Case Report

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The restoration of a tooth with fractured cusps and short clinical crown: A case report

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A 41-year-old Thai female was presented at the Department of Operative Dentistry, Mahidol University with buccal cusp fracture and severely damaged tooth structure on an upper left second molar which was a result of previous large restoration and the patient's parafunctional habit. In this case, crown restoration was indicated. In short clinical crown condition which surgical crown lengthening or orthodontic force eruption are contraindicated, more retention and resistance were increased by nearly parallel walls with additional slot preparation and careful placing of subgingival margin to gain crown height. Full metal crown was selected as it required less occlusal reduction and the resin cement with proper surface treatment was utilized to maximize the retention. After the 9-month follow-up, the restoration was in good condition and the patient was satisfied with the result.

Keywords: additional slot preparation, cuspal fracture, short clinical crown, tooth fracture

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Introduction

Tooth fracture is one of the common problems [1] for patients which encourage them to make a dental visit. The severity and consequences of the fracture can range from minor, which requires no treatment, to severe, resulting in root canal therapy (RCT), or even tooth loss [2-6].

According to the newsletter of the American Association of Endodontists (AAE) in 2008, longitudinal tooth fractures can be classified into 5 types; craze lines, split tooth, fractured cusp, cracked tooth, and vertical root fracture. The major factors predisposing cracks are natural features (e.g. lingual inclination of the lingual cusps of mandibular molars and steep cusp/fossa of maxillary premolars, bruxism, clenching, extensive attrition and abrasion) and iatrogenic causes (e.g. the use of rotary instruments, cavity preparation and the width and depth of the cavity) [3, 4]. Rivera and Walton [6] suggested that cuspal fractures may be iatrogenic if the unsupported and undermined tooth structure is not properly removed. In such a case, there is usually a history of extensive deep interproximal caries or a subsequent large Class II restoration.

As large substantial tooth structure is destroyed due to the fractured cusp, the tooth may be extensively damaged. To restore the form and function, it has been suggested that a tooth with cuspal fracture without pulpal exposure can be restored with direct restoration. However, if the remaining tooth structure does not provide enough retention for direct restoration, placing a crown is suggested [4].

The following case report describes the restorative management of the left maxillary second molar with mesiobuccal (MB) and distobuccal (DB) cusp fractures, in the presence of a short clinical crown condition.

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Case report

A 41-year-old female was referred to the Department of Operative Dentistry, Mahidol University, Bangkok, Thailand for the restoration of the upper left second molar. The clinical examination revealed MB and DB cusp fractures with old MODB defective tooth-colored restoration and 2° caries (Figure 1). The remaining tooth structure at buccal aspect was at the gingival level while the lingual was intact with a height of 4 to 1.5 mm above the gingival level from the mesiolingual (ML) cusp to distolingual (DL) cusp. The sensibility pulp test resulted in positive. The tooth mobility was observed within normal limitation and percussion test was negative. No pathological periodontal tissue was detected. The radiographic examination affirmed the intact lamina dura with normal PDL space (Figure 2). The patient had no complaints of symptoms at the time of appearing at the Operative Dental Clinic. Nevertheless, she had been through tooth sensitivity and many broken fillings. From the medical and dental history reviewed, the patient did not have any medical problems, however, ice-chewing was her parafunctional habit and may contribute to the etiology of the fractured tooth.

