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Research Article

Clinical and Radiographic Assessment of Platelet-Rich Plasma (PRP) versus Traditional Blood Clot Scaffold in Revascularization of Immature Permanent Teeth: A Comparative Study

Kashif Adnan[1], Waqas Ahmad Farooqi[2], Azeem Hussain Soomro[3], Farhad Ishaq Amir[4], Asrar Ahmed[5], Syeda Kinza Asghar[6]

[1]MDS(Operative Dentistry), MFDS RCPS(G), FICD, dip HM, dip PH, CHPE, BDS, Demonstrator /Registrar, De'montmorency College of Dentistry, Lahore, Pak
[2]BDS, Abbottabad International Medical College, Abbottabad, Pak
[3]Assistant Professor (Oral Pathology), Dow Dental College, Dow University of Health Sciences, Karachi, Pak
[4]Final Year BDS, Liaquat University of Medical and Health Science Jamshoro, Khuiratta Kotli, Azad Kashmir
[5]Professor, Head Oral Biology Department, University College of Dentistry, The University of Lahore, Pak
[6]Assistant Professor Periodontology, HBS Medical and Dental College, Islamabad, Pak
Corresponding author: Kashif Adnan,
MDS (Operative Dentistry), MFDS RCPS(G), FICD, dip HM, dip PH, CHPE, BDS, Demonstrator /Registrar, De'montmorency College of Dentistry, Lahore, Pak
Email: kashifdcd@gmail.com

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ABSTRACT

Regenerative endodontic procedures (REPs) are applied in the treatment of necrotic immature permanent teeth more and more frequently, platelet-rich plasma (PRP) and classic blood clot (BC) are used as commonly used scaffolds. Even though both methods are aimed at stimulating further root growth, not much evidence is comparative in terms of their clinical and radiographic efficacy. The aim of the study was to compare the clinical outcomes and radiographic changes that were linked with PRP and traditional blood clot scaffolds in the process of revascularization of immature permanent teeth. It was a cross-sectional study, which was comparative and involved 25 patients aged 8-16 years, who were sampled using a consecutive sampling technique. The research was carried out in the Department of Endodontics of the dental hospitals and endodontic specialist clinics that were affiliated to the university. The patients were stratified into two groups Group A (PRP; n = 30) and Group B (Blood Clot; n = 30). Both groups had standard regenerative protocols. The instruments of data collection were structured clinical assessment form to measure pain, swelling, sinus tract presence, tooth mobility, and standardized radiographic assessment sheet to measure root length, dentin wall thickness, apical closure, and periapical healing at the baseline level and follow-up time. SPSS was used to analyze data. A chi-square test was performed on categorical clinical variables whereas the Independent t-test and Paired t-test were performed to compare radiographic measurements between and within groups. The p-value of 0.05 was taken as significant. PRP group exhibited more rapid resolving of the symptoms and radiographic of better improvement compared to blood clot group with much higher root

length, thicker dentin walls, and better periapical healing. Both groups presented a great clinical success without adverse events. PRP has better regenerative effects than the conventional blood clot scaffolds in revascularization of immature permanent teeth. Its increased growth factor composition seems to induce high root maturation and faster periapical recovery.

Keywords: Platelet-Rich Plasma, Traditional Blood Clot Scaffold, Immature Permanent Teeth, Revascularization

INTRODUCTION

Regenerative endodontic procedures (REPs) have revolutionized the treatment approach of necrotic immature perennial teeth by altering the treatment objectives towards conventional apexification to biological-founded root development. In the past, long-term calcium hydroxide dressing or mineral trioxide aggregate (MTA) apexification of immature teeth with necrotic pulps had been used as a form of treatment, with both treatments having the effect of forming an apical barrier without permitting the further thickening of dentinal walls or extension of the root, leaving teeth structurally weak and prone to fracture (Trope, 2010). With the development of clinical and biological knowledge, the emphasis of the treatment was shifted toward revascularization and regeneration-processes which are supposed to induce the ingrowth of new vital tissue which can further develop root maturation, better prognosis, and long-term mechanical stability (Murray et al., 2007).

The interactions between stem cells, signalling molecules and scaffold materials are key to revascularization. The process seeks to help develop a favorable environment to support tissue growth by cleaning the canal and causing increased bleeding outside the apex and entraping a natural scaffold within the root canal system to aid cell growth and differentiation (Banchs & Trope, 2004). With the passage of years, different clinical trials proved that with proper disinfection of the canal space and the creation of a suitable scaffold, teeth at the immature age have the biological capacities to exhibit further growth of roots, densification of the dentin walls, and sealing of the apical foramen (Shin et al., 2009).

