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Review Article | **Conservative Dentistry and Endodontics**

PRP (Platelet Rich Plasma) in Endodontics -A Review

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Abstract

Platelet-rich plasma (PRP) has emerged as a promising biologically active adjunct in regenerative endodontics due to its high concentration of autologous growth factors that promote angiogenesis, cell proliferation, and tissue healing. Used as a scaffold and bioactive reservoir, PRP supports pulp–dentin complex regeneration, particularly in immature necrotic teeth. This review highlights the biological basis, preparation methods, and diverse clinical applications of PRP in endodontics. Despite its advantages, limitations related to standardization and growth factor release persist, emphasizing the need for further long-term clinical studies to establish predictable protocols.

Keywords: Platelet-rich plasma (PRP), Regenerative Endodontics, Growth Factors, Angiogenesis, Scaffolds.

INTRODUCTION

Endodontic diseases remain highly prevalent across all age groups. Although conventional root canal therapy demonstrates predictable clinical success, it primarily focuses on eradication of infection and sealing of the root canal system, often at the expense of pulpal vitality and dentinal integrity [1]. The loss of these biological components may compromise the long-term structural and functional resilience of the tooth. Consequently, contemporary endodontics has shifted toward biologically based strategies aimed at preserving or restoring the pulp–dentin complex [2].

Tissue engineering has emerged as a cornerstone of regenerative medicine, offering the potential to replace damaged tissues with biologically functional equivalents. These regenerative strategies rely on the synergistic interaction of three essential components: stem cells, scaffolds, and a conducive microenvironment that supports cellular differentiation and tissue maturation [3]. When translated to endodontics, regenerative endodontic therapy seeks to re-establish functional pulp tissue, promote continued root development, and restore physiological responses such as sensation and immune defense [4].

In addition to traditional endodontic biomaterials such as calcium hydroxide, mineral trioxide aggregate, and other calcium silicate–based cements, biologically active autologous platelet concentrates have gained increasing attention in regenerative protocols [5]. Platelet concentrates have been widely employed in various medical and dental disciplines due to their capacity to accelerate wound healing and enhance tissue regeneration. Among these, platelet-rich plasma (PRP) has been extensively investigated because of its high concentration of platelets and growth factors that actively regulate angiogenesis, cell migration, proliferation, and immunomodulation [6,7].

Within the context of regenerative endodontic procedures, PRP functions not only as a scaffold but also as a reservoir of bioactive molecules capable of supporting stem cell activity and promoting tissue repair. These properties position PRP as a promising adjunct in regenerative endodontics, potentially overcoming the limitations of conventional treatment approaches. This review aims to critically evaluate the biological basis, clinical applications, advantages, limitations, and future prospects of platelet-rich plasma in endodontic therapy.

Evolution of Platelet-Rich Plasma

The regenerative potential of platelets was first recognized in the 1970s, when platelet-rich plasma (PRP) was defined as plasma with platelet concentrations higher than peripheral blood and initially used in hematology. During the 1980s, fibrin glue became the first blood-derived surgical biomaterial, valued for its hemostatic and tissue-healing properties [8]. Advances in centrifugation techniques during the 1990s enabled clinical use of PRP, with its first application in oral surgery reported by Whitman et al. in 1997, initially termed platelet gel [7,9]. The term PRP was later standardized by Kingsley in 1998 [10]. In 2009, Dohan Ehrenfest *et al.,* classified PRP into pure PRP (P-PRP) and leukocyte-rich PRP (L-PRP) based on leukocyte content [11]. The introduction of platelet-rich fibrin (PRF) by Choukroun in 2001 marked the development of second-generation platelet concentrates with improved biological stability [12]. The first documented clinical application of PRP in endodontics was reported by Torabinejad and Turman (2011), who used PRP as a scaffold for revitalization of necrotic immature teeth [13].

Biological Basis of PRP

PRP is an autologous blood derivative containing a platelet concentration higher than baseline levels. Upon activation, platelets release growth factors such as:

- Platelet-derived growth factor (PDGF)
- Transforming growth factor-β (TGF-β)
- Vascular endothelial growth factor (VEGF)
- Insulin-like growth factor (IGF)

These bioactive molecules play a crucial role in angiogenesis, cell migration, proliferation, and differentiation, all of which are essential for pulp tissue regeneration [14-16].

Preparation of PRP

PRP is obtained by centrifuging collected blood to achieve a platelet concentration higher than baseline levels. The procedure begins with venipuncture, during which whole blood is collected into sterile tubes containing an anticoagulant, most commonly acid citrate dextrose (ACD) or sodium citrate, to prevent premature platelet activation [4,12,17]. The collected blood is then subjected to centrifugation, which separates it into three distinct layers based on density: the lower red blood cell fraction, the intermediate buffy coat containing leukocytes and platelets, and the upper platelet-poor plasma (PPP) [18].

PRP preparation may involve a single-spin or double-spin centrifugation protocol [11,14].

Two-Spin Method

1. Blood Collection: 10–20 mL of venous blood into anticoagulant-containing tubes (e.g., sodium citrate).

2. First Centrifugation (Soft Spin) - 1200 rpm for 10 min

Purpose: Separate RBCs from plasma.

