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Revascularization of an Immature Necrotic Mandibular Second Molar Using Calcium Hydroxide: A 3-year Follow Up

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Abstract Endodontic intervention in necrotic immature permanent teeth is usually a clinical challenge. With appropriate case selection and optimal disinfection, regenerative endodontic procedure (REP) can be effective and a desirable result can be obtained. In this report, an immature necrotic mandibular second molar had been treated by REP in two visits. In the first visit, a nonsetting calcium hydroxide was used as intracanal medication after irrigation with 1.5% (NaOCl). In the second visit, blood clots were created in the root canals. MTA was placed over the blood clots and the tooth was restored with a composite filling and stainless-steel crown. A clinical and radiographic follow up was performed for three years where the tooth was deemed a symptomatic with a complete root formation.

Keywords: *revascularization, regenerative endodontic procedure, Calcium hydroxide, immature tooth*

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1. Introduction

Treatment of necrotic immature permanent teeth has always been a challenge in endodontics. It is difficult to get an appropriate apical seal in teeth with open apices by using the traditional endodontic treatment methods owing to the presence of thin dentin walls and the lack of a natural apical constriction that an obturation material can be placed against [1].

For a long time, such teeth have been treated by the apexification procedure, which involves placement of intracanal calcium hydroxide (CaOH) to induce formation of a calcific barrier at the apex. However, there are certain limitations associated with this technique. The lengthy treatment period that might require multiple visits and renewal of the intracanal dressing [2,3], unpredictability of apical closure [4], and susceptibility of cervical root fracture after prolonged exposure to (CaOH) [5] have raised serious concern about the merit of this treatment approach. Single-step MTA apexification was introduced as a better treatment option for teeth with open apices as it overcomes the previous drawbacks and is practiced as a more predictable treatment with a higher success rate [6]. Both of the mentioned methods (i.e., apexification and artificial apical barrier techniques) share the same disadvantage of not allowing the continuation of root development, which leads to a fragile root structure.

Nowadays, regenerative endodontic procedure has gained significant interest in the field of endodontics [7]. Considerable research towards successful regeneration of pulp-dentine complex (PDC) is progressing which emphasizes on replacement of damaged structures such as dentine, PDC cells and root structures [8]. Several published cases with immature roots [9,10] indicate that the REP has the potential to encourage the continued formation of the root width and length. The proposed regenerative treatment generally starts with chemical disinfection of the root canals by different concentrations of sodium hypochlorite (NaOCl) including 6% [11], 5.25% [12], 2.5% [13], and 1.25% [10]. The procedure continues by application of triple antibiotic paste as an intracanal medicament, which is composed of ciprofloxacin, metronidazole and minocycline, as suggested by Hoshino et al [14].

CaOH has also been successfully used for disinfection of the root canals before revascularization procedures [15]. However, reports with CaOH medication are relatively fewer in molar teeth compared to anterior teeth. This case report presents the outcome of the revascularization protocol in CaOH-medicated immature necrotic permanent molar.

2. Case Report

A 13-year-old medically fit Saudi female presented to the endodontic postgraduate clinics of King Saud bin Abdulaziz University for Health Sciences (KSAU-HS),

Riyadh, Saudi Arabia for management of immature permanent mandibular second molar (number 47). Intra-oral examination of the tooth revealed provisional restoration associated with recurrent caries. Tooth was not tender to percussion nor palpation and was not responsive to sensibility test with Endo-Frost cold spray (Roeko; Coltene Whaledent, Langenau, Germany). Periapical radiographs revealed normal periodontal ligament space associated with intact lamina dura and immature roots (Figure 1(a)). Periodontal probings were within the normal limits (<3mm around the tooth) and no mobility was seen. A diagnosis of previously initiated pulp therapy and normal periapical tissue was established. After a discussion of all possible treatment options, regenerative endodontic procedure was considered as the optimal option. After complete explanation of the treatment procedure, risks, and benefits, an informed consent was obtained from the patient's legal guardian.

