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Platelet Rich Fibrin-A Boon in Regenerative Dental Surgery

[1]Dr Rahul Patil, Specialist Prosthodontist, Emirates Health Services, UAE

Corresponding Author: Dr Rahul Patil, Specialist Prosthodontist, Emirates Health Services, UAE

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Abstract

Biocompatible membranes are used in periodontal, oral surgery and implant dentistry to aid in tissue regeneration. Several membranes have been developed over the years, ranging from non-resorbable membranes that must be removed in a separate procedure to collagen membranes that completely resorb on their own, eliminating the need for a second surgery. Autogenous membranes have grown in popularity in recent years. These membranes can be used in a wide range of hard tissue regenerative procedures, including guided tissue regeneration, alveolar ridge preservation, guided bone regeneration, and sinus floor augmentation. Platelet-rich fibrin (PRF) is one such membrane that has gained popularity among clinicians as an autologous membrane. It is a living biomaterial derived from the patient's blood. It has recently been used in dentistry for a variety of treatment modalities.

Keywords: PRF, Neo-Vascularization, Osteo Conduction, Alloplastic

Introduction

The availability of new therapies, biomaterials, and bioactive surgical additives that will improve patient success and predictability in soft and bone tissue healing with regeneration is a key treatment goal in dental implantology, periodontology, and oral surgery. Over the last two decades, an improved understanding of the development, biological and physiological properties, characteristics of PRF in tissue healing and regeneration, has led to more successful therapeutic applications, especially in the fields of dental implantology, periodontology and oral surgery. The gold standard for in vivo tissue healing and regeneration requires a scaffold (fibrin matrix), platelets, growth factors, leukocytes, and stem cells to interact.[1] These key elements are all active components of PRF, and when combined and prepared properly, they are involved in key processes of tissue healing and regeneration, such as cell proliferation and differentiation, extracellular matrix synthesis, chemotaxis and angiogenesis (neo-vascularization).[2]

Case Report

A 23-year-old male patient came to the clinic to have his missing tooth replaced. There was no relevant medical history or but history of dental trauma before few years. On intraoral examination, it was discovered that the patient had an un-aesthetic smile due to the absence of a front tooth which was lost few years after trauma, fracturing incisal edge of neighbouring incisor and he had few missing behind teeth. He lacked a maxillary right lateral incisor (fig 1,2,3).

A labial cortical plate concavity was seen during clinical and radiological examination of the edentulous site of the missing lateral incisor. The upper right incisor had suffered ELLIS class 1 fracture, and the lower right canine was seen over erupted and protruding outwards. It was critical to replace the missing tooth to restore function, aesthetics and prevent further displacement of adjacent teeth. The patient refused to have these adjacent teeth prepared for any type of fixed partial denture as

they were asymptomatic. The proposed plan was to place a dental implant in the edentulous space left by the missing tooth. However, because of bone atrophy at the site, it was required to augment the site with bone after placement of suitable size dental implant. In this case, a block graft restoration would have been the best option, but the patient refused to have another surgical site created. Finally, Alloplastic bone graft material and a suitable membrane were chosen for guided tissue regeneration. Due to financial constraints, it was decided to use the patient's own blood to obtain PRF membrane. This membrane along with Alloplastic hydroxyapatite bone granules was to be used to graft the site after implant placement. Impressions were made to fabricate acrylic Maryland provisional prosthesis which was to be delivered few days after surgery.

On the day of surgery, surgical kit for dental implant and centrifugation machine to obtain PRF was arranged and kept ready for use. After administering Local anaesthesia, a crestal incision was made and a full thickness flap was raised (fig 4). The labial bone concavity at the site was very obvious (fig 5). Standard implant drills with increasing diameters were used (fig 6,7). To allow for bone expansion and to achieve primary stability, the surgical site was slightly underprepared. Implant was placed, torqued to 30N and primary stability was achieved (fig 8,9). Implant was covered with cover screw (fig 10).