Result: Three layers — bottom RBCs, middle buffy coat (platelets + WBCs), top plasma.

3. Collection: Transfer plasma and buffy coat to new sterile tube.

4. Second Centrifugation (Hard Spin) - 2000 rpm for 10 min.

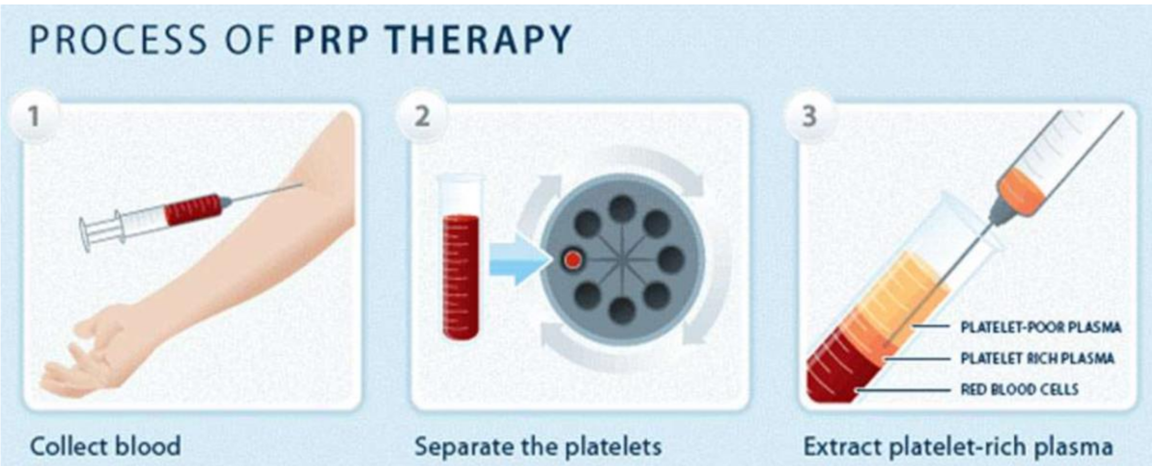
Purpose: Concentrate platelets.

Result: Top PPP (platelet-poor plasma), bottom PRP pellet.

Single-Spin Method

1. **Blood Collection:** Venous blood is drawn into tubes containing an anticoagulant (commonly sodium citrate).
2. **Single Centrifugation:** The blood sample is centrifuged once at a relatively low speed (soft spin), typically around 1500–2000 rpm for 5–10 minutes.
3. **Collection:** After centrifugation, three layers are formed, the upper plasma layer along with part of the buffy coat is collected as PRP. Because only one spin is used, the platelet concentration is moderate compared to double-spin method.

The platelet-rich fraction is then carefully aspirated, avoiding contamination with erythrocytes. This method allows for greater control over platelet concentration and leukocyte content, which may influence the biological properties of PRP [4].



