Case Report

University J Dent Scie 2025; Vol. 11, Issue 2

Clinical, radiographic and pulp sensibility assessment of necrotic mature permanent teeth with moderate to large periapical lesions using a modified revascularization therapy: A series of five cases

Abstract:

Aim : The aim of this case series was to demonstrate the possibility of modified regenerative endodontic procedures (REPs) in necrotic mature permanent teeth for the resolution of periapical radiolucencies and regaining pulp sensibility by using a combination of platelet-rich fibrin and induction of bleeding in root canals as scaffolds.

Methods: This case series included 5 patients who had necrotic pulps with apical periodontitis, either symptomatic or asymptomatic. Patients ranged in age from 20 to 25 years old. A modified regenerative protocol was used to treat 5 anterior necrotic permanent teeth. During first treatment visit, the canals of the teeth were thoroughly chemomechanically debrided, and the canals were medicated with calcium hydroxide paste. At the following appointment, periapical bleeding into the canals was generated by inserting a hand #20 or #25 K-file into the periapical tissues beyond the apical foramen with the tip having a slight curve. Over the blood clot (BC) and platelet-rich fibrin (PRF) scaffold, the coronal canals were filled with a 3 mm layer of biodentine. Composite resin was used to fill the access cavities.

Results: The 5 teeth had follow-up examinations at 6 and 18 months. At follow-up visits over time, there were no clinical signs or symptoms in all teeth. At the end of follow-up period, all teeth showed complete healing of periapical lesions and 3 teeth responded to cold and electric pulp tests.

Conclusions: Combination approach of PRF with BC could eliminate periapical radiolucent lesions, clinical signs or / symptoms and regaining of sensibility which indicates the presence of host's own pulplike vital tissue.

Key-words : Mature teeth, modified regenerative endodontic procedure, necrotic pulp, periapical radiolucencies, vital tissue, platelet-rich fibrin

Introduction:

In 1961, Nygaard-ÖStby found that blood clotting has likelihood of serving as a root canal filling in mature, necrotic teeth.[1] Regenerative endodontic procedures (REPs) was formerly confined to pulp revascularization of necrotic immature teeth through root canal cleaning and over instrumentation to induce bleeding into the root canals.[2]

REPs have recently been proposed as a treatment for necrotic mature permanent teeth with apical periodontitis due to their favourable outcomes in young, immature necrotic teeth. Additionally, mature teeth treated with a regenerative strategy have demonstrated that a successful outcome in terms of the remission of signs/or symptoms and recovery from apical periodontitis may be possible.[3-6]

Access this article online

Website: www.ujds.in

Quick Response Code

DOI: https://doi.org/10.21276/ujds.2025.v11.i2.10

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Received : 12 Dec., 2024, **Published :** 30 June, 2025

How to cite this article: Thakur, V. (2025). Clinical, radiographic and pulp sensibility assessment of necrotic mature permanent teeth with moderate to large periapical lesions using a modified revascularization therapy: A series of five cases. UNIVERSITY JOURNAL OF DENTAL SCIENCES, 11(2).

A number of studies related to this therapy have been published recently, and they suggest that REPs might be an effective replacement for conventional root canal therapy as well as offering enhanced biological characteristics. According to these study findings, REPs may be feasible to be utilized to treat mature permanent teeth in humans that have necrotic pulp which is infected or not infected.[7-10] Furthermore, a recent histologic investigation demonstrated that following REPs in mature teeth, growth of a vital tissue inside the root canal is viable.[11] The detected vital tissue was composed of a fibrous connective and bone-like composition along with few vascular structures.This outcome was revolutionary as it demonstrated for the first time that REPs in mature teeth the ability to form tissue components and structure that mimic those found in the root canals of young immature teeth.[12,13]

Even though the regenerated tissue might not be real pulp tissue, filling the canal with the patient's own vital tissue has following benefits over traditional endodontic therapy : rebuilding the neurovascular system within the canal, which would offer an immune mechanism for defense towards microorganisms.[14]

This case series is meant to show the possible advantages of utilizing REPs for mature permanent teeth having infected or noninfected necrotic pulps and apical periodontitis in terms of eliminating clinical signs/ symptoms and radiographically resolving periapical radiolucent lesions along with regaining of pulp sensibility.

