

## Comparison between the Outcomes of Two Platelet-Rich Concentrates on Apexogenesis in Young Permanent Incisors Requiring Endodontic Retreatment

### Abstract

Platelet-rich fibrin (PRF) and platelet-rich plasma (PRP) have been successfully used for inducing pulp regeneration in nonvital teeth. This case report highlights the difference between the outcomes of using PRF and PRP for pulp regeneration in a 13-year-old male patient, who had reported with endodontic treatment failure in his upper incisors. Gutta-percha and sealant were removed, and triple antibiotic paste (TAP) was placed in all the root canals and sealed with cavit. Subsequently, after TAP removal, 11 and 12 were treated with PRF, while 21 and 22 were treated with PRP. A resorbable matrix was placed over the PRF/PRP, over which mineral trioxide aggregate and glass ionomer cement were placed. After 2 years, all the upper maxillary incisors revealed dentinal wall thickening, root lengthening, and apical closure. However, apical bridge formation occurred only in incisors treated with PRF.

**Keywords:** Apexogenesis, endodontic treatment failure, incisors, open apices, platelet-rich fibrin, platelet-rich plasma

### Introduction

Pulp revascularization refers to the induction of angiogenesis in an endodontically treated root canal. However, pulp regeneration is considered to have occurred only after the formation of odontoblastic layer along the dentin surface; nociceptive, sympathetic, and parasympathetic nerve fibers; fibroblasts; and stem cells.<sup>[1,2]</sup> The concept of regenerating the pulp was introduced by Ostby in 1961, to facilitate the continuation of root growth and apical closure and to reduce the risk of root fracture.<sup>[3]</sup> Platelet-rich fibrin (PRF) and platelet-rich plasma (PRP) have been used previously for pulp regeneration in nonvital teeth. However, there has been no case report in literature that has compared the outcomes of using PRF and PRP in similar teeth in the same patient, following endodontic treatment failure.

### Case Report

A 13-year-old male patient was referred to the Department of Endodontics for radiographic assessment of 11, 12, 21, and 22. On clinical examination,

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Ellis Class II fracture of 11 and 21, and coronal discoloration of 11 and 12 were observed [Figure 1a]. On radiographic examination, 12, 11, 21, and 22 were found to have open apices and contained imperfect gutta-percha obturation [Figure 1b]. The patient had also complained of occasional tenderness while biting. A diagnosis of symptomatic apical periodontitis in previously treated teeth was made. It was decided to retreat the teeth by attempting pulpal regeneration using PRP and PRF, following the removal of the existing obturating material. The patient was informed about the advantages and disadvantages of the method, and written consent was obtained to undertake the procedure in these teeth.

Under rubber dam isolation and local anesthesia (3% mepivacaine without vasoconstrictor), access cavity preparation was made using a round bur and the Endo-Z bur (Dentsply Maillefer, Tulsa, OK). Gutta-percha and sealant were carefully removed using H-files while irrigating with 20 ml of 1.5% sodium hypochlorite. The canals were then rinsed with 20 ml of saline for 5 min. A thick paste of triple antibiotic

**How to cite this article:** Prasad J, de Ataide IN, Chalakkal P, Likhyani LK. Comparison between the outcomes of two platelet-rich concentrates on apexogenesis in young permanent incisors requiring endodontic retreatment. *Contemp Clin Dent* 2018;9:S156-9.

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### Access this article online

#### Website:

www.contempclindent.org

DOI: 10.4103/ccd.ccd\_9\_18

#### Quick Response Code:



paste (TAP) was obtained by mixing equal amounts of API (active pharmaceutical ingredient) formulation of metronidazole ciprofloxacin and minocycline (GAPL, Tuem, India) with distilled water to a final concentration of 0.1 mg/ml. After drying the canals with paper points, TAP was placed in all the four canals using lentulo spirals and covered with cotton pellets. The canals were then sealed with cavite (ESPE, Cergy-Pontoise, France), and the patient was recalled after 2 weeks.

On the second appointment, after confirming the absence of any signs or symptoms, TAP was removed by irrigating with 1.5% sodium hypochlorite and saline. Irrigation was simultaneously carried out with an EndoActivator at 10,000 cycles/min, until the emerging solution was clear of any TAP. H-files were also used to remove any remnants by scrapping the dentinal walls 1 mm short of the radiographic working length, followed by final irrigation with 20 ml of 17% ethylenediaminetetraacetic acid for 1 min.

