ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at:www.ijdsir.com

Volume – 8, Issue – 2, April – 2025, Page No. : 01 - 11

Exploring The Role of Platelet-Rich Fibrin in Modern Dentistry: A Comprehensive Overview

[1]Dr. Rishabh Singh Kalra, BDS, MS Ramaiah University of Applied Sciences, Bangalore, India. Currently, Dental Assistant, Amara Dental Center, Woodland, California, USA.

[2]Dr. Saumya Kapoor, MDS, Oral and Maxillofacial Surgery.

[3]Dr. Aman Arora, General and Laparoscopic Surgeon, Military Hospital, Jamnagar, India.

[4]Dr. Divya Arora, Consultant Dermatology, Livasa Hospital, Mohali, India.

[5]Dr. Apra Kalra, Senior Pathologist, Fortis Hospital, Mohali, India.

Corresponding Author: Dr. Rishabh Singh Kalra, BDS, MS Ramaiah University of Applied Sciences, Bangalore, India. Currently, Dental Assistant, Amara Dental Center, Woodland, California, USA.

Citation of this Article: Dr. Rishabh Singh Kalra, Dr. Saumya Kapoor, Dr. Aman Arora, Dr. Divya Arora, Dr. Apra Kalra, "Exploring The Role of Platelet-Rich Fibrin in Modern Dentistry: A Comprehensive Overview", IJDSIR- April – 2025, Volume – 8, Issue – 2, P. No. 01 – 11.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Platelet-Rich Fibrin (PRF) has emerged as a revolutionary biomaterial in modern dentistry, offering significant advantages in tissue regeneration, wound healing, and surgical outcomes. Derived from autologous blood without the need for anticoagulants or additives, PRF is a second-generation platelet concentrate that enhances soft and hard tissue repair. Its fibrin matrix, rich in growth factors and cytokines, facilitates angiogenesis, collagen synthesis, and cell proliferation, making it an invaluable tool in various dental applications.

This comprehensive overview explores the multifaceted role of PRF in dentistry, emphasizing its benefits in periodontal regeneration, implantology, oral surgery, and endodontics. The article delves into the mechanisms of PRF, highlighting its ability to accelerate healing by promoting sustained release of bioactive molecules. Studies have demonstrated its efficacy in reducing post-surgical complications such as pain, inflammation, and infection, thereby improving patient outcomes. Additionally, PRF has shown promising results in alveolar ridge preservation, sinus lift procedures, and management of extraction sockets.

Despite its advantages, PRF has certain limitations, including variability in preparation techniques and patient-dependent factors that can influence its effectiveness. The review also discusses recent advancements, including the development of advanced PRF (A-PRF) and injectable PRF (i-PRF), which have expanded its clinical applications. Future research aims to optimize PRF protocols and explore its potential in regenerative medicine beyond dentistry.

So, PRF represents a significant advancement in biomaterial science, offering a biocompatible, cost-effective, and minimally invasive approach to enhancing dental procedures. As research continues to refine its applications, PRF is expected to play an increasingly vital role in modern dentistry, improving both clinical efficiency and patient care.

Keywords: Platelet-Rich Fibrin (PRF), Tissue Regeneration, Wound Healing, Dental Implantology, Periodontal Regeneration, Biomaterials in Dentistry, Oral Surgery, Bone Grafting, Healing Biomaterials, Regenerative Dentistry

Introduction

The development of bioactive surgical additives, which regulate inflammation and accelerate the healing process, represents one of the most significant challenges in clinical research [1]. Wound healing is a complex and dynamic process involving cellular organization, chemical signaling, and the extracellular matrix, which work together for tissue repair [2]. While the full mechanisms of healing are not yet completely understood, it is well established that platelets play a pivotal role in both hemostasis and tissue regeneration [3].

The regenerative potential of platelets was first recognized in the 1970s, when it was discovered that platelets contain growth factors that promote collagen production, cell mitosis, blood vessel growth, cell migration, and cell differentiation, among other processes [4,5]. One of the most significant advancements in oral and maxillofacial surgery is the use of platelet concentrates for tissue engineering applications, notably Platelet-Rich Plasma (PRP) and Platelet-Rich Fibrin (PRF). These platelet concentrates are suspensions of concentrated growth factors derived from platelets and act as bioactive surgical additives to enhance local wound healing [1,6].

