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Regenerative pulpotomy as a novel technique using platelet-rich fibrin(PRF) in permanent molars with irreversible pulpitis :Report of 2 cases

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ABSTRACT
The vitality of the dentin–pulp complex is critical for tooth health, supporting functions such as proprioception, repair, and vascularization. While irreversible pulpitis in mature permanent teeth has traditionally been treated with pulpectomy, pulpotomy is now emerging as a conservative alternative when the radicular pulp remains unaffected. Biodentine, a calcium silicate–based material, provides biocompatibility, short setting time, and excellent sealing ability, though some pulpotomy agents still show mild cytotoxicity. Platelet-rich fibrin (PRF), an autologous, regenerative, and cost-effective biomaterial, may enhance healing when combined with Biodentine. This case report evaluates the clinical and radiographic outcomes of pulpotomy using PRF with Biodentine in permanent molars with irreversible pulpitis, focusing on dentin bridge formation over a 12-month follow-up period.
Key words: Vital Pulp Therapy, Pulpotomy, Irreversible pulpitis, Biodentine, Platelet-Rich Fibrin (PRF)

I. INTRODUCTION

The dental pulp is a specialized connective tissue enclosed by dentin, enamel, and cementum, characterized by its rich vascularity and capacity to initiate defense mechanisms against microbial invasion. Dental caries remains the most common cause of pulpal inflammation, which may progress to necrosis if untreated.[1,2] Traditionally, pulp exposure resulting from caries excavation has been managed with root canal therapy (RCT). Although effective, RCT necessitates extensive removal of tooth structure, permanently devitalizes the tooth, and increases the risk of fractures.[3]

With advances in pulp biology and the development of bioactive materials, vital pulp therapy (VPT) has emerged as a minimally invasive and biologically favorable alternative.[4] VPT aims to maintain healthy pulp tissue while eliminating infected or inflamed portions, thereby preserving natural tooth function. Clinical procedures include direct pulp capping, partial pulpotomy, and full pulpotomy, with success largely depending on accurate diagnosis, control of inflammation, and the choice of biomaterial.[5]

Mineral trioxide aggregate (MTA) and Biodentine (BD), calcium silicate–based cements, have shown superior sealing ability and biocompatibility compared to traditional calcium hydroxide.[6]Biodentine, in particular, offers advantages such as shorter setting time, ease of handling, and better color stability, and has demonstrated high clinical success in permanent teeth with irreversible pulpitis. However, limitations including reduced dentin toughness over time and mild cytotoxic effects have been reported.[7]

Recent research has focused on autologous biologically active materials to overcome these drawbacks. Platelet-rich fibrin (PRF), a second-generation platelet concentrate, releases growth factors that modulate inflammation and stimulate pulpal healing. Preliminary studies suggest that combining PRF with Biodentine enhances regenerative outcomes in pulpotomy procedures. However, clinical evidence remains limited, underscoring the need for further investigation.[8,9]

This case report presented a new management for two carious pulpally-involved permanent mature molar teeth with symptoms suggesting irreversible pulpitis. The clinical/radiographic outcomes of these cases were

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evaluated over regular follow-up periods to gauge the prognosis of the treatment performed using a novel regenerative coronal pulpotomy technique using PRF and Biodentine.

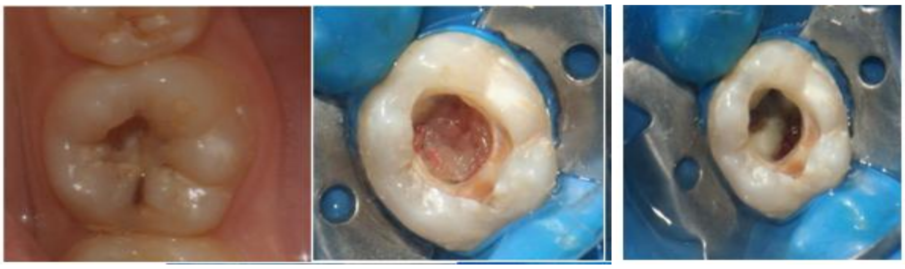
II. CASE REPORTS

Case 1:

A18 year old male patient presented to the Department of Conservative Dentistry and Endodontics complaining of acute spontaneous pain in the lower left posterior region. Dental history was recorded emphasizing on history of the present illness. Extra oral examinations showed neither swelling nor tenderness related to this area. Clinical examination revealed large carious lesion in the occlusal surface of tooth number #36 (Fig. 1A). Tooth was mildly tender to percussion. No associated sinus tract were found around the affected tooth, periodontal probing of the tooth was found to be within the normal limits. Pulp sensibility was performed with Endo-frost Endo-ice (Coltnene/Whaledent, Langenau, Germany) and Digitest II electric pulp tester (Parkell, NY, USA)showed sharp pain lingering after the removal of the stimulus. Radiographic examination revealed extensive deep occlusal caries extending from enamel and dentin to the pulp. Periapical radiolucency at the apical third region of mesial root of periodontal ligament space following root shape was detected on radiograph.Diagnosis of acute symptomatic irreversible pulpitis with symptomatic apical periodontitis was established based on clinical assessment, history of spontaneous pain, radiographic examination, pulp sensibility test associated with lingering pain to Endo ice cold stimuli.