Case Series:

In the department of endodontics,5 patients were treated using regenerative endodontic procedures . The main complaint, medical and dental histories of the patients were compiled. Preoperative IOPA radiographs of each tooth were obtained. Tests of pulp sensitivity were conducted utilizing cold and an electric pulp tests. Examinations were done intra-oral and extra-oral. The presence of sinus draining tracts, swelling, and tooth color change were also noted. Based on the primary complaint, clinical signs and symptoms, pulp sensibility tests, and radiographic results, pulpal-periapical disease was diagnosed.

Table 1 summarizes the demographic data of the patients. There were 5 patients in the current case series, 3 men, and 2 women with age of the patients between 20 to 25 years old.

REPs were used to treat 5 mature anterior teeth. Caries in 3 teeth led to apical periodontitis and pulp necrosis. Apical periodontitis and pulpal infection occurred in 2 teeth that had a history of trauma. On radiographs, all teeth showed periapical radiolucent lesions of endodontic origin (Table 2).

Treatment Procedures:

First Visit:

The anterior teeth received a local anesthetic with 2% lidocaine and 1:100,000 epinephrine, which was isolated using a rubber dam.

The access cavity was created after the caries was taken out. The pulp chamber was cleaned with irrigation of 1.5% sodium hypochlorite (NaOCL; Prevest DenPro, Jammu, India) after the canals were identified.

Using the electronic apex locator (iPex; NSK, Japan), and periapical radiographs, a working length was established. Ni Ti hand K-files (NITIFLEX; DENTSPLY MAILLEFER, Ballaigues, Switzerland) were used in a step-back technique to clean and shape the root canal up to the radiographic apex.

The apical foramina was increased to K-file size #60, and 2 ml of 1.5% sodium hypochlorite solution was injected into the root canal after each file.

The final phase of irrigation consisted of 5 ml of 1.5% NaOCl (HYPOSOL; Prevest DenPro, Jammu, India), followed by the same volume of 17% EDTA (NEOEDTA; Orikam Healthcare Pvt Ltd, Gurugram, Haryana, India), both of which were applied for 1 minute. All irrigation was done using irrigation needles (30-G) with two side vents (RC Twents ; Prime Dental Products Pvt Ltd, Thane, Maharashtra, India).Calcium hydroxide paste was applied to the canals as an intracanal medication after they had been dried with paper points (COLTENE, Altstätten, Switzerland). For one week, the access cavity was sealed with a small sterile cotton ball and an interim restoration (NEOTEMP; ORIKAM Healthcare Pvt Ltd, Gurugram, Haryana, India).

Second Visit:

After 1 week, if no signs of infection were seen, a local infiltration anesthesia without vasoconstrictor (LOXICARD 2%; Neon, Mumbai,India) was injected at the site. A rubber dam was applied and medicament was completely removed

with 1.5% NaOCl solution irrigation. After 1 minute of irrigation with a 17% EDTA solution, paper points were used to dry the canal. A hand #25 K-file was inserted 3 mm into the periapical tissues with the intent to induce bleeding into the canal.

The file was carefully turned 2 to 3 times in a clockwise direction before being removed in a counterclockwise direction. When bleeding was apparent in the canal, a sterile cotton ball was put 3 mm into the canal for 4 minutes to promote the construction of blood clot. PRF was made utilizing the method pioneered by Dohan et al. in France.[15]A sterile scissor was used to separate this freshly made PRF gel. PRF gel was compressed into a fibrin membrane with sterile gauge and cut into small fragments. Using a finger plugger, these fragments were placed slowly and carefully inside the canal beneath the CEJ. Biodentine (Septodont) covering of 2-3 mm thickness was placed above a collagen barrier (Colo Plug; Cologenesis Healthcare Pvt. Ltd, Salem, India) followed by restoration with a resin-based composite (NT Premium; Coltene, Altstätten, Switzerland).

Postoperative Assessment Clinical Assessment:

After REPs, pain level, pain on palpation and percussion, swelling, sinus tract was evaluate at each follow-up. Pain levels before and after procedure, were assessed using a numerical visual analog scale (VAS). At the conclusion of the 18 months follow-up period, EPT and thermal (cold) tests were utilized to determine if the teeth in the REPs group had regained responsiveness or not.

Radiographic Assessment:

In addition, the periapical lesion scores were assigned using the following criteria:-[16,17]

1. The periapical lesion was absent ; if the radiographic periodontal gap was less than 0.5 mm postoperatively.
2. Decrease in the periapical lesion; if postoperatively radiographic radiolucency was less than 20% preoperatively.
3. Increase in the periapical lesion; if postoperatively radiographic radiolucency was greater than 20% preoperatively.
4. Uncertain: if the situation cannot be described as the absence, diminution, or increase of radiolucency.

