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CASE REPORT

Apexification Using Mineral Trioxide Aggregate and Modified Internal Matrix: A Case Report

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Abstract

When pulpal necrosis occurs in immature teeth, one of the treatment alternatives is the creation of an artificial apical barrier through the placement of an apical plug. However, controlling the mineral trioxide aggregate (MTA) during placement has proven difficult. Several studies evaluated the use of resorbable barriers to act as an internal matrix to prevent accidental extrusion of MTA. The aim of this case report was to document the effectiveness of Surgicel as a modified internal matrix for proper placement of MTA during management of immature teeth with necrotic pulp using the apical plug technique. A 12-year-old female patient reported with the chief complaint of a badly mutilated lower right second premolar. The tooth suffered enamel hypoplasia and had a defective coronal structure. It was asymptomatic except for slight tenderness to percussion. Based on the clinical and radiographic findings, a diagnosis of pulpal necrosis with symptomatic apical periodontitis was made. The 3- and 6-month followup showed radiographic evidence of continued root and hard tissue formation. Based on these findings, we infer that Surgicel can be used as a modified internal matrix to prevent extrusion of the MTA into the periapical area and allow for proper MTA placement.

Keywords: Apexification; Apical plug; Mineral trioxide aggregate; Calcium hydroxide; Surgicel; Modified internal matrix

Introduction

When pulpal necrosis occurs in immature teeth, their roots usually have thin, fragile walls, making it difficult to clean and to limit the plugging material so as to avoid its extrusion into the periapical area.

Traditionally, calcium hydroxide ($Ca[OH]_2$) has been used to induce apexification which involves inducing a calcified barrier in the root of the tooth with necrotic pulp and open apex. The disadvantages include variability in the treatment time, uncertainty of apical seal formation, and delayed treatment completion.[1]

Mineral trioxide aggregate (MTA) apexification has the advantage of shorter treatment duration. However, Jeeruphan et al demonstrated that apexification with either $Ca(OH)_2$ or MTA completely prevented any further root development in terms of increase in the radiographic measures of either root length or width.[1] Another drawback is the difficulty in handling which makes packing of MTA into the apical part without risking extrusion, a rather complicated procedure. Moreover, the extruded MTA in the periapical area may remain unset and affect the healing process.[2]

Several studies evaluated the use of resorbable barriers to act as an internal matrix and prevent unintentional extrusion of MTA during its placement. Gharechahi and Ghoddusi demonstrated that resorbable collagen may be successfully used as a periapical barrier.[2] Al-Daafas and Al-Nazhan found that the use of calcium sulfate as an internal matrix prevented MTA extrusion into the contaminated perforated area, but it caused an inflammatory reaction.[3]

Surgicel (oxidized regenerated cellulose) is a hemostatic material used to assist in the control of small hemorrhages and oozing blood. It decreases the pH of its surroundings, thus creating an antimicrobial effect. The dissolution of Surgicel depends on the quantity, site of implantation, and the environmental factors, and the process may take anywhere between two and six weeks.[4]

The purpose of this case report was to document the effectiveness of using Surgicel as a modified internal matrix to allow for proper placement of MTA during management of immature teeth with necrotic pulp using the apical plug technique.

Case Presentation

A 12-year-old female patient reported to the Dental and Maxillofacial Department of the Bahrain Defence Force Hospital with the chief complaint of a badly mutilated lower right second premolar. On examination, the tooth was noted to have suffered enamel hypoplasia that resulted in a defective coronal structure and extension of the defective parts' margins subgingivally. No other dental or mobility-related findings were noted. The tooth was generally asymptomatic except for slight tenderness to percussion. Thermal tests showed no response, but radiographic findings revealed incomplete root formation, a wide open apex, thin fragile root walls in the apical region, radiolucent area in the periapical region, and a slightly enlarged periodontal membrane space (Figure 1). Based on the clinical and radiographic findings, a diagnosis of pulpal necrosis with symptomatic apical periodontitis was made.

Pulp regeneration was not recommended as the coronal structure was greatly affected, and a post-supported core build-up was a necessity. Instead, apexification using MTA was the treatment of choice.

Figure 1: Pre-operative periapical radiograph showing the immature mandibular second premolar associated with open apex and periapical radiolucency.

