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Case Report

Digital and Conventional Workflow for Endocrown Fabrication in Pulpotomy Permanent Tooth: Case Report

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Abstract

A higher chance of carrying out a successful full pulpotomy is dependent on the coronal restoration. Preservation of healthy dental structure is essential for providing mechanical stabilization of tooth-restoration integrity and increasing the number of suitable surfaces for adhesion. In this case, endocrown was a suitable restoration due to large coronal destruction. However, the preparation design and material selection affect the manufacturing technique. As shown in this case, the CAD/CAM technique demonstrated technical errors such as marginal chipping and overmilling, for these reasons changing to conventional technique for lithium disilicate endocrown fabrication was adopted. After one week of permanent cementation, the restoration was in good condition and abutment was normal with good gingival health.

Keywords: CAD/CAM, endocrown, lithium disilicate ceramic, pulpotomy, resin nano-ceramic

Introduction

Full pulpotomy in permanent teeth aims to retain pulp vitality and relieve pain from acute pulpitis. Pulpotomy is an alternative treatment for vital pulp therapy and root canal treatment to preserve pulp tissue and retain tooth vitality for the long term.[1,2] The success rate of full pulpotomy procedures varies from 82.9% to 100% depending on the type coronal restoration.[3]

For deep carious lesions or teeth with large cavities, indirectly bonded restoration is more suitable than direct restoration.[4] Teeth that are indirectly restored with resin composite or ceramic have better fracture resistance and marginal integrity, reduced cervical marginal microleakage, less surface roughness, less postoperative sensitivity, and minimal soft-tissue irritation than those directly restored with resin composite.[4] Overall, indirect restorations have a lower annual mean failure rate than direct restorations in posterior teeth.[5]

Endocrown restorations have been reported as a promising treatment to rehabilitate extensively damaged endodontically treated teeth.[6,7] The endocrown can be defined as a single piece restoration which contains an extension to the pulp chamber that replaces part of the crown. The macro retention provided by the pulp chamber axial walls associated with the adhesive luting cement makes the endocrown restoration suitable for teeth with short and/or curved roots when the endodontic post cannot be used or when a more conservative approach is planned.[8]

Endocrowns are commonly fabricated using ceramic based on leucite, lithium disilicate, and zirconia ceramics. Even though ceramics show excellent mechanical properties, they are prone to non-repairable fractures extending to the root, owing to their brittle characteristics. In consequence, alternative materials with a more compliant behavior have been introduced for endocrown fabrication, such as resin composites and polymer-infiltrated ceramics as they exhibit higher resilience and more resistance to higher occlusal forces.[9]

However, the endocrown treatment is contraindicated for substrates with insufficient adhesion, or pulp chambers with less than 3 mm deep or cervical margins less than 2.0 mm wide for most of its finishing line.[6]

Case report

A 16-year-old female was referred to the Department of Restorative Dentistry with a chief complaint of large filling and tooth chipping at the lower left region. The medical history was noncontributory. Clinical examination of tooth 36 showed extensive tooth colored restoration at occlusal surface with enamel-dentin fracture (Figure 1). The electric pulp test was positive. The tooth has undergone vital pulp therapy (pulpotomy) for 2 years. The patient had an acceptable oral hygiene and normal occlusion. Pre-operative occlusal scheme when lateral excursion was cuspid protected occlusion.

Radiographic examination showed radiopaque area of restoration from occlusal surface to floor of pulp chamber. The alveolar crest was in normal height with normal periapical tissue (Figure 2).

An endocrown restoration was selected for this tooth because of thin remaining walls and minimal amount of remaining tooth structure. The tooth preparation was done using a sterile high-speed diamond bur under water coolant with at least 2.0 mm occlusal clearance for entire occlusal surface in order to provide appropriate thickness for the ceramic restoration. The central retention was achieved by the height of pulp chamber (at least 3.0 mm.) while maintaining the thickness of mineral trioxide aggregate (Proroot MTA®, Dentsply Tulsa Dental, Tulsa, USA) at 3.0 mm over the pulpal floor and eliminating undercuts in the access cavity. The cervical finish line has to be supragingival where the bevel finish line is at buccal surface and chamfer finish line is at lingual surface (Figure 3). After preparation, the immediate dentin sealing (IDS) was done with a 3-step etch-and-rinse dentin bonding agent (DBA) (OptiBond FL™ Kerr Corporation, Orange, USA) in order to increase the dentin bond strength.