As more than half of the tooth structure was damaged, crown restoration was the chosen to restore the form and function of the tooth. Despite the short clinical crown height, the crown lengthening cannot be prepared due to the risk of furcation involvement of the adjacent tooth. The margin of the crown restoration was designed to be placed equal to or 0.5-mm below the gingiva in order to avoid the risk of invading the biological width. The preliminary impressions were made for fabricating the study models. These models were used to create a temporary restoration by making the silicone index. At the following appointment, after the initial tooth preparation was done, the defective restoration and 2° caries were removed. The resin composite (filtek Z350XT shade A3, 3M ESPE, St Paul, MN, USA) with the dental adhesive (Clearfil SE bond, *Kuraray* Co, Ltd, Osaka, Japan) was used for core built-up, blocking out the undercut and covering any irregularity. The tooth was, then, prepared for full metal crown restoration. Because of a short clinical crown, the preparation was

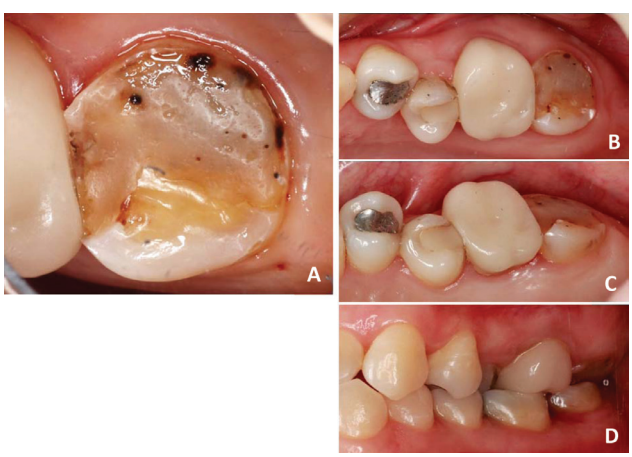

Figure 1 The Initial examination of the upper left second molar (A) the MODB-fractured tooth with old MODB defective restoration and 2° caries, (B,C,D) The fractured part was at the gingival level while the lingual intact part was 1.5-4 mm above the gingival level.

Figure 2 The radiograph showed normal apical tissue of the upper left second molar.

prepared as parallel as possible to obtain retention form. The additional preparation of two vertical slots parallel to the long axis of the tooth was created to maximize the resistance and retention form (Figure 3) using the flat-end taper rough diamond bur with 1-mm diameter at the tip (Intensiv SA, Montagnola, Switzerland). The margin was placed 0.5 mm subgingivally to the gingival margin to achieve the maximum crown height. The final preparation was refined to achieve the adequate occlusal clearance of 1-1.5 mm.

The final impression was done using polyether (Impregum, 3M ESPE, St Paul, MN, USA) with a triple tray. The silicone index, which prepared from the study models as mentioned above, was used intra-orally with bis-acryl composite resin material (Protemp4, shade A3, 3M ESPE, St Paul, MN, USA) to fabricate the temporary crown. After that, the temporary crown was taken out for polishing, then, was cemented with zinc oxide non-eugenol cement (RelyX Temp NE, 3M ESPE, St Paul, MN, USA). Master cast and die were fabricated using type IV dental stone. Full contour wax pattern of crown restoration was conducted before casting into a full metal crown (Figure 4). Palladium alloy was selected as it has good corrosive property but less expensive compared to gold alloy as the patient had a limited budget.

For the next appointment, after provisional crown removal, the tooth was cleaned with moisten pumice and a rubber cup. The crown restoration was tried-in to the tooth. The adaptation was verified as well as the restoration contour and contact area to an adjacent tooth. After that, the occlusal surface was adjusted to make simultaneous occlusal contact, both in centric and eccentric movement, without interferences (Figure 5).