Image J software (Version 1.53e; National Institutes of Health, USA) was utilized to calculate the possible changes in root , root space dimensions and difference in lesion size from pre-operative and post-operative radiographs.[7] After 6 months of follow-up period, the teeth were asymptomatic and the periapical lesions were partially filled trabecular bone formation indicated evidence of healing. At 18-month follow-up period,the teeth were asymptomatic and the periapaical lesions were completely filled with trabecular bone formation indicated complete healing with intact lamina dura and normal periodontal ligament space.

Using the preoperative radiograph as the source image, the recall and final radiographs were digitally aligned with the TurboReg plug-in (Biomedical Imaging Group, Swiss Federal Institute of Technology, Switzerland), followed by linear measurements in Image-J software.[18] The results of the measurements showed that the dimensions of the root space had remained unchanged at the 18-month follow-up period.

TABLE 1. Demographic Data

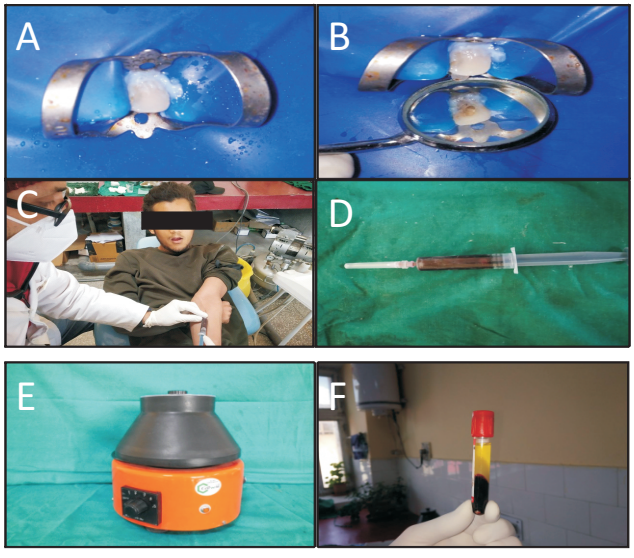
Patient no.	Sex	Age	Tooth no.
1	M	25	8
2	F	20	7
3	M	20	7
4	F	24	8
5	M	23	10

M – Male, F – Female

TABLE 2. Clinical sign/symptoms, Diagnosis, and Treatment findings of 7 teeth treated with REPs

Patient no.	Tooth no.	History	Diagnostic Tests	Radiographic examination	Diagnosis	Periapical lesion	Last Follow-up (month)
1	8	Trauma	ept(-), pt(-)	PAL	NP and AAP	Healed	18
2	7	Caries	ept(-), pt(+)	PAL	NP and SAP	Healed	18
3	7	Caries	ept(-), pt(+)	PAL	NP and SAP	Healed	18
4	8	Trauma	ept(-), pt(-)	PAL	NP and AAP	Healed	18
5	10	Caries	ept(-), pt(+)	PAL	NP and SAP	Healed	18

AAP, asymptomatic apical periodontitis; ept, electric pulp test; NP, necrotic pulp; PAL, periapical lesion; pt, percussion test; SAP, symptomatic apical periodontitis



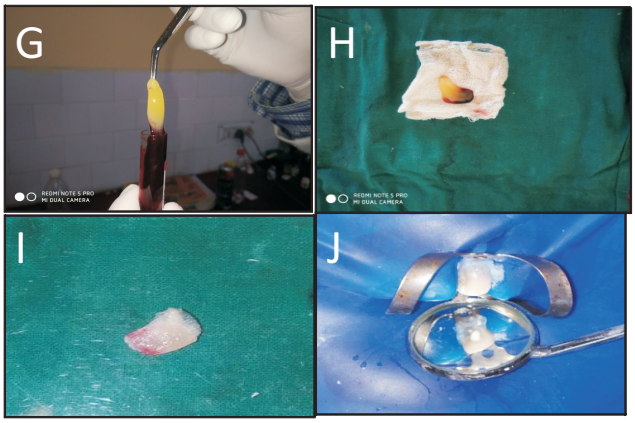


Figure 1:- (A) Rubber dam isolation of tooth. (B) Access cavity preparation. (C) and (D) Blood drawn from patient. (E) and (F) Centrifugation machine and blood after centrifugation. (G) and (H) PRF gel before and after separation. (I) PRF gel after compression. (J) MTA placement after insertion of PRF fragments into the canal.

