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Clinical applications of platelet-rich fibrin (PRF) in dentistry and oral surgery: A review of the literature

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ABSTRACT

Platelet-rich fibrin (PRF) is a biomaterial obtained from patients themselves. That made it an essential material in oral and maxillofacial surgery due to its effectiveness in stimulating tissue repair. PRF is obtained from the patient's blood through a simple centrifugation process—without the addition of anticoagulants—that creates a fibrin scaffold filled with platelets, white blood cells, and growth factors. These biological elements play a major role in angiogenesis and stimulation cells to multiply while healing. Lately, working with PRF has gained popularity because it is easy and relatively cheap. Also, it helps achieve better results in many dental procedures. We created this review to take a closer look at the latest research about PRF production, characteristics, and how it is used in clinical work. We searched through databases such as PubMed and Scopus to select the most relevant works from the last few years. Our review focuses on how PRF performs in socket healing, implant placement, bone grafting, and gum surgery. Research indicates that work with PRF can actually support wound healing, improve bone growth, and alleviate common postoperative problems such as pain or swelling. Therefore, it looks promising in implantology and gum treatment. Many clinicians are using slightly different preparation methods and we still lack enough clinical trials so we still need more research. Overall, PRF remains a material with great potential to improve the way we manage patients in modern dental clinics.

Keywords: PRF, platelet-rich fibrin, oral surgery, dentistry, regenerative therapy

1. INTRODUCTION

Reconstruction of oral tissues remain a significant obstacle for those working in oral surgery. Routine procedures such as tooth extractions, implant placement, and bone grafting base on body's ability to heal effectively both soft and hard tissues. Proper regeneration is a decisive factor whether the treatment will be successful and the prevention of complications. For this reason, significant progress has been made in developing biomaterials that can support the body's natural healing process (Castro et al., 2017; Miron et al., 2017).

In recent years, platelet concentrates have emerged as a smart way to support this healing process. These materials are collected from the patient's blood and contain active elements such as platelets, leukocytes, and fibrin. These elements are crucial for managing processes like cell growth and angiogenesis. Platelet-rich fibrin (PRF) has gained real popularity because it is simple to use and it gives good results in a wide range of procedures. PRF was first introduced by Choukroun et al., in 2001 as a second- generation concentrate. Unlike the older method with the use of platelet-rich plasma (PRP), no chemicals or anticoagulants are needed to produce PRF. The patient's blood must be drawn and centrifuged to obtain a fibrin clot, which is naturally rich in growth factors. This matrix acts as a scaffold through which bioactive molecules slowly penetrate to the surgical site over time. This slow-release characteristic is why PRF is so attractive for oral regenerative work.

The main advantage of PRF is that it supports the healing of both mucosa and bone. The fibrin network provides a stable place for cells to settle and move. Moreover, PRF carries growth factors like PDGF, TGF-β, and VEGF. These molecules are responsible for stimulating the growth of new blood vessels and supporting bone formation. That is why more and more surgeons are using PRF in their daily work (Miron et al., 2017; Kobayashi et al., 2016).