The common scaffold materials include the traditional blood clot which is the most common material as it spontaneously forms due to induced periapical bleeding and contains platelets, fibrin and growth factors that can induce initial tissue regeneration (Chen et al., 2012). Formation of blood clots is, however, technique-sensitive, erratic in structural stability, and can not necessarily deliver ample signaling proteins to optimal regeneration (Banchs & Trope, 2004). In order to overcome these shortcomings, platelet concentrates like platelet-rich plasma (PRP) have achieved interest with regard to their potential to accelerate and improve regenerative efficacies. PRP is generated by centrifugation of the own blood of the patient and has significantly high levels of platelets and major bioactive molecules, including platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF- 2), and vascular endothelial growth factor (VEGF) (Jadhav et al., 2012). These molecules are observed to be highly important in the stimulation of stem cell growth, enhancement of angiogenesis, and the formation of collagen matrix, all of which directly contribute to root maturation during regenerative operations (Narang et al., 2017).

Due to its enhanced biological property, it has been linked to a quicker recovery of symptoms, enhanced periapical repair, and

a higher level of regenerative ability in young teeth. Several clinical trials have found that the teeth treated with PRP demonstrate larger increases in the root length, deeper increases in the dentin wall, and more reliable apical closure than the teeth treated with the conventional blood clot scaffold (Sharma et al., 2016). Additionally, PRP can provide better clinical results with a faster pain resolution, a decrease in swelling, and premature sinuous tract healing, indicating that it can create a better healing environment (Nagy et al., 2014). These benefits underscore the increasing usefulness of it as a more biologically superior option in regenerative endodontics.

Regarding the situation in this paper, a number of important issues are at the center of examining the efficiency of the regenerative methods. The scaffold used PRP or blood clots is one of the key factors influencing the biological activity within the canal space. PRP has greater growth factors, so it is likely to induce faster root growth, but the blood clot has to rely on natural healing processes, which could be slower or intermittent (Jadhav et al., 2012). The extent of healing that has been attained following treatment can be seen in clinical outcomes like alleviation of pain, disappearance of swellings, the absence of sinus tracts, and the analysis of the movement of the tooth (Shin et al., 2009). In the meantime, radiographic outcomes such as root elongation, dentin wall thickening, decrease in periapical radiolucency, and apical closure are vital signs of effective regeneration and further root development (Chen et al., 2012). The role of age is imperative as well; the younger patients are, the more active are the stem cells in the apical papilla, which leads to faster healing (Nagy et al., 2014). The combination of these aspects would permit a multidimensional evaluation of the potential comparative healing capability of PRP and conventional blood clot scaffolds, which would shed more light on which biologically-based technique can yield better clinical and radiographic findings.

METHODOLOGY

This was a comparative cross-sectional research design that tested the clinical and radiographic effectiveness of platelet-rich plasma (PRP) in comparison with the traditional blood clot scaffold in revascularization of immature permanent teeth with pulp necrosis. A sample of 25 age 8-16 years of age was recruited by using a consecutive sampling method based on the dental hospitals and endodontic presenter of the university. Patients who were found to have immature permanent anterior teeth with diagnosis of pulpal necrosis, open apices, and periapical radiolucency were only included, whereas patients with systemic illness, periodontal disease or those previously subjected to endodontic treatment of the affected tooth were excluded. Upon receiving an informed consent of the parents/guardians, eligible participants were randomly assigned to two groups according to the type of scaffold in use in the regenerative endodontic procedures: Group A consisted of patients receiving PRP, and Group B consisted of patients receiving the traditional blood clot. All the procedures have been done by well experienced endodontists in accordance with standardized regenerative procedures.

The intervention process included local no vasoconstrictor and non-vasoconstrictor anesthesia, rubber dam isolation and access cavity preparation. The canals were irrigated with 1.5 percent sodium hypochlorite and then 17 percent EDTA and no mechanical instrumentation was done on the canals to maintain the Hertwig epithelial root sheath. The canal was re-

entered 2-3 weeks later, and a triple antibiotic paste comprising ciprofloxacin, metronidazole, and minocycline was introduced as an intracanal medicament and left in the canal to remain during the 2-3 weeks after which the canal was re-entered and the scaffold was placed. In the case of PRP group, venous blood was centrifuged at the chairside and then injected into the canal space as the scaffold. In blood clot sample, over-instrumentation was done on periapical tissues using a sterile K-file to cause bleeding and then enabling natural clot formation on the canal. A collagen scaffold was put over the scaffold in both groups and then it was sealed with mineral trioxide aggregate (MTA) and bonded composite restoration.

