ISSN: 0972-0707

Journal of Conservative Dentistry

Volume 18 Issue 6 Nov - Dec 2015

Official Publication of
Indian Association of Conservative Dentistry and Endodontics
Online full text at
www.jcd.org.in

PubMed

Medknow

Wolters Kluwer

Case Report

Pulp revascularization of immature maxillary first premolar

Nuha S. Al-Ghamdi, Saad Al-Nazhan[1]

Department of Restorative, Dental Sciences, Collage of Dentistry, King Khalid University, Abha, [1]Department of RDS, Division of Endodontics, King Saud University, College of Dentistry, Riyadh, Saudi Arabia

Abstract

An immature maxillary first premolar in an 8-year-old female was treated using a regenerative approach. The root canal was gently irrigated with 5.25% sodium hypochlorite without instrumentation under aseptic conditions and then medicated with calcium hydroxide ($Ca[OH]_2$) for 3 weeks. The $Ca(OH)_2$ was removed, and bleeding was initiated mechanically using a hand file to form an intracanal blood clot. Mineral trioxide aggregate was placed over the blood clot, and the access cavity was sealed with a double filling. Increases in root length and width were radiographically evident, at the 6-month follow-up exam. The case was followed for 3 years. The development of 3 roots with complete apical closure was confirmed using cone beam computed tomography.

Keywords: Calcium hydroxide; maxillary first premolar; mineral trioxide aggregate open apex; pulp revascularization

INTRODUCTION

Conventional root canal treatment of necrotic pulp in immature teeth is challenging clinically due to incomplete root development.[1] Several methods have been used to manage the open apex of immature teeth, including apexification with calcium hydroxide ($Ca[OH]_2$) or mineral trioxide aggregate (MTA).[2-5] Although this technique induces successful apical closure with healing of the apical pathosis, the root length and thickness do not usually increase. In addition, the likelihood of root fracture may be increased.[6,7]

As an alternative to traditional methods, the use of a regenerative endodontic procedure has been advocated as it may reinforce the root dentinal walls through the deposition of hard tissue and promote the development of a normal apical morphology.[8-10] Regenerative endodontic (revascularization/pulpal regeneration) treatment has been recently recognized by the American Association of Endodontics (AAE) as a legitimate endodontic procedure[11] and may be employed for the treatment of infected root canals in immature teeth. As defined by the AAE, this procedure is designed to physiologically replace damaged tooth structures, including dentin and dentin and root structures, as well as cells of the pulp-dentin complex. If performed properly, this treatment results in the re-establishment of biological function which is unrelated to complete regeneration of damaged tissue.[12]

Complete pulp tissue regeneration is unlikely in immature necrotic teeth when periapical tissues are infected, but removal of the infected tissue by a decontamination process may create a favorable environment for undifferentiated periodontal cells within the invagination to repair damaged tissue.[13,14] The difference between root canal revascularization and endodontic regeneration of necrotic immature teeth which are accompanied by periapical pathosis is the best described by Garcia-Godoy and Murray:[14] While the infected root canal is decontaminated with medicaments and stirred to cause bleeding, in regeneration, the root canal

Address for correspondence:
Prof. Saad Al-Nazhan, Department of RDS, Division of Endodontics, King Saud University, College of Dentistry, P.O. Box 60169, Riyadh 11545, Saudi Arabia.
E-mail: snazhan@ksu.edu.sa

Date of submission : 20.06.2015
Review completed : 30.07.2015
Date of acceptance : 01.10.2015

Access this article online

Quick Response Code:

Website: www.jcd.org.in

DOI: 10.4103/0972-0707.168824

How to cite this article: Al-Ghamdi NS, Al-Nazhan S. Pulp revascularization of immature maxillary first premolar. J Conserv Dent 2015;18:496-9.

is instrumented to remove the necrotic tissue, and a scaffold is placed in the wound after bleeding is established.

