Case Report

Novel Apexification Method In a Non-Vital Tooth With an Open Apex: A Case Report

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Abstract

Many materials have been introduced for apexification each having their own advantages and disadvantages. This case report aims to present a new method of apexification using a combination of deproteinized bovine bone mineral (DBBM) and enamel matrix derivative (EMD). After irrigating the canal of the maxillary right canine with 2.5 % sodium hypochlorite, a mixture of Bio-Oss and EMD was packed into the apical region for formation of an apical barrier and the canal was obturated by thermoplastic gutta percha technique with AH26 sealer; coronal seal was achieved by resin bonded composite. The size of the periapical lesion decreased significantly after 3, 6, 12 and 18-months. The patient had no radiographic signs or clinical symptoms at 24-month follow up and complete maturation of the apex and healing of the periapical bone were achieved.

Key words: Apexification; Enamel matrix protein; Endodontics; Root canal therapy; Bio-Oss

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INTRODUCTION

Apexification is a method to induce a hard tissue barrier in a root canal with an immature open apex for the continued apical development of an incomplete root [1]. Several materials are used for the management of open apices. The first study on these materials was done by Coviello and Brilliant in 1979; they introduced tricalcium phosphate [2].

In 1993, Schumache and Rutledge suggested calcium hydroxide as a permanent apical barrier [3] and finally Torabinejad and Chivian introduced mineral trioxide aggregate (MTA) as an apical plug [4].

The long-term use of $Ca(OH)_2$ may increase the risk of root fracture, especially in roots with thin dentinal walls, and the treatment takes a long time [5].

Although MTA has more benefits, using MTA in teeth with funnel shape apices and large periapical lesions is difficult and it often spreads beyond the apex [6].

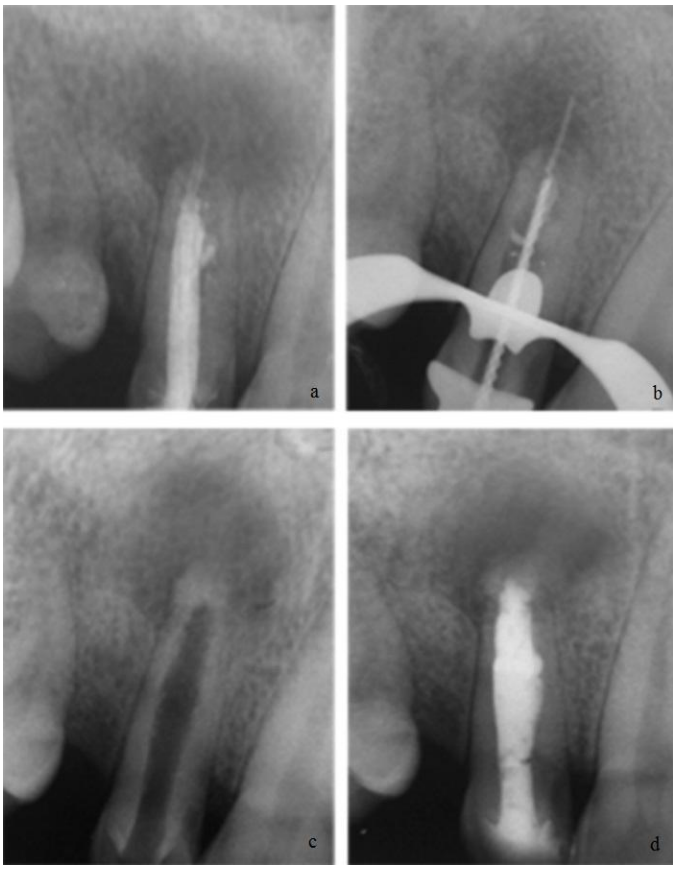

Fig 1. (a) Previous root canal treatment with incomplete root canal obturation, internal root resorption and a wide open apex; (b) access preparation was performed and working length was determined; (c) a mixture of Bio-Oss and EMD was packed into the apical region by a plugger; (d) canal was filled by thermoplastic technique and coronal seal was achieved by resin-bonded composite.

