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**MINIREVIEWS**

- 1 Minireview of the clinical efficacy of platelet-rich plasma, platelet-rich fibrin and blood-clot revascularization for the regeneration of immature permanent teeth

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## Minireview of the clinical efficacy of platelet-rich plasma, platelet-rich fibrin and blood-clot revascularization for the regeneration of immature permanent teeth

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### Abstract

The aim of this mini-review was to investigate and

compare the clinical efficacy of platelet-rich plasma (PRP) and platelet-rich fibrin (PRF), *vs* blood clot revascularization (BCR) for the regeneration of immature permanent teeth. The clinical efficacy of PRP, PRF, and BCR to regenerate 90 immature permanent teeth after one year, were compared for their ability to accomplish apical closure, a periapical lesion healing response, root lengthening, and dentinal wall thickening. The 90 cases were published in three different articles. The mean success rate for apical closure after one year was: PRP (89.2%) PRF (80%), and BCR (75.6%). The mean success rate for root lengthening after one year was: BCR (88.9%), PRP (68.2%), and PRF (65%). The periapical lesion healing response was 100% for BCR and 100% for PRP. Dentinal wall thickening was 100% for BCR, and 100% for PRP. All the PRP, PRF, and BCR treatments appeared to be effective. The published clinical results for PRP, PRF, and BCR indicate that these treatments are effective for the regeneration of immature permanent teeth.

**Key words:** Saving immature teeth; Regenerative endodontics; Dental pulp; Revascularization; Apical closure

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**Core tip:** The fractured or decayed immature permanent teeth of children and young adults aged 6 years to 28 which have a restorable crown, but thin dentinal walls may be regenerated by using a revascularization procedure which draws blood and stem cells into a disinfected root canal space. This study has shown that in addition to the most common method of using a blood clot revascularization technique, a platelet-rich plasma and a platelet-rich fibrin technique may also be used as alternatives.

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## INTRODUCTION

Millions of mature teeth are saved by root canal therapy. The overall success rates for endodontic treatment after an average of 22 mo was 99.3%<sup>[1]</sup> and the success rate remains above 83.34% after eight years<sup>[2]</sup>, and 86.02% after ten years<sup>[3]</sup>. It is the endodontic management of permanent incompletely developed teeth, after a traumatic injury, which have a poor prognosis when treated by conventional root canal therapy<sup>[4]</sup>. A common problem with incompletely developed teeth is that the dentinal walls are thin and weak, and are prone to stress fracture<sup>[5]</sup>. The long-term use of calcium hydroxide as a root canal dressing may increase risk of root fracture<sup>[6]</sup>. Immature teeth that have open and often divergent apices are not suitable for complete cleaning and obturation with traditional techniques and materials<sup>[7]</sup>. Ideally incompletely developed teeth require a "regenerative endodontic procedure" (REP) to thicken the dentinal walls to help prevent the subsequent fracture of the tooth<sup>[8]</sup>. REPs might not always result in complete root formation, and may not completely reduce the chances of root fracture<sup>[9]</sup>, more successful REPs need to be investigated.

Regenerative endodontic therapies began around 1952, when a German dentist called: Dr. Hermann advocated the use of calcium hydroxide as a dressing for after a vital pulp amputation<sup>[10]</sup>. Today, many dentists still use calcium hydroxide, mainly for apexification<sup>[11]</sup>, although MTA has overtaken calcium hydroxide to become the most popular pulp repair material<sup>[12]</sup>. Subsequent regenerative dental procedures include the development of guided tissue or bone regeneration procedures and distraction osteogenesis<sup>[13]</sup>; the application of platelet rich plasma (PRP) for bone augmentation<sup>[14]</sup>; the use of platelet rich fibrin (PRF) for periodontal wound healing<sup>[15]</sup>; and blood clot revascularization (BCR) by a Norwegian dentist called Dr. Nygaard-Ostby for the regeneration of tissues within the root canals of pulpomatized teeth<sup>[16,17]</sup>. There maybe a resistance among clinicians to use PRP and PRF instead of BCR, because PRP and PRF requires a venous blood draw from the arm of the patient at the time of treatment, and this adds time and complexity to the tasks necessary to deliver the dental treatments, in addition to the added cost of the PRP and PRF kits<sup>[18]</sup>.

