Chairside CAD/CAM Composite Onlays for the Restoration Of Primary Molars

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After pulp therapy or with multi-surface caries in primary molars, pre-formed stainless steel crowns are usually placed to ensure tooth longevity. Esthetic alternatives, such as zirconia crowns, have been proposed, but they are invasive. Here we describe two cases of chairside computer-aided design and computer-aided manufacturing (CAD/CAM) technology used to treat extended and/or deep caries on primary molars. A powder-free chairside CAD/CAM system, a milling unit and machinable high-performance composite blocks were used. The tooth preparation consisted of preparing the cavity without undercut, to have supra-gingival margins whenever possible, occlusal reduction of thin walls, and proximal box finishing by ultrasonic tips. After the optical impression, the virtual onlay was designed and adapted (from the morphology of a first permanent molar), then chairside-manufactured out of a composite block and bonded by using a self-adhesive resin cement. This technique combines minimally invasive treatment; high strength, biocompatible and aesthetic material; no gingival trauma; easy execution; and patient and parent satisfaction. However, the equipment is quite expensive and the software still does not include the morphology of primary teeth.

Key words: *CAD/CAM, composite block, primary tooth, deep caries.*

INTRODUCTION

After pulp therapy or in the case of multi-surface caries in primary molars, a preformed stainless steel crown (SSC) is usually placed to ensure tooth longevity[1]. This is a simple and reliable restorative treatment because its implementation is rapid, but it involves invasive tooth preparation and an unsightly result[2]. Several alternative treatments have been proposed[3]. Polycarbonate molds are aesthetic, easily adaptable and retentive and require little chairside time; however, they may break, dislodge or discolor with time[4]. Composite build-up by using celluloid molds, also called "strip crowns" are aesthetic and easy to repair if necessary, but this is a highly sensitive technique in that saliva/blood contamination may alter their color and/or the bond; they also may chip or fracture, have poor durability and may cause gingival inflammation[5]. Preformed SSCs with a resin window, also called "open-faced SSCs" are more aesthetic than SSCs and retentive but appear slightly grey (because of metal visibility through the composite), composite placement is time-consuming and difficult to perform in case of moisture/bleeding, and this facing may break[6]. Pre-formed SSCs with a tooth-colored coating resin (on their facial surface), also called "pre-veneered SSCs" are aesthetic, retentive and relatively rapid to place; however, as compared with SSCs, they are more difficult to adapt, the resin veneer may be fractured, and they require long chairside time[6,7]. Finally, pre-formed zirconia crowns are aesthetic, retentive, biocompatible and rapid to place, but they cannot be crimped, require an invasive preparation, cause a slight abrasion of the opposing teeth and can fracture during placement[5].

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Thus, all these full coverage restorations are relatively aesthetic, but they are more or less invasive and some are fragile.

The current trend is toward minimally invasive dentistry. This modern medical approach relies on conservative caries removal methods with minimal cavity design[8]. These methods are possible with adhesive restorative materials that do not require mechanical retention features and partial coverage restorations instead of full contour restorations[8,9]. Moreover, the importance of physical appearance these days has led to greater aesthetic expectations by parents, with increased demand for tooth-colored pediatric dental restoration[10]. Children are also conscious of their dental aesthetic appearance[11]. Therefore, such contemporary concepts — tooth structure preservation and biomimetics — could be applied to primary teeth, even if the lifetime in the arch is limited.

Over the past 25 years, computer-aided design (CAD) and computer-aided manufacturing (CAM) (CAD/CAM) have become an increasingly popular part of dentistry. This technology allows for fabricating posterior restorations with sufficient strength and natural appearance by an easier, faster and more accurate implementation process[12]. Machinable high-strength composite blocks are polymerized under optimized pressure and temperature parameters, which improves mechanical properties as compared with direct restoration composites[13]. As well, intraoral scanners have become increasingly smaller, powder-free (a contrast powder was required for older intraoral scanners and sprayed on the tooth surfaces to eliminate reflections when taking an optical impression) and with faster data acquisition, which could allow for their use in children[12].

