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COMPARATIVE ANALYSIS OF POST-EXTRACTION ALVEOLI HEALING WITH AND WITHOUT THE APPLICATION OF PLATELET-RICH FIBRIN

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Abstract

The healing of the alveoli after extraction is an essential process in the recovery of patients after tooth extractions. The use of platelet-rich fibrin (PRF) has been proposed as an effective method to accelerate this process and improve bone regeneration. This review aims to analyze and compare the results of post-extraction alveoli healing with and without the application of PRF, based on recent clinical trials and data from the literature. The use of platelet-rich fibrin (PRF) in bone regeneration after tooth extractions offers significant clinical advantages. PRF facilitates the gradual release of essential growth factors, such as PDGF (platelet-derived growth factor), TGF-β (transforming growth factor beta), and VEGF (vascular endothelial growth factor), stimulating the proliferation and differentiation of osteoprogenitor cells essential for the formation of new bone. The fibrin matrix provides a three-dimensional scaffold, supporting cell migration and attachment, thus improving the structural organization of tissue in healing. PRF significantly improves angiogenesis by promoting the formation of new blood vessels, ensuring a constant supply of oxygen and nutrients to the regenerated bone.

Keywords*:* healing of post-extraction alveoli; platelet-rich fibrin (PRF); bone regeneration.

Introduction

Tooth extraction is one of the most common dental procedures, and optimal healing of the post-extraction alveoli is crucial for preventing complications and preparing the site for subsequent procedures such as dental implants. PRF is an autologous biomaterial, derived from the patient's blood, which contains growth factors and cytokines that stimulate tissue and bone regeneration [1-3].

Post-extraction alveoli healing is an essential process for the complete recovery of patients after tooth extractions, influencing the preparation of the site for implants and the prevention of complications. Platelet-rich fibrin (PRF) has been introduced as an innovative method to accelerate bone healing and regeneration. This review aims to compare the results of post-extraction alveoli healing with and without the application of PRF, analyzing recent clinical trials and data from the literature [2-4].

PRF is an evolution of platelet concentrates, first used in the 2000s. Unlike its predecessors, PRF is obtained without anticoagulants, allowing the formation of a three-dimensional fibrinous clot that retains growth factors and cytokines essential for healing [1-4].

The studies included in this review show that the application of PRF significantly accelerates soft tissue healing and bone regeneration. Patients who benefited from PRF showed

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faster soft tissue healing and higher bone density compared to those in the control group. PRF also reduced the incidence of post-extraction complications such as dry alveolitis [1-5].

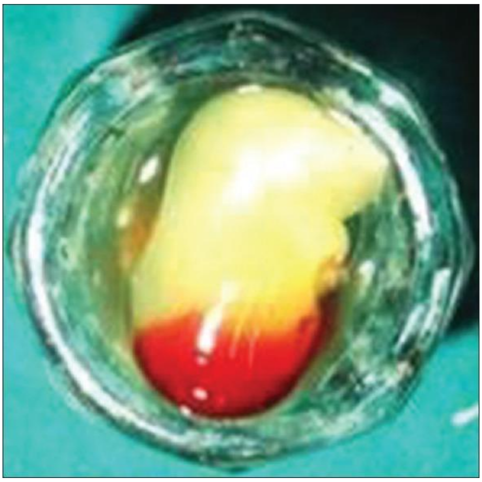

Fig 1. In a sterile vessel, we have platelet-rich fibrin [5].

PRF works by gradually releasing growth factors, which stimulate cell proliferation, angiogenesis, and tissue regeneration. The three-dimensional structure of PRF provides mechanical support for the cells involved in healing, creating an environment conducive to bone and soft tissue regeneration [5-7].

The use of PRF has numerous clinical advantages, including reducing healing time and improving the quality of newly formed bone. These benefits can lead to more effective planning of subsequent treatments, such as dental implants. Also, the reduction of post-extraction complications contributes to a better patient experience and the reduction of the need for subsequent interventions [6-8].

Recently, research has focused on optimizing PRF application protocols, including variables such as the amount of blood collected and centrifugation techniques. Novelties include the use of PRF in combination with other biomaterials to further improve clinical outcomes. The use of PRF in other areas of regenerative medicine is also being explored, expanding its potential for application [5-8].

The available data indicates that PRF is an effective adjunct in the healing of post-extraction alveoli, providing significant benefits in bone regeneration and soft tissue healing. However, variability in obtaining PRF and associated costs are limitations that need to be addressed by standardizing protocols and long-term evaluation of clinical outcomes. Future studies should focus on these aspects to maximize the clinical benefits of PRF. In conclusion, the use of PRF represents a promising approach to improve post-extraction alveoli healing, with significant implications for dental practices and regenerative medicine [6-9].

