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Management of non-vital traumatized tooth with open apex using Biodentine as an apical matrix: A case report

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Abstract

Pulpal necrosis and an open apex pose a challenge for its endodontic treatment. Traditionally teeth with open apex & pulpal necrosis have been treated using calcium hydroxide to form an apical barrier against which the obturating material can be condensed. Whereas the most contemporary approach to treat such cases is revascularization or regeneration procedure. However considering the multiple appointments and the requirement of long term follow up in both the procedures, patients are more compliant towards single visit apexification procedures using calcium silicate based cements like MTA and Biodentine. This case report presents endodontic management of traumatised tooth with an open apex using biodentine as an apical plug & includes an overview of the materials that can be used for the management of an open apex.

Keywords: Biodentine, immature teeth, Open apex, blunderbuss canal.

Introduction

The immature root with a necrotic pulp presents multiple challenges to successful endodontic treatment. The complete formation of root and closure of the root apex occurs up to 3 years after the eruption of the tooth. [1] Traumatic injury to young permanent teeth during this period may cause pulpal inflammation or necrosis resulting into incomplete development of the dentinal walls and root apices. These teeth present as wide canals with thin dentinal walls and short roots.

The management of a nonvital tooth with open apex consists of the induction of a natural or artificial apical

barrier which can act as a stop for the obturating material. Apexification can be defined as a method to induce a calcific barrier in the root with the open apex of an immature, pulpless tooth. [2]

The goal of this treatment is to obtain an apical barrier to prevent the passage of toxins and bacteria into periapical tissues from the root canal. Technically, this barrier is necessary to allow compaction of root filling material. [3, 4]

Using a suitable biocompatible material the barrier can be achieved that reduces leakage of sealing material and allows favourable response of the periodontal tissues for periapical healing & apexification.

However multiple directions have emerged in the management of this clinical situation that differ from the traditional calcium hydroxide apexification procedure.

Examples are use of an apical matrix of tricalcium silicate based cements like MTA & Biodentine.

Mineral trioxide aggregate (MTA) has been shown to be a very effective root filling material for sealing immature root canals with open apices that could otherwise impose technical challenges in obtaining adequate obturation. MTA has an ability to facilitate periradicular healing by inducing the hard-tissue formation. [5]

The main drawbacks of this class of materials so far have been slow setting kinetics and complicated handling, which rendered these technique sensitive procedures even more difficult and restricted their use. [6]

Biodentine™ is a new calcium silicate based cement of the same type as MTA ®. It exhibits physical and chemical properties similar to those described for certain Portland cement derivatives. [7] Its biocompatibility has also been validated experimentally by Laurent et al. [8]

Based on all its properties, Biodentine™ has been claimed to be a bioactive dentin substitute for the repair of root perforations, apexification and retrograde root filling by the manufacturers. A modified powder composition, the addition of setting accelerators and softeners, largely improved the physical properties of this material making it much more user-friendly with a shorter setting time. [9]

The present article showcases the endodontic management of traumatized tooth with an open apex using biodentine as an apical plug & includes an overview of the materials that can be used for the management of an open apex.

Case report

Chief complaint and Clinical Examination

A 23 years old male patient presented to out-patient department with the complaint of discoloured left upper central incisor (Fig. 1). Electrical pulp testing yielded no response from the tooth of chief concern when compared to the adjacent teeth which responded immediately. No tenderness on percussion was observed. There were no signs of intraoral or extraoral swelling or presence of sinus tract. The periodontal probing was within normal limits. Diagnostic radiograph showed incomplete apical root development & thin dentinal walls. (Fig.2).

Fig.1: Preoperative clinical photograph showing discoloration and Ellis class IV fracture with 21

Fig.2: Diagnostic radiograph revealing open apex and thin dentinal wall with respect to tooth 21

Diagnosis and treatment planning: Based on clinical and radiographic examination diagnosis of immature open apex with Elli's class IV fracture was made with 21. Patient being non- compliant to multiple sitting procedure of regeneration, treatment of apexification using biodentine followed by endodontic treatment and full coverage restoration was planned.

Consent from patient: Procedure was explained to the patient & consent was obtained.

Procedure: Following rubber dam isolation conventional endodontic access was gained.

The working length was established 1 mm short of the radiographic apex using # 30 k file (Fig. 3).

Fig. 3: working length estimation using 30 k file

The canal was gently instrumented till #80 K & H files using circumferential filing motion with copious irrigation with 3% sodium hypochlorite. The canal was thoroughly dried with paper points & Calcium hydroxide was placed as an intracanal medicament and the access cavity was sealed. Patient was dismissed for 2 weeks.