While there have been many reports on central incisors, mandibular premolars, and molars, the revascularization of maxillary premolars has not been reported. This report presents a case of successful continuous root development with a revascularization protocol for an immature permanent maxillary first premolar with necrotic pulp.

CASE REPORT

An 8-year-old female was referred to the dental clinic at King Fahad Hospital, Jeddah, Saudi Arabia, for root canal treatment. She had severe, continuous pain in the right maxillary first premolar (number 14), which had been treated with caries excavation and a pulpectomy. Otherwise, her medical history was unremarkable. Since she was asymptomatic, when she attended her appointment, cold and electric pulp testing was not applied. The tooth was not tender on percussion or palpation. Periodontal probing was within normal limits. A radiograph of the tooth revealed an immature root with an open apex, wide pulp canal, and no apical radiolucency [Figure 1]. The pulp was diagnosed as necrotic with normal apical tissues. A pulp regeneration procedure was chosen.

The treatment plan was discussed with the patient's parents, and informed consent was obtained.

Topical anesthesia was applied to the area, and then one carpule of 2% lidocaine with 1: 100,000 epinephrine was administered via buccal and palatal infiltration. The temporary filling was removed, and the crown was built up with a glass ionomer (GI) [Figure 2a]. A rubber dam was placed, and the pulp chamber was accessed and irrigated with 10 mL of 5.25% sodium hypochlorite using a side vent needle. No instrumentation was done. The canal was dried gently with paper points, and $Ca(OH)_2$ (Vitapex; Neo Dental Chemical Products, Tokyo, Japan) was applied as intracanal medication. A cotton pellet was placed in the pulp chamber, and the access cavity was sealed with GI filling [Figure 2b]. The patient was asked to return in 3 weeks.

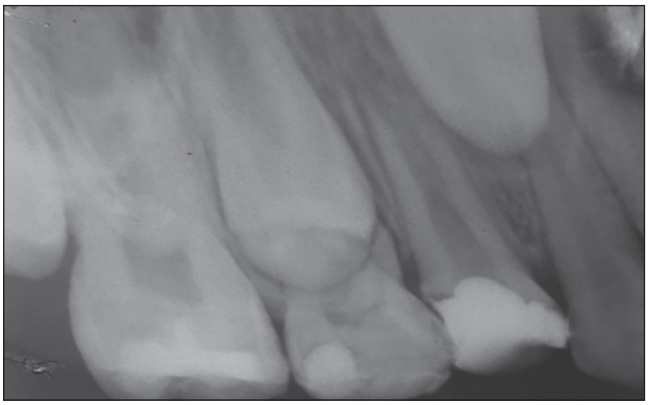

Figure 1: A preoperative periapical radiograph showing tooth number 14 with previously initiated endodontic treatment

The tooth was asymptomatic at the second appointment. One carpule of 2% lidocaine without a vasoconstrictor was administered. A rubber dam was placed, and the tooth was re-accessed. The $Ca(OH)_2$ was removed using 10 mL of sterile saline, as the final irrigation. The canal was dried with paper points, and apical bleeding was induced with a sterile number 15 K-file. A blood clot was allowed to form 2 mm below the cement-enamel junction, and then ProRoot MTA (Dentsply Maillefer, Ballaigues, Switzerland) was gently condensed over the blood clot. A wet cotton pellet was placed on top of this, and the access cavity was sealed with GI filling [Figure 2c].

The next day, the GI filling and cotton pellet were removed, and the pulp chamber was filled first with a layer of GI and then with composite. After 3 months, the patient reported to the clinic with no symptoms and radiography showed no remarkable changes [Figure 3a]. After 6 months, the tooth was asymptomatic, and the coronal filling was intact. X-rays revealed a clear increase in root length and shape and the apical part of the root had bifurcated [Figure 3b]. The patient was referred to the periodontics clinic to have a stainless steel crown constructed.