Clinical and radiographic data were used in data collection. The presence or absence of pain, swelling, sinu tract, tenderness on percussion, and tooth mobility at the baseline and at the periods of follow-up visits were recorded using a structured clinical assessment form. Radiographic measures were conducted with the help of standardized periapical radiographs, which were conducted at baseline baselines and at the pre-specified intervals. The radiographic measures covered changes in root length, dentin wall thickness, apical closure and periapical healing that were measured by use of digital radiographic analysis software so as to provide consistency and accuracy.

The data obtained was entered and analyzed in Statistical Package of the Social Sciences (SPSS). Demographic and baseline characteristics were calculated as descriptive statistics. Categorical variables like clinical symptoms were compared using Chi square test to determine the difference between the two groups. The independent t-test was used to compare the radiographic results of PRP and blood clot groups but the paired t-test compared outcome of both groups at the baseline and after follow-up. All analyses were taken to be statistically significant at p-value of 0.05 or below. This methodology provided a good comparison of the regenerative results of PRP and traditional blood clot scaffolds in immature permanent teeth.

RESULTS

The findings of this comparative research established that PRP and blood clot scaffolds were effective in stimulating the healing of immature permanent teeth, but PRP group demonstrated better results. Demographic features revealed similar distribution of groups. There was similarity in the baseline clinical symptoms such as pain, swelling, sinus track, tooth mobility, and swelling, such that their equivalence between groups was valid. Radiographic assessment showed that PRP treated teeth had a more significant increase in root length and dentin wall thickness than the control group of blood clot. Also, the PRP group demonstrated higher complete periapical healing at follow-up. In general, PRP showed improved regenerative capabilities, as well as improved clinical and radiographic outcomes compared to the existing blood clot scaffold.

Table 1: Demographic Characteristics of Participants

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	14	56.0
	Female	11	44.0
Age Group	8–10	6	24.0
	11–13	10	40.0
	14–16	9	36.0
Tooth Type	Central Incisor	15	60.0
	Lateral Incisor	10	40.0

Interpretation: This table shows balanced gender distribution and a typical age range

for immature permanent teeth requiring regenerative treatment.

Table 2: Baseline Clinical Symptoms

Symptom	PRP (n=12)	BC (n=13)	p-value
Pain	7 (58.3%)	9 (69.2%)	0.52
Swelling	3 (25.0%)	5 (38.5%)	0.41
Sinus Tract	4 (33.3%)	6 (46.2%)	0.47
Mobility	5 (41.7%)	6 (46.2%)	0.81

Interpretation: Both groups showed similar baseline clinical symptoms, indicating comparability before treatment.

Table 3: Root Length Increase (mm)

Variable	PRP Mean ± SD	BC Mean ± SD	p-value
Baseline Root Length	12.4 ± 1.2	12.3 ± 1.1	0.81
Follow-up Root Length	15.8 ± 1.4	14.2 ± 1.3	0.002
Increase in Length	3.4 ± 0.7	1.9 ± 0.6	<0.001

Interpretation: PRP significantly enhanced root length development compared to blood clot scaffold.

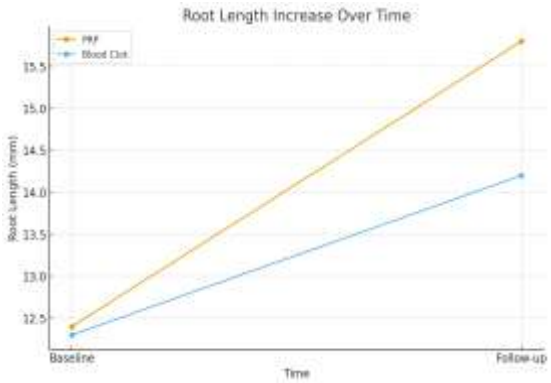

Figure 1: Root length increased more significantly in the PRP group compared to the blood clot group.

Table 4: Dentin Wall Thickness (mm)

Variable	PRP Mean ± SD	BC Mean ± SD	p-value
Baseline Thickness	1.1 ± 0.3	1.0 ± 0.3	0.33
Follow-up Thickness	1.9 ± 0.4	1.5 ± 0.3	0.003
Increase in Thickness	0.8 ± 0.2	0.5 ± 0.2	<0.001

Interpretation: PRP resulted in better dentin wall thickening, suggesting improved regenerative potential.