In 1997, Whitman et al. introduced PRP in oral surgical procedures, observing significant advantages such as enhanced osteoprogenitor cell activity in host bone and bone grafts.(7) However, the use of PRP also presents certain risks, particularly due to the inclusion of bovine thrombin, which can induce antibodies to factors V, XI, and thrombin, potentially leading to coagulopathies that may compromise patient safety [5, 2].

In contrast, PRF, introduced by Choukroun et al. in 2001, represents a new generation of platelet concentrate. PRF is composed of an autologous fibrin matrix and offers several advantages over PRP, such as easier preparation and the absence of chemical additives, making it entirely autologous [2,8]. Its use in oral and maxillofacial surgery has proven to be highly effective in promoting tissue healing, with PRF being preferred for procedures such as bone augmentation, ridge preservation, and guided bone regeneration (GBR) [9, 10]. Blood concentrates, such as PRF, have long been used in dentistry, with the primary concept being that the presence of blood at the surgical site supports the healing process [2,10].

The first autologous platelet product used in dentistry, PRP, is created through a two-step centrifugation process [1]. By adding thrombin (typically bovine-derived) and calcium chloride, PRP is activated, releasing a variety of growth factors that accelerate wound healing and tissue remodeling [4]. PRP has been shown to enhance the proliferation and differentiation of osteoblasts, contributing to improved healing, particularly in the early stages following surgery [1, 4]. However, despite its beneficial effects, PRP has certain limitations, including the need for a complex preparation process and a one-time release of growth factors upon application, which limits its long-term effectiveness [11].

PRF, on the other hand, was designed to overcome many of these limitations. It is generated through a single-step centrifugation process and does not require anticoagulants, making it a simpler and more accessible option for clinicians [2,6]. The fibrin matrix in PRF is more permeable than that in PRP, facilitating the sustained release of growth factors and improving cell organization during the healing process [2,10]. The solid form of PRF is particularly useful in oral surgery, where it is commonly applied as a membrane to cover bone substitutes in bone regeneration procedures [12]. Furthermore, PRF's composition includes a variety of blood cells, such as platelets, lymphocytes, and monocytes, which are essential for the natural healing cascade [9,10].

Both PRP and PRF have demonstrated considerable efficacy in enhancing tissue healing in oral surgery. While PRP continues to be used in various clinical settings, PRF is gaining preference due to its ease of preparation, prolonged release of growth factors, and superior support for tissue regeneration [5, 7, 10].

Materials and Methods

The Procedure: How PRF is Prepared and Applied

The preparation of Platelet-Rich Fibrin (PRF) is a straightforward and minimally invasive process. The procedure involves the following steps:

1. **Blood Draw**: A small sample of the patient's blood is drawn, similar to a routine blood test [6].
2. **Centrifugation**: The blood is placed in a centrifuge, where it is spun at a specific speed and duration to separate its components: red blood cells, platelet-rich plasma, and fibrin [2].
3. **PRF Collection**: After centrifugation, the fibrin clot, which is rich in platelets and leukocytes, is carefully collected. This clot is then compressed to form a membrane or plug that can be applied to the surgical site to enhance healing [12].

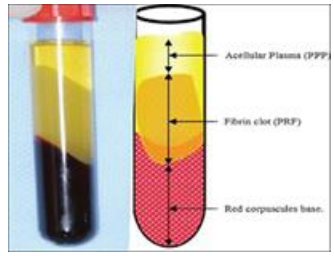

Figure 1: Layers of PRF [26]

PRF preparation is simple and utilizes the same equipment as Platelet-Rich Plasma (PRP). About 5 ml of whole blood is drawn into two 6-ml sterile vacutainer tubes, which are then centrifuged at 3,000 rpm for 10 minutes. This process separates the blood into three distinct layers: acellular platelet-deficient plasma on top, the PRF clot in the middle, and red blood cells at the bottom. The PRF clot is then removed from the red blood cell layer using sterile tweezers and scissors, placed on a sterile plate, and stored under refrigeration [10].

