THE JOURNAL OF PROSTHETIC DENTISTRY

DENTAL TECHNIQUE

Double-milled CAD-CAM composite resin restorations: A proof-of-concept approach to producing histoanatomic bilaminar restorations

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ABSTRACT

Bilaminar semi-indirect composite resin computer-aided design and computer-aided manufacturing (CAD-CAM) restorations may represent a noninvasive and straightforward alternative to direct composite resin or indirect porcelain veneers. They involve partial reduction (incisoproximal cutback) of a CAD-CAM composite resin restoration, creating a histoanatomic dentin base, which can then be freehand-layered with an enamel-like composite resin. However, advanced knowledge of dental anatomy is required as well as additional skills to shape the enamel layer to the original shape that was milled. This article describes a possible answer to this dilemma. The restoration was kept attached to the block while doing the histoanatomic cutback. After the bonding of a thicker bulk of enamel to the cutback base, the block was machined again by using the same design. The method relies on the optimal combination of the freehand additive approach and the subtractive automated process. (J Prosthet Dent 2020; 124:5-9)

The concept of layering porcelain to display different hues and opacities to mimic the appearance of the natural tooth is well established.[1] Layering techniques were adopted for composite resin restorations only after the advent of light-polymerizing technology and the development of composite resins with different opacities.[2] In the mid-1990s, significant advances were achieved with the introduction of fluorescent and opalescent microhybrid composite resin systems,[3] including the polychromatic technique by Fahl et al[4] and the natural layering approach by Dietschi.[5] In 2011 and 2014, Bazos and Magne[6,7] described the histoanatomic approach to advance the understanding of nature's structural and optical characteristics, revealing previously unreported enamel-dentin relationships.

After the semi-direct (1 clinical session) and semi-indirect (2 clinical sessions) techniques were developed for composite resin posterior restorations,[8-10] the development of composite resin computer-aided design and computer-aided manufacturing (CAD-CAM) blocks in the early 2000s brought new options. The intrinsic properties of composite resin made polymer blocks the ideal match for milling units, allowing thinner designs with better margins and in a shorter time.[11-13] Additionally, better handling properties, including reparability and the availability of blocks with different opacities, allowed customization of a CAD-CAM restoration by cutting back a dentin base and veneering it with a translucent enamel with a freehand application.[14] Such an approach was less invasive and costly than a bonded ceramic restoration.[14] Nevertheless, it still required advanced knowledge of tooth anatomy because the composite resin is applied and finished directly in the mouth.

Obtaining the definitive shape of the outer translucent layer by milling instead of freehand layering would be more convenient, predictable, and less labor intensive. The key step of the proposed approach relies on keeping the restoration attached to the block after milling. After the incisoproximal cutback, enamel material is bonded in excess of the original coronal volume, and the block is repositioned in the milling chamber for a second identical machining (double milling).

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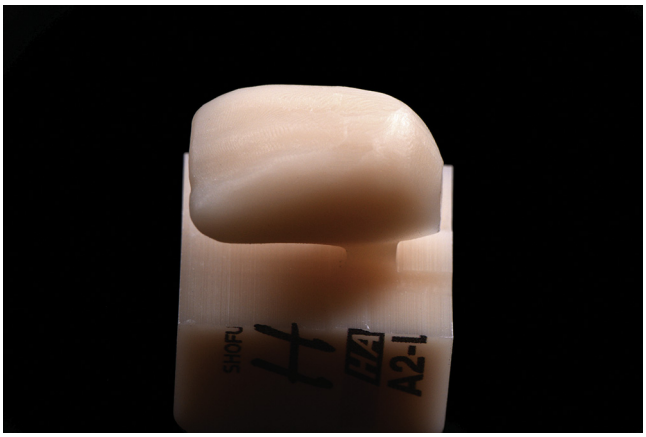

Figure 1. Restoration after first milling (Shofu Block HC A2-LT).

