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Revascularization of Necrotic Permanent Immature Teeth Using Platelet-Rich Fibrin: A Case Series

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Abstract: *Incomplete root development often arises secondary to pulpal necrosis as a result of trauma or caries. Since completion of root development and apical closure occurs 3 years after eruption, any traumatic injuries or caries during this stage may interfere with dentin formation and hampers root development resulting in wide canal and open apices. Open apex affects proper instrumentation and prevents the achievement of an adequate apical stop. Although apexification procedure is feasible, long term survival of teeth is questionable due to thin and incompletely formed dentinal walls. In young patients, the regenerative endodontic procedure is the ideal treatment option. Two cases presented in this article used revitalization procedure with platelet-rich fibrin (PRF) membrane as a scaffold.*

Keywords: *Biodentine, Open apex, Regenerative endodontics, Revascularization*

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I. Introduction

Regenerative endodontics, a paradigm shift in the management of immature teeth with infected canals is a procedure which utilizes the concept of tissue engineering for continued root maturation and apical closure. This technique utilizes the ability of residual pulp, apical and periodontal stem cells to differentiate and colonize the root canal space[1-3].

Incomplete root development often arises secondary to pulpal necrosis as a result of trauma or caries[4]. Since completion of root development and apical closure occurs 3 years after eruption, any traumatic injuries or caries during this stage may interfere with dentin formation and hampers root development resulting in wide canal and open apices.

Traditional approaches of calcium hydroxide apexification and MTA barrier techniques have been used for treating immature teeth with pulp necrosis. Though, there is no further root development, roots remain thin and fragile with high risk of fracture.

Recently it has been suggested that regenerative endodontic procedures could effectively replace damaged structures, including dentin and root structures as well as pulp-dentin complex. Here the differentiated stem cells induce hard tissue deposition and restores the root canal to a healthy state by continued development of root and surrounding tissues[5].

II. Case Report 1

A 17-year-old girl reported to the department of conservative dentistry and endodontics with a chief complaint of swelling and pain of upper front teeth region. The pain was continuous and throbbing in nature for 1 week. She had a history of trauma to the maxillary anterior region 12 years back. Clinical examination revealed discoloration of #21 (Fig 1.a), which was sensitive to both percussion and palpation tests. Thermal and electric pulp vitality test results were negative. Periodontal probing depths were within normal limits. Radiographic examination revealed ill-defined radiolucency at the periapex in relation to #21 with wide-open apex (Fig 1.b). Based on radiographical and clinical finding, the case was diagnosed as symptomatic apical periodontitis with open apex in relation to #21. The revascularization procedure with PRF was decided for treatment.


Fig 1: a)Pre-operative clinical picture of #21, b) Pre-operativeintraoral periapical radiograph showing wide root canal with open apex and periapical lesion in relation to #21

After taking informed consent, rubber dam applied over #21, and access opening was done. Working length was then determined radiographically. Necrotic debris from the canal was removed and irrigated with 17% EDTA and normal saline. The canal was dried with paper points. The triple antibiotic paste was placed into the canal and access cavity was sealed with IRM. The patient was reviewed after 3 weeks and seemed to be completely asymptomatic. After routine blood examination, 10 ml of whole blood was collected, and PRF was prepared. Local anaesthesia was then administered. After rubber dam isolation, the access cavity was reopened, and saline irrigation was done to remove the antibiotic mixture. Final irrigation was done with 17% EDTA and the canal was dried with paper points. Periapical bleeding was induced by pricking with a 10K file beyond the working length. Fragmented PRF membrane was placed in the pulp chamber and pushed apically with the help of endodontic pluggers (Fig 2.a). Biodentine (Septodont, France) was placed directly over the PRF (Fig 2.b). After waiting for 10 minutes, 1mm thickness of GIC was placed over biodentine, and the rest of the space was filled with a composite restoration [double seal technique] (Fig 2.c).

Fig 2: Clinical procedures. a) Fibrin membrane placed until roof of pulp chamber. b) Biodentin placed over PRF c) Cavity restored with double seal technique

The patient was reviewed at 1, 6, and 12 months intervals with radiographs (Fig 3) along with vitality checking. On 12th month review, vitality tests with EPT and cold elicited a positive response, which was comparable to the contralateral incisor. Radiographic examination revealed the resolution of periapical lesion, thickening of the dentinal walls and apical closure. Later a temporary crown was cemented (Fig 4).