A digital impression was obtained via a digital scanner (Cerec® Primescan camera Dentsply, Charlotte, USA). Temporary restoration was fabricated by Bis-Acryl composite resin (Protemp 4, 3M ESPE, Beirut, Lebanon) and temporarily cemented by using a spot etch technique at pulpal floor of the cavity. First, the endocrown was designed and manufactured with lithium disilicate block (CEREC® Tessera, Dentsply, Charlotte, USA). After milling, the margin of the restoration was chipped, and internal surface was overmilled (Figure 4). Therefore, the type of material was changed to resin

Figure 1: Pre-operative intraoral views: (A) occlusal view of maxillary teeth, (B) right buccal view, (C) anterior view of teeth, (D) left buccal view, (E) occlusal view of mandibular teeth

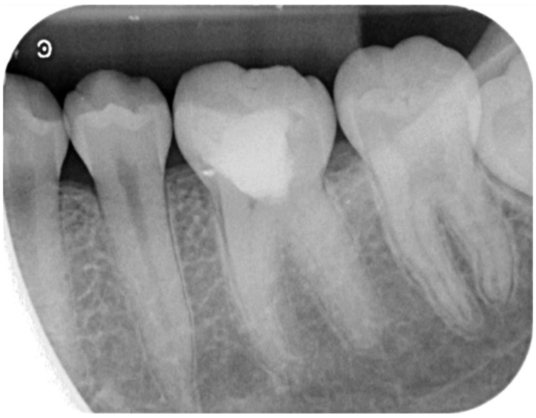

Figure 2: Pre-operative radiograph

nanoceramic block (GC® Cerasmart, Tokyo, Japan) but an overmilling was found at the inner surface and under margin was found at the distal surface of the crown.

The process was finally changed from digital to conventional workflow. The impression was taken by double impression technique. The master model and die were made from gypsum type IV for fabrication of the lithium disilicate endocrown (IPS e.max Press, Ivoclar vivadent, Schaan, Liechtenstein) using lost wax technique (Figure 5C). Conventional fabrication along with lithium disilicate press material showed the satisfactory results in marginal adaptation and marginal chipping. (Figure 5A-C).

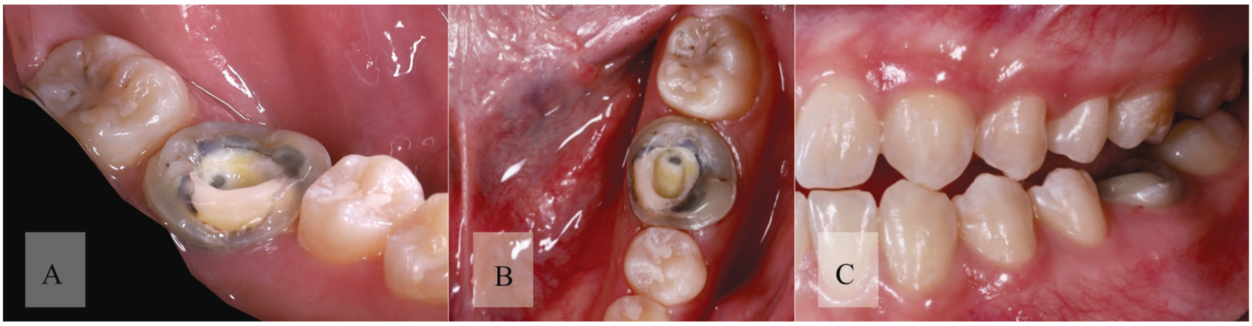

Figure 3: After preparation: (A) lingual view, (B) occlusal view, (C) buccal view