Coronal pulpotomy using PRF/Biodentine combination was explained to the patient as an alternate to conventional RCT. The medical examination and tests for the bleeding time,clottingtime,platelets count were done and were within the normal range.

After local anesthesia and rubber dam application, the crown and the surrounding rubber dam was disinfected with 2% chlorhexidine solution. A sterile highspeed round bur was used for caries excavation; after exposure, a sterile Endo-Z bur was used to refine the access cavity. The coronal pulp was removed at the level of canal orifices using large sharp spoon excavator to remove remnants of pulp tissue in the pulp chamber. Sterile saline was used for pulp chamber irrigation thenhemostasis was achieved by the application of a cotton pellet moistened with 2.5% NaOCl for 2-3 min and repeated if required up to 10 min. PRF was prepared by drawing 10 mL of the patient own blood into two 5 ml test tubes without the addition of any anticoagulants. Tubes were placed in Choukroun PRF Duo Quattro System centrifuge. Then they were immediately centrifuged at 2700 rpm for 10 minutes. The PRF was obtained in the middle of the test-tube, between the clear acellular plasma layer on the top and the red blood corpuscles at the bottom of the tube. Sterile artery forceps was inserted into the test tube to retrieve the PRF clot which was separated from the underlying RBC layer using scissors and then placed it in the PRF box. The PRF box (Waldent K40/1) was used to extract a fibrin clot membrane from the PRF. A 4×4 mm² sized PRF membrane was positioned over the amputed pulp. Biodentine was then prepared and placed over the PRF plug with a thickness of 2 mm approximately and was allowed to initial set for about 12 min. The cavity was restored using resin-modified glass ionomer cement (RMGIC) then covered with composite resin restoration. An immediate postoperative periapical digital radiograph was taken, and the patient was recalled for follow-up after three, six and 12 months for clinical and radiographic evaluation.



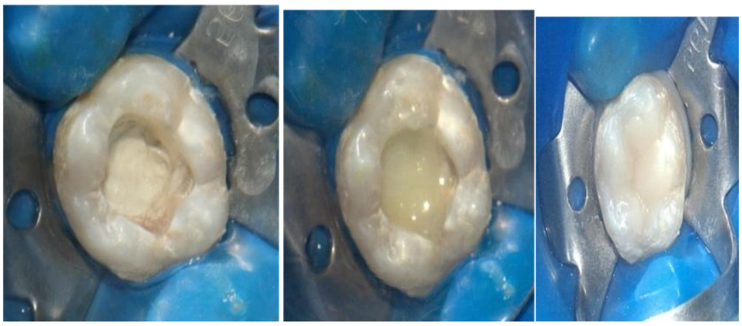


Figure 1: A: Showing a carious lesion on the occlusal surface of tooth #46; B: Removal of coronal pulpal tissues and hemostasis achieved; C: PRF plug was placed over the remaining radicular pulp; D: Biodentine was placed over the PRF plug; E: RMGIC placed over the Biodentine; F: Composite restoration as a final restoration.