The efficacy of BCR, or PRP or PRF has proved controversial for the regeneration of teeth: A randomized clinical trial which compared PRP, PRF and BCR

concluded that BCR was the standard procedure for revascularization of non-vital permanent immature teeth<sup>[19]</sup>. Meanwhile another clinical case series of BCR and PRP, concluded that PRP was the most successful therapy<sup>[20]</sup>. Another clinical study, concluded that the regenerative effects of PRP and BCR were similar, except that PRP could increase the root length of immature teeth<sup>[21]</sup>. Further research is needed to determine if BCR, or PRP or PRF can give improved treatment outcomes, to guide clinicians to deliver the most effective treatment to benefit patients.

The successful outcome of the REP is commonly measured as; the ability to accomplish apical closure of the tooth root, a periapical lesion healing response, root lengthening, and dentinal wall thickening, because these indicate the regeneration of tissues<sup>[19-21]</sup>.

The aim of this study was to compare the clinical efficacy of PRP and PRF, vs BCR for the regeneration of 90 immature permanent teeth after one year, compared using a meta-analysis for their ability to accomplish apical closure, a periapical lesion healing response, root lengthening, and dentinal wall thickening. The diverse treatment outcomes of the 90 treated teeth had been published in three different articles<sup>[19-21]</sup>.

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## EXISTING RESEARCH

The clinical efficacy of PRP, PRF, and BCR to regenerate 90 immature permanent teeth after one year from three articles<sup>[19-21]</sup>, were compared using a meta-analysis for their ability to accomplish apical closure, a periapical lesion healing response, root lengthening, and dentinal wall thickening.

This study did not require ethical approval from the Institutional Review Board because it used a publicly available data. The de-identified data was previously published in three articles<sup>[19-21]</sup>. The three articles were selected from Medline following the search terms "immature permanent teeth,clinical, platelet rich plasma (PRP), revascularization, and clinical." This search returned one article which was excluded, because it investigated replanted teeth. Two articles were excluded because they were a case report of one tooth. The three articles were included in this mini-review because they were clinical trials of permanent immature teeth treated with PRP revascularization treatments, which measured the outcomes of treatment radiographically for more than one year.

The clinical criteria selected for evaluating the success of PRP, PRF, and BCR was apical closure of the tooth root, a periapical lesion healing response, root lengthening, and dentinal wall thickening<sup>[19-21]</sup>.

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## SUCCESS RATE FOR ROOT LENGTHENING

The mean success rate for apical closure after one year

**Table 1** Meta-analysis data of blood clot revascularization, platelet-rich plasma and platelet-rich fibrin for the regenerative endodontic treatment of immature teeth following trauma a one year follow-up

Article	Procedure (PRP, PRF or BCR)?	Apical closure?	Periapical lesion healing response	Root lengthening	Dentinal wall thickening
Jadhav <i>et al</i> <sup>[20]</sup> , 2013	PRP	3/3 (100%) Satisfactory, good and excellent)	3/3 (100%) (Satisfactory, good and excellent)	3/3 (100%) (Satisfactory, good and excellent)	3/3 (100%) (Satisfactory, good and excellent)
Jadhav <i>et al</i> <sup>[20]</sup> , 2013	BCR	3/3 (100%) (Satisfactory, good and excellent)	3/3 (100%) (Satisfactory, good and excellent)	3/3 (100%) (Satisfactory, good and excellent)	3/3 (100%) (Satisfactory, good and excellent)
Alagl <i>et al</i> <sup>[21]</sup> , 2017	PRP	14/15 (93.3%) (Complete closure)	15/15 (100%) (All lesions healed)	NA	NA
Alagl A <i>et al</i> <sup>[21]</sup> , 2017	BCR	8/15 (53.3%) (Complete closure)	15/15 (100%) (All lesions healed)	NA	NA
Shivashankar <i>et al</i> <sup>[19]</sup> , 2017	PRF	16/20 (80%) (Apical foramen response <i>vs</i> no response)	NA	13/20 (65%)	NA
Shivashankar <i>et al</i> <sup>[19]</sup> , 2017	BCR	14/15 (93.3%) (Apical foramen response <i>vs</i> no response)	NA	13/15 (86.7%)	NA
Shivashankar <i>et al</i> <sup>[19]</sup> , 2017	PRP	16/19 (84.2%) (Apical foramen response <i>vs</i> no response)	NA	12/19 (73.70%)	NA
Mean for all publications	PRF	16/20 (80%)	18/18 (100%)	13/20 (65%)	NA
Mean for all publications	BCR	25/33 (75.6%)	18/18 (100%)	16/18 (88.90%)	3/3 (100%)
Mean for all publications	PRP	33/37 (89.2%)	NA	15/22 (68.20%)	3/3 (100%)