Under aseptic conditions, 10 ml of blood was derived from the medial cubital vein of the patient's left arm. It was then transferred into a test tube (without anticoagulant) and centrifuged (REMI Model R-8c, India) at 3000 rpm for 15 min to obtain PRF. After centrifugation, the test tube showed acellular platelet poor plasma (PPP) in the top portion, PRF clot in the intermediate portion, and red blood cells at the bottom portion. PRF was removed from the test tube with the help of a sterile tweezer and placed in a dappen dish [Figure 1c]. It was then immediately sectioned into pieces using sterile scissors and gently condensed into the canals of 11 and 12 using size 30 endodontic pluggers (Dentsply Maillefer Ballaigues) until the cemento-enamel junction (CEJ). Resorbable matrix was placed over the PRF, over which white mineral trioxide aggregate (MTA; ProRoot MTA, Dentsply) was placed.

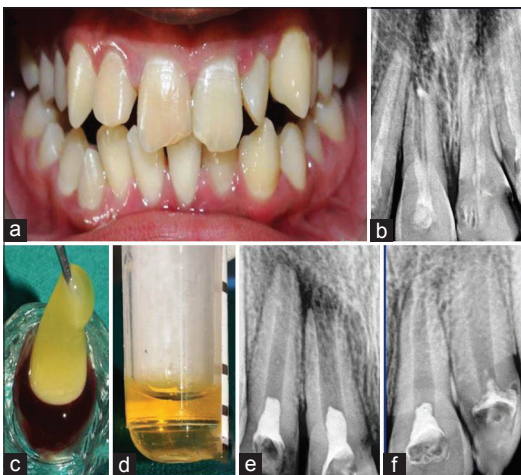
The moist cotton pellets were placed over the MTA and sealed with a temporary restoration.

After 24 h, glass ionomer cement restoration of 3–4 mm thickness was placed over the MTA. During that appointment under aseptic conditions, 10 ml of blood was derived from the antecubital vein of the right arm. It was then transferred into a test tube coated with an anticoagulant (acid citrate dextrose) and centrifuged at 3000 rpm for 10 min. The supernatant plasma obtained was then pipetted into another test tube and centrifuged at 1500 rpm for 15 min to separate PRP from PPP. The bottom one-third of the contents of the test tube which contained PRP [Figure 1d] was injected into canals of 21 and 22 until the CEJ. The methods used for the placement of resorbable matrix, MTA, temporary restoration, and Glass ionomer cement restoration were similar to those used for PRF. Radiographs were taken after completing the above procedures in the incisors [Figure 1e and f].

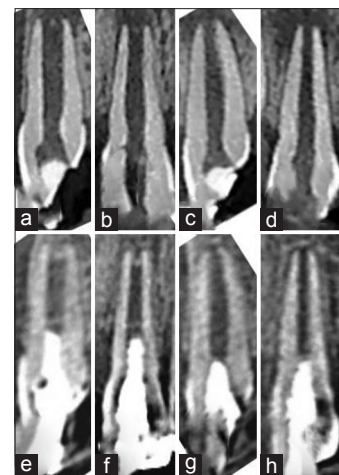
The patient was recalled after 1 month for radiographic evaluation. Thereafter, clinical evaluation was undertaken every 6 months until 2 years. At the end of 2 years following treatment, CBCT revealed dentinal wall thickening, root lengthening, and apical closure in all the incisors treated with PRF and PRP. However, apical bridge formation was observed only in those incisors (11, 12) that were treated with PRF [Figures 2 and 3]. All the above signs indicated pulpal regeneration in all the incisors.

## Discussion

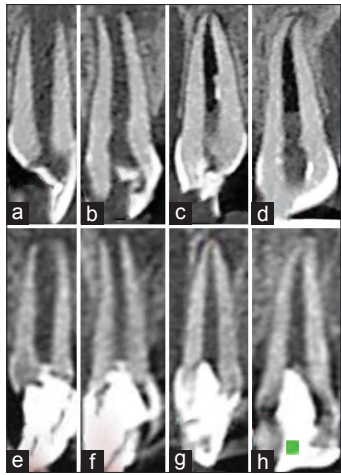
PRP is a first-generation platelet concentrate with an autologous platelet concentration of 1–2 million/mL after centrifugation.<sup>[4]</sup> It constitutes growth factors such as platelet-derived growth factor (PDGF), transforming growth factor (TGF- $\beta$ ), insulin-like growth factor (IGF), vascular