Bio-Oss is derived from cancellous bovine bone and all organic components and pathogens are removed by chemical extraction [7]. It has been demonstrated that Bio-Oss has morphological and structural properties quite similar to the human bone [8]. Due to the rough topography and its potential in proliferation and synthesis of bone matrix, Bio-Oss is the most frequently used biomaterial in bone regeneration procedures [9]. Enamel matrix derivative (EMD) is a novel approach to stimulate periodontal regeneration [10]. It has been demonstrated that enamel matrix proteins produced from Hertwig's epithelial root sheath via tooth development play an important role in cementogenesis, bone formation and periodontal regeneration [11, 12].

Findings from clinical studies show that the EMD stimulates the regeneration of periodontal tissue including acellular cementum, periodontal ligament (PDL) and alveolar bone [13-15]. Hoang et al. showed that enamel matrix proteins are novel attachment proteins for both periodontal ligament and bone cells [16].

We hypothesized that using both Bio-Oss and EMD could be effective for treatment of open apex teeth with periapical lesions.

As mentioned above these materials cause osteogenesis; which is the critical goal in treatment of teeth with open apices. The aim of this case presentation is to evaluate the use of Bio-Oss and EMD as a biologic apical barrier and osteogenesis inducer in a non-vital tooth with an open apex and periapical lesion.

CASE REPORT

A 26 year-old man was referred to the Department of Endodontics, School of Dentistry, Isfahan University of Medical Sciences, Isfahan, Iran; he was healthy and his past medical history was unremarkable. His chief complaint was pain of the maxillary right canine during mastication. The intraoral examination showed no swelling but the percussion test showed pain on tooth #23. There was no pain on palpation. Radiographic evaluation revealed a large periapical radiolucency around the apex of the maxillary right canine, previous root canal treatment with incomplete root canal obturation, internal root resorption and a wide open apex (Figure 1a). The diagnosis was failure of root canal treatment.

We explained our treatment plan and the patient signed the consent form.

Treatment

After the local anesthesia administration (buccal infiltration) and rubber dam isolation, an occlusal access cavity was prepared; also, all remaining caries and hypomineralized enamel were removed. Working length was determined using an apex locator and radiography with a size 50 K-file (Kerr, Romulus, MI, USA, Figure 1b). Gutta-percha was removed with a Hedstrom file (Maillefer, Ballaigues, Switzerland) and the canal was irrigated with 2.5% sodium hypochlorite.

Because of the long time lapse of open apex and risk of bacterial infection, calcium hydroxide dressing was placed in the canal and the access cavity was temporarily sealed with Cavit (Masterdent, NY, USA). After one week, in the second visit, the canal was irrigated with 2.5 % sodium hypochlorite and dried with paper points. A mixture of Bio-Oss and EMD was packed into the apical region by a plugger (Dentsply, Maillefer, USA). Formation of apical barrier was checked by a size 15 K-file (Kerr, Romulus, MI, USA) and radiography (Figure 1c).

The canal was filled using thermoplastic gutta percha technique with AH26 sealer and coronal seal was achieved by resin-bonded composite (ESPE, Filtek, 3M, St Paul, MN, USA, Figure 1d).

Post-operative follow-up

The size of the periapical lesion decreased significantly after 3, 6, 12 and 18-months (Figure 2a-d). Also the patient had no sign or symptom with no tenderness to percussion or palpation. Periodontal pocket depths and physiologic mobility were normal.

At 24-month follow up, complete maturation of the apex and healing of the periapical bone were confirmed radiographically (Figure 2e).

DISCUSSION

Hertwig's epithelial root sheath is formed by the fusion of inner and outer enamel epithelium; which eventually forms the root [17]. A vital and healthy pulp is required for the thickening of the dentinal walls and closure of the apex.

