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Platelet-Rich Fibrin In Endodontics: Biological Basis, Clinical Applications, And Future Perspectives

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Abstract
Platelet-rich fibrin (PRF) has emerged as a promising autologous biomaterial in regenerative dentistry due to its ability to release growth factors in a sustained manner and promote tissue healing. In endodontics, achieving predictable regeneration of pulp-dentin complex and periapical tissues remains a major challenge. The introduction of PRF has opened new possibilities in regenerative endodontic procedures, periapical surgery, and management of large periapical lesions. This narrative review summarizes the biological basis of PRF, its various forms, and current clinical applications in endodontics. A literature search was conducted using electronic databases including PubMed, Scopus, and Google Scholar. Available evidence suggests that PRF serves as an effective scaffold, enhances angiogenesis, and accelerates hard and soft tissue healing. However, lack of a standardized protocols and limited high-quality clinical trials restricts definitive conclusions.

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I. Introduction

Endodontic therapy primarily aims to eliminate infection and preserve the natural dentition by promoting healing of periapical tissues.[1] Conventional endodontic treatment is highly successful; however, challenges arise in cases involving immature teeth, large periapical lesions, and compromised healing potential. Regenerative endodontics has gained significant attention as it seeks to replace damaged pulp tissue and restore normal function biologically.[2]

Platelet concentrates have been introduced in regenerative medicine to enhance wound healing. Among these, platelet-rich fibrin (PRF), a second-generation platelet concentrate, has gained popularity due to its autologous nature, ease of preparation, and sustained release of growth factors. PRF has been increasingly applied in endodontics for regenerative procedures and surgical interventions.[3] Therefore, this narrative review aims to discuss the biological rationale, types, clinical applications, advantages, limitations, and prospects of PRF in endodontics.

II. Methodology Of The Narrative Review

A narrative literature review was conducted using electronic databases, including PubMed, Scopus, and Google Scholar. Keywords such as 'platelet-rich fibrin', 'PRF', 'endodontics', 'regenerative endodontics', and 'periapical healing' were used.

Articles published primarily in the last 10 years were considered, although seminal studies were also included. In vitro, animal, clinical trial, case series, and case report studies written in English were reviewed. No formal systematic review protocol was followed.

Biology and Composition of Platelet-Rich Fibrin

Platelet-rich fibrin is a fibrin matrix obtained from autologous blood without the use of anticoagulants. The centrifugation process produces a dense fibrin scaffold that is rich in platelets, leukocytes, cytokines, and circulating stem cells. PRF releases growth factors, including platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-β), vascular endothelial growth factor (VEGF), and insulin-like growth factor (IGF), over an extended period.[4-7]

The fibrin architecture of PRF provides a natural scaffold that supports cell migration, angiogenesis, and tissue regeneration. Leukocytes present in PRF contribute to immune regulation and antimicrobial activity, making it particularly useful in infected endodontic environments.[8]

Types of Platelet-Rich Fibrin

Several modifications of PRF have been developed to optimize its biological properties. Leukocyte-rich PRF (L-PRF) is the conventional form widely used in clinical practice. Advanced PRF (A-PRF) is produced using lower centrifugation speeds, resulting in higher leukocyte content and increased growth factor release. Injectable PRF (i-PRF) remains in liquid form for a short duration, allowing it to be used as an injectable scaffold or combined with graft materials. These variations expand the clinical applicability of PRF in endodontics.[9]

III. Applications Of PRF In Endodontics

PRF in Regenerative Endodontic Procedures

Platelet-rich fibrin (PRF) has emerged as a promising scaffold in regenerative endodontic procedures (REPs), particularly as an alternative to the conventional induced blood clot. PRF offers a more stable fibrin matrix enriched with platelets, leukocytes, and growth factors, which can enhance stem cell migration, proliferation, and differentiation while promoting angiogenesis.[10] Recent evidence supports the biological and clinical advantages of autologous platelet concentrates in REPs, with systematic reviews and meta-analyses confirming favourable outcomes in immature necrotic permanent teeth when PRF is incorporated into treatment protocols. Clinically, the use of PRF in REPs has been associated with improved healing and continued root development, including increased root length, thickening of dentinal walls, and enhanced apical closure. Meta-analytic findings suggest that PRF may improve radiographic outcomes and regenerative potential compared with traditional scaffolds, contributing to more predictable tissue repair and maturation of immature teeth. Additionally, broader reviews of platelet concentrate in endodontics highlight PRF as one of the most frequently used biologically active scaffolds in regenerative and surgical endodontic applications, reinforcing its expanding clinical relevance.[11-13]

PRF in Periapical Surgery

Platelet-rich fibrin (PRF) has been increasingly applied as an adjunct in periapical surgical procedures to enhance both hard and soft-tissue healing. A recent systematic review and meta-analysis of randomized controlled trials found that the adjunctive use of PRF in periapical surgery was associated with significantly reduced postoperative pain and improved patient-reported clinical outcomes, although differences in radiographic bone healing were not statistically significant in all included studies.[14] This comprehensive analysis of RCTs reinforces the potential clinical benefits of PRF in managing postoperative discomfort and supporting the early phases of healing following surgical intervention for periapical lesions. [14] Additionally, contemporary randomized clinical evidence has shown that PRF membranes used over the osteotomy site during apicoectomy significantly lowered pain scores and swelling compared with controls, further highlighting their value in improving early postoperative recovery. [15]

