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# Platelet Concentrates in Dentistry: Biological and Clinical Insights

**Camila Roberta Nepomuceno Atripoli[1*], Camilla Jusevicius Arouche Alves Toledo[2], Sandra Regina Candido da Silva[3]**

[1]Specialist in Implant Dentistry, MSc Candidate in Healthcare Management, St. Francis College, New York, USA

[2]Specialist in Implant Dentistry, MSc in Temporomandibular Dysfunction and Orofacial Pain, Brazil

[3]Specialist in Orthodontics, FAMOSP; Specialist in Implant Dentistry, Brazil

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***Corresponding author:** Camila Roberta Nepomuceno Atripoli, Specialist in Implant Dentistry, MSc Candidate in Healthcare Management, St. Francis College, New York, USA



## Abstract

**Background:** Platelet concentrates, including Platelet-Rich Plasma (PRP), Platelet-Rich Fibrin (PRF), and Leukocyte- and Platelet-Rich Fibrin (L-PRF), are autologous biomaterials used to enhance tissue regeneration in dentistry.

**Objective:** To review the biological mechanisms, technical protocols, and clinical applications of platelet concentrates, with emphasis on PRF and its advanced formulations.

Methods: This narrative review synthesizes current literature on PRP, PRF, A-PRF, i-PRF, and C-PRF. Special focus is given to centrifugation parameters, tube materials, and clinical outcomes in oral surgery, implantology, periodontology, and endodontics.

**Results:** Evidence demonstrates that PRF accelerates wound healing, promotes angiogenesis, and enhances bone regeneration. Recent innovations such as A-PRF+ and i-PRF show improved growth factor release and wider clinical versatility.

**Conclusion:** PRF and its derivatives are cost-effective, autologous biomaterials with broad applications in dentistry. Future research should focus on standardizing protocols and integrating PRF with regenerative technologies such as stem cells and bioprinting.

Clinical Relevance: Understanding the technical and biological aspects of PRF enhances clinicians' ability to optimize outcomes in oral rehabilitation and regenerative procedures.

**Keywords:** Platelet-Rich Fibrin; PRF; PRP; Regenerative dentistry; Oral surgery; Implantology; Periodontology

## Introduction

The use of platelet concentrates in medicine and dentistry has evolved significantly over the past three decades. Initially, Platelet-Rich Plasma (PRP) was introduced as an autologous source of growth factors, but its reliance on anticoagulants and exogenous activators limited its clinical practicality. Subsequently, Platelet-Rich Fibrin (PRF)

emerged as a second-generation concentrate, eliminating the need for anticoagulants and providing a more physiologically relevant fibrin matrix capable of sustained release of bioactive molecules.

The development of advanced formulations such as A-PRF, A-PRF+, i-PRF, and C-PRF reflects ongoing efforts to optimize platelet and leukocyte retention, improve angiogenesis, and broaden clinical applications. PRF has been applied across multiple fields of dentistry, including implantology, periodontology, oral surgery, and endodontics, with growing evidence supporting its ability to enhance healing and regenerative outcomes.

This article provides a comprehensive overview of the biological principles, technical protocols, and clinical applications of PRF and its derivatives, highlighting their benefits, limitations, and future perspectives.

### Technical Overview

#### Centrifugation Parameters

The preparation of PRF depends critically on centrifugation parameters. Reporting relative centrifugal force (RCF, g) rather than revolutions per minute (RPM) is essential, as RCF varies according to rotor radius. Studies demonstrate that low-speed centrifugation (A-PRF, A-PRF+) preserves more leukocytes and platelets, enhancing growth factor release and angiogenesis [1].

#### Tube Materials

The choice of collection tubes directly impacts the biological quality of PRF. Glass tubes are preferred, while silica-coated tubes have been shown to release microparticles that may induce cytotoxicity [2]. Clinicians are advised to verify tube composition to avoid contamination and ensure reproducibility.

#### Handling and Compression

Following centrifugation, the fibrin clot is separated and gently compressed to form a PRF membrane. Compression should be standardized (typically 3-5 minutes) to maintain consistent membrane thickness and growth factor content [3].

## Biological Mechanisms

#### Growth Factor Release

PRF serves as a reservoir for various growth factors including platelet-derived growth factor (PDGF), transforming growth factor-β (TGF-β), vascular endothelial growth factor (VEGF), and insulin-like growth factor (IGF). The fibrin matrix provides sustained release over 7-14 days, supporting prolonged tissue regeneration.