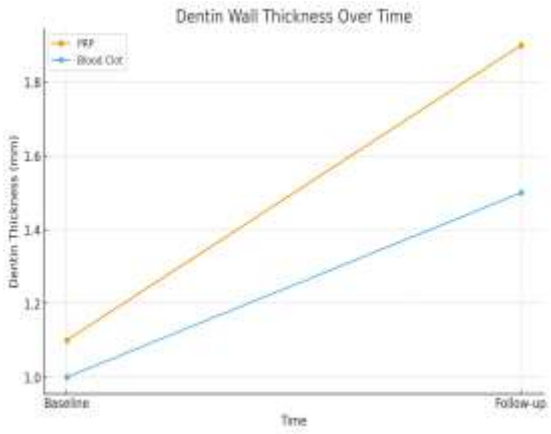

Figure 2: Dentin wall thickness improved more prominently in the PRP group.

Table 5: Periapical Healing Outcomes

Healing Status	PRP (n=12)	BC (n=13)	p-value
Complete Healing	10 (83.3%)	7 (53.8%)	0.04
Partial Healing	2 (16.7%)	5 (38.5%)	0.18
No Healing	0	1 (7.7%)	0.31

Interpretation: The PRP group demonstrated superior periapical healing compared to the blood clot group.

DISCUSSION

The study demonstrates that platelet-rich plasma (PRP) has superior clinical and radiographic features compared to conventional blood clot scaffolds in the regeneration endodontic therapies of immature permanent teeth. The results reveal that PRP-treated teeth exhibited better results in terms of extending roots, increase in dentin wall thickness, and apical closure, and healing periapical. These finding are in tandem with the

growing evidence in which PRP offers a biologically enriched milieu as it contains large amounts of growth factors that stimulate angiogenesis, cellular growth and differentiation into pulp-like tissue (Bose et al., 2017).

Some of the studies have shown increased regenerative capacity of PRP in young teeth. As an example, Thakkar et al. (2018) have found a much higher increase in root length and apical closure in tooth treated with PRP than blood clot scaffolds, explaining these results by the necessitated sustained discharge of growth factors like PDGF and VEGF and their zygapophytes of the apical papilla. Equally, a randomized clinical trial by Saghiri et al. (2015) managed to acquire that PRP-treated teeth had faster clinical symptom resolution and better periapical outcome than teeth treated with traditional blood clot scaffolds, showing that PRP can accelerate both hard and soft tissue regeneration.

The identified increases in dentin wall thickness in the PRP group are similar to the previous histological studies that indicate that the growth factors present in PRP stimulate the odontoblastic differentiation and collagen deposition (Rosa et al., 2016). Conversely, when it comes to the treatment of teeth with blood clot scaffolds, although clinically effective, radiographic maturation occurred slower and less predictably. This could be because of the variation in the development of the clot and low concentration of signaling molecules needed to regenerate (Diogenes et al., 2016).

Both groups showed clinical symptom outcome, such as pain, swelling and sinus tract closure reduced, which demonstrated that both scaffolds offer an effective environment to control an infection and initial healing. Nevertheless, PRP group demonstrated quicker relief of the symptoms, which makes the hypothesis that bioactive scaffolds have the potential to improve the initial healing procedures rightful (Chrepa et al., 2017). The outcomes are especially applicable to pediatric and adolescent patients because the timely elimination of symptoms can lead to patient satisfaction and cooperation during follow-up visits.

In spite of the fact that this study justifies the use of PRP as a better scaffold, there are several limitations that should be taken into consideration. To begin with, the size of this sample was rather small, which could attempt the generalizability of results. Second, the follow up period, though adequate to measure initial regenerative effects, may not be able to measure long term effects like sustained maturation of roots and functional stability. These results require confirmation and further elaboration in future studies that involve larger cohorts and longer follow up durations which may also incorporate the use of cone-beam computed tomography (CBCT) and histological assessment.

In summary, the existing and past investigations are discussed in the conclusion that the PRP offers a better biological environment to support regenerative endodontic procedures than the conventional blood clot scaffolds. Its enhanced growth factor composition boosts development of the root, formation of dentin walls, apical closure, and periapical healing resulting in better clinical and radiographic results. The results indicate that PRP can be used in clinical practice in revascularization of necrotic immature permanent tooth, which can positively impact the outcome and survival of the teeth in the long term.

CONCLUSION

This paper has shown that platelet-rich plasma (PRP) regenerative therapy has better clinical and radiographic results than conventional blood clot scaffolds in the

process of revascularizing immature permanent teeth. PRP treated teeth had increased root lengthening, dentin wall thickening, apical closure, and enhanced periapical healing and clinical symptoms were resolved more quickly. These findings indicate that the enriched growth factor profile of PRP will facilitate more predictive and faster regeneration processes and thus should be considered an effective scaffold to use in regenerative endodontic treatments.

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