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A Case Report on the Use of Platelet-Rich Plasma to Revitalize Root Development with Necrotic Pulps and Open Apexes

Dyg Siti binti Kanchil
Wangaya Regional General Hospital, Denpasar, Indonesia

ABSTRACT

A growing body of evidence is demonstrating the possibility for regeneration of tissues within the pulp space and continued root development in teeth with necrotic pulps and open apexes. The purpose of this case report is to add a regenerative endodontic case to the existing literature about using platelet-rich plasma (PRP). Methods: An 11-year-old boy whose maxillary second premolar tooth had been accidently extracted and immediately replanted developed pulpal necrosis and symptomatic apical periodontitis. After preparing an access cavity, its necrotic pulp was removed. The canal was irrigated with 5.25% NaOCl solution and dried with paper points. A triple antibiotic mixed with distilled water was packed in the canal and left for 22 days. Twenty milliliters of whole blood was drawn from the patient's forearm for preparation of PRP. After removal of the antibiotic mixture, the PRP was injected into the canal space up to the cementoenamel junction level. Three millimeters of grey mineral trioxide aggregate was placed directly over the PRP clot. Three days later, the tooth was double-sealed with permanent filling materials. Results: Clinical examination 5 1/2 half months later revealed no sensitivity to percussion or palpation tests. Radiographic examination of this tooth showed resolution of the periapical lesion, further root development, and continued apical closure. Sensitivity tests with cold and an electric pulp test elicited a positive response similar to those found in the first premolar tooth. Conclusions: On the basis of short-term results of the present case, it appears that regeneration of vital tissues in a tooth with necrotic pulp and a periapical lesion is possible; PRP is potentially an ideal scaffold.

KEYWORDS

Case report, Open apex, Regenerative endodontics.

1. Introduction

The potential for revascularization and continued development of replanted teeth has been well-documented in the dental trauma literature; however, the presence of infection has been shown to interfere with this process (8–10). It has therefore traditionally been thought that successful revascularization cannot be an expected outcome after a tooth has become infected. However, there is a growing body of evidence to suggest that revascularization of the pulp space, along with continued growth of the root, might in fact be possible after pulpal necrosis and apical pathosis occur in teeth with immature apexes. Several single case reports and case series have been published that demonstrate radiographic signs of continued thickening of the dentinal walls and subsequent apical closure of roots in teeth with periapical lesions.

Hargreaves et al (4) have identified 3 components contributing to the success of this procedure. They include stem cells that are capable of hard tissue formation, signaling molecules for cellular stimulation, proliferation, and differentiation, and finally, a 3-dimensional physical scaffold that can support cell growth and differentiation. Platelet-rich plasma (PRP) has been mentioned as a potentially ideal scaffold for regenerative endodontic treatment regimens (4, 20). A search of literature reveals an absence of any publication that has used PRP in pulp regeneration of human teeth with necrotic pulps and open apexes. The purpose of this case report is to add a regenerative endodontic case to the existing literature about using PRP.

2. Case Report

An 11-year-old boy was seen in the Department of Pediatric Dentistry at Wangaya Regional General Hospital for evaluation and treatment of a maxillary right second premolar. The patient was accompanied by his father, who reported that his son's tooth had been accidently extracted and immediately replanted 1 month before their visit to the dental school. The patient did not have symptoms immediately after this iatrogenic mishap, but he subsequently developed sensitivity to mastication. The medical history of the patient was noncontributory. He had no priordental visit to the dental school. Extraoral examination of this patient showed the presence of a large scar on his forehead as a result of an automobile accident 1 year before his dental appointment. Intraoral examination of this patient showed an absence of any soft tissue abnormalities. Clinical examination of his teeth revealed the presence of a slightly discolored tooth #4. The rest of his teeth appeared intact and without any restorations. Tooth #4 was sensitive to both percussion and palpation tests. It did not respond to CO2 ice or an electric pulp tester (EPT). Adjacent teeth were negative to percussion andpalpationtestsandrespondedpositivelytocoldandEPT.Periodontal probing depths were within normal limits for tooth #4 and its adjacent teeth. Radiographic examination of tooth #4 revealed an immature root and an open apex (Fig. 1A). A periapical radiolucency was noted around the apex of this tooth. A cone-beam image of this area showed a tooth with anopenapex and a large canal in the buccolingualdirection. On the basis of clinical and radiographic findings, a pulpal diagnosis of necroticpulp and a periapicaldiagnosis ofsymptomatic apicalperiodontitis were made for tooth #4. After consultation with an endodontist (MT) and considering various options for treatment of this tooth, the patient was referred to graduate endodontics; the decision was made to perform a regenerative endodontic procedure with the aid of PRP.