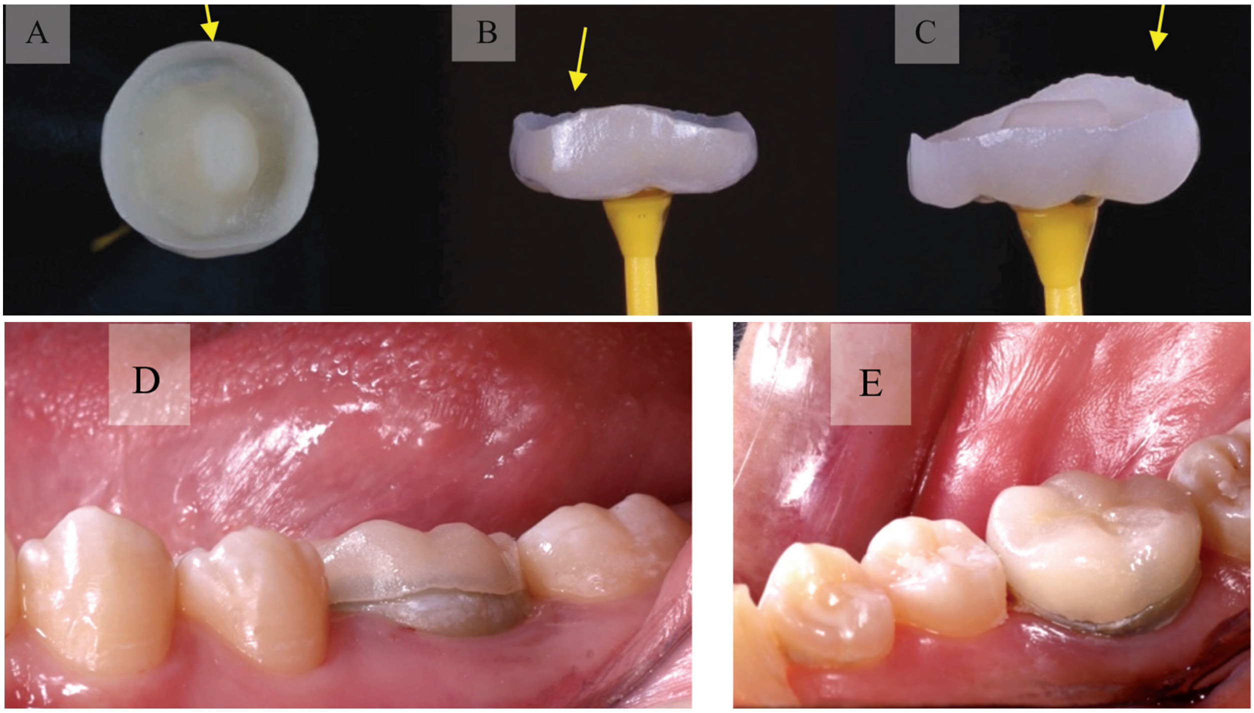

Figure 4: Displays milling lithium disilicate block (CEREC® Tessera, Dentsply, Charlotte, USA): (A) overmilling at inner surface of restoration, (B)-(C) marginal chipping, (D)-(E) try-in endocrown lithium disilicate block shows short margin (CEREC® Tessera, Dentsply, Charlotte, USA)

For the cementation procedure, the restoration was etched with hydrofluoric acid for 20 s, silane was applied before the restoration was cemented on the tooth with a dual cure resin cement (Multilink® N, Ivoclar vivadent, Schaan, Liechtenstein), tack-curing for 3 s and excess resin was removed before 40 s light-curing was applied on all surfaces of the endocrown restoration. A postoperative bitewing radiograph was taken after restoration placement.

Seven days follow-up showed that the tooth 36 was asymptomatic, negative to percussion, no tooth mobility and good gingival health wherein the restoration was in good condition and no discoloration of restoration was observed.

Radiographic examination showed radiopaque of endocrown with radiopaque of cement line underneath. Alveolar crest and periapical tissue showed normal condition (Figure 6).