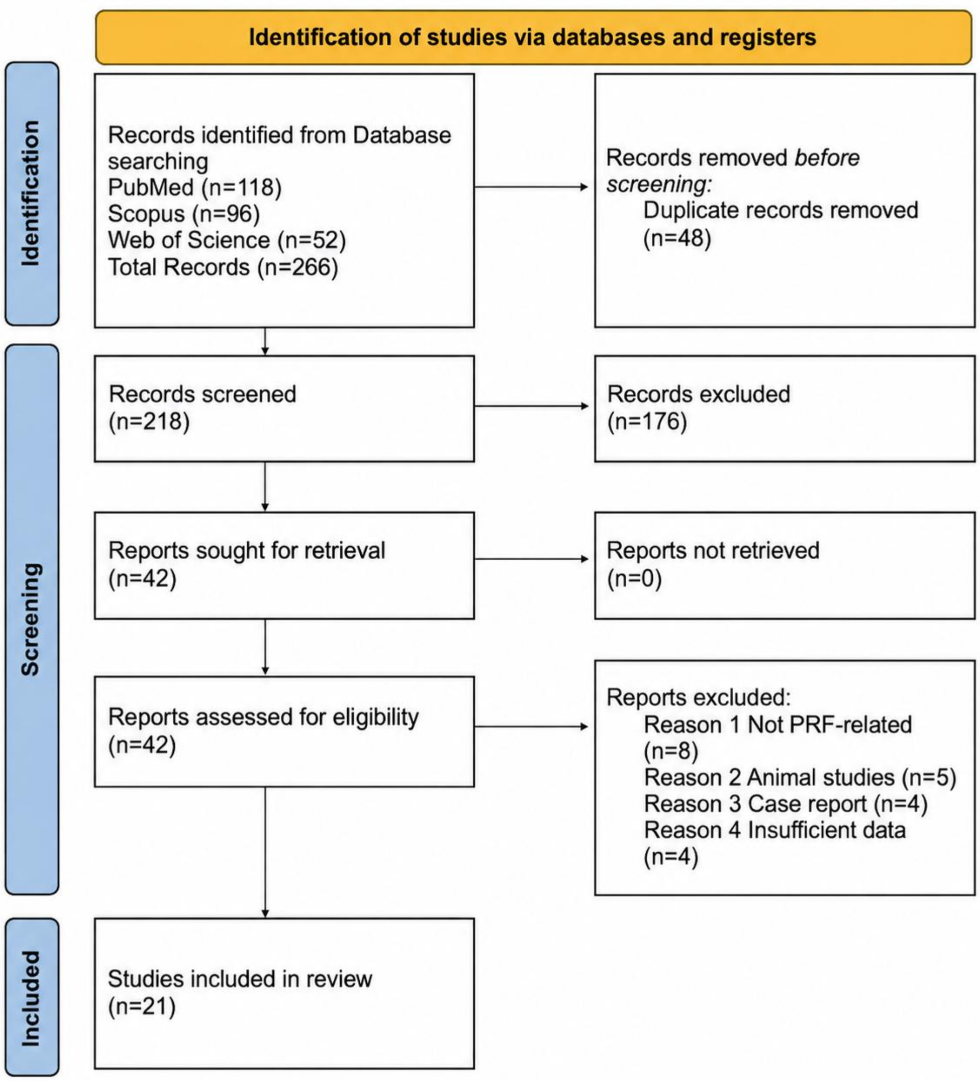

Figure 1. PRISMA flow diagram

The use of PRF has increased a lot over the past two decades. It is now commonly used in socket preservation procedures, sinus lifts, and periodontal treatment. In tooth extractions, it can accelerate healing and provide greater comfort to the patient. In the field of implantology, we are investigating how PRF can help the implant fuse with the bone (osseointegration) more effectively. It is also used in gum surgery to rebuild lost tissue and improve clinical attachment (Temmerman et al., 2016; Alissa et al., 2010). Another great advantage is that PRF is autologous – it is the patient's own blood – so the risk of having an allergic reaction or developing any disease is almost non-existent. Preparation is simple and economical, requiring no specialized laboratory equipment. These benefits make PRF an excellent choice for dentists who want to biologically support their patient’s wound healing in a standard office setting.

Despite all this interest, there are some things we are still trying to understand. Different spin speeds and preparation methods can affect how the PRF actually behaves and change the effectiveness of the treatment. Although many studies say that using PRF gives good results, the methods for conducting these studies varies a lot. For this reason, we need to look at the current literature to understand exactly where the PRF method stands in modern practice.

This review analyses the current evidence regarding the biology, preparation techniques, and actual clinical use of PRF. We pay special attention to wound healing, bone growth, and gum therapy. By pulling all this research together, we hope to provide a clear picture of what PRF can and cannot do in today's dental office (Castro et al., 2017; Miron et al., 2017).

2. REVIEW METHODS

We conducted a narrative literature review to check the evidence regarding the use of PRF in oral and maxillofacial surgery. We found relevant articles by searching PubMed, Scopus, and Google Scholar using terms such as “platelet-rich fibrin”, “PRF”, and “bone regeneration”.

We focused mainly on English-language works from the last 20 years, although we retained some classic studies for contextual reasons. To fully understand how PRF works, we looked at both clinical and laboratory studies. We paid the most attention to systematic reviews, meta-analyses, and randomized trials that tested PRF in real-world dental settings.