After 1 year, the tooth was still asymptomatic, and radiography showed complete root development [Figure 4a]. A 3-year follow-up radiograph confirmed apical closure with a distinct intact lamina dura [Figure 4b]. Axial, coronal, and sagittal two-dimensional section cone-beam computed tomography (CBCT) images showed complete development of the tooth with one palatal and two buccal roots [Figure 5].

DISCUSSION

Regenerative endodontic procedures in immature teeth involve copious irrigation without instrumenting the root

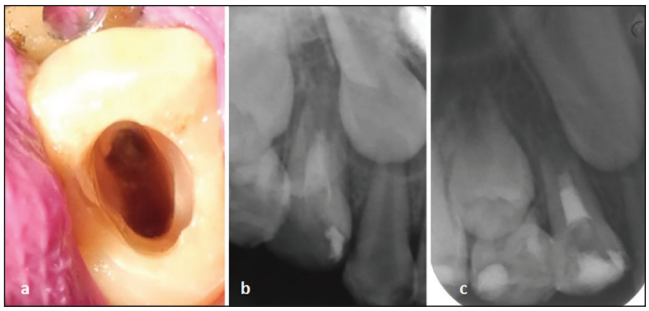

Figure 2: (a) The crown built up with glass ionomer restoration and the access opening. (b) $Ca(OH)_2$ was administered as an intracanal medication. (c) Mineral trioxide aggregate filling was applied after blood clot formation

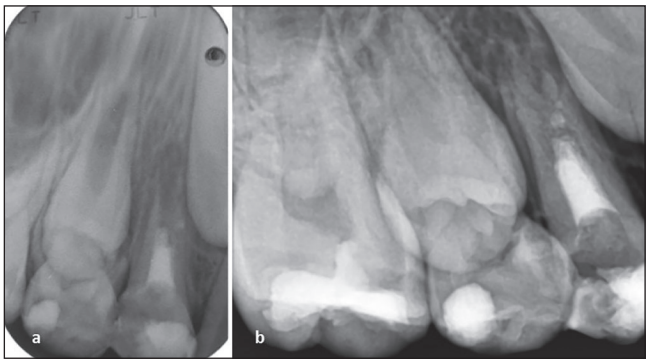

Figure 3: (a) Periapical radiography at the 3-month follow-up exam showed no definite apical changes. (b) After 6 months, an increase in root length and signs of two developing roots were observed

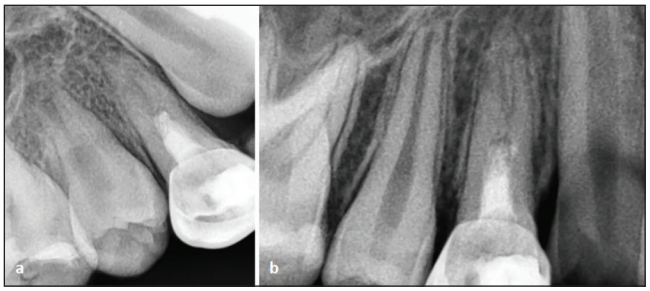

Figure 4: Follow-up radiographs after 1 year (a) And 3 years (b) Showing complete development of the roots with an intact lamina dura

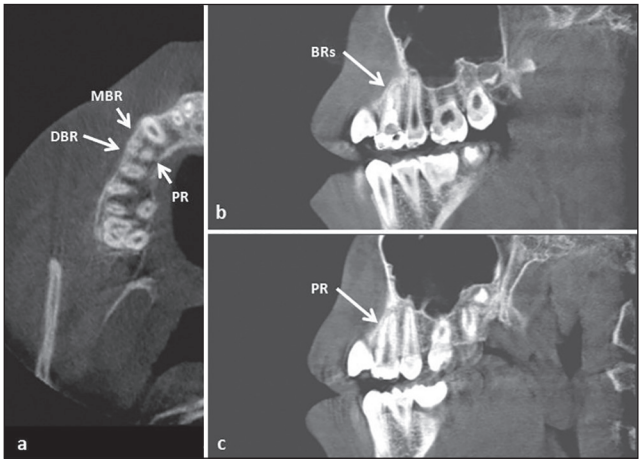

Figure 5: Axial cone beam computed tomography of the apical third of the root (a) Revealed three roots: Mesiobuccal, distobuccal, and palatal roots. Sagittal imaging showed the two buccal roots (b) Palatal roots (c). MBR: Mesiobuccal root, DBR: Distobuccal root, PR: Palatal root, BR: Buccal root