**Figure 1:** (a) Anterior view of the upper incisors, (b) Pretreatment radiograph of the upper incisors, (c) Platelet-rich fibrin placed in a dappen dish, (d) Platelet-rich plasma in a test tube, (e) Immediate radiograph of 11 and 12 following treatment, (f) Immediate radiograph of 21 and 22 following treatment



**Figure 2:** (Cone-beam computed tomography images): (a) Pretreatment lateral view of 11, (b) Pretreatment anterior view of 11, (c) Pretreatment lateral view of 12, (d) Pretreatment anterior view of 12, (e) 2 years' posttreatment lateral view of 11, (f) 2 years' posttreatment anterior view of 11, (g) 2 years' posttreatment lateral view of 12, (h) 2 year' posttreatment anterior view of 12



**Figure 3: (Cone-beam computed tomography images): (a) Pretreatment lateral view of 21, (b) Pretreatment anterior view of 21, (c) Pretreatment lateral view of 22, (d) Pretreatment anterior view of 22, (e) 2 years' posttreatment lateral view of 21, (f) 2 years' posttreatment anterior view of 21, (g) 2 years' posttreatment lateral view of 22, (h) 2 years' posttreatment anterior view of 22**

endothelial growth factor (VEGF), epidermal growth factor, and epithelial cell growth factor. These growth factors get released during the degranulation of alpha granules in platelets and eventually stimulate proliferation of stem cells that induce tissue formation.<sup>[5,6]</sup>

PRF is a second-generation platelet concentrate. It consists of a mixture of glycan chains, cytokines, and structural glycoproteins enmeshed within a slowly polymerized fibrin network. PRF consists of a 3D architecture, containing various growth factors such as PDGF, TGF  $\beta$ 1, VEGF, and IGF.<sup>[7]</sup> These growth factors can stimulate scaffold remodeling and dental pulp stem cells that can result in angiogenesis and pulp tissue formation.<sup>[8]</sup> PRF consists of 210-fold higher concentration of platelets and fibrin.<sup>[9]</sup> The advantages of PRF over PRP are ease of preparation and the absence of biochemical handling of blood. Moreover, PRF is strictly autologous since it requires no addition of external anticoagulants.<sup>[10]</sup>

Minimal instrumentation was carried out during the above procedures to minimize any further weakening of dentin walls and to preserve growth factors and stem cells essential for the regeneration process.<sup>[11]</sup> To prevent any cytotoxicity that could occur at higher concentrations, TAP concentration was maintained at 0.1 mg/ml,<sup>[12]</sup> and the concentration of sodium hypochlorite used for irrigation was maintained at 1.5%.<sup>[13]</sup> An EndoActivator was also used for the removal of TAP remnants similar to the method used by Arslan *et al.*<sup>[14]</sup>

In this case, dentinal wall thickening, root lengthening, and apical closure had occurred in all the incisors treated with PRF and PRP. However, apical bridge formation was observed only in those incisors (11, 12) that were treated with PRF. This could have probably occurred due to the

various advantages PRF over PRP. It has been reported that after the placement of PRP, the maximum release of growth factors (TGF- $\beta$ 1 (81%) and PDGF) is found on the first day followed by a continuous decline until the 14<sup>th</sup> day. Since the ingrowth of cells into the root canal could occur after 14 days, the efficacy of growth factors from PRP for the formation or thickening of dentin is limited.<sup>[15]</sup> Moreover, PRP inhibits the differentiation of bone mesenchymal stem cells (BMSCs).<sup>[16]</sup> However, PRF is associated with the slow and sustained release of growth factors for up to 28 days, with peak levels at around the 14<sup>th</sup> day with a continuous rise in cytokine levels.<sup>[15]</sup> PRF also upregulates osteoprotegerin and expresses alkaline phosphatase. Moreover, PRF stimulates the proliferation and differentiation of BMSC.<sup>[17]</sup>

In this case report, a comparison between the effectiveness of PRF and PRP in pulp regeneration was made from adjacent maxillary incisors. Since the treatment was carried out in the same patient, the physiologic response would have been similar after both procedures due to similar cellular structure. This results in an accurate comparison between the outcomes of using both the methods. There is no case report in the literature that has documented a similar comparison. However, the inability to perform pulp vitality tests in the incisors due to the presence of coronal MTA barriers remains the limitation of the study.

## Conclusion

PRF and PRP are efficient in inducing pulp regeneration and apexogenesis in teeth that have undergone endodontic treatment failure. However, apical bridge formation was observed only in teeth that were treated with PRF.

## Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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