Articles discussing the use of PRF in bone extractions, implants, or grafts were included in the analysis. We excluded articles that did not focus on dentistry or did not provide a clear explanation of the methods used. We also skipped any duplicate articles or studies with missing data. After initially reviewing titles and abstracts, we read the full texts of the most relevant articles. We analyzed factors such as study size, clinical purpose, and actual patient outcomes. We focused primarily on wound healing, bone growth, pain levels, and frequency of problems. At the end, we organized research by topics including PRF’s biology, its mechanics, and practical use in surgery. Thanks to this we could create a solid summary of the advantages and disadvantages of PRF use nowadays. The article screening process followed the PRISMA guidelines (Figure 1).

3. RESULTS AND DISCUSSION

Mechanism of Action of Platelet-Rich Fibrin

The reason why PRF is so effective for regeneration is its biological composition and the way it slowly releases growth factors. It creates a complex fibrin matrix for platelets and white blood cells that manage the healing process. These elements work with the body to grow new blood vessels and bone, which are essential components for recovery after the surgery. The slow release of growth factors is perhaps the most important. Platelets in the matrix act as a reservoir for the active molecules. The main factors here are PDGF, TGF-β, and VEGF. These are chemicals that stimulate the body to produce more collagen and create new capillaries. Platelet concentrates are a concentrated suspension of growth factors found in platelets, which act as bioactive surgical additives that are applied locally to induce wound healing. They can be classified into four main groups according to their leukocyte and fibrin content, including pure platelet-rich plasma, leukocyte- and platelet-rich plasma, pure platelet-rich fibrin, and leukocyte- and platelet-rich fibrin The presence of these factors for a long time leads to faster and more efficient tissue repair (Miron et al., 2017; Kobayashi et al., 2016, Borie et al., 2015, Dohan et al., 2009).

Fibrin itself plays an important role. It provides a natural scaffolding that helps cells move and adhere to where they are needed. Cells such as fibroblasts and osteoblasts (bone-building cells) can move through the fibrin network to build new tissue. The three-dimensional matrix ensures that the growth factors remain active for many days, so that the effect of the treatment lasts long after the surgery is completed. PRF also promotes angiogenesis—the formation of new blood vessels. Without blood flow, healing is impossible, as this is how oxygen and nutrients reach the wound. Growth factors like VEGF help by stimulating endothelial cells to form new capillaries. Thanks to better blood supply, soft tissues and bones regenerate much faster.

Besides tissue regeneration, PRF helps manage the body's inflammatory response. White blood cells in the PRF matrix release signals that are essential for the initial stages of repair. Inflammation is necessary to remove damaged cells and start the healing process. Research has also shown that PRF helps bone-forming cells (osteoblasts) work better. Factors such as PDGF and TGF-β signal these cells to proliferate and form the foundation of new bone tissue. This is extremely useful for procedures such as sinus lift or guided bone regeneration (Castro et al., 2017, Miron et al., 2017).

Finally, PRF stabilizes the initial blood clot. After the tooth is removed, the clot is what protects the wound. If this fails, a dry socket develops, which is very painful. PRF strengthens this natural clot, making healing much more predictable and less risky for the patient. Essentially, PRF works through a combined action - mechanical support and chemical signaling. The combination of growth factors, physical scaffolding, and immune cells creates the suitable environment where body can regenerate (Table 1). This explains why PRF is necessary in modern dentistry.

Table 1. Biological Components of Platelet-Rich Fibrin and Their Functions

Component	Biological Function	Clinical Relevance
Platelets	Release growth factors (PDGF, TGF-β, VEGF)	Stimulate tissue repair and bone regeneration
Fibrin matrix	Three-dimensional scaffold for cell Migration	Stabilizes Blood clot and supports wound healing
Leukocytes	Modulate inflammatory response and immune defense	Reduce infection risk and regulate healing
PDGF	Stimulates fibroblast and osteoblast proliferation	Promotes soft tissue and bone formation
TGF-β	Enhances collagen synthesis and extracellular matrix formation	Improves tissue remodelling
VEGF	Promotes angiogenesis	Increases Blood supply and accelerates healing

Clinical Applications of Platelet-Rich Fibrin in Dentistry

Because PRF so effectively promotes tissue healing and bone growth, it is widely used in dentistry. Over the last two decades, many studies have been conducted to test how this method works in clinical practice. It is most commonly used in tooth extractions, implants, bone grafts, and gum surgery (Temmerman et al., 2016; Alissa et al., 2010).