canal, followed by the application of antimicrobial agents and placement of a biocompatible filling over the initiated blood clot to preserve the remaining apical vital pulp tissue. The status of the pulp tissue and size of the apical opening determine the treatment outcome.[8,9] In the case presented here, three completely developed roots with normal periapical tissue were observed radiographically and by CBCT over a 3-year period. Similar findings have been described in most case reports.[9,10,15] Thickening of the root canal wall and closure of the apical foramen are achieved by growth of the periodontal ligament tissue and the deposition of cementum inside the canal space, as demonstrated by Thibodeau *et al*.[16] in immature dog teeth. In addition, the rich apical blood supply at the open apex in immature teeth facilitates the survival of postnatal dental pulp stem cells residing in the dental pulp tissue regardless of the status of the periapical tissue.[17,18]

Blood clot, platelet rich fibrin (PRF) and platelet rich plasma (PRP), act as natural scaffolds for numerous growth factors and were recently employed by several investigators for regenerative endodontic procedures. The blood clot, which is initiated during treatment, acts as a scaffold promoting tissue regeneration and root maturation.[19] It has been hypothesized that induction of bleeding inside the root canal allows stem cells from the apical papilla to proliferate within the root canal.[20] In addition, vascular endothelial growth factors incorporated into the blood clot may contribute to cell proliferation occurring inside the root canal space of immature teeth, promoting tooth development and maturation.[21] The importance of the blood clot in the periapical healing of teeth with empty canals was reported by Ostby[22] while failure to initiate a blood clot inside the canal has a negative effect on the outcome of regenerative endodontics.[16,23]

Despite the increased concentration of growth factors and cell proliferation of platelet concentrates when compared to blood clots,[24] PRF and PRP were not used in this study due to the age of the patient and the unavailability of materials. According to Hotwani and Sharma,[25] additional randomized and controlled clinical trials are needed to substantiate the long-term benefits and outcomes of PRF and PRP-associated treatments in clinical applications.

In this case, there was no periapical infection; this provided a good environment for the remaining vital apical tissue to allow the tooth to continue its normal development. Disinfection of the root canal space with an intracanal medicament plays a role in apical closure. Triple antibiotic treatment and $Ca(OH)_2$ have been used with good results. As an alternative to triple antibiotic treatment, $Ca(OH)_2$ was used here and provided satisfactory results similar to other reported cases.[9,15,16,19] $Ca(OH)_2$ is an effective bactericidal agent with negligible cytotoxicity and has little impact on the diffusion of growth factors and biomolecules from dentin.[26] Due to its high pH (12.5), contact with $Ca(OH)_2$ may cause tissue necrosis when used in revitalization procedures, resulting in destruction of vital apical tissues, which interferes with cell differentiation.[27,28] To overcome these effects on cellular toxicity, we restricted use of $Ca(OH)_2$ to the coronal third of the root canal as has been previously suggested.[10,29] A triple antibiotic was not used to avoid crown discoloration and allergic reactions.[30,31]

In addition, antibiotic treatment increases the risk for development of bacterial resistance which might have led to treatment failure.[32]

CBCT has been applied extensively in endodontics to diagnose apical pathologies and root fractures and to evaluate root canal morphology.[33,34] The morphology of the root and canal system, in this case, was viewed using CBCT, which confirmed the complete development of three roots. The presence of 3 canals in a Saudi female is rare. Elkady and Allouba[35] evaluated the root and canal morphology of maxillary premolars in a Saudi subpopulation using CBCT and reported that 0.0% had three canals while Al-Nazhan *et al*.[36] reported an incidence of 1% using conventional radiographs.

