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CASE REPORT

Pulp Revascularization in an Immature Mandibular Premolar Associated with Pulp Necrosis and Sinus Tract Discharge: A Case Report

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Abstract

Owing to the popularity of pulp regenerative procedures, the American Association of Endodontics (AAE) issued guidelines based on clinically proven protocols that govern such procedures. Our aim was to follow the pulp regeneration guidelines recommended by the AAE and evaluate the outcome.

A 12-year-old male patient reported with the chief complaint of dull, spontaneous, repetitive pain episodes related to the lower left second premolar accompanied by sinus tract discharge. A diagnosis of pulpal necrosis with symptomatic chronic periapical abscess was made.

Following endodontic access, irrigation with sodium hypochlorite was done followed by the application of a triple antibiotic paste as intracanal medication. At the second visit, irrigation, blood clot induction through laceration of the periapical area, and placement of a mineral trioxide aggregate seal were performed. The third visit involved clinical assessment and placement of a permanent coronal seal. Followup was done after 3 and 6 months.

Clinical resolution was achieved within 3 weeks of initiation of treatment, and radiographic evidence of continued root development was observed during the 3rd month followup visit.

In conclusion, adherence to the AAE guidelines for pulp regeneration resulted in resolution of the clinical symptoms with an outcome that may be considered successful both clinically and radiographically.

Keywords: Anti-bacterial agents, Bicuspids, Mineral trioxide aggregate, Periapical abscess, Sodium hypochlorite

Introduction

When pulpal necrosis occurs in a permanent immature tooth, the ideal treatment approach would be to promote continued root development and restore the pulp vitality in terms of function and cellular structure.

Traditionally, calcium hydroxide ($Ca[OH]_2$) was used to induce apexification, which involves induction of calcific barrier formation in teeth with necrotic pulp and open apex. The disadvantages include variability in the treatment time and uncertainty of apical seal formation. Mineral

trioxide aggregate (MTA) apexification has the advantage of shorter treatment duration. However, Jeeruphan et al reported that apexification by either $Ca(OH)_2$ or MTA completely prevents any further root development in terms of increase in the root length or width.[1]

It has been reported in the literature that when necrotic canals of monkey canines with immature apices were filled with citrated whole blood or gel foam after disinfecting with sodium hypochlorite (NaOCl), there was continued root development.[2]

The term revascularization refers to the restoration of blood supply in the pulp of traumatized teeth with ischemia. Endodontic regenerative procedures depend on the presence of an enriched source of stem cells within the apical papilla, and the release and use of local growth factors embedded in the dentin.[3]

Iwaya et al showed that disinfection of necrotic tissue with NaOCl in an immature premolar followed by ciprofloxacin and metronidazole medications resulted in continued root formation and clinical evidence of re-innervation. Banchs and Trope reported a similar outcome after disinfection with NaOCl and chlorhexidine (CHX) followed by placement of an triple antibiotic paste (TAP) consisting of metronidazole, ciprofloxacin, and minocycline.[4,5] Both these case reports illustrated three important principles of endodontic regenerative procedures: 1) elimination of bacteria from the canal system, 2) creation of a scaffold for the ingrowth of new tissue, and 3) prevention of reinfection by creating a bacteria-tight seal.

Owing to the popularity of the regenerative procedure, the American Association of Endodontics (AAE) issued guidelines based on clinically proven protocols that govern such procedures. The aim of this case report was to follow the AAE guidelines for pulp regeneration procedure and evaluate the outcome.[6]

Case Report

A 12-year-old male patient reported to the Dental and Maxillofacial Department of the Bahrain Defence Force Hospital, with the chief complaint of spontaneous, repetitive episodes of dull pain in the lower left second premolar with occasional swelling and a yellowish discharge. On examination, the tooth had intact coronal structure but no mobility and was tender to percussion accompanied by a sinus tract discharge. Radiographic findings showed incomplete root formation, a wide open apex, thin fragile root walls apically, radiolucency in the periapical region, and a slightly enlarged periodontal membrane space (Figure 1). Thermal and electric pulp sensibility tests did not elicit any response. Based on the clinical and radiographic findings, a diagnosis of pulpal necrosis with symptomatic chronic periapical abscess was made.