PRF in Extraction Socket Healing

One of the most common uses of PRF is immediately after the tooth is extracted. Tooth extraction is a basic oral surgery procedure, but it is often associated with pain, swelling, and slow healing. Placing PRF in the socket speeds up the process and helps fill the hole with healthy tissue and bone. Studies have shown that PRF can accelerate tooth socket healing by increasing blood flow. The fibrin matrix acts as a biological plug that keeps the clot stable and helps repair cells penetrate. Growth factors from platelets signal repair cells to begin building new bone and tissue. (Temmerman et al., 2016; Alissa et al., 2010)

A huge advantage is that PRF appears to lower the risk of dry socket. This occurs when the clot dissolves too early, exposing the bone and causing severe pain. PRF can help avoid this problem altogether because it strengthens the clot and promotes the growth of mucous membrane on the surface (Temmerman et al., 2016; Alissa et al., 2010). It also helps with postoperative recovery – patients usually experience less pain and swelling. The white blood cells contained in PRF help control inflammation, making the recovery process much smoother. This is especially helpful in difficult cases, such as the removal of impacted wisdom teeth. The application of PRF to mandibular third-molar extraction sockets may promote socket healing and improve blood clot retention, while reducing the occurrence of postoperative localized osteitis. The use of leukocyte- and platelet-rich fibrin (L-PRF) has been proposed as a regenerative approach for the reconstruction of alveolar ridges and the restoration of both soft and hard tissues in oral and maxillofacial surgery (Simonpieri et al., 2012, Hoaglin et al., 2013).

PRF in Implant Dentistry

Implantology is another field where PRF plays a significant role. The available literature suggests that PRF has a positive effect in improving alveolar preservation on extraction sockets and around dental implants. The use of PRF membranes may support periosteal healing and tissue maturation during complex implant rehabilitation procedures. For an implant to function, it must properly integrate with the bone. In this case, PRF is often used to accelerate the healing process and maintain the health of the surrounding gums. The growth factors contained in PRF help osteoblasts attach to the implant surface. This is especially important in the first few weeks when the implant is most susceptible to damage. Implantation with PRF may lead to a more stable result by stimulating the formation of new bone and blood vessels around the screw. (Castro et al., 2017; Miron et al., 2017, Canellas et al., 2019, Simonpieri et al., 2009)

PRF has been investigated as a biological adjunct in implant dentistry, including its potential use for promoting osseointegration and managing peri-implant bone defects. Good gum health prevents bacterial growth and problems such as periimplantitis (inflammation of the gums around the implant). Some studies indicate that using PRF during surgery leads to the development of thicker gum tissue, which is important for achieving long-term success. Surgeons also use PRF for sinus lifts and bone grafting performed before implant placement. In these cases, PRF can be used alone or in combination with bone graft material to improve effectiveness. (Castro et al., 2017; Miron et al., 2017, Simonpieri et al., 2012).

PRF in Bone Regeneration Procedures

Rebuilding lost bone is one of the most important aspects of oral surgery. Whether caused by periodontal disease or an old injury, bone loss usually means a bone graft is necessary. PRF is a great help in these procedures because it contains a wealth of growth factors that tell the body to build new bone. Alb-PRF may promote tissue regeneration by providing a slow and sustained release of growth factors, which can support fibroblast proliferation and the expression of factors involved in tissue repair (Castro et al., 2017, Fujioka-Kobayashi et al., 2021).

In guided bone regeneration (GBR), PRF can be used as a protective membrane or it can be put directly into the bone graft. The fibrin matrix prevents reposition of grafted material, while growth factors help osteoblasts to migrate to the appropriate place. It is also popular for sinus lifts. The use of PRF in this case may accelerate bone healing and limit the risk of postoperative complications. (Castro et al., 2017; Miron et al., 2017).