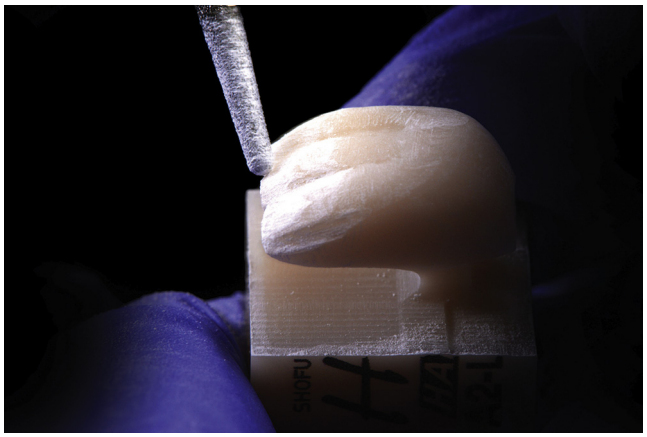

Figure 2. Concave incisoproximal cutback by using round-ended taper diamond rotary instrument. Reduction fades at transition between middle and cervical thirds.

TECHNIQUE

1. Mill the restoration with a low-translucency (LT) composite resin block (Shofu Block HC [Shofu Dental Corp], Lava Ultimate [3M], CERASMART [GC], BRILLIANT Crios [Coltène]), with the sprue located where no cutback is planned (lingual surface for crowns or large restorations and proximal surface for veneers). Interrupt the milling process approximately 90 to 120 seconds before completion so that the sprue will remain thicker. This preserves sufficient rigidity between the restoration and remaining block (Fig. 1).
2. Remove the block and restoration from the milling chamber and then create a continuous concave incisoproximal cutback by using a round-ended taper (850.31.016 FG; Brasseler USA) or rounded diamond rotary instrument (801.31.014 FG; Brasseler USA) at low speed. Extend the reduction vertically to form the dentin mamelons and interlobe depressions (Fig. 2).
3. Roughen the just-modified surface with airborne-particle abrasion (27-μm aluminum oxide at 0.2 MPa, MicroEtcher II; Zest Dental Solutions) and then clean it in an ultrasonic bath with distilled water for 2 minutes (or steam cleaner), followed by silane (Bis-Silane; Bisco) treatment (20 seconds of application time, air-drying for 2 times, and then heat-drying for 1 minute at 100 °C).
4. Perform internal characterization by applying mixed blue and lavender color modifiers (OPTIGLAZE Color [GC] or Kolor+ [Kerr Corp]) in the incisoproximal concavity. Outline the dentin mamelons previously created by the rotary instrument as well as the incisal halo (Fig. 3). Light-polymerize the colorants and wet the remaining modified surface with an adhesive resin (OptiBond FL; Kerr Corp) (Fig. 4).
5. Apply a generous layer of enamel composite resin (Inspiro Skin Shades [Edelweiss], ENA HRi enamel [Micerium], Estelite Omega Body Enamel [Tokuyama]) to cover completely and beyond the modified surface, as well as ensuring noticeable additive volume (Fig. 5). Optionally, the composite resin can be preheated at 68 °C in a warmer (Calset; AdDent) to facilitate placement and improve physical properties. Proceed with uniform light-polymerization for at least 40 seconds. Position the block restoration in a silicone index (previously fabricated from the same block or from an identical intact block), keep building the anterior face of the block with composite resin (Fig. 6A), and then light-polymerize (VALO;

Figure 3. Application of incisoproximal blue and lavender with conical instrument (CompoSculp PFIDD1/2 or fine tip brush size 00), followed by light-polymerization.