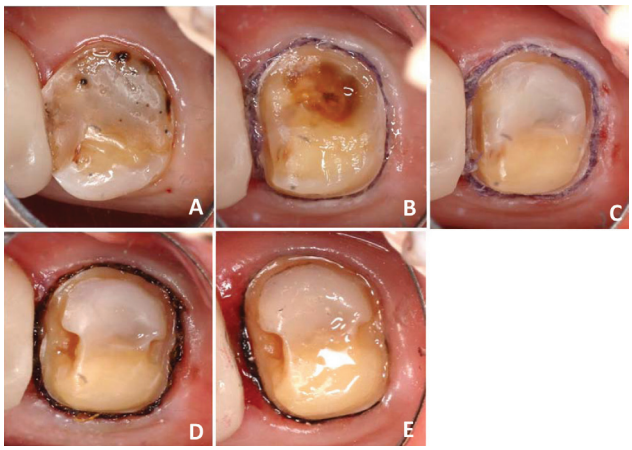

Figure 3 Tooth preparation for metal crown; (A) the initial tooth preparation, (B) the defective restoration and 2° caries removal, (C) the resin composite buildup, (D) the additional preparation of two parallel slots for secondary retention and resistance, and (E) the final preparation with 0.5 mm subgingival margin.

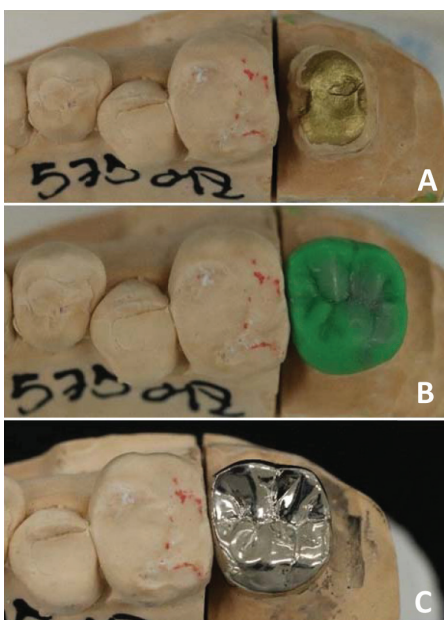

Figure 4 The laboratory procedures to construct metal crown restoration; (A) the master cast and die fabrication, (B) the wax pattern of the restoration, and, (C) the casting of the full metal crown restoration.

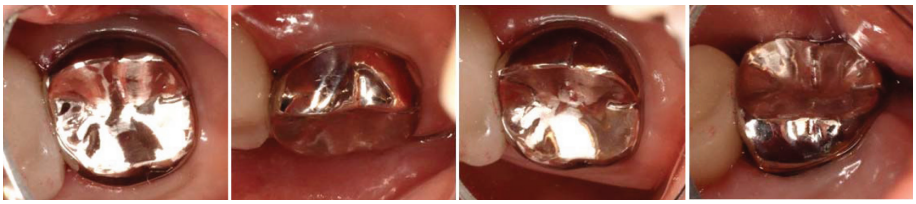

Figure 5 The tried-in restoration to the preparation for verification of adaptation, restoration contour and contact area to an adjacent tooth. Then, the occlusal surface was adjusted to make simultaneous occlusion.

The crown was cemented to the tooth via the self-etching bonding system and dual-cured resin cement (Panavia F2.0, *Kuraray* Co., Osaka, *Japan*). The inner surface of the restoration was treated with 50-micron aluminum oxide air-abrasion (KCP alpha alumina 50, American Dental Technologies, TX, USA) at a distance of 10 mm for 10s with approximately 3-bar pressure [7] for supplementary micromechanical retention, followed by alloy primer application (*Kuraray* Noritake Dental Inc., Okayama, *Japan*) to achieve chemical bonding to the resin cement. The crown loaded with resin cement was then seated to the prepared tooth. After 5-second of light activation with a light intensity of 1,200 mW/cm^2 (Bluephase G2, Ivoclar vivadent Inc., NY, USA) on buccal and lingual aspects, excessive cement was removed using hand instruments. Glycerin gel strip (OXYGUARD II, Kuraray Co., Ltd., Tokyo, Japan) was used around the margin of the restoration and each surface was further light-cured for 40 seconds for further polymerization. After 3-minute of its initial setting time, the excessive cement was thoroughly cleaned.