Fig 3: 1 year follow up radiograph showing resolution of lesion and thickening of dentinal walls

Fig 4: Post operative view after temporary crown placement

III. Case Report 2

A 14 year old girl reported with a chief complaint of pain and discoloration on the maxillary anterior region for 6 months. The pain was dull, aching in nature and was relieved under medications. She gave a history of trauma on the maxillary anterior region 5 years back.

There was no relevant medical history. Clinical examinations revealed discoloration of #21 (fig 5a). The tooth was sensitive to both percussion and palpation tests. Vitality check of both #11 and# 21 did not respond to cold and electric pulp tester. Periodontal probing depths were within normal limits. Radiographic examination revealed ill-defined radiolucency at the periapex with wide open apex in relation to #21 and ill-defined radiolucency at the apex of #11(fig 5b). Based on radiographical and clinical finding, the case was diagnosed as symptomatic apical periodontitis with open apex in relation to #21. The revascularization procedure with PRF (Platelet Rich Fibrin) was decided as the treatment plan.

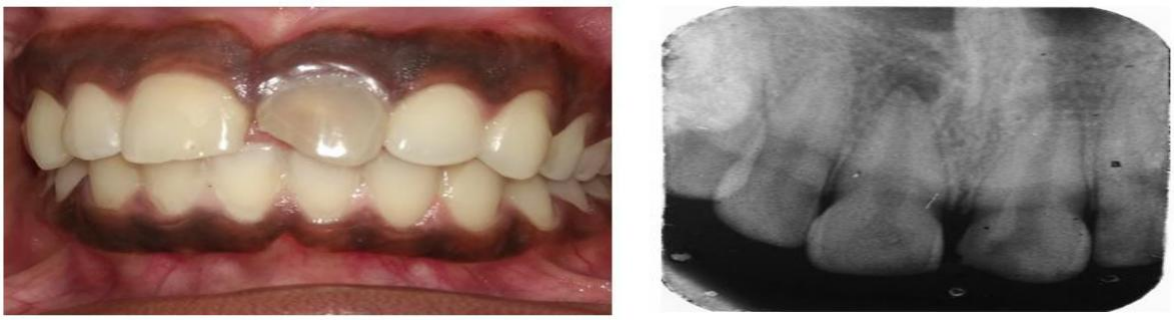

Fig 5: a) Pre-operative clinical picture of #21, b) Pre-operative intraoral periapical radiograph showing wide root canal with open apex in relation to #21

After taking informed consent, rubber dam applied over #21, and access opening was done. Pus discharge was present from the canal. Then working length was determined radiographically. Necrotic debris from the canal was removed and irrigated with 17% EDTA and normal saline. The canal was irrigated with normal saline & 17% EDTA and was dried with paper points. The triple antibiotic paste was prepared by mixing equal proportions of ciprofloxacin 500mg (Ranbaxy Lab, India), metronidazole 400mg (Unique Pharmaceuticals, Mumbai, India) and minocycline 100mg (Aurobindo, Andhra Pradesh, India) with propylene glycol into a thick paste. After placing the triple antibiotic paste, the access cavity was sealed with IRM.

The patient was reviewed after 3 weeks and seemed to be completely asymptomatic. Then the local anaesthesia was administered. After rubber dam isolation, the access cavity was reopened, and saline irrigation was done to remove the antibiotic mixture. Final irrigation was done with 17% EDTA and canals were dried with paper points. After routine blood examination, 10ml of whole blood was drawn from the patient. The blood sample was transferred into a test tube without anticoagulant and centrifuged immediately (REMI Model R-8c, India) at 3000 rpm for 10 minutes to obtain the PRF. After centrifugation, PRF was removed from the test tube with the help of sterile tweezers. Jelly-like PRF was converted into the membrane in a modified endodontic file box (Fig 6.a). This fibrin membrane was fragmented into small pieces with the help of surgical scissors. So, that

it can be easily placed inside the canals (Fig 6.b). Biodentine (Septodont, France) was placed directly over the fibrin clot (Fig 6.c). After waiting for 10 minutes, GIC (1mm) was placed over biodentine, and the rest of the space was filled with a composite restoration.

Fig 6: Clinical procedures. a) PRF clot placed on modified endobox for membrane preparation. b) Fibrin membrane placed until roof of pulp chamber. c) Cavity restored with biodentine.

