Conservative management of extensively damaged endodontically treated tooth using computer-aided design and computer-aided manufacturing-based hybrid-ceramic endocrown: A clinical report

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Abstract

Restoring extensively damaged endodontically treated posterior teeth is always a challenge in dentistry. The use of endocrowns has gained popularity in restoring severely damaged endodontically treated teeth (ETT) in recent years. In this clinical report, a structurally compromised mandibular second molar with symptomatic irreversible pulpitis and normal apical tissue was endodontically treated. Surgical crown lengthening was attempted thereafter to increase the crown height. However, marginal periodontal tissue re-growth occurred after surgical crown lengthening. The tooth was subsequently restored with endocrown which was fabricated using computer-aided design and computer-aided manufacturing-based hybrid-ceramic. In conclusion, endocrown can be a viable restorative modality for ETT with compromised clinical crown height.

Keywords: Computer-aided design and computer-aided manufacturing; endocrown; endodontics; hybrid-ceramics

INTRODUCTION

A tooth that requires root canal treatment often presents with extensive loss of tooth structure because of caries, tooth surface loss, or iatrogenic reasons. The failure rate of 28.6%–35.9% has been well documented in endodontically treated tooth (ETT) with <3 remaining tooth walls.¹ A cuspal coverage is therefore crucial for ETT, especially for the posterior tooth which is subjected to high masticatory force.² Although conventional crown and onlay have been well postulated for this purpose, good retention can be difficult to achieve with insufficient coronal dentine thickness. This problem could be potentially solved by post placement, but this approach might create incipient craze, strip perforation, or even root fracture.³ With the introduction of endocrown, the principle of minimally invasive dentistry by preserving maximum coronal tooth structure is adhered to. The procedural complications are thus minimized and could be an alternative option to manage severely compromised ETT. This clinical case report describes the conservative management of endodontically treated molar with extensive loss of coronal tooth structure using computer-aided design and computer-aided manufacturing (CAD/CAM) based hybrid-ceramic endocrown.

CASE REPORT

A 78-year-old male was referred to the Restorative Clinic of the Faculty of Dentistry, the National University of Malaysia for management of tooth 47. He suffered worsening sharp pain at tooth 47, especially when having cold and hot beverages for 2 weeks. His comorbidities include hypertension, type II diabetes mellitus, atrial fibrillation,
hypercholesterinemia, benign prosthetic hyperplasia, and right ear deafness. He attends regular follow-up at the general hospital and his medical condition is well controlled with medications.

Intraoral examination revealed heavily restored tooth 47 with approximately 0.5–1.0 mm clinical crown height and limited interocclusal space [Figure 1a-d]. It was highly sensitive to air blow but not tender to percussion. Further investigations showed an exaggerated response to the electrical pulp test and cold test with lingering pain on removal of the stimuli. The pain which lasted for a few minutes was scored seven over ten. Radiographically, the crown to root ratio of tooth 47 was favorable [Figure 1e]. However, the existing restoration extended into the pulp chamber with no periapical pathology observed. Tooth 47 was diagnosed to have symptomatic irreversible pulpitis with normal apical tissue.

After obtaining the patient's consent for treatment, the tooth was treated with nonsurgical root canal treatment under the dental dam, followed by surgical crown lengthening with the target of achieving an adequate clinical crown height of at least 4.0 mm. Unfortunately, the final crown height of only 2.0 mm was achieved due to soft-tissue rebound 3 months postsurgery [Figure 1f]. Tooth 47 was then prepared conservatively following the design of endocrown[4,5] with modifications made to fit this particular case: 2.0 mm occlusal reduction for sufficient restorative thickness; axial wall preparation with the chamfer finish line and 2.0 mm extension into pulp chamber with 5°–7° occlusal divergence angle [Figure 2a]. The base of the pulpal floor was flattened for better seating of endocrown.

The prepared tooth was subsequently scanned using an intraoral scanner (CEREC Bluecam). CEREC software [Figure 2b-e] was used for the endocrown design and milled by CEREC MC XL using zirconia silica ceramic in a resin interpenetrating matrix (A2 shade SHOFU Black HC, Shofu Dental Corporation, Japan). The milling process took <10 min. The holding pin from the endocrown was removed with a rotary diamond bur (Diamond Point FG Regular Grit, Shofu Dental Corporation, Japan).

During the same visit, the endocrown [Figure 2f] was tried and stained through Lite Art Color Stains (Shofu Dental Corporation, Japan). The occlusion was checked, adjusted with ceramic finishing burs (CeraMaster Coarse, Shofu Dental Corporation, Japan) and finally polished with ceramic polishing burs (Dura-Green and-white, Shofu Dental Corporation, Japan). The fitting surface of the endocrown was sandblasted using 50 µm aluminum oxide for 15 s under 315Pa pressure, cleaned, air-dried, and primed with a single coating HC Primer (Shofu Dental Corporation, Japan) according to the manufacturer’s instructions. The surface was gently air-dried and light-cured for 20 s. The tooth of interest was etched with 37% phosphoric acid, rinsed, and finally bonded using ScotchBond (3M™ ESPE). After light curing for 15 s, the endocrown was cemented with resin luting cement (RelyX Ultimate, 3M™ ESPE). A radiograph of postcementation was taken to further verify the seating of endocrown on tooth 47 [Figure 2g-k].