A written consent was obtained from the patient's guardian indicating their approval and understanding of the procedure in terms of its management and prognosis as well as its adverse effects.

First Visit

After administration of local anesthesia, access was achieved using the cavity access set (DENTSPLY Maillefer, Ballaigues, Switzerland) under x16 magnification of a dental operating microscope (M320 Leica, Germany). The canal was gently debrided using Hedstrom Files size # 50 (DENTSPLY Maillefer, Ballaigues, Switzerland) followed by copious irrigation with freshly prepared 3% sodium hypochlorite (NaOCl) using a side-vent irrigation needle. The working length was determined radiographically with a K-File placed in the canal. The canal was dried using sterile paper points. Calcium hydroxide (AH Temp, DENTSPLY De Trey, Konstanz, Germany) was introduced into the canal using a flexible cannula and the cavity was sealed with a temporary filling.

Second Visit

After 2 weeks, the tooth was found to be asymptomatic with no signs or symptoms of inflammation or infection. After rubber dam isolation and removal of the temporary filling, the canal was irrigated with 3% NaOCl and 17% ethylene diaminetetra acetic acid (EDTA) (TG cleanser - Technical & General Ltd, UK). Irrigation activation was done using the EndoActivator (DENTSPLY Tulsa Dental, Tulsa, OK). The canal was dried and a small piece (1 cm x 1 cm) of Surgicel (ETHICON, USA) was pre-cut, inserted, and pushed into the periapical area using Dr. Machtou Plugger size #1-2 (DENTSPLY Maillefer, Ballaigues, Switzerland), under a dental microscope. White Pro-Root MTA (DENTSPLY Maillefer, Ballaigues, Switzerland) was mixed to a thick creamy consistency, according to the manufacturer's instructions, and placed in the canal using an MTA carrier (Messing Gun, Produits Dentaires, Vevey, Switzerland). MTA was condensed with the butt end of sterile damp paper points to obtain a 4-mm MTA plug-in thickness. After confirming the MTA plug level and thickness radiographically, a wet cotton pellet was added coronal to the MTA mass to allow for proper hydration and the cavity was sealed with a temporary filling.

Third Visit

Two days later, after rubber dam isolation and removal of the temporary filling, the canal was irrigated with 3% NaOCl and 17% EDTA using an Endo Activator. The canal was then dried and obturated using injectable, heated gutta-percha – cartridge size #23G was used and operated by Calamus Dual (DENTSPLY Maillefer, Ballaigues, Switzerland). Finally, an X-Post size #2 was cemented with the core build-up to restore the coronal structure (Core & Post Solution, DENTSPLY De Trey GmbH, Konstanz, Germany).

Followup

The patient was recalled at the end of 3- and 6-month intervals, and the tooth was evaluated clinically for any signs or symptoms. Apical closure and hard tissue formation were noted radiographically (Figures 2 to 4). Finally, a full-coverage coronal restoration was recommended.

Figure 2: Post-operative periapical radiograph at 3-month interval.

Figure 3: Post-operative periapical radiograph at 6-month interval.

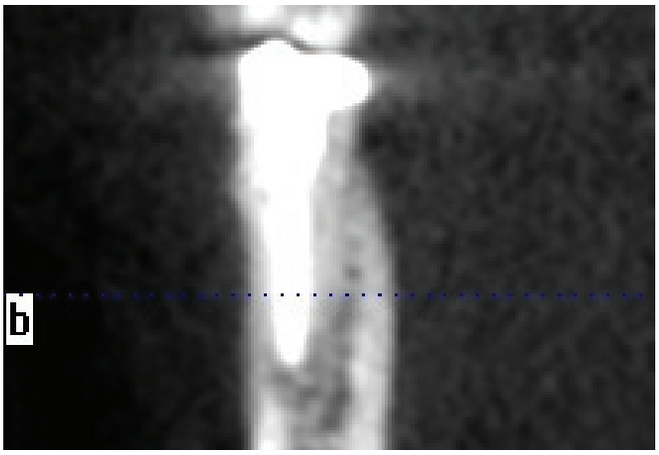

Figure 4: Post-operative Cone beam computed tomography (CBCT) at 6-month interval.