Here we describe two cases of chairside computer-aided design and computer-aided manufacturing (CAD/CAM) technology used to treat extended and/or deep caries on primary molars.

CASE PRESENTATIONS

Case 1

A seven-year-old girl had a deep carious lesion on her primary lower left first molar that had required pulpotomy, which resulted in a disto-occlusal cavity. An SSC was placed on the primary lower right first molar. The patient's mother was not satisfied with the SSC and reported that her child was mocked by her classmates. A chairside CAD/CAM composite onlay was suggested to restore the left first molar.

The tooth was prepared with supra-gingival margins (whenever possible) according to the following criteria (fig. 1a): cavity preparation (bur kit for inlays and onlays, Komet, Paris, France) without undercuts to facilitate the optical impression and to allow for the insertion/removal of the restoration; occlusal reduction of thin walls (the disto-lingual wall in this case) to reach a minimal thickness of two millimeters (mm), providing an adequate thickness for the composite; finishing of the proximal box with a one-side diamond-coated ultrasonic tip (Sonicflex® no. 35, KaVo Dental, Charlotte, NC, USA) to prevent damage to the adjacent tooth. The type of restoration (single restoration, inlay/onlay) was selected by using the CAD/CAM software. Then, a powder-free intraoral scanner (Cerec® AC Omnicam, Sirona, Bensheim, Germany) was used to obtain optical impressions of the prepared area (fig. 1b), the antagonist (fig. 1c) and occlusion (fig. 1d). The margins were delineated on the virtual model. The latter could be rotated for critical inspection of all margins in an occlusal view (fig. 2a), then more specifically the lingual margin in a lingual view (fig. 2b). The software calculated a restoration proposal, then the virtual restoration (fig. 2c) was chairside-manufactured from a high-performance composite block (Lava Ultimate, 3M-ESPE, St. Paul, MN, USA) (fig. 2d) in

Figure 1: (a) Tooth preparation: no undercuts, occlusal reduction of the disto-lingual thin wall and finishing of proximal box with an ultrasonic tip. (b) Virtual model of the prepared tooth. (c) Virtual model of the antagonist. (d) Virtual occlusion.