**DISCUSSION**

Endodontically treated tooth that suffered a substantial loss of coronal tooth structure may be difficult to restore and the task could be more challenging with limited interocclusal space. Although the clinical crown height could be increased using a surgical crown lengthening, the treatment was ineffective in this case due to gingival margin rebound, possibly as a result of short flap-to-osseous crest distance at suturing.[6] This is consistent with a study which has reported significant tissue rebound to the flaps that are positioned <3 mm from the alveolar crest leading to coronal gingival proliferation during the healing period.[7] Additionally, thick gingival biotype can be another cause of soft tissue rebound. Therefore, it is important to take into account of the gingival biotype when planning for the extent of ostectomy.[8]
As the target clinical crown height was not obtained following the surgery, retention of a subsequent full-coverage crown remains problematic. Although conventional post-core-crown can be a solution to retain the final restoration, this method possesses several unforgivable risks. Therefore, restoring the tooth with an endocrown is a practical postendodontic restoration. The design of the present case is optimized in an attempt to achieve better treatment outcomes. The preparation of 2.0 mm pulp chamber depth helps to provide optimal retention and resistance for endocrown without risking catastrophic root fracture. Besides, preparation of 6° divergence on axial walls of the pulp chamber could ensure a better internal fit of endocrown as compared to 10° axial wall divergence.

The material of choice for the fabrication of endocrown is of utmost importance. A CAD/CAM lithium disilicate reinforced ceramic is the most commonly used material due to its high mechanical strength, superior adhesion properties to the tooth structure, and excellent esthetics. Nevertheless, the brittle property of this material cannot be omitted when planning a posterior restoration. A newly developed hybrid-ceramic which contains predominant ceramic particles embedded within an organic polymer matrix draws the attention to have a slight “flexible” ceramic. This novel material with a partially sintered ceramic network can be easily milled with less bur damage and shorter milling time as well as repaired or modified with conventional composite resin. Radiographically, hybrid-ceramic appeared to be slightly more radiolucent than the surrounding natural tooth structure. This observation is a very useful feature in recall visits as secondary caries or prosthesis failures can be easily identified.

It was commonly known that fracture resistance of a ceramic crown increases as the occlusal thickness increases, but controversy remains whether the small differences in thickness could have a significant role in the overall strength of an endocrown. The optimal ceramic occlusal thickness usually ranges from 3 mm to 7 mm. Some authors suggested that 1.5 mm occlusal thickness of ceramic endocrown can adequately withstand the occlusal forces, however, functional cusps of the endocrown fractured after several months. With the enhanced mechanical properties found in hybrid-ceramic, we have decided on 2.0 mm occlusal thickness in this case.

Butt joint margin without ferrule was first introduced by Bindl and Mormann to avoid further reduction of remaining axial wall thickness. However, with minimal ferrule height prepared on the affected tooth, an increase in fracture resistance was observed in many studies. It is demonstrated that 1.0 mm ferrule-containing endocrown preparations exhibit significantly greater failure loads (1101N) than endocrown without ferrule (638N). The addition of 1.0 mm ferrule would increase the bonding surface area for up to 36%, counteract the shear stresses, distribute the load, and
decrease the resin cement thickness as compared to butt margin designs. By using a hybrid-ceramic endocrown, a lesser depth of finishing margin is needed, which translates to lesser destruction of the subject tooth during preparation without compromising its strength.[10]

As the usage of endocrown is on the rise, adhesive bonding of such restoration is important to enhance their long-term clinical success.[12] Various surface pretreatment protocols are recommended for bonding on ceramic restorations depending on different chemical compositions. For etchable ceramics such as lithium disilicate, etching the surface with hydrofluoric acid significantly increases the bonding strength. Nevertheless, airborne-abrasion with alumina particles is a more appropriate technique to adequately roughen the surface of zirconia-based hybrid-ceramic restorations and further improve the bonding strength to resin cement. The reliable bonding strength is further enhanced by the application of HC Primer on the bonding surface of the hybrid-ceramic restoration. The primer which contains urethane dimethacrylate, methyl methacrylate, and acetone could penetrate the matrix of hybrid-ceramics and forms a durable bond to the adhesive resin.[13]

Furthermore, the use of dual-cure resin cement containing methacryloyloxydecyl dihydrogen phosphate monomer can provide favorable chemical bonding on both hybrid-ceramic restoration and dental substructure.[14] Although this class of ceramics is considered new in the market with little evidence, numerous clinical studies showed good clinical outcomes with a high survival rate of 91.4% in 5 years.[15]

CONCLUSIONS

With the appropriate preparation design of endocrown as well as cementation protocol, CAD/CAM-based hybrid-ceramic can be a viable alternative in the fabrication of a successful endocrown.

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Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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