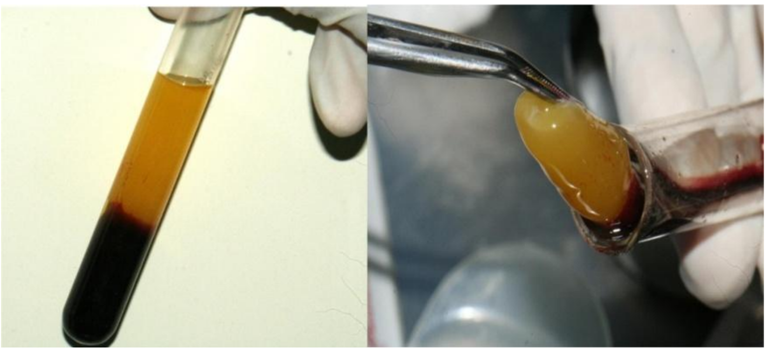


Figure2 : PRF after Centrifugation of Blood

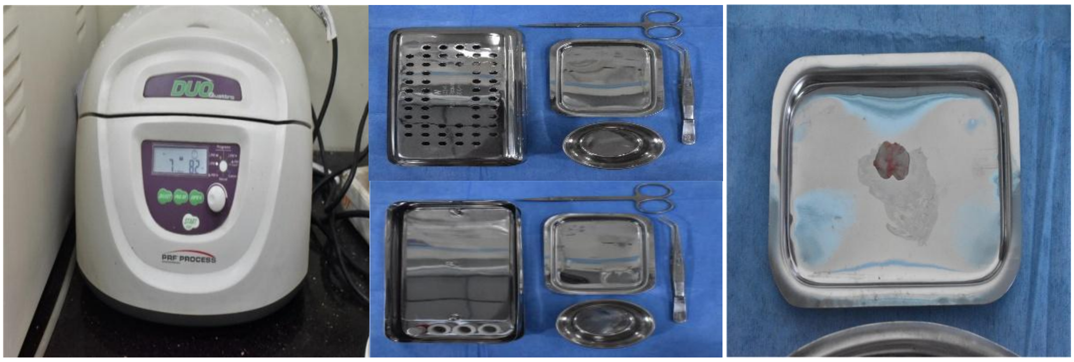


Figure 3: A)Choukroun PRF Duo Quattro System centrifuge ;B) Waldent PRF Container Box(K40/1) ;C) PRF Membrane

Case 2 :

A 21 year oldfemale patient was presented to the post graduate clinic complaining of sharp spontaneous pain lasting for minutes in the mandibular right posterior region. The medical history was noncontributory. Extra-oral examinations revealed absence of swelling or palpable lymph nodes in the head and neck regions. Intraoral examinations showed that the tooth #46 showed a deep carious lesion involving the occlusal surface. Sensibility test was done and showed sharp pain lingering after the removal of the stimulus. There was slight tenderness on percussion with no sinus tract opening near to the tooth, periodontal probing depth of the tooth was within normal limits, with normal physiological mobility. Radiographic imaging showed large deep carious lesion extending through the enamel, dentin and pulp in tooth #46 with normal periapical changes.Based on the clinical,radiographic and pulp sensibility examinations, the diagnosis was “symptomatic irreversible pulpitis”. The patient was informed of regenerative pulpotomy treatment and consent was obtained.The patient was treated with the same regenerative pulpotomy procedure using PRF as in case 1, and she was recalled for follow up after three, six and 12 months for clinical and radiographic evaluations.

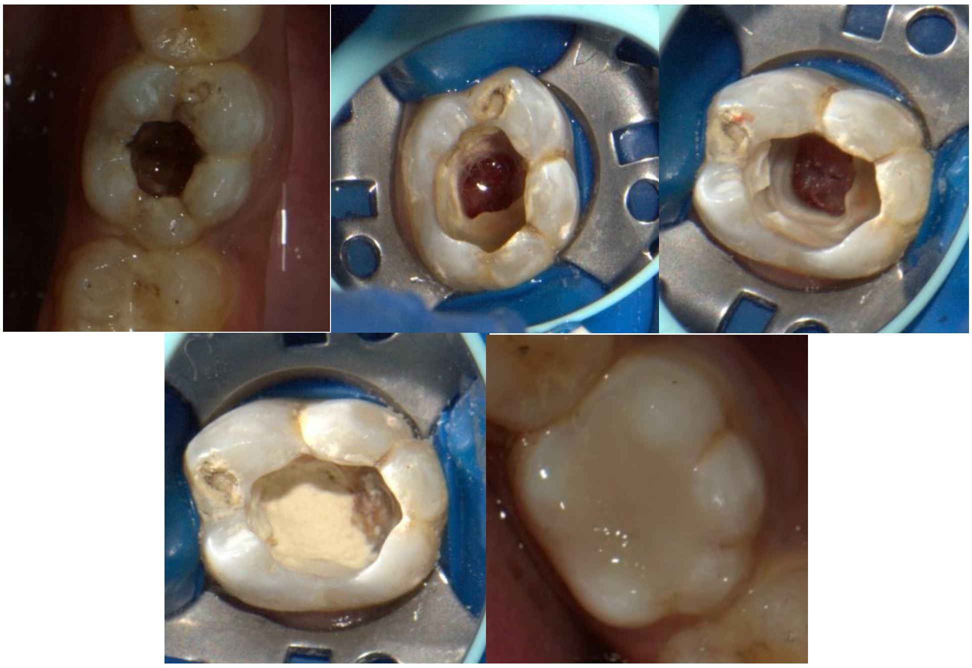


Figure 4: A: Showing a carious lesion on the occlusal surface of tooth #46; B: Removal of coronal pulpal tissues and hemostasis achieved; C: PRF plug was placed over the remaining radicular pulp; D: Biodentine was placed over the PRF plug; E: Composite restoration as a final restoration.