The occlusion was re-evaluated to ensure the proper occlusal contact, then, all the restoration surfaces were polished and finished to attain the smooth and shiny appearance (Figure 6). The radiographic examination was conducted to ensure the cement removal (Figure 7). The final result was shown in a clinical follow-up at 3 and 9 months (Figure 8, 9). The patient was satisfied with the restoration as no sensitivity or pain had occurred during the function. In addition, the patient was informed to take good care of oral hygiene and avoid ice chewing to maintaining favorable oral health.

Figure 6 Immediately after the full metal crown cementation.

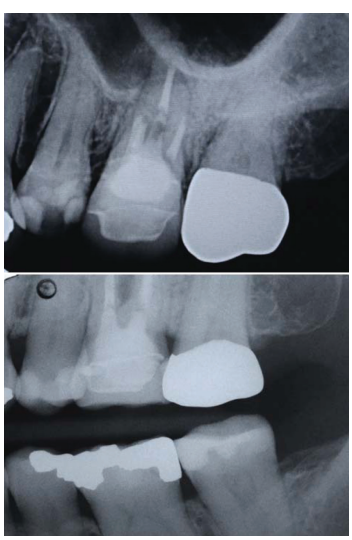

Figure 7 The radiographs showed proper adaptation with the restoration margin was placed approximately 2 mm above the alveolar bone level.

Figure 8 The final result of the restored upper left second molar with the full metal crown restoration at 3-month follow-up.

Figure 9 The final result of the restored upper left second molar with the full metal crown restoration at 9-month follow-up.

Discussion

Normally, a cuspal fracture which involves the dentin which stops at the cementoenamel junction or slightly below has an excellent prognosis [2, 6]. For severely damaged tooth, evaluation of the prognosis is necessary to achieve successful treatment. Assessment of the periodontal status, endodontic status, and structural status should be done before commencement of the treatment [8].

With regards to the periodontal aspect, the tooth being restored must have adequate and stable periodontal support and the margin of the restoration should not invade the biologic width [5, 6], while in relation to the endodontic aspect, the presence of a healthy pulp is needed. If there are signs and symptoms of irreversible pulpal inflammation, root canal treatment is suggested [5, 6]. In addition, the remaining tooth structure to provide a predictable restorative result requires sufficient structural integrity, firstly to retain the proposed restoration, and secondly to withstand any mechanical stresses [5, 8]. A multi-disciplinary approach involving endodontic, periodontal, orthodontic, prosthodontic, and surgical intervention may be required. Fractures that involve the periodontal attachment may require extraction, though hemisection or root amputation may be appropriate for some multi-rooted teeth [2]. In the absence of irreversible pulpitis, many techniques have been described to bind or remove the fracture so as to prevent flexure of the cusp, crack propagation, and bacterial microleakage. Definitive treatment has included pin retained amalgam, bonded amalgam, bonded composite, cusp overlay restoration, and full coverage crown [2, 4, 6].

In this case, as the fracture did not invade pulpal tissue and there are no signs and symptoms of irreversible pulpitis, root canal treatment is not included in the treatment modality. The periodontal support of the tooth is stable and adequate as the fractured plane cascaded at the gingival level and there is enough attached gingiva at the buccal area. Since the substantial tooth structure is less than fifty percent, full coverage crown is recommended.

Crown retention and resistance form are primarily related to crown length, total occlusal convergence degree, and axial surface area [9]. For a short clinical crown, which is defined as any tooth with less than 2 mm of sound, opposing parallel walls remaining after tooth preparation [10], retention and resistance form of the crown restoration are decreased [9, 11]. Many techniques