The father of the patient was informed that this treatment was an attempttoinitiatefurtherrootdevelopment, andthattheproposedtreatment might not be successful. A written informed consent was obtained from the patient's father. Local anesthesia was obtained by using 2% lidocaine with 1:100,000 epinephrine. After application of a rubber dam, an access cavity was prepared on tooth #4. On entry into the root canal, no hemorrhage was noted from the root canal of this tooth. The necrotic pulp was removed with the aid of a large barbed broach. The working length was determined by placing a large file in the canal and taking a periapical radiograph (Fig. 1B). The canal was irrigated with approximately 10 mL of 5.25% NaOCl and dried with paper points. Equal proportions of ciprofloxacin (Bayer, Leverkusen, Germany), metronidazole (Shionogi and Co, Ltd, Osaka, Japan), and minocycline (Aurobindo, Andhra Pradesh, India) were ground and mixed with distilled water to a thick paste consistency. This antibiotic mixture was placed in the canal using an amalgam

carrier and packed with large endodontic pluggers. The access cavity was sealed with Cavit (ESPE, Chergy Pontoise, France).

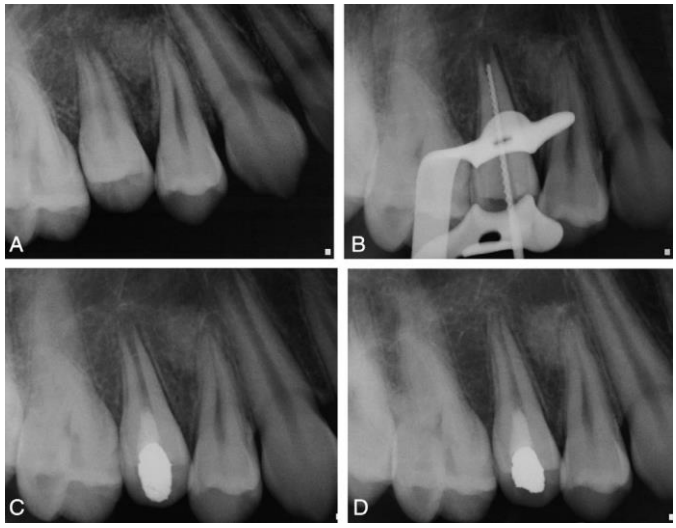

Figure 1. (A) Preoperative radiograph reveals presence of an immature root and an open apex in the second maxillary premolar tooth. (B) A large file is used to determine the root length radiographically. (C) Tooth is double-sealed with Cavit and amalgam. (D) Radiographic examination of the patient 5 1/2 months later shows resolution of periapical lesion, further root development, and continued apical closure of root apex in second maxillary premolar tooth.

The patient returned to the endodontic clinic 22 days later without any symptoms. Tooth #4 was asymptomatic to both percussion and palpation tests. A 20-mL sample of whole blood was drawn from the patient's right arm for PRP preparation. Local anesthesia was obtained by using 2% lidocaine with 1:100,000 epinephrine. After rubber dam isolation, the temporary restoration was removed, and the antibiotic mixture was washed out by using sterile saline irrigation. The canal was dried with paper points. The SmartPReP2 APC+ Autologous Platelet Concentrate+ Procedure Pack (Harvest Technologies Corp, Plymouth, MA) with the Harvest SmartPReP2 Platelet Concentrate System (Harvest Technologies Corp) was used to prepare the PRP. It was then injected into the canal space up to the level of the cementoenamel junction (CEJ) and allowed to clot for 5 minutes. Three millimeters of grey MTA (ProRoot MTA; Dentsply Tulsa Dental Specialties, Tulsa, OK) was placed directly over the PRP clot. A moist cotton pellet was placed over the MTA and provisionally restored with Cavit. The patient returned 3 days later to the endodontic clinic and was asymptomatic.After rubber damapplication, the provisional restoration and cotton pellet were removed, and setting of the MTA was confirmed. The tooth was then double-sealed with 2 mm of Cavit and an amalgam restoration (Fig. 1C). The patient returned to the endodontic clinic after 5 1/2 months for re-evaluation. The patient stated that the tooth had become sensitive to cold since his last visit. Clinical examination revealed further discoloration of the clinical crown. Compared with adjacent teeth, tooth #4 was a symptomatic and was not sensitive to percussion or palpationtests. Sensitivity tests with cold and EPT now elicited a positive response similar to those found in the first premolar tooth. Radiographic examination showed resolution of the periapical lesion, further root development, and continued apical closure of the root apex in tooth #4 (Fig. 1D). The patient is scheduled for a 12-month re-examination.