III. FOLLOW UP:

The clinical cases were evaluated at follow-up intervals of three, six, and twelve months. Patients of these cases remained asymptomatic, demonstrating both clinical and radiographic success. On examination, the treated teeth were functional, with no pain during chewing, and no evidence of swelling or sinus tract formation. Each patient exhibited negative responses to axial percussion and apical palpation.

Radiographically, all teeth showed a normal trabecular bone pattern around the roots and maintained a normal periodontal ligament (PDL) space, including case 1, which initially presented with preoperative PDL widening. No signs of internal or external resorption or intracanal calcification were detected. All patients continue to remain under systematic annual follow-up.

Case 1 :

Figure 5:A) Preoperative image B) Postoperative image

C) **6 month follow-up** **D) 12 month follow - up**

Case 2 :

Figure 6: A) Preoperative image B) Postoperative imageC) **6 month follow-up D) 12 month follow - up**

IV. DISCUSSION

Tissue engineering, as proposed by Langer and Vacanti in 1993, is based on three essential components: cells, extracellular matrix, and bioactive molecules.[10] In regenerative endodontics, this concept is represented by the triad of stem cells, scaffolds, and signaling molecules, along with a vital blood supply that sustains the regenerative process.[11]Two basic strategies are employed for pulp regeneration: cell-based and cell-free approaches.[12] The cell-based method has been widely explored for the regeneration of pulp–dentin-like tissues.[13]

Among biologically driven scaffolds, Choukroun's platelet-rich fibrin (PRF) has emerged as a promising material. Unlike platelet-rich plasma (PRP), which undergoes rapid dissolution, PRF consists of a fibrin matrix that resorbs gradually, mimicking a natural blood clot. It is obtained through a simple, cost-effective one-step centrifugation process without the need for anticoagulants or biochemical additives, while simultaneously preserving platelets and leukocytes.[14] In contrast, PRP requires a two-step centrifugation with anticoagulants and exogenous agents for polymerization. PRF also offers the advantage of forming an elastic, resistant membrane capable of sustained cytokine release[15] Studies have demonstrated that PRF continuously releases key growth factors such as TGF-β1, PDGF, and VEGF, with peak activity aligning with cellular proliferation around the 14th day.

Conversely, PRP exhibits an early burst release of cytokines, with a rapid decline thereafter.[16] The unique biological properties of PRF, including enhanced angiogenesis, cell proliferation, differentiation, and immunomodulatory effects, make it particularly suitable for regenerative endodontic procedures.[17]

In the present case reports, PRF was applied as an autologous scaffold to promote repair and regeneration in a young patient with symptomatic irreversible pulpitis and closed root apex. Literature on pulpotomy therapy in mature teeth is limited and often debated; however, systematic reviews have reported remarkably high success rates of 99.4% for partial pulpotomy and 99.3% for full pulpotomy in permanent teeth with closed apices.[18] In the current cases, although clinical features suggested irreversible pulpitis, it is likely that only the coronal pulp at the site of carious exposure was irreversibly inflamed, while the radicular pulp retained vitality. Nevertheless, the exact histological status remains uncertain. Importantly, diseased pulp tissue may not always be completely necrotic, as some surviving pulp cells can retain stem cell potential and contribute to autologous regeneration.[19]

Biodentine is a bioactive hydraulic calcium silicate cement that closely resembles the mechanical and biological properties of dentin while stimulating pulp cells to produce reparative dentin.[20] Its powder component comprises tricalcium silicate, dicalcium silicate, calcium carbonate, calcium oxide, iron oxide, and zirconium oxide, whereas the liquid phase contains calcium chloride and a water-reducing agent. Owing to its bioactivity and favorable handling characteristics, Biodentine can be placed as a bulk dentin substitute without the need for surface preconditioning and demonstrates a relatively short setting time.[21] The use of Biodentine as a protective capping material over PRF plugs has been shown to effectively stabilize and shield the membranes from mechanical stresses during restorative procedures, as reported by Solomon R. et al.[22] This strategic combination offers a synergistic effect, wherein PRF contributes an ideal biological scaffold with sustained release of growth factors, while Biodentine provides excellent sealing ability and biocompatibility. Together, they create a dual-approach that enhances pulp healing and accelerates the regeneration of irreversibly inflamed pulpal tissues.

V. CONCLUSION

The combined regenerative potential of PRF and the sealing ability of Biodentine provide a conservative and effective alternative to extirpation in the management of irreversibly inflamed pulpal tissues. The favorable outcomes observed in this case report can be attributed to appropriate case selection, strict aseptic protocols, and the clinician’s expertise. These findings suggest that pulpotomy with regenerative materials may represent a reliable treatment option for adult permanent teeth with closed apices; however, larger clinical trials and further studies are required before it can be established as a standard of care.

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