Soft tissue healing

Most studies reported faster and more effective soft tissue healing in patients who benefited from applying PRF to the alveoli post-extraction. The mean time to complete soft tissue healing was significantly reduced in patients in the PRF group compared to those in the control group [6-9].

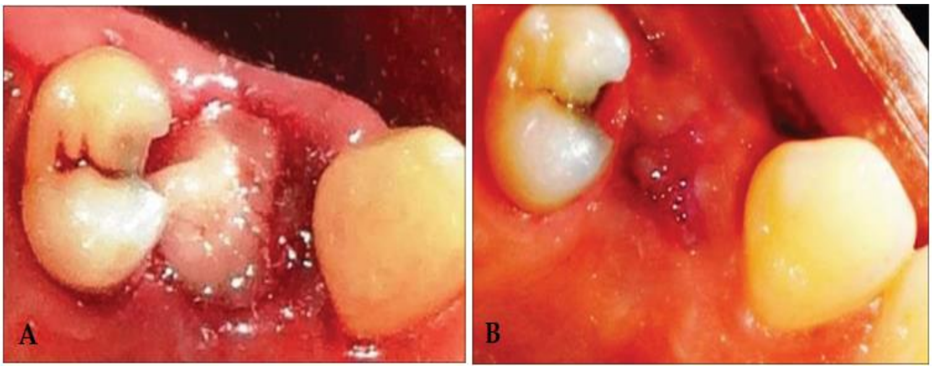

Fig 2. A) Unbridled and grafted extraction due to platelet-rich fibrin.
B) Clinical image with tissue healing at one month. [5]

Soft tissue healing is an essential process in the recovery of patients after tooth extractions. Soft tissues, including the gums and oral mucosa, play a crucial role in protecting the alveolar bone and preventing infections. The use of platelet-rich fibrin (PRF) has been proposed as an effective method to accelerate this process [5,6-9].

Post-extraction soft tissue healing involves several stages: in the first 24-48 hours after extraction, an inflammatory response occurs that involves the recruitment of immune cells at the extraction site to remove debris and fight infection. This takes place over the following days and weeks when fibroblast cells and epithelial cells migrate to the affected area to begin the formation of new tissue. Over several weeks and months, the newly formed tissue is remodeled and matured, resulting in fully healed tissue [6-9].

PRF is an autologous biomaterial obtained by centrifuging the patient's blood without the addition of anticoagulants. PRF contains a high concentration of growth factors and cytokines that are released gradually, stimulating healing processes. The main benefits of PRF in soft tissue healing include growth factors in PRF, such as PDGF (platelet-derived growth factor) and TGF-β (transforming growth factor beta), which promote fibroblast and epithelial cell migration and proliferation [7-10].

PRF stimulates the formation of new blood vessels, essential for the supply of oxygen and nutrients necessary for tissue regeneration. PRF can modulate the inflammatory response, contributing to faster healing and reducing postoperative discomfort. The three-dimensional structure of PRF provides mechanical support for the cells involved in healing and acts as a physical barrier against bacterial contamination [8-10].

Clinical studies have shown that patients treated with PRF show faster and more effective soft tissue healing compared to traditional methods. In a study of 60 patients, the PRF-treated group showed complete soft tissue healing on average at 4 weeks, compared to 6 weeks in the control group. Also, the incidence of post-extraction complications, such as infections and dry alveolitis, was significantly reduced in the PRF group [7-10].

Bone regeneration

Radiological studies have shown faster bone regeneration and higher bone density in the alveoli treated with PRF. Histological analyses confirmed the presence of a newly formed bone of higher quality in the PRF group. The application of PRF was associated with a reduced incidence of post-extraction complications such as dry alveolitis. Growth factors in PRF contributed to more uniform healing and reduced local inflammation [10-13].

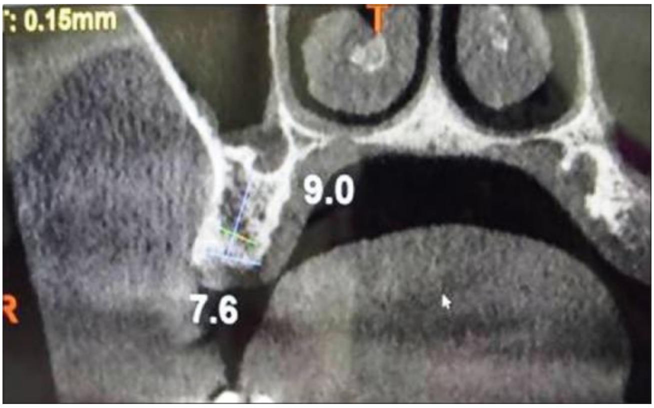

Fig 3. The image shows a CT (computed tomography) scan of a portion of the human jaw. This includes numerical measurements indicated with 7.6 and 9.0 millimeters. The area marked with 9.0 mm seems to be related to the height of the maxillary bone in that region. The area marked with 7.6 mm probably refers to the width of the jawbone. [5]

Bone regeneration is a vital process for restoring the structural and functional integrity of the bone after a tooth extraction. It involves a series of complex biological events that lead to the formation of new bone in the alveolus after extraction. Platelet-rich fibrin (PRF) is used to facilitate and accelerate this process[10-13].