3. Discussion

The present case report along with previous case reports and series clearly demonstrates that under certain circumstances, teeth with necrotic pulps and open apexes are capable of regenerating tissues within the root canals that cause continued hard tissue deposition, root lengthening, closure of the apexes, and responding to cold and/or EPT. Because using this procedure results in restoration of some of the functional properties of

involved teeth, it is appropriate to identify this technique as regeneration of pulp-dentin complex and restrict the use of the term revascularization to trauma studies (4). Despite the low level of evidence of this case and previous cases (11–21), these reports that are actual observations in patients can be the basis for future studies at higher levels of evidence.

This case has some similarities and some differences with the previous case reports and series (11–21). Like previous reported cases, our young patient had a tooth with an open apex, short diverging and thin root canal walls, a necrotic pulp, and a periapical lesion. Kling et al (8) suggest an apical opening of at least 1 mm in the mesiodistal direction for a successful revascularizationof anavulsed permanent tooth after replantation. Despite the presence of this size opening in this tooth (gauged by a #120 size file while probing the canal), revascularization of this tooth did not happen for this patient. The pulp of the tooth might have been contaminated during extraction and placement of the tooth in its socket. Similar to many previous reports (11, 12, 16, 17, 20, 21), we also used 5.25% NaOCl as an intracanal irrigant and triple antibiotics (12, 15, 17, 20, 21) as an intracanal medicament to disinfect the root canal of this tooth. Like many recent cases (12, 14–17, 19–21), MTA was placed over the blood clot to isolate the root canal from the external surface of the tooth and create a hard tissue barrier at its contact point with the blood clot. It might have also provided signaling molecules for the growth of stem cells (22). Like others, we also double-sealed the access cavity preparations with permanent filling materials. We observed continued thickening of the dentinal walls, root lengthening, and apical closure in 5 1/2 months. Comparison of our radiographic findings with those of others at approximately the same recall times (11–13, 16–21, 23) shows a remarkable increase in root length and closure of the apex in this case that might be due to the use of PRP. When tested, our patient reported positive responses to cold and EPT. Pulp tissue, periodontal ligament, dentin, cementum, and bone have been found within the root canals of teeth in experimental animals undergoing regenerative endodontic procedure (10, 24). Histologic studies are not available regarding the nature of formed tissue(s) after this procedure in humans. A few cases have reported positive responses to cold and EPT after a regenerative endodontic procedure (11, 20, 21). The presence or absence of responses in these teeth depends on the coronal level of tissue grown in the root canal and the thickness of filling materials over this tissue(s). As in the present case, if the filling materials are placed close to the cementoenamel level, it is more likely to elicit a positive response to cold or EPT. Presence of a thick layer of restorative material(s) can prevent stimulation of vital tissues within the root canal of these teeth and absence of a response to stimuli such as EPT and cold. Unlike previous cases, our case is the first successful regenerative endodontic procedure after a failed replanted tooth with an immature apex that had developed pulpal necrosis and an apical lesion. A number of case reports present evidence of revascularization of replanted immature teeth, with reports of continued root thickening and apical closure, sensitivity to thermal stimulus and electrical pulp testing, and normal laser Doppler flowmetry readings (25–27). Andreasen et al (28) reported a successful revascularization rate of 34% in a prospective study that included 94 replanted immature teeth. Similar results have been found by other investigators (8, 29, 30).