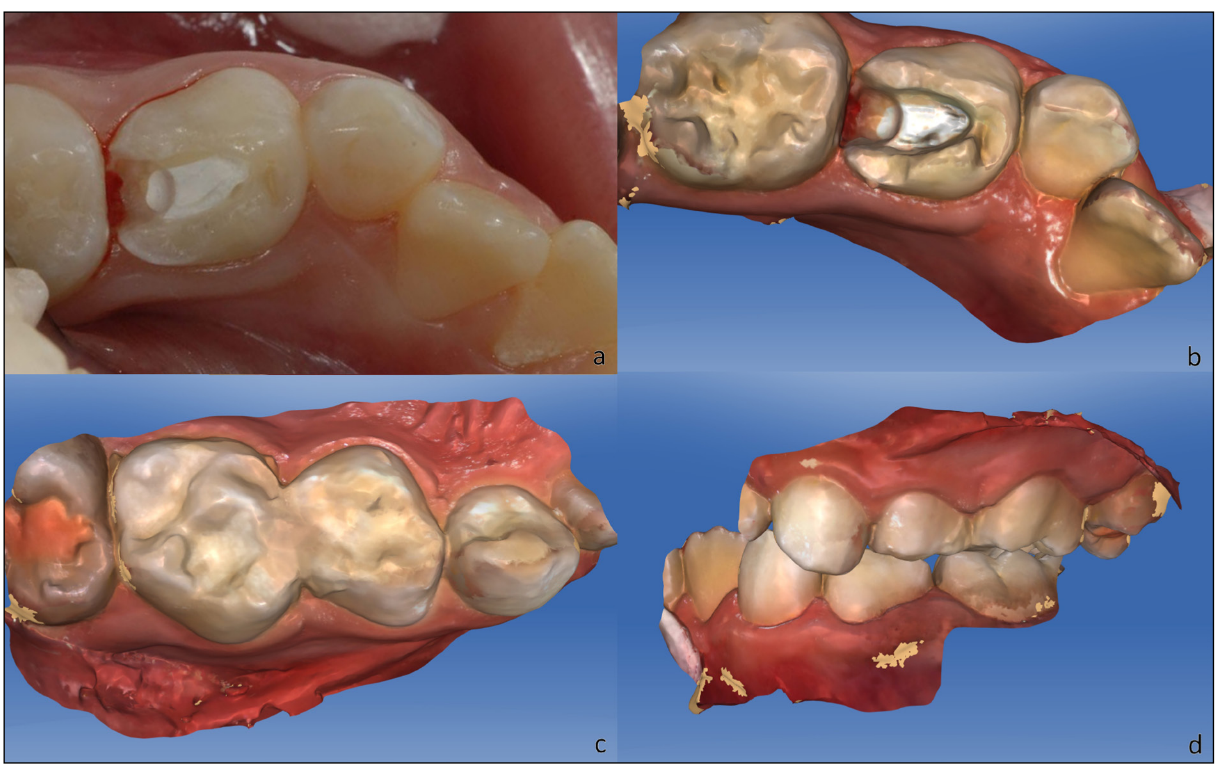
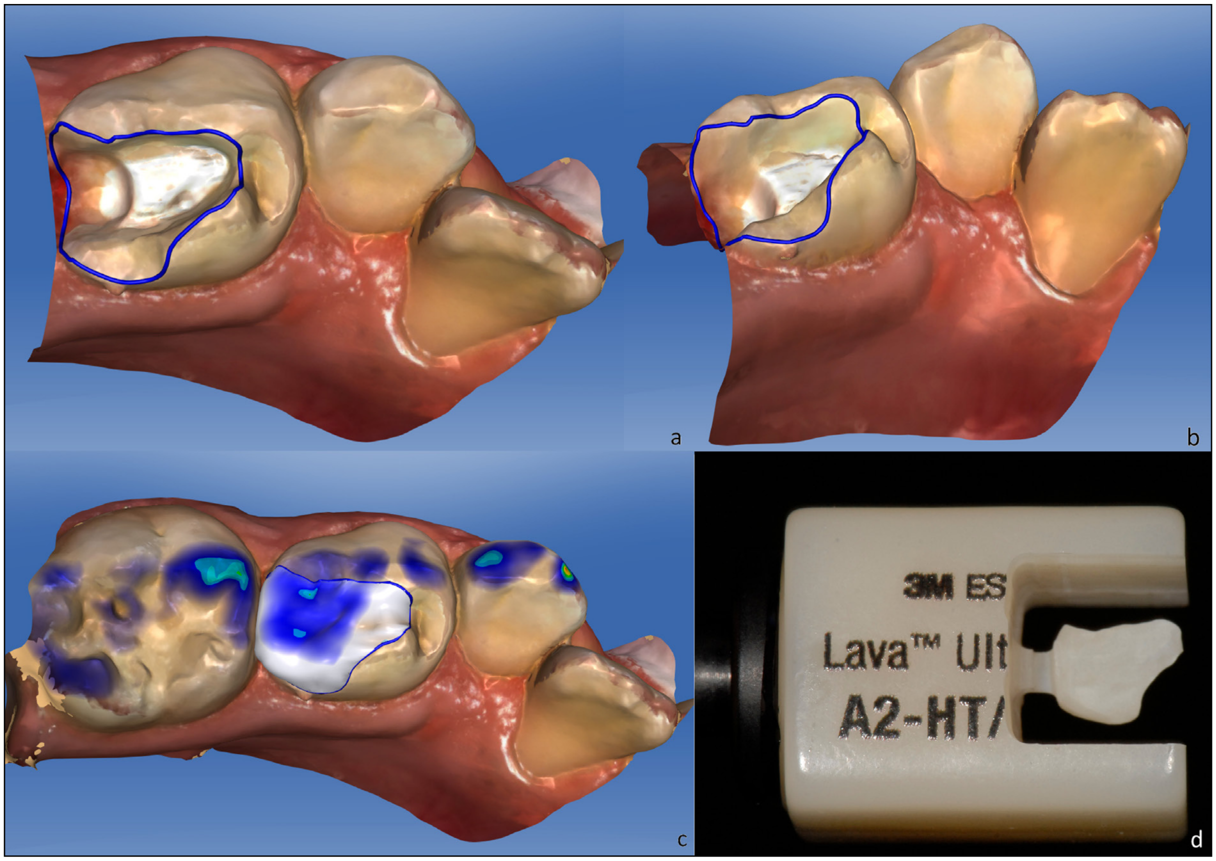