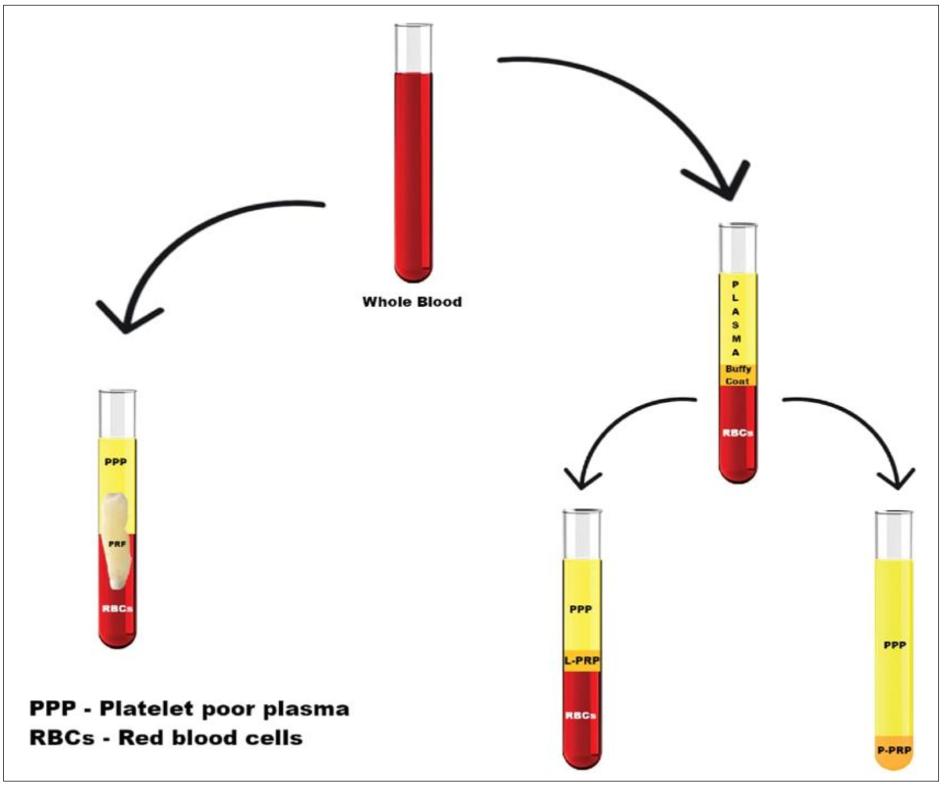


Figure 1: Showing preparation of PRP

Following preparation, PRP is activated to induce platelet degranulation and release of growth factors. Activation is commonly achieved by the addition of calcium chloride, thrombin, or a combination of both, leading to fibrin polymerization and formation of a platelet gel. This gel serves as a biologically active scaffold, facilitating cell migration, angiogenesis, and tissue regeneration through the sustained release of growth factors such as platelet-derived growth factor, transforming growth factor-β, and vascular endothelial growth factor [14,16].

The autologous nature of PRP eliminates the risk of immunologic rejection and disease transmission, making it a safe and biocompatible material for clinical use. However, variations in centrifugation protocols, platelet concentration, leukocyte content, and activation methods result in heterogeneity among PRP preparations, underscoring the need for standardized preparation protocols, particularly in regenerative endodontic applications [2].

Applications of PRP in Endodontics:

In the endodontic field, platelet concentrate use has been increasing for several indications, replacing or combining with existing materials. The use of PRP has been reported for procedures such as pulpotomy and as a pulp capping agent; to promote the apexification and revascularization of immature teeth; in apical surgery, combined with bone graft materials; in tooth reimplantation of avulsed teeth or in intentional reimplantation; or in the management of root resorptions and/or root fractures [2].

Regenerative Endodontic Treatment of Immature Necrotic Teeth

One of the most widely studied applications of PRP is in regenerative endodontic treatment (RET) of immature permanent teeth with necrotic pulp and open apices. In such cases, PRP is placed into the disinfected root canal space to act as a biologically active scaffold. It facilitates the migration, attachment, and differentiation of stem cells from the apical papilla, thereby promoting continued root development, increased root length, thickening of dentinal walls, and apical closure. Compared with traditional apexification techniques, PRP-assisted regeneration offers the advantage of restoring physiological root maturation and improving fracture resistance of the tooth [19].

PRP in Pulpotomy

PRP can also be used in regenerative pulpotomy procedures, particularly in immature permanent teeth and some primary teeth, due to its regenerative and anti-inflammatory properties in which the coronal pulp is removed, and the pulp wound is covered with PRP and then sealed with MTA and glass ionomer cement [20].

PRP in Direct Pulp Capping

PRP has been evaluated as a biological pulp-capping agent because it is rich in growth factors (PDGF, TGF-β, VEGF) that stimulate odontoblastic differentiation, angiogenesis, and reparative dentin formation [21].

Management of Periapical Lesions

PRP has been used as an adjunct in the management of large periapical lesions, particularly in cases requiring periradicular surgery. When placed in periapical defects following curettage, PRP enhances bone regeneration by accelerating angiogenesis and osteoblastic activity. The growth factors released from activated platelets stimulate soft- and hard-tissue healing, leading to faster resolution of periapical radiolucencies and improved postoperative outcomes [22,23].

Pulp Revascularization Procedures

In pulp revascularization protocols, PRP serves as an alternative to the traditional blood clot scaffold. Its controlled composition and higher concentration of growth factors provide a more predictable regenerative environment. PRP promotes revascularization of the root canal space by stimulating neovascularization and supporting the survival and proliferation of progenitor cells. Clinical studies have demonstrated favorable outcomes with PRP in terms of symptom resolution, periapical healing, and continued root maturation [13,24].

Enhancement of Healing Following Periradicular Surgery

PRP has been employed to enhance healing following periradicular surgical procedures such as apicoectomy and root-end resection. Application of PRP to the surgical site reduces postoperative inflammation, accelerates soft-tissue healing, and promotes bone regeneration. Its immunomodulatory and antimicrobial properties further contribute to improved healing responses, particularly in medically compromised patients [14].

Advantages of PRP

- Autologous and biocompatible
- Rich source of growth factors
- Enhances angiogenesis and tissue regeneration
- Reduces inflammation and accelerates healing

Limitations of PRP

- Technique-sensitive preparation
- Requires venipuncture and additional equipment
- Short duration of growth factor release
- Lack of standardization in preparation protocols

Comparison with Other Scaffolds

Compared to blood clot and platelet-rich fibrin (PRF), PRP provides a higher initial concentration of growth factors but lacks the sustained release seen with PRF. Therefore, selection of scaffold should be based on clinical requirements and operator preference [2].

Future Perspectives

Advances in scaffold engineering and combination therapies using PRP with stem cells and biomimetic materials may further enhance regenerative outcomes. Long-term randomized clinical trials are required to establish standardized protocols and validate clinical predictability.

CONCLUSION

PRP represents a biologically active scaffold with significant potential in regenerative endodontics. Its ability to promote angiogenesis, cell proliferation, and tissue healing makes it a valuable adjunct in selected clinical cases. However, further evidence-based research is necessary to optimize its clinical application and long-term success.

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