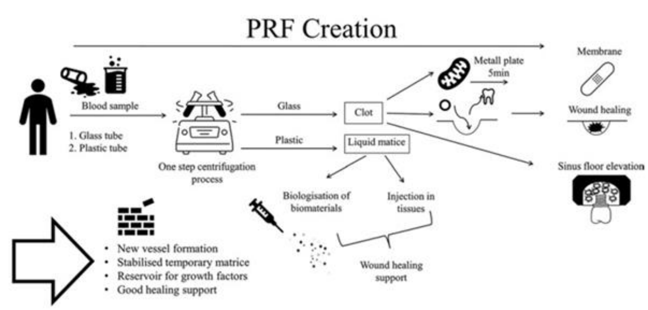

Figure 2: PRF creation [39]

Role of PRF in Wound Healing

Platelet-Rich Fibrin (PRF) plays a crucial role in wound healing by providing a sustained release of growth factors, promoting cell proliferation, stimulating angiogenesis, enhancing collagen synthesis, and supporting immune regulation. Additionally, PRF contributes to wound coverage through its fibrin matrix, mechanical adhesion, and the trapping of circulating stem cells [2,8,10,12].

Wound healing is a complex, dynamic process that is typically divided into three phases:

1. **Inflammatory Phase (1-4 days)**: This phase involves initial hemostasis and inflammation, which are crucial for preparing the wound bed for subsequent healing stages [5].
2. **Proliferation Phase (2-22 days)**: In this phase, key processes such as epithelialization, angiogenesis, granulation tissue formation, and collagen deposition occur, setting the stage for tissue regeneration [6].
3. **Maturation (Remodeling Phase) (6-12 months)**: Collagen remodeling, maturation, and tissue contraction take place in this final phase, helping restore the structural integrity and function of the wound [6,13,14].

PRF is composed of a fibrin matrix formed through slow polymerization, incorporating platelets, leukocytes, cytokines, and circulating stem cells, all of which are essential for tissue regeneration [1,15]. The fibrin matrix in PRF serves as an excellent scaffold for cell migration, including endothelial cells, fibroblasts, and osteoblasts. This matrix also supports the controlled release of growth factors over an extended period, contributing to enhanced tissue repair at the wound site [10,16].

Among the growth factors present in PRF, Transforming Growth Factor Beta (TGF-β) and Platelet-Derived Growth Factor (PDGF) are particularly important for soft tissue and bone healing. These factors promote collagen synthesis and stimulate callus formation during the early phases of wound healing [17]. PDGF, a key activator for mesenchymal cells, is often one of the first factors to reach the wound site and supports osteoblastic proliferation and chemotaxis of monocytes and fibroblasts, which are critical for tissue repair [14,18].

Vascular Endothelial Growth Factor (VEGF), another potent growth factor found in PRF, plays a significant role in angiogenesis by stimulating the formation of blood vessels, which is essential for supplying nutrients and oxygen to the healing tissue [19]. The presence of VEGF in PRF also helps enhance vascular permeability, promoting tissue regeneration [20].

The PRF fibrin matrix itself has mechanical properties that contribute to wound coverage. It provides structural support for the tissue and helps reduce necrosis and flap shrinkage, which is especially beneficial in oral and maxillofacial surgeries. The matrix also promotes neoangiogenesis, ensuring that the healing tissue receives an adequate blood supply [15]. Fibrin, fibronectin, and other components in the matrix are essential for guiding wound coverage by influencing fibroblast and epithelial cell behavior. These cells migrate to the wound site, synthesize extracellular matrix components, and form new tissue [2,12].

Furthermore, PRF is capable of trapping circulating stem cells at the wound site, enhancing tissue regeneration. During the early stages of healing, neovascularization leads to the recruitment of stem cells, which are encapsulated in the PRF matrix. These stem cells can then undergo differentiation, contributing to the repair and restoration of damaged tissues [21, 22].