Figure 2: (a) Delineation of margins on the virtual model in an occlusal view. (b) The delineation of margins in a lingual view. (c) Virtual design of the onlay with the virtual occlusal contacts (in blue). (d) The onlay manufactured out of a high-performance composite block.



a milling unit (MC XL®, Sirona, Bensheim, Germany). The milled onlay was separated from the block, and the sprue remaining from the milling process was manually removed. The onlay was tried-in: its seating was verified, and the margins, proximal and occlusal contact points were carefully checked. After the adjustments, the onlay was polished with use of a diamond polishing system (Optrafine®, IvoclarVivadent, Schaan, Liechtenstein). The inner surface was sandblasted with 50-µm aluminum oxide powder, and a thin layer of high-performance composite primer (G-MultiPrimer, GC Corp., Tokyo) was applied. For easier handling, a microbrush tip was temporarily bonded to the occlusal surface of the onlay by using a drop of flowable composite resin (fig. 3a). Rubber dam isolation was not mandatory, but moisture control was needed. A device with a cotton roll holder (Automaton®, MEBA, Denkingen, Germany) was used (fig. 3b). The onlay was bonded with self-adhesive resin cement (RelyX Unicem, 3M-ESPE, St. Paul, MN, USA). Pressure was applied to the restoration during photo-polymerization. A short insolation hardened the excess luting material and allowed for its easy removal by using a scaler (mini Crane Kaplan, CK6, Hu-Friedy, Frankfurt am Main, Germany). Each surface of the restoration was then light-cured for at least 20s. Occlusal contacts were checked and margins were finished by using diamond polishing instruments (OptraFine, IvoclarVivadent, Schaan, Liechtenstein) and polishing discs (Sof-Lex™, 3M-ESPE, St. Paul, MN, USA). The restoration was barely visible (fig. 3c) and the radiographs showed its good adaptation (fig. 3d). The young girl and her mother were very satisfied with the outcome.

At two-year follow-up, the restoration showed good integration over time, good adaptation and no composite defects (fig. 3e). Radiographs revealed physiological root resorption (fig. 3f), thereby highlighting the long-lasting nature of CAD/CAM restorations.

Case 2

A seven-year-old girl had a deep carious lesion on her primary maxillary right first molar that had required pulpotomy, thereby resulting in a mesio-occluso-distal cavity. The tooth was prepared with supra-gingival margins and partial sub-gingival margins (at the proximal boxes) according to the criteria described for case one. The thin buccal wall was reduced to two mm thick (fig. 4a). Then, the same steps as in case one for optimal impressions, margin delineation (fig. 4b), restoration design (fig. 4c) and milling were performed. The milled onlay was tried-in, bonded and polished. The final restoration was slightly visible (fig. 4d). The choice of a low-translucency material may have improved the aesthetic outcome.

At eight months' follow-up, the restoration was still well integrated (fig. 4e).

Figure 3: (a) Microbrush tip temporarily bonded to the occlusal surface for easier handling. (b) Isolation for the bonding procedure. (c) Final view of the bonded onlay. (d) Radiograph of the bonded onlay. (e) Occlusal view at 2 years' follow-up. (f) Radiograph at 2 years' follow-up.