Discussion

A proper planning is necessary for the clinical success of full pulpotomy procedures. The success rate depends on the quality of the coronal restoration due to failure of vital pulp therapy that could be caused by insufficient

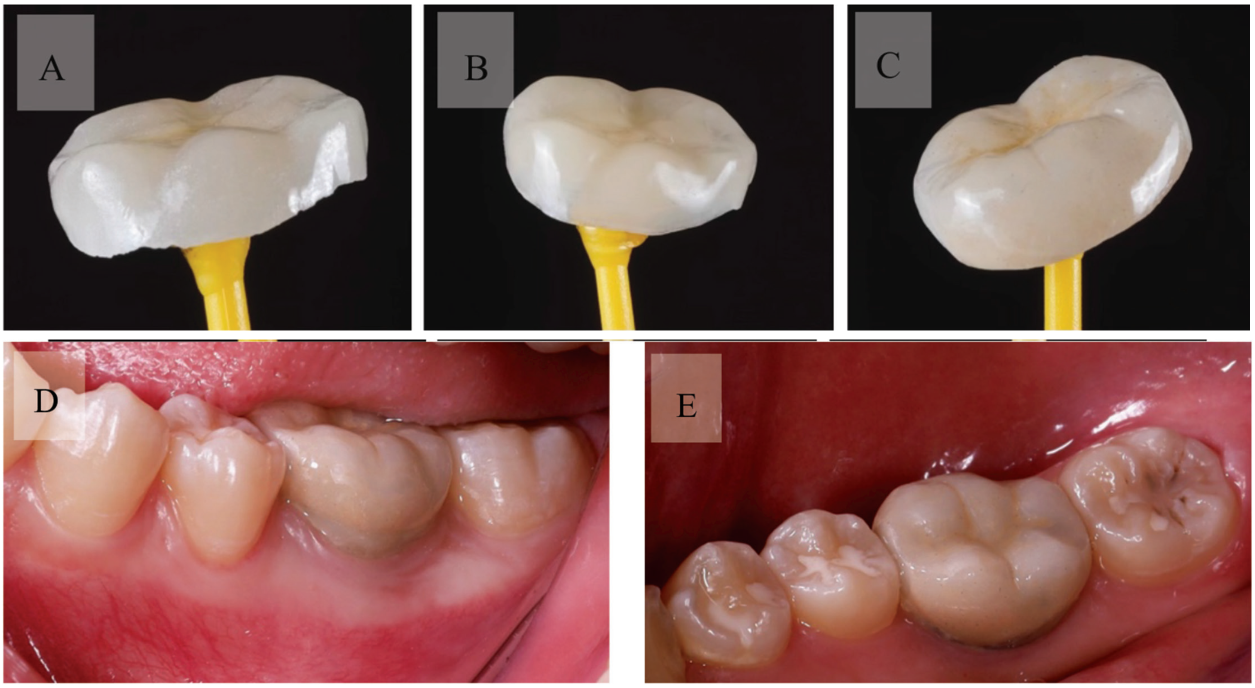

Figure 5: Restoration shows: (A) lithium disilicate block (CEREC® Tessera, Dentsply, Charlotte, USA), (B) resin nanoceramic block (GC® Cerasmart, Tokyo, Japan), (C) lithium disilicate press (IPS e.max Press, Ivoclar vivadent, Schaan, Liechtenstein), (D)-(E) after cementation of lithium disilicate press

Figure 6: Radiographic examination after insertion for 7 days: (A) periapical, (B) bitewing

sealing between the pulp capping material and the coronal restoration.[10]

In this case, tooth 36 was treated by pulpotomy, so post placement could not be done. One of a postless alternatives for treating previously initiated therapy is using the pulp chamber as an extension of crown. This restoration type combines the crown and core build-up in a single element or so called "monoblock".[11] The endocrown requires a simpler and less invasive preparation compared to the multi-step approach of the post-and-core build-up with full crown, resulting in decreased treatment time and costs.[12]