PRF also plays a key role in immune regulation. The leukocytes and cytokines present in PRF, such as IL-1β, IL-6, and TNF-α, provide anti-inflammatory and immune-modulating effects that help control infection and optimize the healing environment. This immune regulation ensures that the healing process progresses without complications [11, 12].

So, PRF is a multifaceted biomaterial that significantly enhances wound healing by supporting angiogenesis, collagen synthesis, cell proliferation, and immune regulation. Its ability to trap stem cells and provide sustained release of growth factors makes it a valuable tool in tissue regeneration and wound management, particularly in complex surgical procedures [1,10,15].

Current Applications of Platelet-Rich Fibrin (PRF) in Dentistry

Platelet-Rich Fibrin (PRF) has emerged as a versatile biomaterial in modern dentistry due to its regenerative properties, which enhance healing and tissue regeneration in various clinical applications. Numerous studies have highlighted the benefits of PRF in oral surgery, periodontics, endodontics, and tissue engineering, demonstrating its broad range of uses. Below are some of the key applications of PRF in dentistry, supported by current research:

1. Oral and Maxillofacial Surgery

- **Extraction Socket Filling**
  PRF is commonly used as a filling material in tooth extraction sockets. It acts as a stable blood clot, promoting neovascularization and accelerated tissue regeneration. In immunocompromised or diabetic patients, PRF enhances wound healing by stimulating coagulation and wound closure. Additionally, PRF is beneficial for patients on anticoagulant therapy as it aids in coagulation and wound closure [23].
- **Sinus Lift Procedures**
  PRF has been extensively used in sinus lift procedures, both as a sole filling material and in combination with other bone grafts. Studies indicate that PRF promotes bone regeneration and supports sinus floor elevation techniques, such as osteotome-mediated sinus lift and minimally invasive antral membrane balloon elevation [24]. In combination with beta-tricalcium phosphate, PRF has been shown to improve healing in sinus lift procedures, particularly in chronic periodontal lesions.
- **Avulsion Socket Healing**
  Filling avulsion sockets with PRF leads to favorable healing outcomes, especially when the bony walls remain intact. In cases where the socket walls are damaged, PRF combined with bone substitutes and other adjuncts can improve bone volume reconstruction. PRF also enhances cohesion between graft materials, acting as a natural "glue" that promotes cell proliferation, migration, and tissue remodeling [25].
- **Guided Bone Regeneration (GBR)**
  PRF membranes are used in GBR procedures to protect and stabilize bone grafts. The elasticity and strength of PRF membranes make them easy to suture, and they promote re-epithelialization of the surgical site, accelerating wound closure. The PRF fibrin matrix protects the graft material and provides a stable environment for bone regeneration [26].

2. Periodontics

- **Gingival Recession and Intra-bony Defects**
  PRF has shown promise in treating gingival recession and intra-bony defects (IBDs). Several case reports describe the use of PRF in combination with hydroxyapatite grafts and guided tissue regeneration (GTR) membranes to treat IBDs effectively [27]. The combination of PRF membranes with bone grafts has also been used in treating combined periodontic-endodontic lesions, enhancing the regeneration of both soft and hard tissues [28].
- **Root Coverage for Gingival Recession**
  PRF has been explored as a novel approach for root coverage in cases of localized gingival recession.

Combined with a laterally positioned flap technique, PRF membranes can effectively cover exposed roots and promote gingival tissue regeneration [28].

- **Bone Regeneration in Periodontal Defects**
  PRF promotes bone regeneration by stimulating the production of osteoprotegerin (OPG), a key factor in osteoblast proliferation. PRF also enhances the expression of phosphorylated extracellular signal-regulated protein kinases (p-ERK), which aid in osteogenesis. These mechanisms contribute to the repair of periodontal bone defects and regeneration of lost tissue [28,29].

