Unique CAD/CAM three-quarter crown restoration of a central incisor: a case report

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Computer-aided design and computer-aided manufacturing (CAD/CAM) dentistry has been in use for more than 2 decades. Recent improvements in this technology have made CAD/CAM restorations a viable alternative for routine dental care. This technology is being taught in dental schools to prepare students for contemporary dental practice and is particularly useful in unique restorative situations that allow conservation of tooth structure. This case report describes the restoration of a central incisor that was previously restored with an unesthetic three-quarter gold crown. The tooth exhibited recurrent caries and an unaffected labial wall of supported enamel. A CAD/CAM three-quarter crown was planned to conserve tooth structure. After preparation, the tooth was scanned for a CAD/CAM crown in order to fabricate a ceramic restoration, which was then milled and bonded, producing an esthetic result. Typically, in cases of esthetic enhancement, a labial laminate restoration is fabricated, but in this situation, a different approach was necessary to make a design for the lingual surface of an anterior tooth.

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Computer-aided design/computer-aided manufacturing (CAD/CAM) dentistry has made tremendous inroads in the way dentists can now conceptualize restorations. Dentists should consider these technologies in their practices, especially since the number of dental technicians is significantly decreasing.

CAD/CAM restorations were first introduced over 2 decades ago, but their accuracy did not meet the standards of cast restorations. As the technology evolved, digital scanning and designing became more refined, which resulted in more accurate marginal adaptation. CAD/CAM has now been developed to the point that dental schools are introducing this technology in their curriculum. This paper presents a case report of the replacement of an anterior defective gold three-quarter crown with a conservative, uniquely designed CAD/CAM restoration in a dental school environment. This was accomplished using a CAD/CAM system with in-office milling capabilities.

Case report

A 64-year-old male presented to the predoctoral clinic at the Nova Southeastern University, College of Dental Medicine, Florida, with the chief complaint of wanting to replace the gold filling on his front tooth with a “tooth-colored” one. Clinical examination revealed tooth No. 8 was restored with a three-quarter gold crown and had recurrent caries on the lingual, mesial, and distal surfaces (Fig. 1 and 2). The facial surface of the tooth had gingival recession and a shallow, noncarious abfraction lesion. The periodontal health of the patient included a past history of recession and moderate periodontitis with nonbleeding sulcular depths of 2-3 mm (Fig. 3 and 4).

The patient’s occlusion was evaluated and presented with an Angle’s Class I canine and molar relationship on the right side, and a Class I canine relationship on the left side. There was 0.5 mm of overbite and 2 mm of overjet. The patient had a tendency to posture his mandible forward during the initial examination. The patient presented with generalized moderate wear and reported no parafunctional habits. There was no muscle tenderness upon palpation, nor was there any clicking or popping of the temporomandibular joints.

Fig. 1. Preoperative frontal view of tooth No. 8.
Fig. 2. Preoperative maxillary occlusal view of tooth No. 8.
Following periodontal therapy and re-evaluation, the restoration was removed. Caries was excavated and the remaining tooth was assessed to determine the most conservative and esthetic restoration that would preserve as much tooth structure as possible. Treating the tooth with a full crown would require removing the labial enamel, leaving only minimal dentin. The decision was made to use a bonded monolithic ceramic CAD/CAM three-quarter crown restoration on tooth No. 8 in order to preserve the labial enamel and remove as little tooth structure as possible.

The tooth was prepared for a lingual three-quarter crown with internally rounded shoulder margins and a flat incisal edge, following the CAD/CAM design protocol (Fig. 5). The preparation design included an internally rounded 1.2 mm lingual shoulder, mesial, and distal grooves to improve resistance and retention, a lingual reduction of 1.5 mm, and an incisal reduction of 2 mm. Diamond burs were used for the tooth preparation (Two Striper Brand Burs Diamond Bur Kit, Premier Products Co.).

A polyvinyl siloxane impression (Aquasil, DENTSPLY International) was made of the maxillary arch in a custom tray (Triad, DENTSPLY International). An alginate impression (Kromafaze, Dux Dental) was made of the mandibular arch in a stock tray (RimLock, DENTSPLY International). The impressions were poured with Type IV dental stone (Resin Rock, Whip Mix Corporation). A provisional restoration was fabricated for the patient utilizing a urethane dimethacrylate provisional material (Revotek, GC America, Inc.), and provisionally cemented (Temrex, Temrex Corp.).

The master cast for tooth No. 8 (Fig. 6) was powdered (CEREC, Optispray, Sirona Dental Systems, Inc.), and scanned using the CEREC Acquisition System (Sirona Dental Systems, Inc.). However, because the existing 3.85 CEREC Biogenic software (Sirona Dental Systems, Inc.) at the time of this study defaulted to a design of a labial veneer, this CAD/CAM restoration for a lingual veneer could not initially be designed (the latest 4.0 CEREC Biogenic software can now produce the lingual veneer design).

In order to obtain the correct lingual veneer three-quarter crown design for the restoration in this study, the CAD/CAM manufacturer’s correlation mode procedure was chosen. As such, there was no need for an interocclusal record or impression of the opposing arch since the lingual contour of the contralateral tooth is used as a template for the occlusion and anterior guidance, without consideration of the opposing arch.18

The digitized information was sent to the dental school’s CEREC inLab milling machine (Sirona Dental Systems, Inc.) and the restoration was made utilizing Sirona CEREC VitaBlocs’ Vita CE0124 28150 (VITA Zahnfabrik). The final milled restoration was seated...
on the cast to ensure accuracy of fit and contour. Following a slight adjustment, the restoration was glazed (Vita Vacumat 30, VITA Zahnfabrik) with Empress Universal Glaze (Ivoclar Vivadent, Inc.).

