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Use of different scaffolds in regenerative endodontics in case of immature necrotic young permanent tooth: A clinical case series

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Abstract
The management of immature necrotic permanent teeth poses challenges due to thin dentinal walls and open apices, with traditional apexification failing to promote root development, thereby increasing fracture risk. Regenerative endodontic techniques offer a biological alternative by encouraging pulp-dentin regeneration and continued apex growth. This clinical investigation evaluated the effectiveness of Platelet-Rich Fibrin (PRF), Concentrated Growth Factor (CGF), and induced bleeding as scaffolds in treating such teeth, assessing radiographic outcomes like periapical healing, root lengthening, and dentinal wall thickening, along with clinical responses to sensitivity, percussion, and palpation tests. Three anterior teeth from patients aged 18–22 were treated with standard disinfection protocols followed by different scaffolds-CGF (Case 1), PRF (Case 2), and induced bleeding (Case 3)-then sealed with a 3mm layer of MTA or Biodentine and permanent composite restoration. Follow-ups with radiographic imaging at 3, 6, and 12 months revealed symptom resolution across all cases. CGF showed the most significant improvement with a PAI score reduction from 4 to 2, approximately 2mm root lengthening, and 1.5mm dentinal wall thickening. PRF yielded slightly lesser benefits with a PAI score drop from 3 to 2, 1.5mm root length gain, and 1mm wall thickening. The induced bleeding method, while clinically successful, showed the least radiographic improvement with a PAI decrease from 4 to 3, root elongation of 0.5mm, and minor dentinal wall thickening. Thus, although all three approaches were effective, CGF demonstrated superior regenerative potential, PRF served as a viable alternative, and induced bleeding remained a useful option where resources were limited.

Keywords: Regenerative endodontics, concentrated growth factor, platelet-rich fibrin, induced bleeding, immature necrotic teeth, periapical healing, root development

Introduction

Materials and Methods

Three patients aged between 18 to 22 years with immature necrotic permanent anterior teeth were selected for treatment based on the presence of open apices measuring at least one millimetre, verified necrotic pulps confirmed through negative sensibility test results, and radiographic evidence of incomplete root formation [1]. Following AAE latest guidelines all patients underwent a standardized disinfection protocol involving minimal instrumentation, irrigation with 1.5% sodium hypochlorite, a final rinse with 17% EDTA, and placement of a modified triple antibiotic paste for three weeks. Scaffold placement varied by case: in Case 1, 10ml of blood was centrifuged under specific variable speed parameters to obtain CGF, which was placed in the canal up to the cementoenamel junction (CEJ); in Case 2, 10ml of blood was centrifuged at 3000 rpm for ten minutes to produce PRF, which was also placed up to the CEJ; and in Case 3, bleeding was induced using a sterile 15 K-file extended 2mm beyond the apex, allowing the canal to fill with blood up to 3mm short of the CEJ [2]. For coronal sealing, a 3mm layer of MTA was applied in Case 1, while Biodentine was used in Cases 2 and 3, all positioned at CEJ level, followed by permanent restoration of the access cavity using composite resin after 24 hours [3]. Evaluation criteria included clinical assessments for pain, tenderness, mobility, and sensibility along with radiographic examinations at 3, 6, 12, and 24 months, focusing on periapical healing using the Periapical Index (PAI), root length, and dentinal wall development [4].

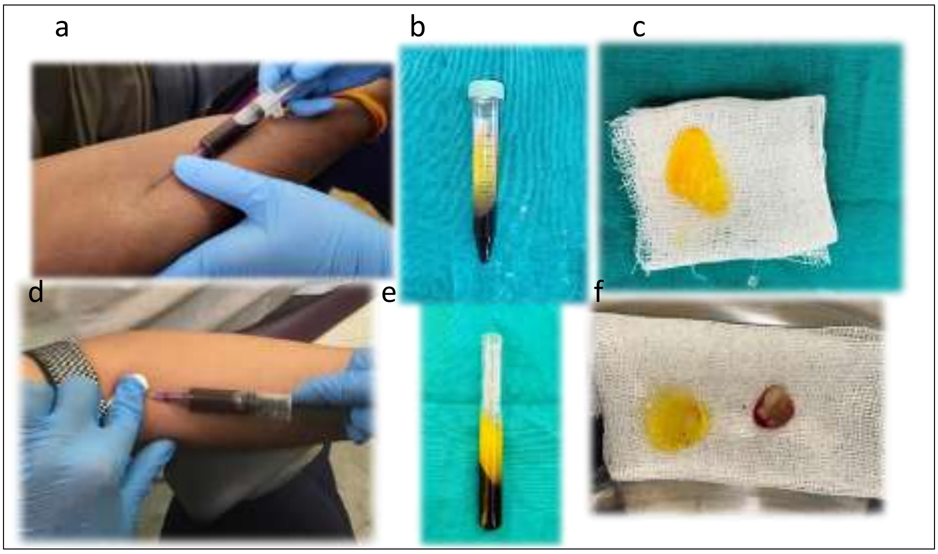

Fig 1: a. Blood sample withdrawn for CGF, b. CGF prepared after centrifugation, c. CGF separated from test tube, d. Blood sample withdrawn for PRF, e. PRF prepared after centrifugation, f. PRF separated from test tube.