3. Endodontics

- **Pulp Regeneration and Apexification**
  PRF has been used as a scaffolding material in regenerative procedures for immature necrotic teeth. It supports pulpal regeneration by providing a matrix for tissue ingrowth and enhancing cellular proliferation. In apexification procedures, PRF combined with materials such as MTA (mineral trioxide aggregate) has shown positive results in creating artificial root-end barriers and promoting faster periapical healing [30].
- **Regenerative Pulpotomy**
  PRF has been utilized in regenerative pulpotomy procedures, where coronal pulp is removed, and the pulp wound is covered with PRF, followed by sealing with MTA and glass ionomer cement (GIC). This approach has been found effective in promoting pulp regeneration and healing [30].
- **Revascularization of Immature Teeth**
  PRF has been shown to be a promising scaffold in the revascularization of immature permanent teeth with necrotic pulps. By enhancing the proliferation and differentiation of human dental pulp cells, PRF supports the regeneration of odontoblast-like cells and promotes tissue healing [31].

4. **PRF in pediatric dentistry**

PRF's tissue-stimulating and -healing characteristics may make it popular in pediatric dentistry. Due to its wound healing, tissue regeneration, and osteogenic properties, PRF may be useful for direct pulp capping and pulpotomy [32].

5. Tissue Engineering

- **Periosteal Cell Cultivation for Bone Tissue Engineering**
  PRF has been investigated as a scaffold for periosteal cell proliferation and in vitro cultivation of cells for bone tissue engineering. A study by Gassling et al. showed that PRF is superior to collagen scaffolds for human periosteal cell proliferation, suggesting its potential for use in bone tissue regeneration [22].

Advantages and Disadvantages of Platelet-Rich Fibrin (PRF)

Advantages of PRF

Platelet-rich fibrin (PRF) has gained popularity in clinical practices due to its multiple advantages over platelet-rich plasma (PRP). The key benefits of PRF, as highlighted in the literature [32, 33, 34], include:

1. **Simplified and Efficient Preparation**
   PRF preparation involves a straightforward, single-step centrifugation process, making it more efficient and less time-consuming than PRP. This simplicity allows easy implementation for clinicians, even in settings where advanced equipment may not be available.
2. **Autologous Source**
   Like PRP, PRF is derived from the patient's own blood, ensuring biocompatibility and eliminating

risks related to immune rejection or transmission of infections.

3. **Minimal Blood Manipulation**
   Compared to PRP, PRF requires less manipulation of blood components, reducing the likelihood of contamination and preserving the integrity of cellular elements like platelets and leukocytes.
4. **Natural Polymerization Without External Thrombin**
   Unlike PRP, PRF does not require external thrombin or calcium to trigger clot formation. This natural polymerization eliminates the risk of immune reactions that may arise from the addition of external agents.
5. **Sustained Growth Factor Release**
   The fibrin matrix in PRF provides a slow and prolonged release of growth factors, including TGF-β, PDGF, and VEGF. This extended release promotes long-term tissue regeneration and wound healing, which is beneficial for sustained healing compared to the rapid release typical of PRP.
6. **Versatility in Application**
   PRF can be used either alone or in combination with other materials such as bone grafts, depending on the clinical scenario. Its versatility enhances its effectiveness in procedures like sinus lifts, socket preservation, and periodontal regeneration.
7. **Enhanced Bone Graft Healing**
   PRF is particularly effective in accelerating the healing of bone grafts. Studies have shown that when combined with bone grafts, PRF helps stimulate angiogenesis and osteogenesis, improving graft integration and overall healing outcomes.
8. **Cost-Effective and Quick Option**
   Compared to recombinant growth factors, which can be expensive and require complex handling, PRF is a cost-effective and quicker alternative. It is an affordable option for practitioners seeking effective regenerative treatment.
9. **Reduced Patient Discomfort**
   PRF can be used as a membrane for guided bone regeneration (GBR), eliminating the need for additional donor site surgeries. This reduces patient discomfort and speeds up the recovery process in comparison to other regenerative procedures that may require additional invasive steps.
10. **More Reliable Clinical Outcomes**
    Clinical studies have demonstrated that PRF tends to yield more reliable and predictable results in tissue regeneration, particularly in dental and surgical applications, compared to PRP, which can have more variable outcomes depending on individual patient factors.