Discussion

The major problem in cases with a wide open apex is the need to limit the treatment material to a working length, preventing extrusion of a large amount of it into the periapical area which may lead to persistent inflammation. Lemon et al introduced the "internal matrix concept" for the treatment of root perforations. They recommended placement of hydroxyapatite through the perforation to form an external barrier that would prevent extrusion of the repair material.[5]

In this case, the canal was irrigated using NaOCl and aqueous 17% EDTA solution. The combination of these two irrigants used alternatively has been shown to be effective in removing the smear layer and the pulpal remnants from within the canal system. Moreover, the activation of irrigating solutions has been proposed to enhance their action and penetration. The EndoActivator is designed to improve the irrigation phase. It is a cordless, battery-powered handpiece with a sonic motor. Its design allows for the safe agitation of intra-canal solutions and can produce vigorous intra-canal fluid agitation.[6]

One of the characteristics of MTA as a bioactive material is its ability to form an apatite-like layer on its surface when it comes in contact with physiologic fluids in vivo. Investigations have shown that it can conduct and induct hard tissue formation through the release of calcium ions for cell attachment and proliferation as well as providing an antibacterial environment by its alkaline pH. It modulates cytokine production, encourages differentiation and migration of hard tissue-producing cells, and acts as a biologic seal.[7]

The difficulty in handling MTA has been viewed as one of its shortcomings. Various carriers such as Teflon sleeves, specially designed pluggers and carriers have been used to enhance the ease of handling. Several authors compared manual and ultrasonic placement of MTA of varying thicknesses. The results showed that the manual method resulted in better adaptation with fewer voids than the ultrasonic method for all thicknesses.[8] Other investigations compared the effect of the condensation pressure on the compressive strength and microstructure of MTA. The outcomes revealed that the surface hardness decreased when more pressure was applied during MTA condensation and greater condensation pressure resulted in fewer voids and micro-channels. The authors hypothesized that with the application of greater condensation pressure, the material became more compact with fewer micro-channels, and they attributed the reduced compressive strength and surface hardness to reduced water uptake that hindered complete MTA setting.[9]

Bargholz introduced the modified internal matrix concept. He recommended the use of collagen as a completely resorbable barrier material and MTA as a perforation repair material.[10] The same concept is utilized for the placement of the MTA apical barrier in immature teeth – using a matrix avoids the extrusion of the material into the periodontal tissues and allows a favorable response of the periodontal tissues. Various materials such as $Ca(OH)_2$, hydroxyapatite, collagen, calcium phosphate, and tricalcium sulphate were investigated for use as a matrix.

Gharechahi et al demonstrated that resorbable collagen can be successfully used as an extra-radicular barrier. They reported that the collagen barrier not only prevented the extrusion of the MTA apical plug but also prevented the contact of MTA with tissue fluids and blood during the plug insertion which in turn reduced the optimum water-to-powder ratio that is essential to produce the necessary physical and chemical properties of the resultant set material. They concluded that the hydration process was adversely affected, leading to a set MTA mass of inferior physical and chemical properties.[2] Similarly, a study using an animal model by Shabahang revealed that when MTA was in contact with periapical tissues, it induced a hard tissue barrier; however, when collagen was in contact with periapical tissues, no apical hard tissue barrier was formed.[11]

In our case, Surgicel was pushed through the apical foramen into the periapical area followed by placement of MTA, mixed into a thick creamy consistency, in the canal to form a 3-4 mm thick MTA plug to allow for optimal setting.[12] The Surgicel was used as a modified internal matrix that

allowed MTA to come in contact with physiological fluids such as blood for proper hydration to achieve optimum physical and mechanical properties. Clinically, it prevented extrusion of the MTA into the periapical region, thus preventing a poor-quality MTA mass that could adversely affect the healing and trigger an inflammatory reaction.

Conclusion

Within the limitation of this case report, we arrived at the conclusion that Surgicel can be used as an alternate modified internal matrix to prevent extrusion of MTA when used as an apical plug. However, further studies are needed to show the long-term biological effects of Surgicel on the surrounding periapical area and the rate of its resorption. Clinical and histological studies are needed to evaluate the dissolution rate of Surgicel in the periapical area and investigate the risk of any adverse effects.

Conflict of Interests

The author has no conflict of interest to declare.

Ethical Statement

This case report was approved by the research ethics committee, Bahrain Defence Force Hospital.

The patient's guardian's approval and signed informed consent was obtained before initiating the treatment/procedure.

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