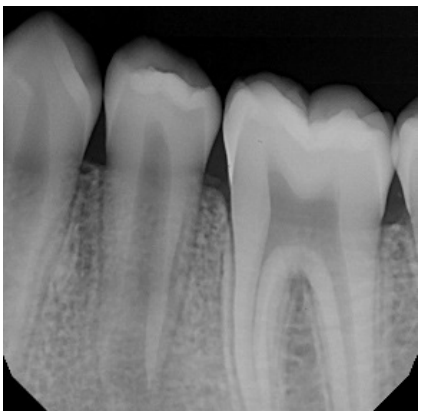

Figure 1: Pre-operative radiograph showing the immature root with open apex and radiolucency

Informed Consent

A written informed consent was obtained from the patient's guardian denoting their approval and understanding of the procedure in terms of its management and prognosis.

First Visit

Topical lidocaine (Xylocaine spray, AstraZeneca, Sweden) was applied for anesthesia as a local anaesthetic could not be used due to the necrotic tooth. After rubber dam isolation, access was obtained with a cavity access set (DENTSPLY Maillefer, Ballaigues, Switzerland) under a dental operating microscope (M320 Leica, Germany) at x16 magnification. The canal was gently filed using Hedstrom Files size #50 (DENTSPLY Maillefer, Ballaigues, Switzerland) followed by copious irrigation with freshly prepared 1.25% NaOCl using a side-vent irrigation needle. The canal was dried using sterile paper points. The TAP (equal volumes

of metronidazole, ciprofloxacin, and minocycline mixed in 1:1:1 ratio with sterile water) was introduced into the canal using a Lentulo spiral, and the cavity was then sealed with a temporary filling.

Second Visit

The symptoms were evaluated after 3 weeks, and the tooth was found to be asymptomatic with complete resolution of the sinus tract discharge. After rubber dam isolation and temporary restoration removal, irrigation was done with NaOCl 1.25% to remove the TAP. This was followed by irrigation with 17% EDTA (TG cleanser - Technical & General Ltd – UK) and laceration of the apical tissues to create a blood clot within the canal space just below the cemento-enamel junction using an endodontic explorer. Once bleeding was achieved, MTA was added using a carrier (Messing Gun, Produits Dentaires, Vevey, Switzerland) and gently packed. The cavity was then sealed with a temporary filling.

Third Visit

The 3rd visit was scheduled for two days later to allow for optimal effect of the physico-mechanical properties of the set MTA. The tooth was found to be asymptomatic. A composite filling was placed coronally to seal the access cavity, after rubber dam isolation and removal of the temporary filling.

Followup

The patient was recalled at 3- and 6-month intervals (Figure 2). The tooth was evaluated clinically and radiographically for any signs or symptoms. Radiographic images showed evidence of increased root length, thickness, and resolution of periapical radiolucency. Also, a small calcific bridge was noted at the mid-root level. Complete apical closure was noted at the 3-month followup visit with obliteration of canal space at the apical level; the canal was still wide, coronal to that area and apical to the calcific bridge. Radiographs at the 6-month followup visit showed further root development and root wall thickening as well as complete periodontal and periapical healing (Figures 3 and 4).

Figure 2: 3-month followup periapical radiograph showing root development and resolution of radiolucency.

Figure 3: 6-month followup periapical radiograph showing further root development and complete resolution of radiolucency.

Figure 4: 6-month followup Cone beam CT image showing further root development and complete resolution of radiolucency.

Discussion

In the initial phases of pulpal inflammation, vital pulp therapy may be effective in maintaining the ability of the radicular pulp to continue root formation in immature teeth. When there is radicular infection involving immature teeth, the current treatment options include apexification with $Ca(OH)_2$, MTA plug technique, or regenerative endodontics.

The long-term use of $Ca(OH)_2$ for apexification has many disadvantages such as multiple treatment

appointments, possible re-infection, and root dentin weakening, which might increase the risk of cervical root fractures. The MTA had the advantage of treatment completion in a considerably lesser period of time with predictable results. Moreover, using an MTA apical plug resulted in a more uniform apical barrier formation and reduced the need for further appointments.[7] However, the disadvantage was that it only addressed the apical opening and did not induce further root development. Furthermore, an accurate determination of the root length is required to ensure complete canal debridement and confine the treatment materials to the canal space to avoid extrusion into the periapical area resulting in inflammatory reaction and possible damage to adjacent structures.