After approval of the color try-in paste (Variolink II, Ivoclar Vivadent, Inc.), a yellow shade resin cement was selected and used under rubber dam isolation. The restoration was etched with 10% hydrofluoric acid for 60 seconds and thoroughly rinsed and dried with oil-free air. The restoration was silinated (Monobond Plus, Ivoclar Vivadent, Inc.) for 1 minute. The preparation was etched and scrubbed with 37.5% phosphoric acid for 15 seconds, then rinsed with copious water spray, and lightly air-dried. Bonding agent (Excite F DSC, Ivoclar Vivadent, Inc.) was applied to the tooth with gentle agitation for 10 seconds. The tooth was air dried for 3 seconds and the bonding agent cured for 20 seconds (Bluephase, Ivoclar Vivadent, Inc.).

The adhesive luting material (Variolink II, Ivoclar Vivadent, Inc.) was applied without catalyst to the intaglio surface of the restoration. The restoration was seated with firm pressure, allowing the excess resin luting cement to extrude. The curing light was waved over the restoration initially for 3 seconds and then the excess luting material was removed with an explorer and dental floss. Glycerin oxygen inhibitor gel (Liquid Strip, Ivoclar Vivadent, Inc.) was applied over the margins of the restoration to allow the complete setting of the luting cement. The margins were then completely cured for 40 seconds on each surface of the tooth.

After final curing, the margins were re-evaluated with an explorer and floss to ensure that no luting agent remained. Interocclusal contacts were marked with fine articulating paper (Accufilm I, Parkell, Inc.) and minor final adjustments were made intraorally. The margins and occlusal surface of the restoration were polished with finishing burs and polishers (Dialite, Brasseler USA; Sof-Lex Discs, 3M ESPE). A periapical radiograph was taken to confirm complete cement removal (Fig. 7). The patient accepted the final restoration as blending well with his natural dentition (Fig. 8-10). Figure 11 shows the restoration continuing to be functional and esthetic at a 2-year follow-up.

Discussion
Conventional treatment planning in this case could have included a full metal-ceramic or all-ceramic restoration to replace the existing gold three-quarter crown after the removal of the recurrent caries in tooth No. 8. Examination of the patient revealed an intact facial enamel wall with recession and a gingival abfractive defect. Performing a full crown preparation on this tooth would have been very destructive, potentially requiring endodontic therapy,
and possibly leading to an unesthetic result. Currently, a paradigm shift of bonding with resin cements in the dental industry is guiding more dentists toward the use of conservative preparation designs. In this case, the manufacturer’s correlation mode instructions were used to direct the CEREC software to design a lingual veneer with resin cements in the dental industry.

This restoration was completed in order to preserve tooth structure, to maintain the natural enamel on the facial surface of the tooth, and to avoid a margin placed on cementum or dentin for an acceptable esthetic result. It was believed that this could be easily accomplished with a CAD/CAM restoration with a CEREC Vita Block to have a monolithic restoration with acceptable strength. The restoration was bonded to the tooth structure, and at a recall visit, the restoration was found to be in place successfully after 2 years, without debonding, chipping, or fracture.

The combination of the anterior tooth location, a difficult shade match, and the potential for a cement line close to the incisal edge posed challenges to obtaining an esthetic result. The patient was willing to accept a possible esthetic compromise, knowing the restoration was conservative and that tooth structure would be saved. The three-quarter crown was tested with a provisional restoration for 2 weeks to ensure that the restoration design would be successful, and it was maintained by the patient without dislodging or fracturing. The restoration was fabricated expeditiously with minimal expense in a dental school environment with a CEREC inLab system. At the 1- and 2-year follow-up evaluations, the patient demonstrated a more retruded mandibular position (Fig. 12).

CAD/CAM dentistry may be utilized to fabricate restorations that are durable and esthetically pleasing with superior fracture strength and excellent marginal adaptation. In the predoctoral dental clinic, time does not allow for preparation, scanning, designing, milling, and bonding in one appointment. Consequently, a cast is made from a traditional PVS impression in a custom tray. The student assists the faculty in the digital scanning of the cast along with the designing and milling of the restoration. This restoration is evaluated for marginal integrity, proper contours, and excellent occlusal and proximal contacts prior to bonding. The discussion between the student and faculty contributes to the educational process in understanding the laboratory aspect. Certainly, in a private dental office, an experienced practitioner could scan, design, mill, and bond the restoration in a single office visit.

Dental practitioners and dental school educators must evaluate their philosophy of restorative dentistry and consider CAD/CAM technology for the conservation of tooth structure and more bonding of select indirect restorations. The use of this technology aids the dentist in obtaining an accurate, esthetic and acceptable restoration, which is accomplished expeditiously and economically, utilizing cutting edge digital protocols.

Conclusion
This case report presents the replacement of an anterior three-quarter gold crown with a conservative, esthetic, CAD/CAM ceramic restoration in a dental school environment. A 2-year follow-up verified that the three-quarter restoration was functional and more esthetic than the patient’s original three-quarter gold crown. This unique case report is one example of a CAD/CAM bonded restoration that was creatively planned and designed to allow for the conservation of tooth structure and to support the philosophy of minimally invasive dentistry.

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