Stages of bone regeneration

The inflammatory stage lasts 24-48 hours. Immediately after extraction, a blood clot forms that initiates the inflammatory response. Inflammatory cells, such as neutrophils and macrophages, are recruited to clean the area of debris and bacteria and release cytokines and growth factors [11-13].

The stage of granulation tissue formation lasts from days to weeks. The proliferation of fibroblasts and the formation of new blood vessels (angiogenesis) creates a capillary-rich granulation tissue that will support bone formation. Osteoblasts, cells specialized in bone synthesis, migrate to the affected area and begin to deposit the bone matrix [11-14].

The osteogenesis stage lasts from weeks to months. Osteoblasts synthesize collagen and other extracellular matrix proteins, which are subsequently mineralized to form new bone. The organic matrix is mineralized by the deposition of hydroxyapatite, strengthening the bone structure [11-14].

The remodeling phase lasts from months to years. The newly formed bone is continuously remodeled by the coordinated activity of osteoclasts (which resorb old bone) and osteoblasts (which form new bone). Adaptive remodeling ensures that the final bone structure is optimized to withstand the mechanical loads it will be subjected to [11-15].

The Role of Platelet-Rich Fibrin (PRF)

PRF can improve bone regeneration through several mechanisms, continuous release of growth factors, PRF gradually releases growth factors such as PDGF, TGF-β, and VEGF, which stimulate osteoblast proliferation and activity and angiogenesis. The three-dimensional matrix of PRF provides a framework for osteogenic cell migration and granulation tissue formation. PRF can reduce excessive inflammation, creating a more favorable environment for bone regeneration. PRF contains leukocytes and platelets that release cytokines and bioactive proteins, promoting tissue regeneration [11-14].

Clinical studies have shown that the use of PRF in post-extraction alveoli leads to faster and higher-quality bone regeneration. In a comparative study, patients treated with PRF had significantly higher bone density and a more organized bone structure compared to those who followed conventional treatments. Also, the incidence of complications, such as persistent bone defects, was reduced [13-15].

The use of PRF in post-extraction bone regeneration has significant implications for clinical practice. This can reduce the time it takes for dental implants to integrate and improve their stability and longevity. It can also reduce the need for additional interventions to correct bone defects[14-16].

Mechanisms of action

PRF works by gradually releasing growth factors, which stimulate cell proliferation, angiogenesis, and tissue regeneration. The three-dimensional structure of PRF provides mechanical support for the cells involved in healing [15-18].

Bone regeneration is a complex process that requires coordination between several cell types and biochemical factors. The use of platelet-rich fibrin (PRF) in this context brings several advantages that facilitate and accelerate the healing process. In this section, we will explore the mechanisms of action by which PRF contributes to bone regeneration [15-18].

The gradual release of growth factors is due to the PRF acting as a storehouse of growth factors, gradually releasing them into the affected area. These growth factors include PDGF (platelet-derived growth factor) which stimulates the proliferation and differentiation of osteoblasts and mesenchymal cells, which are essential for the formation of new bone. TGF-β (transforming growth factor beta) regulates collagen synthesis and stimulates osteoblasts, contributing to the formation of the bone extracellular matrix. VEGF (vascular endothelial growth factor) promotes angiogenesis, the formation of new blood vessels that provide oxygen and essential nutrients for bone regeneration [16-19].

PRF forms a three-dimensional fibrinous matrix that provides structural support for the migration and attachment of cells involved in bone healing. Osteoblasts attach and migrate to this matrix, where they begin to deposit the bone matrix. The three-dimensional structure serves as a scaffold for the formation of granulation tissue and new bone, facilitating cell organization and uniform distribution of growth factors [15-18].

Angiogenesis is essential for bone regeneration, as new blood vessels provide oxygen and nutrients needed by osteogen cells. VEGF is a major growth factor that promotes the formation of new capillaries in the affected area. Improved vascularization ensures a constant supply of immune and osteoprogenitor cells, accelerating the healing process [16-19].

Controlled inflammation is crucial for optimal healing. The cytokines released by PRF help reduce excessive inflammation, which can prevent healing. PRF may decrease the production of pro-inflammatory mediators such as IL-1 and TNF-α, preventing chronic inflammation and promoting faster healing [17-19].