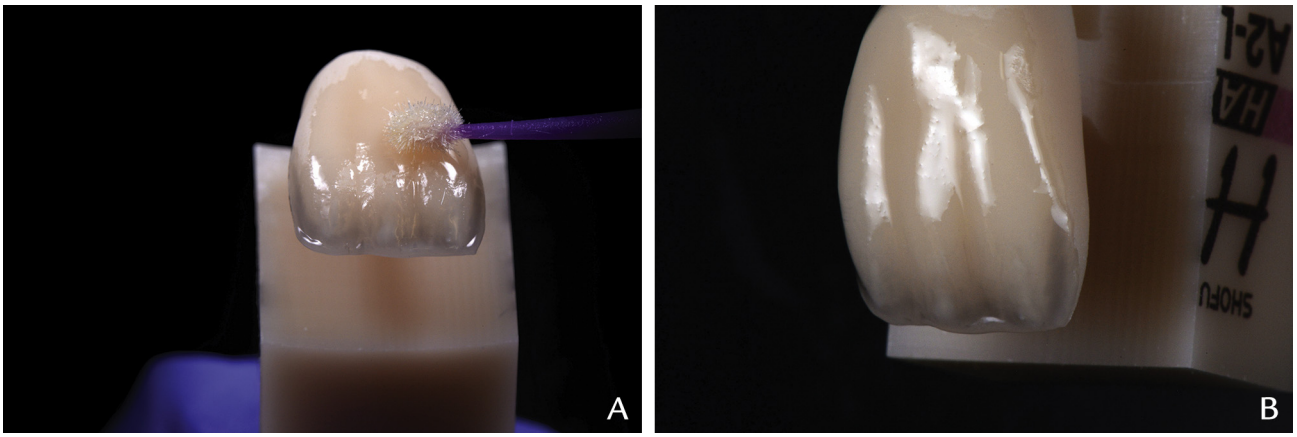

Figure 4. A, B, Wetting with adhesive resin (OptiBond FL). Rest of cutback (no prepolymerization needed).

Ultradent Products, Inc) (Fig. 6B). This step is essential to ensure that the length of the intact block is reproduced so that the milling unit will execute the second milling by using the same coordinates. The composite resin used to reproduce the length of the block does not necessarily need to be the same one used to build the enamel layer (a color that is not used very often or from a batch that is about to expire).

6. Reposition the customized block in the milling chamber and mill the same original proposal (Figs. 7-9).
7. Remove the sprue and polish the restoration according to the instructions of the composite or block manufacturer or personal preference (either dry or wet polishing). Conserve the texture reproduced by the milling (secondary and some of the tertiary anatomy). Alternatively, apply a surface-coating agent (OPTIGLAZE Color Clear/G-Coat Plus; GC) (Fig. 10).

When more than one restoration is fabricated, the same silicone index can be reused for all restorations as long as the length of the blocks in the lot does not deviate more than 0.05 mm from the original block. Digital calipers with 0.01-mm resolution (Mitutoyo 500-196-30; Mitutoyo) can be used to measure the length of the blocks.

DISCUSSION

The possibility of obtaining histoanatomic bilaminar restorations by means of a completely CAD-CAM workflow is the main benefit of the presented technique. No additional materials are needed, except for the silicone material for the index. This could improve the esthetic capabilities of chairside CAD-CAM systems, bringing them close to the level achieved by skilled dental technicians when making layered restorations.

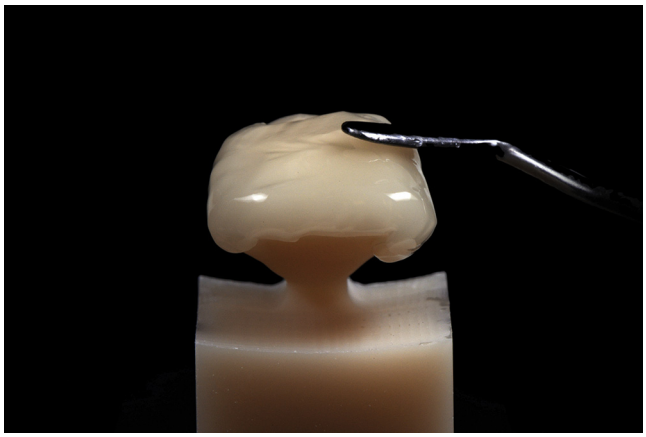

Figure 5. Application of enamel skin (overcontoured and overextended) with higher translucency composite resin.

Furthermore, the technique is applicable to other types of block, including ceramic or polymer-infiltrated ceramic network materials (VITA Enamic; VITA Zahnfabrik). Optionally, the cutback step could be performed digitally in a duplicate file of the original design. A special module in the CAD-CAM software program could also be developed to streamline the process into a single file.

