

Revascularization/Regeneration Performed in Immature Molars: Case Reports

Sönmez IS*/ Akbay Oba A**/ Erkmen Almaz M***

These 3 case reports the outcome of revascularization treatment in necrotic immature molars. During treatment, a tri antibiotic mix was used to disinfect the pulp for 2 weeks. Then a blood clot was created in the canal, over which mineral trioxide aggregate was placed. After 24 months, the immature molars showed continuation of root development. The patients were asymptomatic, no sinus tracts were evident and apical periodontitis was resolved. Results from these cases show that revascularization/regeneration using 3Mix-MP method could be effective for managing immature permanent molar teeth with pulpal necrosis.

Keywords: Immature permanent teeth, MTA, pulpal necrosis, revascularization

INTRODUCTION

Endodontic treatment of an immature permanent tooth with pulp necrosis is a very difficult and time consuming procedure for both patients and dentists. The traditional treatment of such a tooth is apexification, that involves long-term application of calcium hydroxide.^{1,2} Apexification induces further development of an apex to close the foramina with a calcific barrier,^{3,4} but has a disadvantage of a requirement for multiple visits and a long time period before completion of a root filling. More recently, placement of mineral trioxide aggregate (MTA) acting as an artificial barrier for the alternative apexification protocol has been used. With this technique, the duration of treatment is shortened and is generally completed in one or two appointments.⁵ However, both calcium hydroxide or MTA placement do not promote the continued development of the root⁶, so with a thin root dentin and large canal lumen, the tooth is prone to fracture.³

Pulp tissue of an immature open-apex tooth has a great potential to regenerate in response to damage, owing to its rich blood supply and stem cells. Therefore to allow successful apexogenesis (normal development of the root apex of a tooth) to occur, diseased open-apex teeth should be treated as conservatively as possible.² Contrary to apexification, apexogenesis encourages a longer and thicker dentinal composed root to develop.⁵ In recent years, the concept of 'Pulp Revascularization/regeneration' therapy has been developed, that attempts to obtain a longer and thicker root.⁷ The key factor for

the success of revascularization/regeneration procedure is disinfection of the root canal system.¹ For the disinfection of the infected root canals; various combinations of antibiotics have been shown to be effective, one example is a mixture of ciprofloxacin, metronidazole, and minocycline. Also in an *in vitro* study the tri-antibiotic paste (mixture of ciprofloxacin, metronidazole, and minocycline) has been shown to sufficiently potent to eradicate bacteria from the infected dentin root canals.⁸

The purpose of these case reports was to examine the effects of pulp revascularization/regeneration with 3Mix-MP paste (including ciprofloxacin, metronidazole, minocycline with propylene glycol and macrogol) for immature necrotic permanent molars.

Case Reports

Three patients, each with an immature permanent molar tooth with pulp necrosis, who referred to the Pediatric Dentistry Clinic of Kırıkkale University Faculty of Dentistry, Kırıkkale, Turkey, were attended to the study. Clinically, all teeth presented deep carious lesions and radiographically, the teeth had an immature apex with periapical radiolucency. Vitality, percussion and palpation exams were performed on the teeth and adjacent teeth. The diagnosis of pulp necrosis and chronic apical abscess was made for the teeth. As the parents did not want extraction of the teeth, other treatment options were offered to the parents. The treatments were carried out with institutional review board approval. The procedures, possible discomforts or risks, as well as possible benefits were explained fully to the parents' of children involved, and their informed consent was obtained prior to the investigation.

The teeth were anesthetized with a local injection of Ultracaine DS (articaine hydrochloride 4% with epinephrine 1:100,000) and isolated with rubber dam. The access cavity was prepared and the root canal was gently flushed with 10 ml of 5.25% NaOCl solution positioned 1-2 mm below the root canal orifice. Then the canal was dried with sterile paper points (DiaDent, Burnaby, BC, Canada) and 3Mix-MP paste was prepared as described by Hoshino *et al*,⁸ placed in the root canal and left for 2 weeks. The access cavity was sealed with Cavit G (3M ESPE, St. Paul, MN, USA). In the next visit, if the teeth were symptom free, the paste was removed by rinsing with

* Işıl Şaroğlu Sönmez, DDS, PhD, Associate Professor. Adnan Mendres University, Faculty of Dentistry, Department of Pediatric Dentistry, Aydın, Turkey

** Aylin Akbay Oba, DDS, PhD, Associate Professor.

*** Merve Erkmen Almaz, DDS, Research Assistant.

Send all correspondence to: Işıl Şaroğlu Sönmez, Adnan Mendres Üniversitesi, Dis Hekimliği Fakültesi, Pedodonti AD, Aydın, Turkey

Tel: +90 318 224 36 18

Fax: +90 318 225 06 85

E-mail: isilsaroglu@yahoo.com



Figure 1. (Case 1) (A) A 9 year-old girl presented with a temporary filling on tooth #46. Conventional endodontic treatment had been started to apply, but not continued. A periapical radiograph showed an open apex associated with a large radiolucency. (B) 24 months follow-up radiograph showing apical closure, thickening of the dentinal walls and resolution of apical radiolucency.

