polycarbonate-based CAD-CAM splint material exhibited greater fracture toughness, high flexural strength, and better dimensional stability associated with low shrinkage, lower water sorption and solubility compared with conventional PMMA under both dry and water storage conditions (30 days at 37 °C).[13,20,21] NMCDs from polycarbonate resin in a digital workflow seem to be a promising alternative to conventional interim RPDs with metal clasps. Nevertheless, in vitro studies are necessary to evaluate the material's properties, and clinical studies are required to validate its performance as a removable prosthesis in partially dentate participants.

SUMMARY

The present dental technique describes the design and fabrication of interim CAD-CAM RPDs with transparent clasps and individualized prosthetic teeth in a digital workflow. This technique provided an alternative solution to conventional interim RPDs with metallic clasps, fulfilling functional and esthetic demands during the interim restoration time while reducing treatment time and costs.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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