PRF in Periodontal Surgery

Periodontal diseases can destroy the bone and ligaments that hold teeth in place. The goal of periodontal surgery is to grow those back. PRF is a natural choice here because it helps promote the proliferation of specific cells involved in gum attachment. Where deep bone pockets are present, PRF can be mixed with the graft material to help the body fill them. Growth factors support the regeneration of ligaments and bones. It also helps develop new blood vessels in the area, ensuring good tissue nourishment during the healing process (Castro et al., 2017).

Clinicians also use PRF for gum recession. In some cases, instead of taking a graft from the patient's palate, a PRF membrane can be used. This is a much more comfortable solution for the patient and gives really good results in covering exposed roots. PRF contains several cellular populations, including platelets, neutrophils, monocytes, lymphocytes, and CD34-positive cells, which may contribute to its biological activity and regenerative potential (Ghanaati et al., 2014).

Essentially, PRF is a versatile tool. It is useful in almost any situation where the body needs to recover faster. Over 500 scientific articles evaluating its use in vitro, in vivo, and clinically have documented its regenerative potential for the repair of bitch soft or hard tissues in the oral cavity which is very helpful in periodontology. Although we need more long-term research to refine this procedure, the potential for improved outcomes in clinical practice is clear. Current evidence supports the use of platelet-rich fibrin (PRF) in periodontal therapy and soft tissue regeneration, whereas evidence regarding its effectiveness in hard tissue and bone regeneration remains limited (Miron et al., 2017).

Advantages and Limitations of Platelet-Rich Fibrin

PRF has become one of the fundamental materials in modern dental offices because it is biological and its preparation is simple. The biggest advantage is that it is autologous, so there is almost no risk of the body rejecting it or causing an infection. This makes it a much cleaner, safer, and more reliable method than using synthetic materials or grafts from other sources.

Another advantage is that PRF works well on both hard and soft tissues. The fibrin matrix is the source of cells, and growth factors support their development. This makes recovery more efficient and reduces the risk of complications such as infections or impaired wound healing. Making PRF is not difficult - it can be done in the middle of a procedure. To prepare PRF, blood must be collected and centrifuged for several minutes in a special device called centrifuge. It does not require a laboratory or any chemicals or anticoagulants, making it a simpler and cheaper method than older PRP. The regenerative potential of A-PRF may be associated with the presence of inflammatory cells, particularly monocytes and macrophages, which can contribute to the release of growth factors involved in tissue regeneration. (Choukroun et al., 2006, Ghanaati et al., 2014)

However, this is not yet a perfect solution. One of the main problems is that there is no single protocol of this procedure. Different machines and different spin times produce different types of PRF. Therefore, it is difficult to determine how well it will work every time accurately. PRF quality depends on every patient. If patient is older or has medical conditions, their blood may contain fewer platelets or growth factors.

Finally, while the results look great, some of the available research is not without its flaws. Small sample sizes or different ways of measuring success rate make it difficult to compare studies (Table 2). There is definitely a need for more high-quality, long-term studies to determine the best way to use PRF for each patient.

Table 2. Advantages and Limitations of Platelet-Rich Fibrin

Advantages	**Limitations**
Completely autologous biomaterial	Lack of standardized preparation protocols
No anticoagulants or additives required	Results depend on centrifugation parameters
Simple and inexpensive preparation	Patient-related variability (age, systemic diseases)
Low risk of immunological reactions	Limited evidence from large randomized Clinical trials
Promotes both soft and hard tissue healing	Different outcome measures between studies
Easy chairside preparation	Difficult comparison among published studies

4. CONCLUSION

Platelet-rich fibrin has established itself as a basic material in modern dentistry and oral surgery. Its unique biological blend of platelets, white blood cells, and fibrin creates ideal conditions for healing and growth. These features make it a great help in almost every surgical procedure, where regeneration is longer and is crucial to move on to the next stages of treatment. Clinical studies have shown that PRF can be effective for tooth extractions, implants, bone grafts, and gum surgery. It supports tissue healing, promotes bone growth, and makes the postoperative period much easier for the patient. Furthermore, because it is 100% natural, it is safe and well-tolerated. In summary, we need to focus on standardizing the way PRF is produced and used. More large-scale trials will help determine the best protocols for specific procedures. Ultimately, PRF is a very promising material that probably will play a great role in regenerative dentistry as the technology continues to improve.

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Data and materials availability
All data associated with this study will be available based on the reasonable request to corresponding author.

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