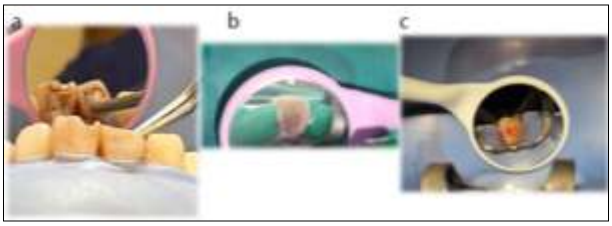

Fig 2: a. Placement of CGF into the canal, b. Placement of PRF into the canal, c. Bleeding is induced through the canal.

In Case 1, a 18-year-old male presented with staining on maxillary right central incisor (tooth #11), diagnosed with Ellis Class IV fracture and negative sensibility, with radiographs showing an immature tooth, open apex, and periapical radiolucency (PAI score 4). After completing the disinfection protocol with 17% EDTA, 10ml of blood was drawn from the antecubital vein, processed using CGF centrifugation protocol, and the CGF layer was placed into the canal with endodontic pluggers, followed by an MTA plug. At 24 -months follow-up, the tooth remained symptom-free, showed periapical healing (PAI score 2), increased root length, and dentinal wall thickening. In Case 2, an 20-year-old female with Ellis Class III fracture of maxillary left central incisor (tooth #21) and negative sensibility exhibited an open apex and periapical radiolucency (PAI score 3). Following standard disinfection and three-week placement of modified triple antibiotic paste, 10ml blood was collected, centrifuged at 3000 rpm for 10 minutes, and the PRF clot was placed in the canal with endodontic pluggers, sealed with a Biodentine plug. After 24 months, the tooth was asymptomatic, with PAI score reduced to 2, and showed root elongation and dentinal wall thickening; due to extensive coronal fracture, prosthetic rehabilitation was completed with a ceramic crown following digital impression and preparation. In Case 3, a 23-year-old boy with Ellis Class II fracture of maxillary right lateral incisor (tooth #12), negative sensibility, and pain on percussion, showed an immature open apex and periapical radiolucency (PAI score 4). After disinfection, bleeding was induced by extending a sterile 15 K-file 2mm beyond the apex, allowing a clot to form 3mm below CEJ, followed by placement of a Biodentine plug. At the 24-months follow-up, the tooth was asymptomatic, PAI score reduced to 3, and radiographic evaluation revealed increased root length and dentinal wall thickness.

Fig 3: a. Preoperative periapical radiograph of tooth #11. Note immature root with open apex, b. Radiograph at 12 months follow-up, c. Radiograph at 24 months follow-up. Note the increase in Dentine thickness and root end closure, d. Preoperative periapical radiograph of tooth #21, e. Radiograph at 12 months follow-up, f. Radiograph at 24 months follow-up. Note apical close closure and root canal obliteration, g. Preoperative periapical radiograph of tooth #12, h. Radiograph at 12 months follow-up, i. Radiograph at 24 months follow-up. Note the increase in Dentine thickness and root end closure.

Results

All three cases demonstrated successful clinical outcomes with complete symptom resolution at the twelve-month follow-up, although sensibility tests remained negative, indicating the formation of non-innervated tissue [3]. Radiographic evaluations revealed varying degrees of success among the three regenerative techniques [4]. CGF showed the most significant improvement due to its higher concentration of growth factors and denser fibrin matrix, though it requires specialized medical devices for preparation [5]. PRF offered a practical and effective alternative using standard centrifugation methods, balancing accessibility with favorable results [6]. In contrast, the induced bleeding technique, while being the most straightforward and cost-effective, produced less predictable outcomes, reflecting its limitations compared to the other scaffold methods [7].

Discussion

The regenerative potential of endodontic treatments relies on growth factors that activate stem cell proliferation and differentiation [7]. CGF exhibits superior performance due to its unique preparation process, which yields a higher concentration of growth factors and a denser fibrin matrix through differential centrifugation, while the presence of CD34-positive cells further enhances angiogenesis [8]. PRF functions as a reservoir for sustained release of growth factors over time, whereas the success of the induced bleeding method is influenced by individual patient factors that affect the concentration of stem cells and platelet-derived growth factors [9]. Procedural success depends on thorough disinfection, preservation of stem cells, and accurate scaffold placement, with 17% EDTA playing a crucial role in exposing dentinal tubules and facilitating growth factor release [10]. The application of biocompatible sealing materials like MTA or Biodentine ensures a bacteria-tight coronal seal [11]. Clinically, all three techniques produced favorable outcomes; however, CGF demonstrated better periapical healing and continued root development compared to PRF [12]. The choice of technique should be guided by clinical presentation, patient-specific factors, and resource availability [13].

Conclusion

The research demonstrates that CGF, PRF, and induced bleeding all offer clinically successful outcomes in the regeneration of immature necrotic permanent teeth, with CGF showing superior results in terms of periapical healing and root development. CGF stands out due to its higher concentration of growth factors and denser fibrin matrix, making it the preferred treatment option when specialized equipment is available. PRF offers a practical and effective alternative, balancing ease of preparation with favourable clinical outcomes, while induced bleeding remains a viable option in settings where advanced equipment is not accessible. For future clinical practice, treatment selection should consider patient-specific factors and resource availability, and further research is recommended to focus on long-term outcomes, tissue analysis, and the development of improved regenerative protocols.

Conflict of Interest

Not available.

Financial Support

Not available.

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