DISCUSSION

To our knowledge, these case reports are the first to describe chairside CAD/CAM-manufactured composite onlays used to treat moderate to severe loss of primary molar structures. CAD/CAM technology has never been used for primary teeth. Bilgin *et al.* perfrmed a CAD/CAM-manufactured PICN endocrown for a primary molar but did not use an intraoral scanning device[14]. Demirel *et al* described the clinical use of a resin nanoceramic CAD/CAM restoration for a primary second molar without a successor[15]. A few studies showed that indirect resin composite onlays could be an acceptable esthetic alternative to SSCs[16-19]. The proposed restorative technique we used in these cases has the following numerous benefits and some limitations.

Partial restoration allows for minimizing the loss of tooth structure as compared with other therapeutics that require peripheral preparation[20]. Furthermore, after pulp therapy, retention is increased with the use of pulp chamber volume. In contrast to pre-formed crowns, CAD/CAM-made onlays fit the tooth preparation perfectly. Thus, the bonding material layer is thinner, thereby also increasing the luting quality[21].

The marginal gingival tissues are inevitably injured during the try-in of pre-formed crowns or pre-fabricated molds[22]. Moreover, the management of their subgingival margins is not easy and mostly cervical adaptation is inaccurate, which causes a deterioration of oral hygiene and periodontal health[23].

CAD/CAM-made composites are milled out of highly polymerized materials. The monomer release is almost nil[24]. Hence, these high-performance composites are more biocompatible than stainless steel (NiCr) crowns[25]. CAD/CAM composites are also more fatigue-resistant than ceramic crowns and cause less abrasion of teeth in the opposing arch[26,27].

The main problem with pre-formed SSCs is their unaesthetic aspect, which has led to the development of numerous other therapeutic options[3]. However, esthetics are not fully satisfactory for veneer crowns[6]; mechanical properties are insufficient for strip crowns[5]; and tissue preservation is strongly affected with esthetic zirconia crowns[5]. The CAD/CAM-made onlays are esthetic, minimally invasive and mechanically strong[26].

The suggested design of tooth preparation is accessible without requiring any specific training for pediatric dentists. It reduces the implementation time, which is a significant feature in treating young patients. However, the morphology of primary teeth is not included in the current software database. Practitioners must adapt the "biogeneric" shape of the restoration, which was calculated by the software, by using in our case the morphology of the first permanent molar. As well, using a chairside CAD/CAM system allows for creating the restoration in a single session.

With the moisture tolerance of self-adhesive resin cements, a rubber dam is not necessary for the bonding procedure[28]. Finally, these resin cements require only one step, without prior application of etchant and/or bonding agents.

The digital impression requires only a few minutes. It can even be stopped when the child is less cooperative, without having to start it all over again. The child can watch the design and milling process, so the treatment can be perceived as a video game, which increases its acceptance. Parents are also extremely pleased with this innovative treatment. The preparation, digital impression and bonding are rapid

Figure 4: (a) Tooth preparation. (b) Delineation of margins on the virtual model. (c) Virtual design of the onlay. (d) Occlusal view after bonding. (e) Occlusal view at 8 months' follow-up.

to execute, but the milling process takes about ten minutes. Nevertheless, the working time in the mouth is not increased. With the introduction of CAD/CAM in pediatric dentistry, smaller composite blocks for primary teeth could be marketed, thereby reducing the time for milling.

The complete equipment (digital impression system, 3D dental design software and chairside mill) has a high investing cost[4,15]. Maintenance fees and training time costs are added. The system is a large investment, especially for small dental offices. Continual development of digital dentistry may lead to reduced cost of CAD/CAM devices.

CONCLUSION

Our case reports show that chairside CAD/CAM dentistry can be used to restore extended and/or deep caries in primary teeth. This technique combines minimally invasive treatment; high strength, biocompatible and aesthetic material; no gingival trauma; a single session; and patient and parent satisfaction. However, the equipment is expensive and the software database does not yet include the morphology of primary teeth.

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