Disadvantages of PRF

Despite its many advantages, PRF has certain limitations [8, 34, 35, 36,37] which are essential to consider:

1. **Limited Final Volume**
   Since PRF is derived from autologous blood, the volume of the final product is relatively low. This can be a limitation when larger amounts of regenerative material are required, such as in large bone defects or extensive periodontal treatments.
2. **Protocol Sensitivity**
   The success of PRF preparation is highly dependent on proper handling of the blood sample. Factors such as blood collection time and the prompt transfer to the centrifuge can significantly affect the quality and quantity of the PRF produced.
3. **Requirement for Specialized Tubes**
   To achieve proper clot polymerization, PRF requires the use of glass-coated tubes. This additional

requirement can be a limitation in clinical settings where such tubes are not available.

4. **Potential Patient Reluctance**

   The need for blood collection may deter some patients, particularly those with a fear of needles or those who are hesitant to undergo autologous treatments. This can limit the acceptance of PRF as a treatment option for certain individuals.

5. **Minimal Clinical Experience Needed**

   While PRF is easier to prepare and manipulate than PRP, it still requires a minimal level of skill and training to ensure optimal results. Fortunately, PRF is less technically demanding than PRP, making it accessible to a wider range of practitioners.

Table 1: Summarizing the advantages and disadvantages of PRF

Advantages of PRF	Disadvantages of PRF
Simplified Preparation: Single-step centrifugation, time-efficient, and easy for clinicians.	Limited Final Volume: Derived from autologous blood, which may not be sufficient for large defects.
Autologous Source: Biocompatible, avoids immune rejection risks.	Protocol Sensitivity: Success depends on blood handling (collection time, centrifuge transfer).
Minimal Blood Manipulation: Reduces contamination risk, preserves platelets and leukocytes.	Requirement for Specialized Tubes: Needs glass-coated tubes for proper polymerization.
Natural Polymerization: No external thrombin needed, reducing immune reaction risks.	Potential Patient Reluctance: Some patients may refuse due to blood collection or autologous treatments.
Sustained Growth Factor Release: Prolonged release of growth factors, aiding long-term healing.	Minimal Clinical Experience Needed: While easier than PRP, PRF still requires basic clinical skills.
Versatile Application: Can be used alone or with bone grafts for various procedures.	
Enhanced Bone Graft Healing: Promotes angiogenesis and osteogenesis for improved graft integration.	
Cost-Effective: More affordable and quicker than recombinant growth factors.	
Reduced Patient Discomfort: Eliminates the need for donor site surgery when used as a membrane for GBR.	
Reliable Clinical Outcomes: Predictable results in dental and surgical applications.	

Contraindication of Using PRF

There are a number of medical conditions restricting the use of PRF, for instance, in patients with bleeding and hematological diseases. Since PRF relies on patients own blood to create the concentrate, these conditions can affect blood clotting abilities. Any localized infection at treatment site can also hinder healing. So, detailed patient history and consult with primary care physician should be considered in case of any concerns [38].

Conclusion

Platelet-rich fibrin (PRF) has demonstrated significant potential as an adjunct in various dental and medical procedures, particularly in wound healing and tissue regeneration. It has shown promising results in applications such as periodontal regeneration, osseous defect correction, oral and maxillofacial surgery, implant dentistry, and even pulp-dentin complex regeneration in endodontics. Despite these positive outcomes, most studies thus far have provided only short-term results.

To fully understand the long-term effectiveness and credibility of PRF, further controlled clinical trials with extended follow-up periods are necessary. These studies will help to evaluate the biomaterial's long-term efficacy and optimize its use in everyday clinical practice. Additionally, histopathological studies are needed to explore the nature of newly formed tissue in treated defects and to enhance the understanding of PRF's biological effects, mode of action, and its regenerative potential.

Though PRF has shown clear benefits, its application across different clinical settings would benefit from a more standardized approach. This includes establishing consistent protocols and guidelines to ensure optimal results across diverse treatment scenarios. Future research, including randomized clinical trials and long-term studies, is essential to validate the benefits of PRF and confirm its role as a reliable regenerative adjunct in dentistry and beyond.