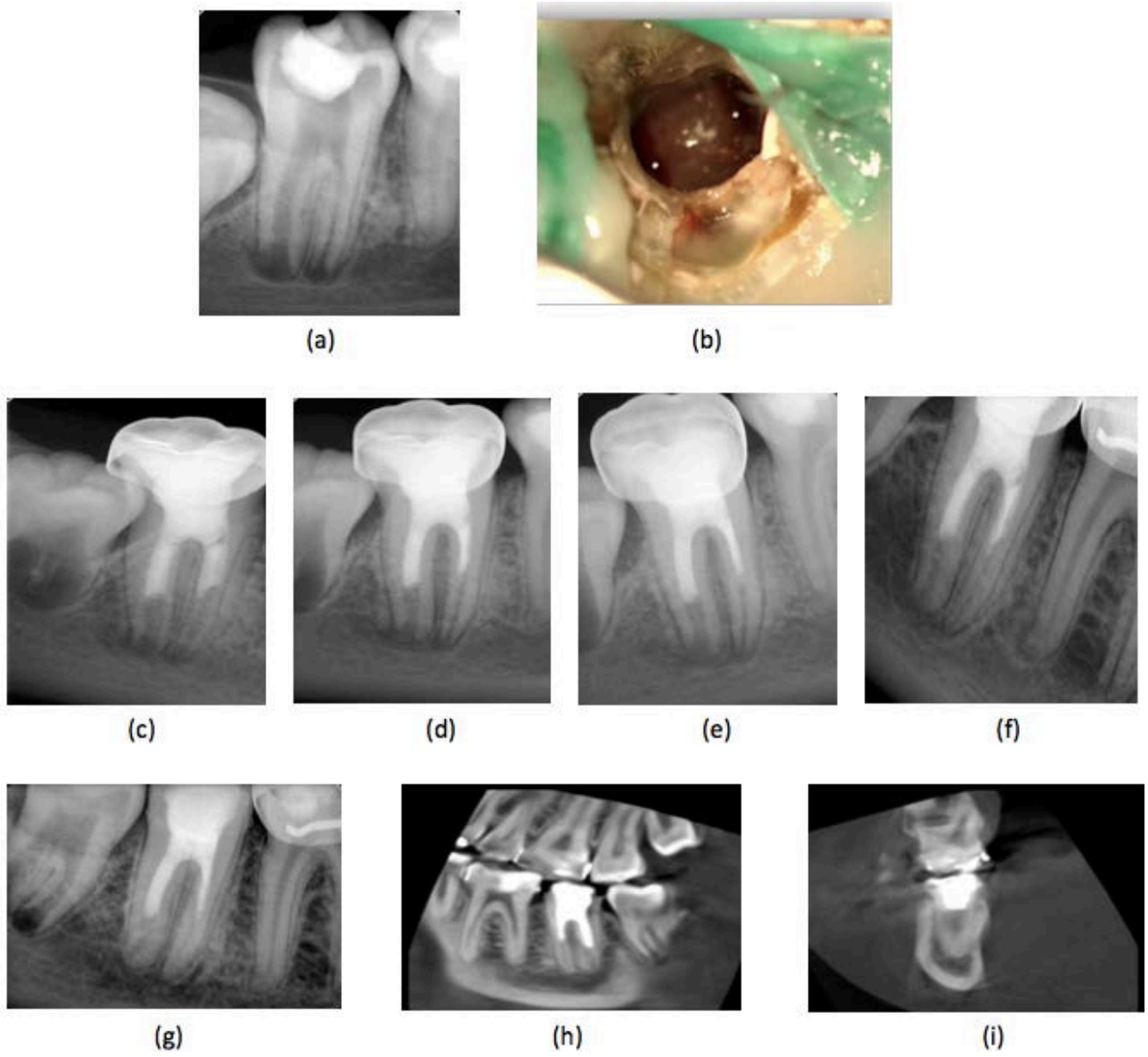

Figure 1. The mandibular right second molar had immature roots (a). During the regenerative endodontic procedure, successful bleeding was made in all canals (b). Follow-up radiographs after 3 months (c). 6 months (d), 12 months (e), 24 months (f), and 36 months (g) showed continued root formation and normal periapical tissue. Sagittal (h) and coronal (i) CBCT views confirmed the findings