The patient was reviewed at 1, 6, and 12 months intervals with radiographs along with vitality checking. On 12th month review, vitality tests with EPT and cold elicited a positive response, which was comparable to the adjacent incisor. Radiographic examination revealed the resolution of periapical lesion, thickening of the dentinal walls and closure of the root apex (Fig 7). Later a temporary crown was cemented (Fig 8).

Fig 7: 1 year follow up radiograph showing resolution of periapical lesion and apical closure in relation to #21

Fig 8: Postoperative view after temporary crown placement

IV. Discussion

Regenerative endodontics is a biological procedure that utilizes the concept of tissue engineering to attain organized repair of dental pulp. Incomplete root development may occur secondary to pulpal necrosis following trauma or caries. Vast majority of regenerative endodontic procedures are undertaken in young patients with immature infected teeth, where root maturation has ceased due to pulpal necrosis. Different regenerative endodontic technique include: 1.) Postnatal stem cell therapy, 2.) pulp revascularization via blood clotting, 3.) Pulp implantation, 4.) Scaffold implantation, 5.) Injectable scaffold delivery, 6.) three-dimensional cell printing and 7.) Gene delivery.

The three considerations for successful regenerative endodontic procedures given by AAE are: Primary goal: Elimination of symptoms and evidence of bone healing. Secondary goal: Increased root wall thickness and increased root length. Tertiary goal: Positive response to vitality test.

A successful revascularization of immature teeth can be attained by 1.) Complete disinfection of root canal system, 2.) a matrix in the root canal space to facilitate the growth of tissue and 3.) a bio- interactive material for a fluid tight coronal seal.

Disinfection of root canal is critical to the success of regenerative endodontic procedures since they prevent infection and facilitates regeneration, repair and stem cell activity. Disinfection is usually achieved by intracanal medicaments like Triple antibiotic paste (TAP), chemical irrigants and calcium hydroxide. For

improving the predictability of regenerative procedures, disinfection should create conditions conducive to stem cell survival, proliferation and differentiation. In the study, TAP containing 500mg of Ciprofloxacin, 400mg metronidazole and 100mg minocycline were used. The concentration of TAP to avoid stem cell damage proposed by AAE is 0.1mg/ml. One of the main disadvantage of TAP is the potential discoloration of tooth by minocycline. Calcium hydroxide (Ca(OH)2) also possess antimicrobial activity and favors stem cell growth by the release of TGF-β. There are studies which demonstrate the potential risk of stem cell damage when higher concentration of NaOCl is used. Lower concentrations are now recommended. However EDTA 17% promoted increased SCAP survival expression as well as partially reverse the deleterious effect of NaOCl. EDTA acts by demineralizing the dentin and exposes the dentin matrix which acts to release growth factors from dentin matrix. The conditioning effect of EDTA also promotes the adhesion, migration and differentiation of dental pulp stem cells to dentin. Therefore, a final rinse with EDTA is advised[6-8]. In our study normal saline and 17% EDTA were used for irrigation[9].

Scaffolds provide a 3 dimensional microenvironment for cell growth and adhesion. They provide physical and chemical signals to facilitate growth and differentiation of cells. PRF as scaffold has several advantages as it is completely autologous. In our study a bacterial tight coronal seal was achieved with biodentin, GIC and composite[10]. The double seal of access opening prevents coronal leakage of microbes and is a prime factor for success of regenerative endodontic procedures. In our study triple antibiotic paste, 17%EDTA and PRF were used.

After 1 year follow up, all teeth showed a positive response to pulp vitality test. Evaluation of radiographs revealed that in case 2, the periapical lesion was resolved and dentinal walls became thickened. In case 1, along with periapical healing, closure of apex also occurred. The reason behind the positive findings might be due to the differentiation of mesenchymal stem cells of apical papilla into various cells for matrix secretion. Along with activation of fibroblast, odontoblast endothelial cells and epithelial cells[11-13]. This may be promoted by the release of growth factors and cytokines released from PRF. The satisfactory results like relief of acute symptoms, periapical healing and positive response to vitality test suggests that revascularization is not possible in the presence of necrotic pulp. This might be attributed to regeneration of pulp-like tissue. But the exact nature can be structured only by histological evaluation.

V. Conclusion

Regenerative endodontics represents a new era in biological and clinical endodontics. It is recommended as an alternative procedure to apexification. The results of our case series are similar with clinical and radiological outcomes of other case reports of revascularization.

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The authors deny any conflicts of interest related to this study.

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