This process takes about three years to complete after the eruption of the tooth [18]. Various factors such as trauma or caries can lead to the death of pulpal tissues; which inhibits normal root formation [19]. Root canal treatment (RCT) of these teeth is very difficult because lack of apical constriction and the presence of open apex do not allow traditional RCT and an apical seal cannot be achieved with common root filling materials [20]. Thin dentinal walls make the tooth more susceptible to fracture during different periods of treatment [18].

Root-filling materials [21] and irrigation solution can exit the root canal via the open apex. Moreover, the larger apical diameter compared to the coronal segment makes the use of instruments more difficult [22]. The thin dentinal walls do not allow normal cleaning and shaping making the treatment of these teeth even more complicated [23].

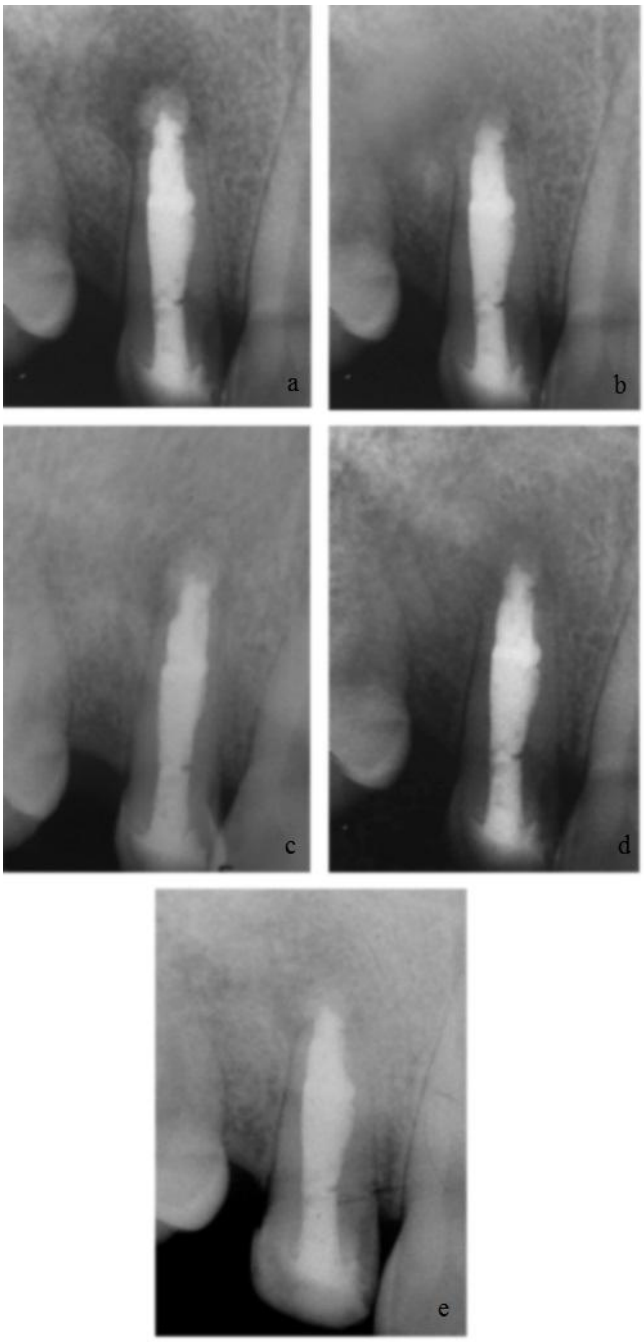

Fig 2. (a) Follow up radiography after 3 months; (b) after 6 months; (c) after 12 months and (d) after 18 months; (e) complete maturation of the apex and healing of the periapical bone were clearly seen.

If an immature tooth becomes non-vital because of caries or trauma, treatment is needed to induce a calcified tissue at the apical end [24]. Various materials have been introduced for this purpose. However, calcium hydroxide is the most commonly used material [25].