Beyond symptom management, surgical interventions using PRF have also demonstrated enhanced early bone regeneration in periapical defects. A recent randomized controlled trial comparing PRF with other regenerative materials reported significantly greater early volumetric bone fill at 3 months post-surgery versus control, underscoring PRF’s biological stimulus for bone repair in endodontic microsurgery. [16] While long-term radiographic differences may be variable, the collective high-level evidence supports PRF’s role as a beneficial adjunct to conventional periapical surgery — whether used alone over defects or in combination with graft materials — by promoting soft tissue healing, reducing discomfort, and accelerating initial bone formation. [14-16]

PRF in Management of Large Periapical Lesions

Large periapical lesions remain difficult to manage because healing is influenced not only by lesion size but also by chronicity, epithelial lining formation (true cysts), persistent intraradicular or extraradicular infection, and reduced vascular supply in large defects. These factors can delay or compromise bone regeneration even after adequate disinfection and surgical curettage. In addition, large lesions may require a longer follow-up period for complete radiographic resolution, and outcomes can be less predictable compared with smaller defects.[17]

Although PRF is beneficial as a scaffold and growth-factor reservoir, it also has important limitations in large lesions. The main clinical limitation is that PRF quantity is limited by the patient’s blood volume and the number of tubes collected, which may be insufficient to fill extensive periapical defects completely.

Furthermore, PRF is rapidly resorbed, has limited space-maintaining ability, and cannot provide structural stability in large cavities unless combined with graft materials. Variability in centrifugation protocols and patient-related factors (platelet count, systemic conditions) also affects PRF quality and consistency. Therefore, while PRF can enhance healing and reduce postoperative symptoms, it may not always be adequate as a sole material in large lesions and is often used as an adjunct with bone grafts or barrier membranes. [14,16]

PRF in Root Perforation and Resorption

PRF has recently been explored as a biologically active adjunct in the management of root perforations and external inflammatory resorption, where healing depends heavily on periodontal ligament (PDL) regeneration and control of inflammation. Because PRF provides a fibrin scaffold enriched with platelets, leukocytes, and growth factors, it may promote cellular migration, angiogenesis, and soft tissue repair at the perforation or resorptive site. This biological environment is particularly useful in defects where conventional repair materials alone may seal the site but do not actively enhance tissue regeneration.[4,5,7]

Platelet-rich fibrin (PRF) has been investigated as an adjunctive regenerative scaffold in conjunction with bioceramic materials such as mineral trioxide aggregate (MTA) for the repair of root perforations and resorptive defects. PRF's three-dimensional fibrin matrix, rich in platelets and growth factors, offers a biologically active environment that may enhance periodontal ligament attachment and facilitate hard and soft tissue healing when used as an internal matrix beneath bioceramic repair materials. While high-level human RCTs specifically addressing PRF + bioceramic repair in perforation and resorption are scarce, in vivo animal evidence demonstrates that using PRF beneath MTA in furcation perforation repair results in greater bone formation, reduced inflammation, and improved tissue regeneration compared with bioceramic material alone, suggesting a synergistic effect on healing.[18]

The rationale for combining PRF with bioceramic materials in such defects is supported by clinical practice and case series that describe using PRF as an internal matrix for MTA in iatrogenic perforation and resorptive lesion repair, with favourable clinical and radiographic outcomes. Bioceramics like MTA are widely established for their biocompatibility and sealing ability in perforation and resorption repair, creating a stable physical barrier, while PRF contributes bioactive factors and a scaffold that may accelerate periodontal healing and tissue regeneration. Although more human randomized clinical trials are needed, existing evidence from experimental and comparative clinical contexts supports the beneficial role of PRF combined with bioceramic materials in managing these challenging endodontic defects.[19]

Comparison of PRF with Other Biomaterials

Compared to platelet-rich plasma (PRP), PRF does not require anticoagulants and provides a longer release of growth factors. When compared to a blood clot alone, PRF offers improved handling characteristics and biological stability. Unlike synthetic scaffolds, PRF is completely autologous and biocompatible, though it lacks standardized preparation protocols.[10]

Advantages and Limitations of PRF

The advantages of PRF include its autologous nature, cost-effectiveness, ease of preparation, and ability to enhance healing. However, limitations include technique sensitivity, variability in preparation protocols, limited working time, and insufficient high-level clinical evidence.[20-22]

Current Evidence and Clinical Outcomes

Most available evidence supporting PRF in endodontics comes from in vitro studies, animal experiments, and case reports. Although results are promising, there is a lack of well-designed randomized controlled clinical trials. Therefore, current conclusions should be interpreted with caution.

Future Directions and Research Gaps

Future research should focus on standardizing PRF preparation protocols and evaluating long-term clinical outcomes. The combination of PRF with stem cell therapy, biomimetic materials, and tissue engineering approaches may further enhance regenerative outcomes in endodontics.

IV. Conclusion

Platelet-rich fibrin represents a promising biomaterial in endodontics due to its biological properties and clinical versatility. While current evidence suggests beneficial outcomes in regenerative and surgical endodontic procedures, further high-quality clinical studies are required to establish definitive clinical guidelines.

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