First, lithium disilicate block was selected (CEREC® Tessera, Dentsply, Charlotte, USA) for endocrown fabrication by CAM technique which presents advantages over the other materials such as aesthetic and ability to bond with resin cement. According to Altier *et al.*,[13] who compared the fracture resistance of three different endocrowns made of lithium disilicate ceramic and indirect resin composite, they concluded that the fracture strength of lithium disilicate ceramic endocrown is higher than that of indirect composites. A recent study demonstrated that there was a good stress distribution of lithium disilicate because its elastic modulus is approximate to tooth structure; which were 95, 84.1 and 18.6 GPa for lithium disilicate, enamel, and dentin respectively.[14,15] Additionally, glass ceramics prevent excessive wear of the opposing dentition due to their similar modulus and hardness to enamel.[16]

The preparation design of tooth 36 endocrown is a bevel finish line at buccal surface but lithium disilicate ceramic (CEREC® Tessera, Dentsply, Charlotte, USA) is too brittle to mill to a knife- edge[17], so chipping around thin areas of the margin occured.

Resin-ceramic CAD/CAM blocks such as Lava™ Ultimate (3M ESPE, Beirut, Lebanon), Cerasmart® (GC, Tokyo, Japan) and Vita Enamic (Vita Zahnfabrik, Bad Säckingen, Germany) are highly preferred in chair-side dentistry due to their advantages, including fast and easy production with no need for crystallization or glaze firing after manufacturing, ease of intraoral repair and polish, and better machinability because of their low modulus of elasticity. Moreover, the low hardness values of resin-ceramic materials are found to prevent the wear of opposing dentition and enable rapid milling and to minimize marginal chipping which is associated with better marginal adaptation.[18] The mechanical properties of the resin-ceramic CAD-CAM block materials tested were within the acceptable range for fabrication of single restorations according to the ISO standard for ceramics (ISO 6872:2008). Cerasmart was observed to have superior flexural strength and better internal fit[19]; for these reasons, the endocrown was fabricated by resin nanoceramic block (GC® Cerasmart, Tokyo, Japan).

Both materials fabricated from CAD/CAM technique still have overmilling problems. Overmilling occurs when the bur is unable to accommodate areas smaller than the size of the bur, especially at cusp tips and sharp line angles, resulting in excess cement space and susceptible restoration.[20] So, we decided to change to conventional technique in order to solve this problem by fabricating endocrown with lithium disilicate press (IPS e.max Press, Ivoclar vivadent, Schaan, Liechtenstein) and also wanted to compare between the full digital and full conventional workflow in this kind of problem.

An error in digital workflow, the limitations of the designing software and the size of the cutting tools, can result in the accuracy of the ceramic restorations from the CAD/CAM technique.[21] The most common causes of errors performing intraoral scanning were the result of improper preparation of teeth, the instability of the scanner in the mouth of the patient, incorrect position, angle of the scanner to the object scanning, contrast spray applied in uneven layer, and the presence of fluid in the scan region and the presence of artifacts in the gingival sulcus region.[22] In this case, the preparation design may be not suitable for digital workflow, as shown from overmilling, marginal chipping and under margin that occurred. For an optimal CAD/CAM endocrown preparation design, clinicians should flatten and round all cusp tips, confirm the absence of undercuts, prepare teeth with 1.0 mm. thick and smooth finish lines. The margin area should be clearly visible for precise milling. Additionally, clinicians can utilize the preparation check and milling simulation steps in CAD/CAM software to verify adequate preparation and identify potential areas that may lead to overmilling.[20] In the event that the operator wants to continue using CAD/CAM in this case, the preparation design should be adjusted to deeper finish line such as chamfer or rounded shoulder in order to avoid limitations of milling process.[23]

From the study of Carvalho T *et al.,*[24] it can be concluded that digital scanning systems were not superior to conventional impression when comparing in fidelity, accuracy, and surface detail reproduction, but have proven to be superior to conventional techniques for clinical chair time, patient and operator preference and patient comfort. Nevertheless, the high cost of these systems still hinders their introduction into the clinical reality.

Conclusions

The preparation design of an endocrown affects the fabrication process of the restoration and material selection. Even though the design was good, manufacturing might not coincide. The digital workflow has many advantages but still has some drawbacks such as overmilling, undermargin and marginal chipping while the conventional workflow provides better clinical outcomes and can decrease error from digital workflow. Therefore, the operator should decide carefully on suitable fabrication techniques and materials for each case.

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