In the next visit the tooth was isolated using rubber dam, calcium hydroxide was removed with H file to working length, while rinsing after alternating solutions of Sodium Hypochlorite & EDTA. Final rinse of normal saline was performed. After drying the canal with paper points Biodentine was mixed following manufacturer's instructions. The MTA carrier was used to carry the mixed material to the canal apex using a pre-fitted stopper 3 mm short of working length & condensed using but end of paper points.2 increments were required to form an apical plug of 5 mm. Following the placement a radiograph was taken before the material did set to ensure the correct placement of the material. (Fig.4)

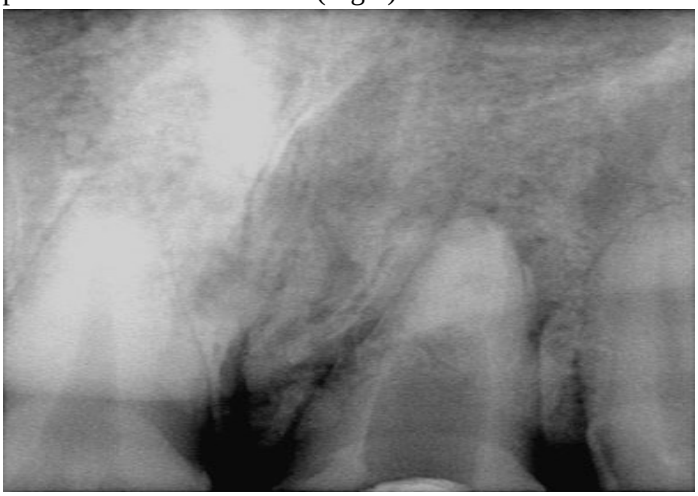

Fig. 4: Radiograph to ensure the correct placement of apical matrix

The paper points & H files were used to clear the walls. The hardness of biodentine was examined with the plugger to confirm the set.The canal was obturated using 0.02 taper Gutta percha with cold lateral condensation technique & Sealapex root canal sealer. The access cavity

was sealed with GIC. Immediate post operative radiograph was taken (Fig 5).

Fig. 5: Immediate post op x ray

The patient was recalled after 1 month. History and clinical examination showed satisfactory healing and an intraoral periapical view was taken which showed adequate periapical response as well.

Complete coverage prosthesis was planned for the tooth post endodontic treatment. Crown preparation was done and a full coverage acrylic crown was luted into place using resin-modified glass ionomer cement to protect the treated tooth and esthetic restoration until the permanent crown was cemented.(Fig 6)

Fig. 6: clinical picture showing the placement of full coverage restoration with 21.

Discussion

Immature permanent teeth pose a special challenge during endodontic procedures not only because of wide open apex but also because of thin dentinal walls. [10, 11] In the conventional procedure the apical induction of barrier takes long time and requires multiple visits. Patient compliance may be poor in such regimen & many fail to return on scheduled visits but the traditional approach has withstood the test of time. [12, 13]

The traditional apexification procedure requires complete canal cleaning, shaping, removal of smear layer and disinfection before the placement of calcium hydroxide to promote the formation of osteocementum or apical bridge formation. This technique is often referred to as the Frank's technique. [14]

The calcium hydroxide kills bacteria, dissolves tissue and creates an environment conducive to hard-tissue formation. [15, 16, 17] The calcium hydroxide is left in canal or changed every 3 months, with intervals as long as 12 months in later stages to enhance the tissue response. [18]

The mean time to barrier formation in incisor teeth has been shown to be 34.2 weeks (range 13 to 67 weeks) [19], but the literature on posterior teeth is unavailable. The tissue response in the traditional technique has been shown to be a gnarled osteocementum type of material. [20]

It is often porous and its formation, thickness, and location are often irregular in nature. It is a valid procedure for both anterior and posterior teeth. However, calcium hydroxide shows certain limitations like the length of time needed to form apical barrier, the number of dressings needed for complete closure of apex, the role of infection caused in the canal in between the appointments and the fracture resistance of the tooth.[21]

Thus there are certain other approaches advocated that include the use of calcium silicate based cements like Biodentine & mineral trioxide aggregate [ProRoot MTA -

Dentsply Tulsa Dental Specialties, Tulsa, OK, USA] [22] and another technique that is referred to by some as revascularization and by others as regeneration within the pulpal space. [23]

The most contemporary approach to the management of teeth with immature root formation and either irreversible pulpitis and periapical periodontitis [24,25,26,27,28] or necrotic infected pulps [29,30] has been promulgated as revascularization, [31] or even regeneration. [32, 33, 34]

In their infancy, these techniques claimed to be taking advantage of the pluripotential cells in the dental papilla and/or periodontal ligament, inducing them to form hard tissue into the root canal or to somehow continue the development of Hertwig's epithelial root sheath. [35]

However over the past decade there is an increasing trend towards single visit dental treatments & thus the materials used for single visit apexification have become more popular than traditional approach or contemporary revascularization procedures. In the case presented here patient was not compliant towards multiple visit & long term treatment plan and thus regeneration was not considered an option.