Components needed for successful regenerative endodontics include absence of intracanal infection, coronal seal to prevent reinfection, a physical scaffold to promote cell growth and differentiation, as well as signaling molecules for the growth of stem cells (4, 20). In the present case, we obtained disinfection of the root canals with the use of 5.25% NaOCl (11, 12, 16, 17, 20, 21) and triple antibiotics (12, 15, 17, 20, 21) as suggested by other investigators. The PRP clot provided an excellent matrix for placement of MTA and subsequent permanent restorations to prevent coronal leakage. Petrino et al (21) in a case series discuss the challenges in regenerative endodontics and recommend the use of an anesthetic without a vasoconstrictor to induce bleeding, a collagen matrix to control placement of MTA to a desired level, and informing the patients/parents about the potential for staining of teeth when triple antibiotics are used to disinfect root canals. The use of an anesthetic without a vasoconstrictor is not necessary if PRP is used for regenerative endodontic procedure. Placementof acollagenmatrixorotherbarriersmightpreventtheconductive and inductive properties of MTA (22). The relatively hard matrix produced by PRP allowed us to place MTA 2–3 mm below the CEJ. The same can

be achieved if intracanal blood is allowed to clot adequately. Further discoloration of the clinical crown during checkup visit might have been a result of application of triple antibiotics containing minocycline (31) and/or use of grey MTA. Sealing the dentinal tubules in the chamber and use of the dentin bonding agent have been suggested to prevent or reduce the intensity of the discoloration caused by application of triple antibiotics (31, 32). The use of white MTA might have also reduced the intensity of crown discoloration. Internal bleaching is also an option at this time.

An ideal scaffold selectively binds and localizes cells, contains growth factors, and undergoes biodegradation over time (4). Regenerativeendodonticshasbeenaccomplishedwithand withoutthepresence of a physical scaffold (11–21, 23). The blood clot as a scaffold and a source of stem cells has been used in many recent cases. The absence of a blood clot has been implicated in unsuccessful cases of regenerative endodontics in a human clinical investigation and an animal study (20, 33). Ding et al (20) discuss the value of the use of PRP in patients in whom it is difficult to produce bleeding in their root canals with a file by using triple antibiotic paste. Unlike previous case reports (11–21, 23), we used PRP as a scaffold in a tooth with necrotic pulp and an open apex. PRP was first introduced by Whitman et al in 1997 (34). It contains growth factors, stimulates collagen production, recruits other cells to the site of injury, produces anti-inflammatory agents, initiates vascular ingrowth, induces cell differentiation, controls the local inflammatory response, and improves soft and hard tissue wound healing (35). PRP has been widely used in the field of dentistry. It has been used after oral maxillofacial (34, 36, 37–39) and endodontic surgery (35, 40) to promote wound healing. PRP has been suggested as a scaffold for regenerative endodontic procedures (4, 20). Preparation of PRP involves taking a blood sample from the patient, centrifuging the blood in the presence of an anticoagulant, removal of erythrocytes from the blood, and adding thrombin and calcium for coagulation of prepared PRP. Because we did not create bleeding before placing PRP in the root canal of the present case, we believe whatever tissue has been produced in the canal is a result of the presence of PRP. It has increased concentrations of growth factors that can attract stem cells present in the apical tissues (vital pulp cells, periodontal ligament, apical dental papilla, bone marrow) and even from periapical lesions.

On the basis of short-term results of this present case, it appears that regeneration of vital tissues in a tooth with a necrotic pulp and periapical lesion is possible, and PRP is potentially an ideal scaffold for this procedure. The advantages of using PRP include its relative ease of application and shorter time to induce vital tissues within the root canal system. The disadvantages of this procedure include drawing blood in young patients, need of special equipment and medications to prepare PRP, and increased cost of treatment. Longterm observation of this case and randomized prospective clinical trials along with animal studies are needed to compare the use of PRP with that of blood clot formation and to determine clinical outcomes of these procedures as well as the nature of tissues generated in the root canal as a result of the use of regenerative endodontic procedure. If these studies prove significant differences between the use of PRP and currently used procedures, patient management and logistics of the PRP procedure need to be addressed.

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