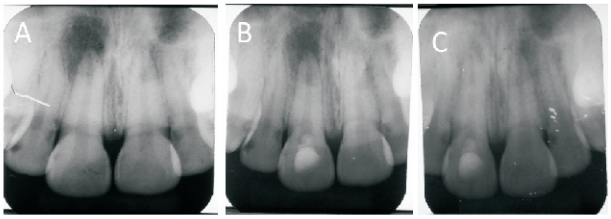


Figure 2. (A) Pre-treatment radiograph of the maxillary right central incisor showing a large well-defined periapical radiolucency at the apex. (B) Periapical radiographs obtained at the 6 months follow-up, shows evidence of healing after REPs. (C) Periapical radiograph obtained after 18 months, the periapical radiolucent lesion was completely healed. Tooth was asymptomatic and responded to pulp sensibility tests.

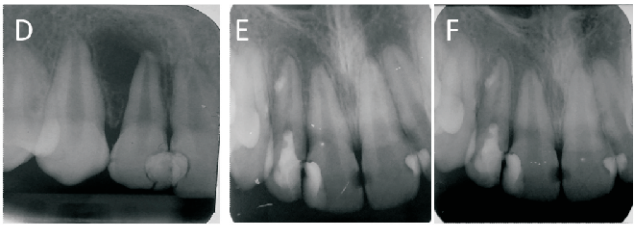


Figure 3. (D) Pre-treatment radiograph of the maxillary right lateral incisor showing a large periapical radiolucency. (E) Periapical radiographs obtained at the 6 months follow-up, shows evidence of healing after REPs. (F) Periapical radiograph obtained after 18 months, the periapical radiolucent lesion was completely healed and formation of a calcified bridge. Tooth was asymptomatic and responded to pulp sensibility tests.

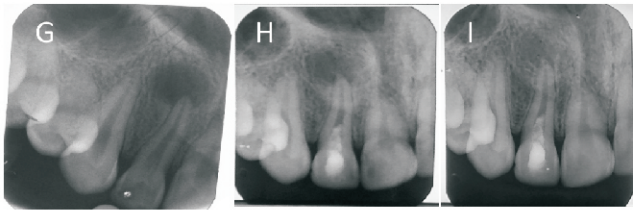


Figure 4. (G) Pre-treatment radiograph of the maxillary right lateral incisor showing a large well-defined periapical radiolucency at the apex. (H) Periapical radiographs obtained at the 6 months follow-up, shows evidence of healing after REPs. (I) Periapical radiograph obtained after 18 months, the periapical radiolucent lesion was completely healed. Tooth was asymptomatic and not responded to pulp sensibility tests.

Figure 5. (J) Pre-treatment radiograph of the maxillary right central incisor showing a large periapical radiolucency at the apex. (K) Periapical radiographs obtained at the 6 months follow-up, shows evidence of healing after REPs. (L) Periapical radiograph obtained after 18 months, the periapical radiolucent lesion was completely healed. Tooth was asymptomatic and responded to pulp sensibility tests.

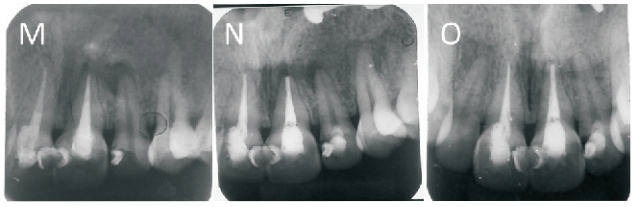


Figure 6. (M) Pre-treatment radiograph of the maxillary left lateral incisor showing a moderate periapical radiolucency at the apex. (N) Periapical radiographs obtained at the 6 months follow-up, shows evidence of healing after REPs. (O) Periapical radiograph obtained after 18 months, the periapical radiolucent lesion was completely healed. Tooth was asymptomatic and not responded to pulp sensibility tests.

Discussion:

The present study utilized the modified regenerative endodontic treatment which showed that combined application of blood clot (BC) and platelet rich fibrin (PRF) as scaffold could improve periapical healing and regain sensibility. In the current case series, 5 mature teeth with apical periodontitis and necrotic pulps have been successfully treated with REPs.