In contrast to traditional procedure or revascularization, apexification using calcium silicate based cements provide an alternative treatment modality in immature pulpless teeth which can be completed in single visit. Morse et al define one visit apexification as the non surgical condensation of biocompatible material into apical end of the root canal. [36] The rationale is to establish apical stop that would enable the root canal to be filled immediately. There is no attempt made to close the root apex but an artificial stop is created.

The advantages of using an apical plug or matrix includes decreased number of patient visits, more predictable apical barrier formation and reduced need for follow up appointments & reduced risk of bacterial contamination due to loss of coronal seal between the appointments.

Mineral trioxide aggregate (MTA) was the first material to be used to induce apical third barrier in single visit apexification procedures.

But long setting time of ProRoot MTA is a major shortcoming of the material, apart from difficult handling characteristics, discoloration potential (gray MTA), low washout resistance and high material cost. [37, 38]

Recently, various new Calcium silicate based cements have been introduced including Biodentine (Septodont, Saint-Maur-des-Fosses, France). Biodentine has been promoted as a dentin substitute which can also be used as an endodontic repair material. The powder component mainly consists of tricalcium silicate, with the addition to the powder of $CaCO_3$ and ZrO_2. The liquid component has calcium chloride ($CaCl_2$), as setting accelerator, in the water reducing agent. [39]

Biodentine can be used as an effective alternative to MTA as highlighted through this case presentation. Apexification with Biodentine requires significantly less time. [40]

This can lessen the treatment time. Biodentine has superior biocompatibility and sealing ability and is less cytotoxic than other materials currently being used in pulpal therapy. [41]

About et al. investigated Biodentine™ bioactivity by studying its effects on pulp progenitor cells activation, differentiation and dentine regeneration in human tooth cultures. The study concluded that Biodentine™ is stimulating dentine regeneration by inducing odontoblast differentiation from pulp progenitor cells. [42]

Laurent et al. investigated the capacity of Biodentine™ to affect transforming growth factor-β1 (TGF-β1) secretion from pulp cells and concluded that Biodentin caused a significant increase of TGF-β1 secretion from pulp cells,

thus inducing an early form of dental pulp mineralization shortly after its application. [43]

Han and Okiji compared calcium and silicon uptake by adjacent root canal dentine in the presence of phosphate buffered saline using Biodentine™ and ProRoot ® MTA. Their results showed that both materials formed a tag-like structure composed of the material itself or calcium-or phosphate rich crystalline deposits.

The thickness of the Ca-and Si-rich layers increased over time, and the thickness of the Ca-and Si-rich layer was significantly larger in Biodentine™ compared to MTA after 30 and 90 days, concluding that the dentine element uptake was greater for Biodentine™ than for MTA. [44]

Kokate and Pawar conducted a study that compared the microleakage of glass ionomer cement, MTA, and Biodentine™ when used as a retrograde filling material and concluded that Biodentine™ exhibited the least microleakage when compared to other materials used. [45]

Biodentine shows a considerable performance even after contamination with the endodontic irrigants like sodium hypochlorite, chlorhexidine or saline (Gunesar et al 2013) [46]

Research suggests that a high pH and released calcium ions are required for a material to stimulate mineralization in the process of hard tissue healing. Sulthan studied the pH and calcium ion release of MTA and Biodentine™ when used as root end fillings. He concluded that Biodentine™ presented alkaline pH and ability to release calcium ions similar to that of MTA. [47] The 24-hour push-out strength of MTA was less than that of Biodentine. Blood contamination affected the push-out bond strength of MTA Plus irrespective of the setting time. [48]

This case report emphasizes the novel approach of using Biodentine to achieve single visit apexification of the cases with an open apex. Biodentine, is a new boon in effective management of teeth with open apex, unlike MTA it has better handling property and its setting time is faster and has an improved mechanical property .This innovative procedure is predictable and less time consuming.

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