Kaiser et al. [26] used this powder with camphorated parachlorophenol to induce a calcified barrier at the apical end. Various techniques have been used for open apex treatment and pulp regeneration inducing the formation of a calcified apical barrier; this treatment is

known as apexification. Creating an artificial apical barrier using MTA is known as MTA Plug used for pulp regeneration [27]. The first two methods have been used for many years but they do not reinforce the weakened structure of the tooth. Therefore, efforts were made to create a new method, which could regenerate the pulp leading to increased dentinal space, increased root length and apical seal formation [20, 28]. This treatment is called regenerative endodontic treatment.

Disadvantages of this treatment include: 1. Long treatment period and multiple treatment sessions; which increase the patient's costs (6 to 24 months) [19], 2. The high pH in the apical region can harm periapical tissues and disable the transformation of undifferentiated mesenchymal cells into odontoblasts [17], 3. The formed barrier is usually incomplete and even in areas that appear complete is full of porosities; which can compromise the apical seal [29], 4. This technique does not increase root length or thickness and makes the tooth more susceptible to fracture [18]. The latter is the most important disadvantage of this technique; which is generally due to the dehydration and proteolytic characteristics of calcium hydroxide [30]. This material removes the organic parts of the dentinal wall so that only the mineral parts remain making the root more susceptible to fracture.

The ideal treatment would be one that increases root length and thickness so that the fracture resistance of the tooth improves. This treatment requires the regeneration of the pulpal tissues [31]. Rule et al. [32] introduced a pulp regeneration technique for creating an apical barrier in non-vital primary teeth. Otsby et al. [33] investigated the regeneration of pulpal tissues in immature teeth but reported controversial results. They believed that provoking the apical tissues would cause blood to enter the pulp; which is essential for the pulp-dentin complex regeneration. This technique is called revascularization.

Recently, a new method has been introduced for regenerating the root of immature teeth; which has shown successful results. This technique requires: (a) proper case selection, (b) tooth preparation, (c) canal disinfection, (d) intra-canal scaffolding and (e) proper coronal seal [19]. The patient must not be over the age of 13 and the tooth should be open apex and without an apical lesion [19]. These teeth should be instrumented preferably with one large file. Disinfecting the root canal is very important which is achieved by sodium hypochlorite irrigation and dressing with calcium hydroxide paste or a combination of three antibiotics (Ciprofloxacin, Metronidazole, Minocycline) [34, 35]. A scaffold is needed for the entrance of stem cells into the canal so that they can differentiate to odontoblasts, osteoblasts, cementoblasts or a combination of them to form a mineralized matrix so that the root can mature [36]. The closure of the root apex is very essential for the success of endodontic treatments [21].

Many materials have been introduced for the apexification procedure [1, 37]. In this case, a mixture of EMD and Bio-Oss was used for apexification; which has major advantages including great handling because it sticks to its holder and can be guided inside the canal, no need to wait for the completion of setting time, exiting the apex has no harmful effects on healing and it is completely absorbent and acts as an osteoconductive agent [12, 38].

It appears that using EMD plus Bio-Oss, which is a tissue regenerator in periodontal lesions, as a sealing plug in root ends is very beneficial because of its osteoconductive properties [13].

Examining the apical barrier in the long-term showed adequate seal and proved to be a part of the physiologic remodeling process. Shariari et al. [39] investigated the effect of the combination of EMD plus Bio-Oss on bone formation in calvarial defects in rabbits.

The results of their study showed that using EMD plus Bio-Oss had synergistic effects on bone regeneration in bone defects. Also, it is demonstrated that EMD and Bio-Oss are biocompatible and osteoconductive [39]. Several clinical studies carried out previously did not report any severe inflammation or histologic reaction [12, 38].

CONCLUSION

Based on the positive effects of EMD and Bio-Oss on bone regeneration and their biocompatibility, these materials can be considered for apexification. More clinical studies should be performed to compare all aspects of these materials to conventional methods.

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