In REPs, the dimension of the apical foramina appears to be of significant importance. It was previously stated that effective revascularization of the pulplike tissue in reimplanted human permanent incisors required an apical foramina of at least 1.1 mm in diameter.[19] However, a study indicated that in an animal model, 0.3 mm was enough to allow for tissue into the canal.[20] In addition, mature maxillary anterior teeth that prepared upto #30 and 35 k-file, respectively, were successfully treated by Abou Samra et al.,[21] and Saoud et al.[6].Furthermore, a systematic review by Fang et al.[22] found that positive outcome was obtained following REPs in necrotic teeth with an apical diameter sizes ranging between 0.5 and 1.0 mm.

Evidently, maintaining high-quality standards of disinfection both during and after the regenerative therapy has been viewed as a crucial component, and if properly managed, is likely to improve the result and prognosis.[23] The use of high-concentration of irrigants and intracanal medicaments between appointments have been proven to be the most efficient methods for achieving total disinfection.; nevertheless, biocompatibility issues must be taken into account.

According to a study, more NaOCl concentrations have a deleterious effect on the viability and growth of stem cells of the apical papilla (SCAPs).[24] This outcome can be avoided by utilizing 1.5% NaOCl and final irrigation with 17% EDTA.[7,9] In addition, the administration of 17% EDTA showed enhanced SCAP longevity as well as substantially correcting the adverse effects of NaOCl. Furthermore, the studies concluded that irrigation of root sections with 1.5% NaOCl combined with 17% EDTA released a much larger amount of transforming growth factor-β1. As a result, this irrigation approach could be useful in regenerative endodontic procedures.[25,26]

According to the study by Sjogren et al.,[27] canals were medicated with $Ca(OH)_2$ for only one week in both groups and Althumairy et al.,[28] showed that it promotes SCAP survival.

The induction of periapical bleeding into the disinfected canal during REPs brings mesenchymal stem cells and many growth factors.[29] Furthermore, the blood clot (BC) could serve as a cross-linked scaffold for migration of stem cells, macrophages, and fibroblasts.[30]

Because of its easy production procedure, low cost, and entirely autologous nature without any artificial additives, platelet-rich fibrin (PRF), also known as Choukroun's PRF, has gained more popularity.In a study by Chen YJ et al.,[31] it was concluded that PRF not only provides a well-organized scaffold for cell adhesion and migration but also supplies necessary growth factors for dental pulp stem cells (DPSC) proliferation and differentiation. Also, the presence of leukocytes and cytokines along with small amounts of lymphocytes in PRF can play a significant role in the self-regulation of inflammatory and infectious phenomenon.[32]

In the current study, improved regenerative endodontic technique was performed using both induced bleeding to generate a blood clot (BC) in the canal combined with PRF as a scaffold and source of growth factors. This was reinforced by a previous by Zhou et al.,[33] in which BC + PRF as scaffolds demonstrated effective periapical healing in REPs.

In the present study, Biodentine had been selected rather mineral trioxide aggregate (MTA) because studies have shown that it encourages increased cell survival and adhesion.[34] Additionally, it does not result in tooth color change.[35]

However, radiographic healing of apical periodontitis and clinical symptoms were primarily used to assess the effectiveness of regenerative endodontic therapy in adult necrotic teeth prior to the onset of a response to pulp sensibility tests. The modified regenerative technique used in this case series led to the survival of mature necrotic teeth without any filling material and with possible revascularization in root canal which is based on positive response to pulp sensibility tests.

At the end of follow-up period, modified regenerative endodontic treatment for all cases resulted in the complete elimination of periapical radiolucency and clinical signs/symptoms which was in aggrement with a previous study.[33,36] At the end of 18-month follow-up period, 3 teeth showed positive response to cold and electric pulp tests. This is consistent with the outcomes of Arslan et al.,[7], El-Kateb et al.,[9] and Nageh et al.,[36] who found that more than 60% and 50% of their patients, respectively, responded to sensibility tests after the follow-up period of 12-month in mature teeth.These findings in may suggest that there was vital pulplike tissue formation in the root canal.[11]

Conclusion:

According to the current case series, a biologically based modified regenerative protocol may be utilized to treat necrotic mature permanent teeth with the aim of eliminating clinical signs /or symptoms and healing of moderate to large periapical lesions along with regaining of pulp sensibility. Filling of the disinfected root canals with the host's own pulplike vital tissue may be better than with nonvital foreign materials because vital tissue has innate and protective immune defense mechanisms. More clinical trials with long-term case follow-ups are needed to establish this modified technique as an alternative treatment modality in near future.

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