In the first visit, an inferior alveolar nerve block with 2% lidocaine and 1: 100,000 epinephrine was given, a rubber dam isolation was made, coronal restoration and caries removal was performed and then a proper access cavity was done by using a diamond-coated fissure bur (Diatech, Heerbrugg, Switzerland) and a high-speed handpiece with copious water spray. Under dental operating microscope (Zeiss OPMI Pico, Carl Zeiss Surgical, Oberkochen, Germany), four canal orifices were located and cervical preflaring was done using size #3 Gates Glidden to facilitate canals irrigation. The canals were irrigated by 20 ml of 1.5% sodium hypochlorite (NaOCl) for 5 minutes and then dried by paper points to receive nonsetting CaOH (AH Temp, Dentsply, York, PA) that was applied to the full length of the canals. Finally, the tooth was temporarily restored with Cavit (3M ESPE, Seefeld, Germany). At the 3-week follow-up the patient was asymptomatic, the molar was not sensitive to percussion and palpation. The tooth was anesthetized with 3% plain mepivacaine (Septodont, Cedex, France) without

vasoconstrictor to facilitate bleeding, as suggested by Petrino et al [13]. The CaOH was washed out from all the canals and the canals were thoroughly irrigated with 20 ml of 17% EDTA for 5 minutes then the root canals received a final irrigation with 10 mL sterile saline. Following canals drying, bleeding was initiated by inserting a 25-K file (Dentsply Maillefer, Ballaigues, Switzerland) beyond the apex by 2 mm in each canal. The bleeding filled all canals 2–3 mm below the cementoenamel junction level (Figure 1(b)). After 10 minutes, after the formation of blood clot in all canals, CollaPlug (Zimmer Dental, Carlsbad, CA) fibers were placed on the blood clot, and then a 3-mm white MTA barrier (Dentsply Tulsa Dental, Tulsa, OK) was prepared according to the manufacturer's instructions and was gently adapted over the blood clot. Finally, a wet cotton pellet was placed over the MTA, and the access cavity was temporarily restored with double seal of Cavit and conventional glass ionomer cement. Three weeks later, the tooth was restored with acid-etch resin composite and stainless steel crown. After three years, a full coverage restoration was performed. The patient returned to the clinic for the 3, 6,12, 24 and 36 months follow-up examination and was asymptomatic (Figure 1(c)-1(g)). No signs of edema, erythema, or sinus tracts were noted. Tooth was not sensitive to percussion or palpation. Periapical radiographs and limited field of view CBCT showed no lesion associated with the tooth (Figure 1(h,i). In addition, increased thickening of the root walls and the root length was observed on both roots. It is noteworthy that the tooth vitality was positive to cold test after 36 months.

3. Discussion

Case reports and series still constitute a considerable amount of the published literature on regenerative endodontic procedures. In today's increasing demand for higher levels of evidence, case reports might possess relatively minor impact in determining the efficacy of a given treatment modality [16]. However, well-documented case reports can make meaningful contributions in identifying potentially important parameters that can guide the design of future prospective clinical trials [13].

The main advantages of revascularization technique over the traditional apexification or artificial barrier technique in endodontic treatment of immature necrotic teeth include continuation of root development and strengthening the root structure [17]. One study showed that the percentage change of root width was significantly greater in the revascularization group (28.2%) compared with the MTA apexification (0.0%) and calcium hydroxide apexification groups (1.5%). In addition, the percentage increase of root length was significantly greater in the revascularization group (14.9%) compared with the MTA (6.1%) and calcium hydroxide apexification groups (0.4%) [18].