Different terms such as revascularization, regeneration, and revitalization are used to describe the introduction of new tissue into the canal space. The term revascularization describes the re-establishment of the vascular supply in immature permanent teeth. Revitalization refers to the ingrowth of tissue that may not resemble the original lost tissue. Regeneration is the replacement of damaged structures including dentin and root structures, as well as cells of the pulp-dentine complex.[3]

Since the early 2000s, there have been several case studies that showed successful regeneration of tissue in the necrotic canal space of permanent teeth with immature apices. There were some differences in their management such as the types and concentration of irrigants and intra-canal medications, number of appointments, length of time between appointments, creation of a blood clot versus use of another scaffold type, type of pulp space barrier, and final restoration. However, despite the variations in treatment, almost all of them resulted in the resolution of apical pathosis and increased the root length and thickness, providing a morphology that was more appropriate for conventional endodontic therapy if future treatment became necessary.[8]

Jeeruphan et al evaluated the outcome after revascularization and reported a survival rate of 100% in comparison to the survival rate of 95% for MTA apexification and 77% for $Ca(OH)_2$ apexification, respectively.[1]

The majority of published cases have reported resolution of pain and sinus tract discharges, healing of apical periodontitis, continued root development, and overall high rate of tooth survival.[1] Similarly, the current case report showed clinical success such as resolution of sinus tract discharge, resolution and continued absence of symptoms, and restoration of function.

Current protocols that involve inducing a blood clot in the disinfected canal space result in the production of different histologic elements of the pulp tissue such as fibroblasts, blood vessels, and collagen. However, other cell types such as odontoblasts were missing. Additionally, non-targeted cell types or tissues might be found such as osteoblasts and cementum.[9]

Many authors found MTA to be a biocompatible material that stimulates biosynthetic activity of periradicular cells and hard tissue formation due to its ability to form an apatite-like layer on its surface when it came in contact with physiological fluids in vivo.[10] Some authors also noted that placement of MTA in the cervical area of the tooth prevented the formation of mineralized tissues in that area, which clearly is critical for the mechanical strength of the tooth. Discoloration of the crown and horizontal fractures in the cervical area have been mentioned in recent reports in which MTA was placed cervically.[11] This outcome raises concerns of failure of current regenerative protocols that depend on MTA.

Another crucial factor is the apical diameter. Research showed that a large apical opening allows for ingrowth of vasculature and stem cells.[12] In our case report, radiographic evaluation showed evidence of successful increase in the root length, increased thickness of root walls, and resolution of periapical radiolucency. In addition, the radiograph at the 3rd month followup showed a small calcific bridge at the mid-root level and complete apical closure with obliteration of the canal space at the apical level while the canal was still wide, coronal to that area and apical to the calcific bridge. However, thickening of the dentin wall was evident along the entire length of the root.

One also needs to take into consideration the antimicrobial efficacy needed to prevent bacterial irritation of the regenerated tissue, with minimal toxicity. It is known that 2.5%-5.25% NaOCl and 2% CHX are among the most effective antimicrobials. However, in vitro and animal model studies have shown that these materials may be toxic to stem cells of the apical papilla at these concentrations and could prevent adhesion of stem cells to dentin. They may also adversely affect the bioactivity of growth factors sequestered in the dentin. Therefore, current clinical guidelines recommend the use of 1.25% NaOCl.[13] In our case, 17% EDTA irrigant was also used due to its ability to release and expose growth factors from the dentin.[14]

The use of antibiotics has also been recommended for their relatively reduced toxicity and potential residual effects during the tissue re-growth phase. Different combinations of antibiotics have been proposed, the most common being the TAP.[14] In our case report, the antibiotics were mixed in a ratio of 1:1:1 using sterile water to form a creamy mix, as per the AAE guidelines.

Conclusion

Within the limitation of this case report, we arrived at the inference that adherence to the AAE guidelines for pulp regeneration resulted in a successful resolution with an outcome that was acceptable both clinically and radiographically.

Conflict of Interests

The author has no conflict of interests to declare.

Ethical Statement

This case report was approved by the research ethics committee of 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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