The coronal pulp space, in this case, was sealed with a GI base followed by a bonded resin material and stainless steel crown. This provided a bacteria-tight seal and had been reported to be an important factor in successful regenerative endodontics.[19]

CONCLUSION

The successful outcome of the present case suggested that a well-controlled revascularization technique is effective for immature teeth with necrotic pulp tissue and periapical pathosis.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Simpson TH, Natkin E. Gutta-percha techniques for filling canals of young permanent teeth after induction of apical root formation. Int Endod J 1972;6:35-9.
2. Abbott PV. Apexification with calcium hydroxide — When should the dressing be changed? The case for regular dressing changes. Aust Endod J 1998;24:27-32.
3. Felippe MC, Felippe WT, Marques MM, Antoniazzi JH. The effect of the renewal of calcium hydroxide paste on the apexification and periapical healing of teeth with incomplete root formation. Int Endod J 2005;38:436-42.
4. Felippe WT, Felippe MC, Rocha MJ. The effect of mineral trioxide aggregate on the apexification and periapical healing of teeth with incomplete root formation. Int Endod J 2006;39:2-9.
5. Simon S, Rilliard F, Berdal A, Machtou P. The use of mineral trioxide aggregate in one-visit apexification treatment: A prospective study. Int Endod J 2007;40:186-97.
6. Andreasen JO, Farik B, Munksgaard EC. Long-term calcium hydroxide as a root canal dressing may increase risk of root fracture. Dent Traumatol 2002;18:134-7.
7. Andreasen JO, Munksgaard EC, Bakland LK. Comparison of fracture resistance in root canals of immature sheep teeth after filling with calcium hydroxide or MTA. Dent Traumatol 2006;22:154-6.
8. Iwaya SI, Ikawa M, Kubota M. Revascularization of an immature permanent tooth with apical periodontitis and sinus tract. Dent Traumatol 2001;17:185-7.
9. Chueh LH, Huang GT. Immature teeth with periradicular periodontitis or abscess undergoing apexogenesis: A paradigm shift. J Endod 2006;32:1205-13.
10. Bose R, Nummikoski P, Hargreaves K. A retrospective evaluation of radiographic outcomes in immature teeth with necrotic root canal systems treated with regenerative endodontic procedures. J Endod 2009;35:1343-9.
11. AAE Position Statement — Scope of Endodontics: Regenerative Endodontics. American Association of Endodontists; 2013. Available from: https://www.aae.org/uploadedfiles/clinical_resources/guidelines_and_position_statements/scopeofendo_regendo.pdf. [Last accessed on 2015 Aug 05].
12. Lin LM, Rosenberg PA. Repair and regeneration in endodontics. Int Endod J 2011;44:889-906.
13. Zhang W, Yelick PC. Vital pulp therapy-current progress of dental pulp regeneration and revascularization. Int J Dent 2010;2010:856087.
14. Garcia-Godoy F, Murray PE. Recommendations for using regenerative endodontic procedures in permanent immature traumatized teeth. Dent Traumatol 2012;28:33-41.
15. Cehreli ZC, Isbitiren B, Sara S, Erbas G Regenerative endodontic treatment (revascularization) of immature necrotic molars medicated with calcium hydroxide: A case series. J Endod 2011;37:1327-30.
16. Thibodeau B, Teixeira F, Yamauchi M, Caplan DJ, Trope M. Pulp revascularization of immature dog teeth with apical periodontitis. J Endod 2007;33:680-9.
17. Lin L, Shovlin F, Skribner J, Langeland K. Pulp biopsies from the teeth associated with periapical radiolucency. J Endod 1984;10:436-48.