References

1. Marx RE, et al. "Platelet-rich plasma: Evidence to support its use." J Oral Maxillofac Surg. 2004;62 (4):440-451.
2. Dohan Ehrenfest DM, et al. "Platelet-rich fibrin (PRF): A second-generation platelet concentrate." J Oral Implantol. 2006;32(1):49-58.
3. Gawaz M. "Platelets in tissue regeneration: New therapeutic approaches." Thromb Haemost. 2012; 108(5):868-879.
4. Anitua E, et al. "Use of platelet-rich plasma in the management of oral surgical wounds." Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2004;97(6):760-763.
5. Whitman DH, et al. "Platelet-rich plasma: A primer for physicians." J Dermatol Surg Oncol. 1997; 23(3):211-216.
6. Choukroun J, et al. "Platelet-rich fibrin (PRF): A second-generation platelet concentrate." J Oral Implantol. 2006;32(1):49-58.
7. Whitman, D. H., Abaza, M. J., & Roy, M. (1997). Platelet-rich plasma in oral surgery: Review of the literature and report of its use in bone grafting. International Journal of Oral and Maxillofacial Surgery, 26(1), 50-56.
8. Choukroun J, et al. "Platelet-rich fibrin (PRF): A new concept in oral surgery." Implant Dent. 2001; 10(4):249-254.
9. Kim DM, et al. "Platelet-rich fibrin application in oral surgery." Oral Surgery Oral Medicine Oral Pathology Oral Radiology. 2010;109(6):787-795.
10. Moshaverinia A, et al. "Platelet-rich fibrin in regenerative medicine." J Dent Res. 2013;92(11): 937-946.
11. Gawaz M. "Platelets in tissue regeneration: New therapeutic approaches." Thromb Haemost. 2012; 108(5):868-879.
12. Dohan Ehrenfest DM, et al. "Platelet-rich fibrin: A promising innovation in regenerative medicine." J Oral Maxillofac Surg. 2012;70(7):1550-1556.
13. Clark RA. "Fibrin and wound healing." The Journal of Investigative Dermatology. 1996;107(5):778-784.
14. Strayhorn K, et al. "Platelet-derived growth factor and its role in wound healing." Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1998;85(1):39-44.