have been suggested to increase both retention and resistance form of the restoration [9, 11-15]. These include parallelism of the axial wall preparation [9, 11, 13, 15], maintaining the tooth height by selection of material which require less occlusal reduction [13], additional preparation features such as grooves or slots [9, 11, 13-15], which significantly limit the path of withdrawal and resist dislodging force and the use of selected resin cement with proper surface preparation before cementation as it showed better retention compared to conventional cements [12, 13, 15]. Another suggested option is subgingival margin placement to increase the height of the preparation. However, the clinician must be concerned with the biologic width of the periodontium, as invading biologic width would result in chronic gingival inflammation [11]. In that case, surgical crown lengthening may be indicated [11, 13]. In addition, force eruption by orthodontic treatment can be used to increase crown height when having adequate interocclusal space [11, 13]. For additional preparation, there are risks of over-preparation and pulpal exposure if an inappropriate preparation was made. On the contrary, the additional preparation can be easily prepared without additional treatment fee. Moreover, this technique helps to reduce the treatment time when compare to surgical crown lengthening and orthodontic force eruption. For surgical crown lengthening, the final restoration for posterior area should be postponed at least 6 to 12 weeks for periodontal healing process prior to the restorative impression [16]. Furthermore, the anatomical limitations, such as root furcation and tooth proximity, could restrict the procedure outcome. For orthodontic force eruption technique, the treatment time may be prolonged up to months due to the process of tooth movement. In addition, posterior area; especially second molar region, is generally difficult to treat due to the insufficient anchorage. [17]

In the present case, as the height of the preparation is less than 2 mm, it is considered as the short clinical crown, thus, the tooth was prepared as parallel as possible with a diamond cylinder bur. Full metal crown restoration was selected. The reliable flexural strength and wear resistance of the metal enable the minimal occlusal reduction compared to others, thus, maintaining the higher tooth height. The two-additional parallel slots were prepared on mesial and distal of the preparation aiming to increase retention and resistance of the restoration. Also, the resin cement combined with metal surface preparation, air abrasion, and alloy primer application, was used to achieve the highest retention possible. Air abrasion refers to a technique for creating a clean rough surface with a high-speed spraying of abrasive particles which help to remove the surface debris and promote the mechanical bond strength of metal surface to adhesive cement. In addition, alloy primer consists of functional monomer; especially thiol group, which can create a chemical bond on metal surface to the resin adhesive cement. From previous studies [18, 19], alloy primer has been introduced to be an effective surface treatment agent for bonding the gold-platinum-palladium alloy. Even though the palladium alloy may not gain the chemical bond from alloy primer effectively, the alloy primer helps to promote the wettability which may increase the adhesive bonding of resin cement to palladium. Although the surgical crown lengthening was preferred to form the favorable crown height with predictable healthy periodontium, the surgical crown lengthening was prohibited in this case, as the procedure would involve bone removal in furcation area of both upper left molars and, thus, compromise the teeth prognosis [11]. Subgingival margin placement was used carefully in order to avoid invading biologic width.

As tooth preparation for restoration can reduce supporting tooth structure and jeopardize the integrity of the tooth and the more surfaces restored or the wider the isthmus, the greater the chance of cuspal fracture [3, 4, 6]. The clinician must beware of this risk by minimizing the preparation as much as possible [4]. Minimal intervention concept integrates with the skillfull dentist can protect redundant sound tooth removal and, subsequently, tooth fractures. Trauma from parafunctional forces and excursive interferences have also been associated with coronal fractures [3, 4]. Detection of occlusal interferences as well as elimination of these interferences could reduce fracture tendency. Also, the patient must be investigated whether they have bruxism, clenching or bad eating habit. Then, the proper management of these causes would be applied to minimize the chance of tooth fracture while maximizing the restoration longevity.

Conclusions

This case report demonstrates the feasibility of restoring the cuspal fractured tooth with short clinical crown. In a condition wherein surgical crown lengthening or orthodontic eruption are contraindicated, retention and resistance form can be achieved by parallel walls with additional slots preparation, carefully placing of subgingival margin, selection of material that required less occlusal reduction, and the use of resin cement with proper surface treatment. The treatment was successful due to the conservation of pulpal and periodontal tissue while restoring form and function of the damaged tooth. In combination with ceasing the parafunctional habit would help prevent further tooth fractures and expand the restoration longevity.

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