#### Angiogenesis and Wound Healing

The presence of leukocytes in PRF contributes to antimicrobial activity and immune modulation. PRF promotes angiogenesis through VEGF release and endothelial cell proliferation, accelerating wound healing and tissue regeneration.

#### Bone Regeneration

PRF enhances osteoblast proliferation and differentiation through the release of bone morphogenetic proteins (BMPs) and other osteogenic factors. The fibrin scaffold provides a favorable environment for cell migration and new bone formation.

## Clinical Applications

### Oral Surgery

In oral surgery, PRF has demonstrated effectiveness in reducing postoperative pain, minimizing the incidence of alveolar osteitis, and accelerating soft tissue healing. Its use in extraction sockets promotes epithelial closure and may reduce complications in medically compromised patients [4].

### Implantology

In implantology, PRF enhances osseointegration, stabilizes grafts, and improves soft tissue healing. It has been applied in sinus augmentation, peri-implant defect regeneration, and immediate implant placement, with evidence supporting improved implant stability [5].

### Periodontology

PRF is widely used in periodontology for the treatment of intrabony defects, furcation involvement, and gingival recession. Meta-analyses show that PRF improves probing depth reduction and clinical attachment level gain, especially when combined with conventional periodontal therapy [6].

### Endodontics

In regenerative endodontics, PRF serves as a biologically active scaffold supporting cell proliferation and differentiation. It enhances the success of revascularization procedures and provides a matrix for stem cell homing [7].

### Emerging Applications

Beyond traditional dentistry, PRF is being explored in regenerative medicine, including tissue engineering, wound healing, and maxillofacial reconstruction. Innovations such as injectable PRF (i-PRF) and concentrated PRF (C-PRF) expand its potential applications [8].

## Advanced PRF Formulations

### Injectable PRF (i-PRF)

Injectable PRF, prepared using lower centrifugation speeds, maintains a liquid consistency suitable for injection into tissues. This formulation shows enhanced growth factor release and improved cell migration properties.

### Advanced PRF (A-PRF and A-PRF+)

A-PRF and A-PRF+ protocols utilize optimized low-speed centrifugation to preserve more platelets and leukocytes, resulting in enhanced biological activity and clinical outcomes.

### Concentrated PRF (C-PRF)

C-PRF represents a concentrated form of PRF with higher platelet and growth factor content, potentially offering enhanced regenerative potential in challenging clinical scenarios.

## Discussion

PRF offers several advantages over PRP, including simplified preparation, absence of anticoagulants, and more sustained release of growth factors. Low-speed centrifugation protocols further enhance its biological potential [9]. However, the heterogeneity of preparation protocols across studies poses challenges for reproducibility.

## Limitations

Current limitations include: - Small sample sizes in many clinical studies - Lack of standardized reporting of centrifugation parameters - Limited long-term clinical data - Variability in preparation protocols between studies

### Future Directions

Future research directions involve: - Combining PRF with biomaterials and stem cells - Integration with advanced technologies such as 3D bioprinting - Development of standardized protocols - Long-term clinical outcome studies - Exploration of personalized PRF formulations

Such approaches may further expand the role of PRF in regenerative dentistry and medicine [10].

## Clinical Recommendations

Based on current evidence, the following clinical recommendations are proposed:

1. Standardized Protocols: Adopt standardized centrifugation protocols reporting RCF values
2. Tube Selection: Use glass collection tubes to avoid contamination
3. Handling Procedures: Implement consistent compression and handling techniques
4. Patient Selection: Consider patient factors that may influence PRF quality
5. Combination Therapy: Consider PRF as an adjunct to conventional treatments

## Conclusion

PRF and its derivatives represent versatile, safe, and cost-effective biomaterials in dentistry. They enhance healing, angiogenesis, and regeneration across oral surgery, implantology, periodontology, and endodontics. While current evidence supports their benefits, standardized protocols and high-quality clinical trials are needed to confirm long-term outcomes.

The evolution from PRP to advanced PRF formulations demonstrates the continuous refinement of regenerative approaches in dentistry. As our understanding of the biological mechanisms improves and technical protocols become standardized, PRF is expected to play an increasingly important role in modern dental practice.

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