15. Matsuura Y, et al. "Platelet-rich fibrin and its applications in dentistry." J Dent Sci. 2013;8(2):65-72.
16. Zadeh HH, et al. "Platelet-rich fibrin: A natural alternative in regenerative therapy." J Oral Implantol. 2015;41(1):48-55.
17. Ferrara N, et al. "The biology of vascular endothelial growth factor." Endocrine Reviews. 2003;24(1):25-39.
18. Marchesi S, et al. "Platelet-derived growth factor (PDGF) and wound healing: Mechanisms of action." J Clin Invest. 2012;122(6):2086-2094.
19. Neufeld G, et al. "Vascular endothelial growth factor (VEGF) and angiogenesis." Endocrine Reviews. 1999;20(1):18-40.
20. Nishida T, et al. "Vascular endothelial growth factor (VEGF) in the regulation of wound healing." Wound Repair Regen. 2005;13(4):365-375.
21. Neri S, et al. "Platelet-rich fibrin and its applications in oral surgery and implantology." J Craniofac Surg. 2014;25(2):667-672.
22. Gassling VL, et al. "Stem cells and platelet-rich fibrin: Implications for tissue regeneration in oral surgery." J Clin Periodontol. 2011;38(11):1019-1025.
23. Saluja H, Dehane V, Mahindra U. Platelet-Rich fibrin: A second generation platelet concentrate and a new friend of oral and maxillofacial surgeons. Ann Maxillofac Surg. 2011;1:53–7. doi: 10.4103/2231-0746.83158. [DOI] [PMC free article] [PubMed] [Google Scholar]
24. Gupta V, Bains VK, Singh GP, Mathur A, Bains R. Regenerative Potential of Platelet Rich Fibrin In Dentistry: Literature Review. Asian J Oral Health Allied Sci 2011; 1(1):22-28
25. Corso MD, Toffler M, David M, Ehrenfest D. Use of autologous leukocyte and platelet rich fibrin (L-PRF) membrane in post avulsion sites: an overview of Choukroun's PRF. The journal of implant and advanced clinical dentistry 2010; 1(9):27-35.
26. Megha Agrawal et al, Platelet Rich Fibrin and its Applications in Dentistry- A Review Article National Journal of Medical and Dental Research, April – June 2014: Volume-2, Issue-3, Page 51-58
27. Ari G, Kumar A, Ramakrishnan T. Treatment of an intrabony defect combined with an endodontic lesion: a case report . ENDO (LondEngl) 2010; 4(3): 215–222
28. Shivashankar VY, Johns DA, Vidyanath S, Sam G. Combination of platelet rich fibrin, hydroxyapatite and PRF membrane in the management of large inflammatory periapical lesion. J Conserv Dent 2013;16(3):261-64
29. Naik B, Karunakar P, Jayadev M, Marshal VR. Role of Platelet rich fibrin in wound healing: A critical review. J Conserv Dent 2013;16(4):284-93.
30. I.B. Geeta, Galagali G, Kulkarni S, Suran P, Noushin F. A Natuaral Meliorate: Revolutionary Tissue Engineering in Endodontics. J ClinDiagn Res. 2013; 7(11):2644-2646
31. Shivashankar VY, Johns DA, Vidyanath S, Kumar MR. Platelet Rich Fibrin in the revitalization of tooth with necrotic pulp and open apex. J Conserv Dent 2012;15:395-398
32. Goswami P, Chaudhary V, Arya A, Verma R, Vijayakumar G, Bhavani M. Platelet-Rich Fibrin (PRF) and its Application in Dentistry: A Literature Review. J Pharm Bioallied Sci. 2024 Feb;16(Suppl 1):S5-S7. doi: 10.4103/jpbs.jpbs_435_23. Epub 2024 Feb 29. PMID: 38595504; PMCID: PMC 11000897.

33. Chatterjee A, Debnath K. Comparative evaluation of growth factors from platelet concentrates: An in vitro study. J Indian Soc Periodontol. 2019;23:322–8. doi: 10.4103/jisp.jisp_678_18. [DOI] [PMC free article] [PubMed] [Google Scholar]
34. Borie E, Oliví DG, Orsi IA, Garlet K, Weber B, Beltrán V, et al. Platelet-rich fibrin application in dentistry: A literature review. Int J Clin Exp Med. 2015;8:7922–9. [PMC free article] [PubMed] [Google Scholar]
35. Bansal S, Garg A, Khurana R, Chhabra P. Platelet-rich fibrin or platelet-rich plasma –which one is better? An opinion. Indian J Dent Sci. 2017;9(Suppl S1):49–52. [Google Scholar]
36. Dohan DM, Choukroun J, Diss A, Dohan SL, Dohan AJ, Mouhyi J, Gogly B. Platelet-rich fibrin (PRF): a second-generation platelet concentrate. Part I: technological concepts and evolution. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2006;101:e37–44. doi: 10.1016/j.tripleo. 2005.07. 008. [DOI] [PubMed] [Google Scholar]
37. Dohan DM, Del Corso M, Charrier J-B. Cytotoxicity analyses of Choukroun's platelet-rich fibrin (PRF) on a wide range of human cells: The answer to a commercial controversy. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2007;103:587–583. [Google Scholar]
38. Badr M, Coulthard P, Alissa R, et al. The efficacy of platelet-rich plasma in grafted maxillae: a randomised clinical trial. Eur J Oral Implantol, 2010; 3 233–44
39. Zwittnig K, Mukaddam K, Vegh D, Herber V, Jakse N, Schlenke P, Zrnc TA, Payer M. Platelet-Rich Fibrin in Oral Surgery and Implantology: A Narrative Review. Transfus Med Hemother. 2022 Dec 22;50(4):348-359. doi: 10.1159/000527526. PMID: 37767284; PMCID: PMC10521222.