In this case, we decided to use revascularization treatment instead of apexification with calcium hydroxide or artificial barrier technique because of the potential to gain the benefits of root development.

Multiple case reports of regenerative endodontic procedures have been published, with significant differences in disinfection protocols. Different concentrations of sodium hypochlorite (NaOCl) including 6% [11], 5.25% [12], 2.5% [13], and 1.25% [10] and different concentrations of chlorhexidine (CHX) including 2% [11] and 0.12% [14] have been successfully used for this purpose. The half- or full-strength (3% and 6%, respectively) concentrations of NaOCl have been shown to prevent stem cells attachment to dentin surfaces, and are toxic to stem cells of the apical papilla (SCAP) [19,20].

In this case, the root canal system was irrigated with 1.5% (NaOCl) followed by normal saline [12]. The root canals then were completely filled with (CaOH) to the periapical area to neutralize lipopolysaccharide produced by anaerobic bacteria and induce continued root formation [21,22]. In the second visit, the antibiotic dressing (CaOH) was removed from the canal using normal saline. Next, 17% EDTA was used as the final irrigant because the use of EDTA is beneficial for providing dentin-derived growth factors [19].

Resolution of signs and symptoms, regaining pulp vitality, radiographic evidence of continued root development, and apical narrowing are important goals of successful REP [23,24]. In this case, a continued root development was observed, which substantiate the findings of Bose et al [25] that placement of (CaOH) in the root canal can contribute to a significant increase in root length and root wall thickness. However, the latter study also showed that the use of the triple antibiotic paste resulted in a greater increase of root wall thickness. In the retrospective study of Chueh et al [26], $Ca(OH)_2$-medicated teeth showed a high rate (91%) of partial obliteration of the root canal, suggesting that the pattern of root development induced by regenerative endodontic treatment might be different from that of physiologic maturogenesis.

The induction of bleeding into the canal may provide stem cells, which can induce dentin formation [27]. It is easier to induce bleeding when an anesthetic solution did not contain a vasoconstrictor. This was proven by several animal and human studies which have shown that there is a significant reduction in pulpal blood flow after infiltration injection of anesthetics containing epinephrine [28]. However, Ding et al [29] discussed that decreased inflammatory reactions after disinfection procedure is the main cause for lack of bleeding.

The importance of a bacteria-tight coronal seal for successful revascularization is well-documented [30]. A majority of reported studies have used a double seal over the blood clot formed inside the canal, MTA and a resin-bonded restoration [31,32]. Sealing ability and biocompatibility of MTA are shown in several studies [31]. In this case, since the tooth was damaged by caries, it was restored with composite filling as core and stainless-steel crown to ensure the occlusal stability and protection until the adolescence. After 3 years, a full-coverage restoration was performed.

CBCT has emerged as a precious tool in endodontics due to its reliability, accuracy, and three-dimensional imaging capabilities. The AAE and The European Society of Endodontology Position Statement stated that CBCT should be considered as an adjunctive imaging method in certain situations such as investigation of teeth with the inconclusive interpretation of two-dimensional

radiographs [33]. In this case, the CBCT was taken to investigate the apical tissues. It confirmed a normal periapical tissue and complete roots formation. A positive response to cold test was obtained after 3 years and this is similar to another study's finding in which the authors reported a positive response to cold in an immature molar tooth with a coronal MTA plug [34].

4. Conclusion

The revascularization is a technically challenging treatment method. Based on the experience of this case, the following clinical tips can be offered for consideration: (1) clinicians should consider the use of an anesthetic without a vasoconstrictor for an easy induction of the bleeding; (2) a collagen matrix is useful for the controlled placement of MTA to a desired level, with only light pressure placed while packing the MTA; (4) patient and parent compliance with the necessary multiple appointment treatment plan may be important for case selection.

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The authors deny any conflicts of interest related to this study.

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