5.25% NaOCl, then the canal was dried with sterile paper points. A size #15 K-file was used to evoke bleeding into the root canal. The bleeding was allowed to reach a level of 3 mm below the cemento-enamel junction and the tooth was left for 15 minutes to form a blood clot.⁶ Then a grey mineral trioxide aggregate (ProRoot MTA, Dentsply, Maillefer) was placed over the blood clot in the canal followed by a wet cotton pellet and sealed with Cavit G. In the next visit, the teeth were restored with a composite resin.

At the 24 month follow up, all patients continued to be asymptomatic, and continued thickening of the dentinal walls with apical closure was obvious. The radiographs showed complete resolution of periapical radiolucencies (Fig 1-3).

DISCUSSION

In recent years, the concept of ‘Pulp Revascularization/regeneration’ therapy that employs the use of a mixture of ciprofloxacin, metronidazole, and minocycline for disinfection of infected root canals have been used successfully in many studies.^{6,9-15} In endodontic treatment



Figure 2. (Case 2) (A) A 9 year-old boy presented with a deep carious lesion on tooth #26. A periapical radiograph showed an open apex associated with a large radiolucency. (B) At 24 month follow-up apical periodontitis was resolved and there was radiographic evidence of proceeding root development.

to understand the target bacteria, oral lesions have been analyzed under strict anaerobic conditions in the studies.¹⁶⁻¹⁸ According to the results of these studies antibacterial drugs were selected. The first choice was metronidazole, because it has a wide bactericidal spectrum against anaerobes.¹⁹ However metronidazole should be mixed with two other drugs, e.g., ciprofloxacin and minocycline, to eliminate all the bacteria, thus some bacteria in lesions were resistant to metronidazole.^{20,21} Some *in vitro* and *in situ* studies showed that the use of tri-antibiotic paste provides effective disinfection;^{8-10,22} therefore in the present cases we have used the tri-antibiotic paste for disinfection of necrotic permanent molars.

MTA has been reported as a biocompatible material that prevents microleakage and promotes regeneration of the original tissues when it is placed in contact with the dental pulp or periradicular tissues.^{7,23} Based on its known beneficial properties, in the present cases mineral trioxide aggregate was used as a coronal plug.

In the present case reports, after 24 month follow-up all three teeth that received revascularization/regeneration treatment were asymptomatic, and improvement in apical periodontitis was observed.



Figure 3. (Case 3) (A) A 9 year-old girl presented with a deep carious lesion on tooth #36. A periapical radiograph showed an open apex associated with a large radiolucency. (B) 24 month follow up radiograph showing closure of the apex. Complete resolution of the radiolucency can be seen.

There was radiographic evidence of proceeding root development. No clinical or radiographical sign of any pathology was present. All canals were treated conservatively; no instrumentation was done in the root canals and canal cleaning was performed by irrigation with 5.25% NaOCl solution. It is suggested that residual viable pulp tissues in the root canal system may provide further development of the root in immature teeth, therefore minimum instrumentation and disturbance of the canal preserve more viable pulp tissues.²

As our study in many revascularization/regeneration studies successful outcomes have been reported.^{13,24,25} However, in all of the studies different techniques were followed. Ding *et al*,⁶ Jung *et al*,¹² Banchs and Trope²⁶ and Thibodeau²⁷ have used the tri-antibiotic paste and MTA as in the present study and postoperative satisfactory clinical results have been reported for a period of 1-5 years follow-up. However, all of the previous case reports have represented immature single-rooted teeth (incisor and premolars).

The nature of the tissue formed in the canal space and its cellular composition are yet to be identified.^{28,29} An animal study that investigates histologic characterization of regenerated tissues in canal

space, reported that revascularization allows ingrowth of vital tissue consisting of tissues resembling cementum, periodontal ligament and bone. These tissues are not pulp parenchymal tissue. Additionally, the formation of cemental bridges at various levels of the canal space was possibly connected with the osteoinductive activity of the MTA.³⁰ But also in a report of 2 cases, calcium enriched mixture (CEM) cement was used as a coronal plug with successful outcomes and CEM has been reported to have cementogenic properties as MTA.²⁹ Accordingly; a biomaterial that promotes cell proliferation, is one of the crucial factors for revascularization treatment.

In an animal study, a new promising disinfection protocol (apical negative pressure irrigation) in immature teeth with apical periodontitis has been introduced with successful results and researchers have been suggested that the use of intracanal antibiotics might not be necessary.³¹ Also, in a previous case report; a new revascularization treatment has been reported without using triple antibiotic paste.¹² In that study, NaOCl and chlorhexidine gluconate used for irrigation in coronal portion of the root canal of a necrotic tooth and in the same session without inducing bleeding, MTA was placed. Successful outcomes have been reported in this revascularization/regeneration procedure. Furthermore; researchers have reported that in severe cases a multi-visit, tri-antibiotic paste revascularization/regeneration procedure may be required.¹²

Consequently, revascularization/regeneration procedure is not standardized and case selection is critical to decide which protocol can be used.¹²

CONCLUSION

Results from the cases in the present study show that revascularization/regeneration using 3Mix-MP method could be effective for managing immature permanent molar teeth with pulpal necrosis with appropriate case selection.

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