The double-milling technique presented here was developed from a modified use of a CAD-CAM system.[15] A special positioning technique (in the CAD-CAM milling chamber) allowed the fabrication of a biologic CAD-CAM restoration by using an extracted tooth. However, in a comparable approach focused on the dental laboratory environment, Schweiger et al[16] produced a ceramic "dentin" core from a dental database which was veneered manually with an incisal ceramic layer and then placed back by using a repositioning device for a second subtractive process. Molina et al[17] produced bilaminar assemblies by bonding to milled restorations (dentin-like core and enamel veneer).

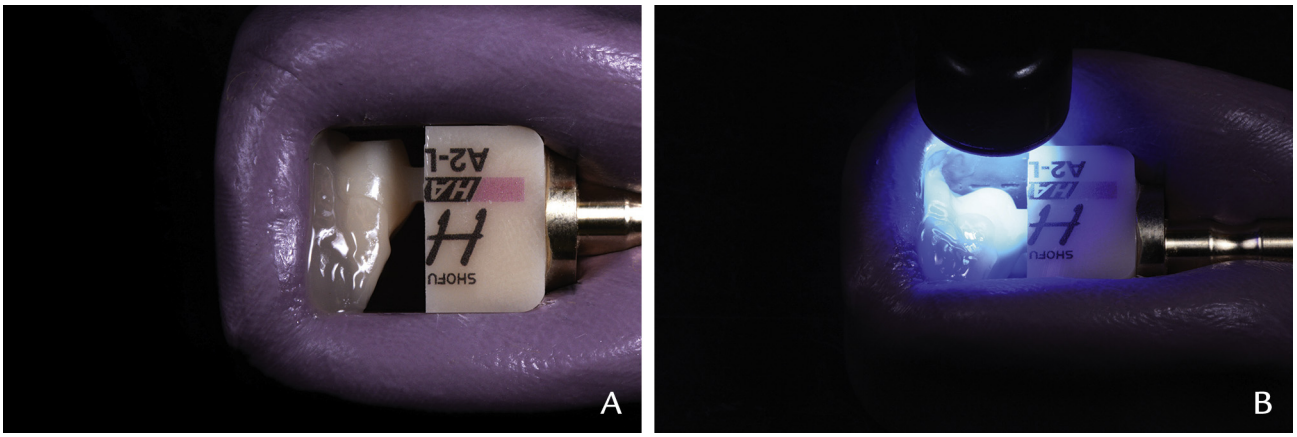

Figure 6. A, Block restoration inserted in silicone index. B, Gap with anterior face of block filled with composite resin to recover original length and then light-polymerized.

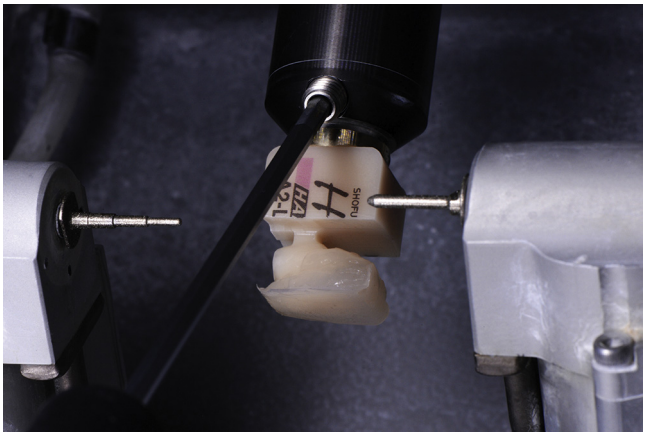

Figure 7. Insertion of customized block.