BCR: Blood clot revascularization; PRF: Platelet-rich fibrin; PRP: Platelet-rich plasma.

was: PRP (89.2%) PRF (80%), and BCR (75.6%). The mean success rate for root lengthening after one year was: BCR (88.9%), PRP (68.2%), and PRF (65%). The periapical lesion healing response was 100% for BCR and 100% for PRP. Dentinal wall thickening was 100% for BCR, and 100% for PRP. All the PRP, PRF, and BCR procedures were similarly effective ( $P > 0.05$ ). The individual and mean results for the PRP, PRF, and BCR procedures are summarized in Table 1.

Traumatic injuries to incompletely-developed permanent teeth affect 22% of children<sup>[22]</sup>. Despite this high demand for RETs to save teeth following trauma and caries, the use of endodontic treatments or RET has proved to be controversial<sup>[8]</sup>. A survey found that 55.1% of dentists were unsure whether RETs would be successful<sup>[23]</sup>. The failure to use RETs to save immature traumatized due to a lack of training or confidence in the outcome, may cause millions of children to grow up with missing natural teeth that could have been saved. To change clinician opinions and to gain a wider acceptance of RETs to be used to help save childrens traumatized teeth it was necessary to determine if the PRP, PRF, and BCR procedures could make RET more successful or if they were similarly effective.

This present study calculated the mean success rate for apical closure after one year was: PRP (89.2%) PRF (80%), and BCR (75.6%). PRP was at least 9% to 13.6% more effective at inducing apical closure in comparison to PRF and BCR. PRP, PRF, and BCR were similarly effective at inducing apical closure in

traumatized immature teeth, however, clinicians who treat hundreds of traumatized immature teeth with REPs, may find that using PRP will slightly increase the rate of procedure success. Potential disadvantages of the use of PRP vs BCR is the increased cost and time needed to prepare the PRP. Clearly, a child who has trypanophobia (a fear of needles) or hemophobia (a fear of the sight of blood) and do not allow venous blood to be drawn from their arm is not a suitable candidate for PRP or PRF procedures.

The mean success rate for root lengthening after one year in this present study was: BCR (88.9%), PRP (68.2%), and PRF (65%). Although, BCR was at least 20.6% to 23.9% more effective at inducing root lengthening in comparison to PRF and PRP. The superior effectiveness of BCR, supports the theory that blood revascularization through the root apex brings mesenchymal stem cells into the root canal space to help accomplish dentinal regeneration<sup>[24]</sup>.

The periapical lesion healing response was 100% for BCR and 100% for PRP. These findings are very good news for patients. It suggests that REPs are very successful at the disinfection of bacteria from the periapical region, which helps to heal localized lesions, and avoid the need for complex apical surgery<sup>[25]</sup>.

An essential requirement for REPs is to accomplish dentinal wall thickening to strengthen the immature teeth and to help prevent them from suffering a fracture<sup>[26]</sup>. The amount of remaining tooth structure is the most critical factor for the fracture resistance of endodontically

treated teeth<sup>[27]</sup>. Immature teeth can have very thin dentin walls. The thicker the dentin wall, the less likely that the tooth will fracture, once the thickness exceeds 1.5 mm, the tooth will have an improved fracture resistance. Only six cases measured the dentinal wall thickness, and no difference was found between the use of PRP and BCR procedure, which were similarly effective.

## CONCLUSION

The published clinical results for PRP, PRF, and BCR indicate that these treatments are similarly effective for the regeneration of immature permanent teeth. The fractured or decayed immature permanent teeth of children and young adults aged 6 years to 28 which have a restorable crown, but thin dentinal walls may be regenerated by using a revascularization procedure which draws blood and stem cells into a disinfected root canal space. This study has shown that in addition to the most common method of using a BCR technique, a PRP and PRF technique may also be used as alternatives. A drawback of the PRP and PRF techniques is extra time needed to draw blood and centrifuge it prior to insertion into the root canals.

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