PRF stimulates the differentiation of mesenchymal cells into osteoblasts. PDGF and TGF-β play a major role in cell signaling that drives osteogenic differentiation. PRF creates a microenvironment that favors osteogenesis, through the controlled release of bioactive factors. PRF contains leukocytes and platelets that contribute to healing. The leukocytes in PRF can help prevent infections by releasing antimicrobial substances. The regenerative cells present in PRF contribute to tissue repair and regeneration [17-20].

Advantages and limitations

There are many benefits to using PRF, including speeding up healing and reducing complications. However, variability in obtaining FRP and associated costs may be limitations.

It is necessary to standardize application protocols and conduct long-term clinical trials to confirm the observed benefits [20-22].

Advantages of using PRF in bone regeneration

PRF provides a prolonged release of growth factors (PDGF, TGF-β, VEGF), which stimulate long-term tissue and bone regeneration. It helps to proliferate and differentiate osteoprogenitor cells, promoting the formation of new bone. The three-dimensional fibrinous matrix provided by PRF acts as a scaffold that supports the migration and attachment of osteogenic cells, facilitating the organization and uniform distribution of growth factors. PRF stimulates the formation of new blood vessels by releasing VEGF, ensuring a constant supply of oxygen and essential nutrients for bone regeneration [21-23].

PRF helps control inflammation by releasing anti-inflammatory cytokines and reducing pro-inflammatory mediators, preventing chronic inflammation and promoting rapid healing. PRF contains leukocytes and platelets that contribute to healing through antimicrobial and regenerative activity, reducing the risk of infections and postoperative complications. PRF is an autologous biomaterial, which means that it is derived from the patient's blood, eliminating the risk of immunological reactions and transmissible infections. PRF can be used in various dental and surgical procedures, including tooth extractions, dental implants, bone reconstructions, and soft tissue healing [20-23].

Limitations of the use of PRF in bone regeneration

The process of obtaining PRF can vary depending on the centrifugation technique, blood collection time, and other technical factors. This can lead to inconsistencies in the quality and quantity of PRF obtained. The use of PRF requires special centrifugal equipment and trained personnel, which can increase the costs of the procedure. Also, not all dental offices are equipped to produce PRF [21-23].

PRF should be used immediately after obtaining, as growth factors degrade rapidly. This limits flexibility in scheduling surgical procedures. There are no standardized protocols for the preparation and application of PRF, which can lead to variability in clinical outcomes. There is a need to develop clear guidelines and standardize procedures to maximize clinical benefits [19-22].

In cases of large or complex bone defects, PRF alone may not be sufficient to ensure complete regeneration. In such situations, it may be necessary to combine PRF with other biomaterials or bone augmentation techniques. Although there is promising clinical evidence, further long-term studies are needed to evaluate the efficacy and safety of PRF in various clinical applications and to identify best practices for its use [20-23].

Conclusions

The available data indicate that PRF is an effective adjunct in the healing of post-extraction alveoli, providing significant benefits in terms of bone regeneration and soft tissue healing. Future studies should focus on optimizing protocols and long-term evaluation of clinical outcomes.

The use of PRF in the treatment of post-extraction alveoli provides significant benefits in terms of soft tissue healing. PRF accelerates the healing process by stimulating cell proliferation, and angiogenesis, and reducing inflammation. Implementing this technology in clinical practice can significantly improve postoperative outcomes and reduce complications associated with tooth extractions. Future studies should focus on optimizing FRP application protocols and assessing its benefits in the long term.

Bone regeneration after tooth extractions is a complex process that can be significantly improved by using PRF. By gradually releasing growth factors and providing adequate structural support, PRF accelerates the formation and remodeling of new bone. The implementation of this technology in clinical practice can significantly improve treatment outcomes and patients' quality of life. Future studies should explore the optimization of FRP application protocols and assess the long-term effects of this method.

PRF improves bone regeneration through a combination of mechanisms that include the gradual release of growth factors, structural support, stimulation of angiogenesis, modulation of the inflammatory response, and stimulation of cell differentiation. These synergistic mechanisms create an optimal environment for the formation of new bone, reducing complications and accelerating the healing process. The use of PRF in clinical practice promises superior results in post-extraction treatments and other procedures that require bone regeneration.

PRF has numerous advantages in bone regeneration, including gradual release of growth factors, structural support, improved angiogenesis, modulation of inflammation, and high biocompatibility. However, there are also limitations, such as variability in obtaining PRF, associated costs, lack of standardization, and limited effectiveness in complex cases. By addressing these limitations and further research, PRF can become a standardized and optimized component in bone regeneration treatments.

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