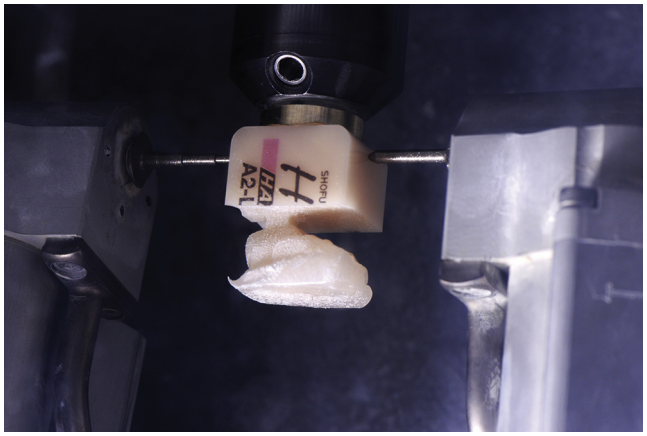

Figure 8. Block measurements before second milling.

When compared with the traditional fully anatomic polished and glazed CAD-CAM restorations, the technique introduced here presents some challenges. The first milling process must be interrupted manually before the sprue is completed. The software program does not allow to automatically stop the milling at a specific time. The interruption requires an operator to stay nearby or to be alerted by a timing device. The success of the restoration also relies on proper adhesion between the modified dentin base and the enamel-like composite resin veneer. To achieve adequate bond strength for clinical service, airborne-particle abrasion is essential, and a silane[18] or resin primer (Scotchbond Universal [3M], One coat 7 Universal [Coltène]) should be applied.[19,20]

Indications of the technique include no or minimum preparation designs for anterior teeth (situations that could be resolved with either direct composite resins or indirect restorations), including restorative treatment for eroded dentition, traumatic dental injuries, diastema closure, and smile redesign. The indications could be expanded to crowns (traditional and implant-supported), provided that the appropriate composite resin material is chosen.

Figure 9. Restoration after second milling. Observe natural incisal effects.

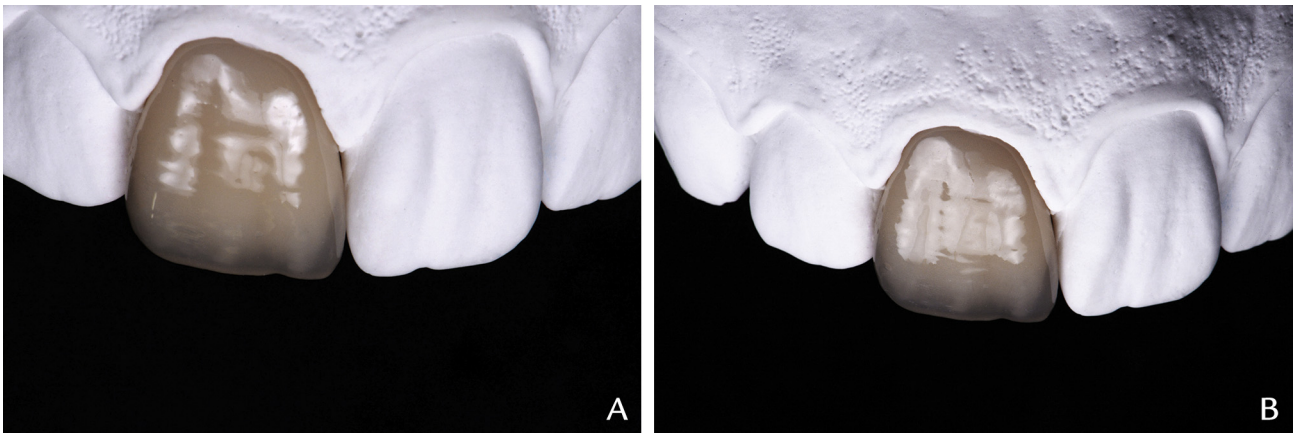

Figure 10. A, Restoration after glazing. B, Topographic elements seen.

SUMMARY

A restoration is milled with a low-translucency composite resin block. The milling process is interrupted just before the sprue is fully completed. Without breaking the sprue, a concave incisoproximal reduction creates a histo-anatomic dentin base, which is then colored and layered in excess with an enamel-like composite resin. The original length of the block is recovered with the assistance of a silicone index so that the second milling is made exactly in the same position. The technique relies on the simplified customization of the block, combining the advantages of histoanatomic natural layering with the power of CAD-CAM automation.

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https://doi.org/10.1016/j.prosdent.2019.09.006