18. Shi S, Gronthos S. Perivascular niche of postnatal mesenchymal stem cells in human bone marrow and dental pulp. J Bone Miner Res 2003;18:696-704.
19. Iwaya S, Ikawa M, Kubota M. Revascularization of an immature permanent tooth with periradicular abscess after luxation. Dent Traumatol 2011;27:55-8.
20. Gronthos S, Mankani M, Brahim J, Robey PG, Shi S. Postnatal human dental pulp stem cells (DPSCs) *in vitro* and *in vivo*. Proc Natl Acad Sci U S A 2000;97:13625-30.
21. Wang Q, Lin XJ, Lin ZY, Liu GX, Shan XL. Expression of vascular endothelial growth factor in dental pulp of immature and mature permanent teeth in human. Shanghai Kou Qiang Yi Xue 2007;16:285-9.
22. Ostby BN. The role of the blood clot in endodontic therapy. An experimental histologic study. Acta Odontol Scand 1961;19:324-53.
23. Ding RY, Cheung GS, Chen J, Yin XZ, Wang QQ, Zhang CF. Pulp revascularization of immature teeth with apical periodontitis: A clinical study. J Endod 2009;35:745-9.
24. Visser LC, Arnoczky SP, Caballero O, Egerbacher M. Platelet-rich fibrin constructs elute higher concentrations of transforming growth factor-β1 and increase tendon cell proliferation over time when compared to blood clots: A comparative *in vitro* analysis. Vet Surg 2010;39:811-7.
25. Hotwani K, Sharma K. Platelet rich fibrin — A novel acumen into regenerative endodontic therapy. Restor Dent Endod 2014;39:1-6.
26. Graham L, Cooper PR, Cassidy N, Nor JE, Sloan AJ, Smith AJ. The effect of calcium hydroxide on solubilisation of bio-active dentine matrix components. Biomaterials 2006;27:2865-73.
27. Banchs F, Trope M. Revascularization of immature permanent teeth with apical periodontitis: New treatment protocol? J Endod 2004;30:196-200.
28. Huang GT. A paradigm shift in endodontic management of immature teeth: Conservation of stem cells for regeneration. J Dent 2008;36:379-86.
29. Chen MY, Chen KL, Chen CA, Tayebaty F, Rosenberg PA, Lin LM. Responses of immature permanent teeth with infected necrotic pulp tissue and apical periodontitis/abscess to revascularization procedures. Int Endod J 2012;45:294-305.
30. Thomas MS. Crown discoloration due to the use of triple antibiotic paste as an endodontic intra-canal medicament. Saudi Endod J 2014;4:32-5.
31. de Paz S, Pérez A, Gómez M, Trampal A, Domínguez Lázaro A. Severe hypersensitivity reaction to minocycline. J Investig Allergol Clin Immunol 1999;9:403-4.
32. Reynolds K, Johnson JD, Cohenca N. Pulp revascularization of necrotic bilateral bicuspids using a modified novel technique to eliminate potential coronal discolouration: A case report. Int Endod J 2009;42:84-92.
33. Matherne RP, Angelopoulos C, Kulild JC, Tira D. Use of cone-beam computed tomography to identify root canal systems *in vitro*. J Endod 2008;34:87-9.
34. Bernardes RA, de Moraes IG, Húngaro Duarte MA, Azevedo BC, de Azevedo JR, Bramante CM. Use of cone-beam volumetric tomography in the diagnosis of root fractures. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2009;108:270-7.
35. Elkady AM, Allouba K. Cone beam computed tomographic analysis of root and canal morphology of maxillary premolars in Saudi subpopulation. Egypt Dent J 2013;59:3419-29.
36. Al-Nazhan S, Al-Daafas A, Al-Maflehi N. Radiographic investigation of *in vivo* endodontically treated maxillary premolars in a Saudi Arabian subpopulation. Saudi Endod J 2012;2:1-5.