A blood sample of 10 cc was obtained from the patient in order to generate PRF (fig 11,12). The blood sample was then placed in a 10-ml B.D vacutainer without anticoagulant and centrifuged for 12 minutes at 2700 rpm. The end result was platelet-poor plasma on top, red corpuscles on the bottom, and a fibrin clot (PRF) in the middle. This PRF was then gently pressed between sterile glass slabs to obtain a membrane (fig 13,14).[3] The planned alloplastic graft material along with the extracted PRF was placed at the implant site and flap was sutured back to achieve guided bone regeneration (fig 15,16). After initial healing, the lab made acrylic Maryland bridge was lute on the adjacent teeth to be used as provisional prosthesis (fig 17). The first signs of soft tissue healing were observed one week after surgery. The bone graft was completely covered, with no soft tissue dehiscence. The graft was not exposed as seen after 2 weeks post operatively. After 6 months, the flap was raised again and cover screw was replaced for 2 weeks with a Gingival former (fig 18).

During prosthetic phase, impression coping was placed to make a closed tray implant level impression in order to fabricate a dental crown. 15^0 angulated abutment was used for aesthetic reasons (fig 19). The final ceramo-metal crown was tried on the abutment intra orally to evaluate the fit and appearance. After final adjustment of the crown, it was lute with Resin cement (fig 20). Post-operative instructions were given to the patient. The missing teeth in lower arch were replaced later with fixed prosthesis.

Discussion

PRF is a living biomaterial derived from human blood that is an autologous fibrin-based membrane. Fibrin (as a supporting matrix), platelets (rich in growth factors), and cells are the essential components required to promote tissue healing and regeneration (mostly the various populations of leukocytes, and stem cells for their antibacterial, neo-vascularization and regenerative properties). These key elements are all active PRF components.

The Evolution and Classification of Patient Blood Derived Biomaterials

1970	Fibrin glue era [4]
1990	Growth factor [5]
2006	The fibrin and leukocyte era [6]
Since 2007	Blood concentrate era [7]

The volume of remaining alveolar bone influences the placement of dental implants. When there is insufficient bone volume to place a dental implant, it is necessary to create new bone structure. Graft material must be biocompatible and be able to withstand biomechanical stresses in order to form new bone structure. When performed in an environment with good blood supply, the use of bone grafts is very successful. This is determined by the primary wound closure and the state of the adjacent bone. Good blood flow ensures that the osteogenic bio-mineralisation cascade receives the necessary cells, growth factors and promoters. [8] The PRF used in this case has broad applicability, from dentistry to medicine, with excellent short-term results; all studies show the safety of its use in dentistry. The PRF is said to be more effective than other surgical additives because its manufacturing method is simpler, more effective, and less expensive. PRF is a by-product of platelet-rich plasma that was developed to improve and accelerate the

repair of autologous platelet-rich bone and soft tissues, as well as growth factors that present an ideal immune and platelet concentrate for osteo-conduction and improve response of the patient's own cells. It has a natural fibrin framework with growth factors that may remain active for a relatively long time and stimulate tissue regeneration effectively.[9] It avoids a donor site surgical procedure and reduces patient discomfort during the early wound-healing period. For PRF manipulation, a clinician with minimal experience is required. It appeared to promote faster wound healing by promoting better soft tissue healing. Since the preparation protocol does not require any anticoagulants, wound healing cascade is not inhibited by anticoagulants and clot formation occurs naturally. Even if the PRF membrane is exposed, there is no risk of membrane infection or bone loss because PRF can also ensure secondary soft tissue healing. Furthermore, several clinical studies have demonstrated the efficacy of PRF in promoting surgical wound healing; the PRF contains platelet growth factors that can improve the vascularisation of the surgical site, promoting neo-angiogenesis. It may induce regeneration in a regenerative chamber of native bone fed by periosteum, despite lacking osteo inductive properties. The osteoconductive power has recently been demonstrated in the article of Schwarz-Arad. [10]

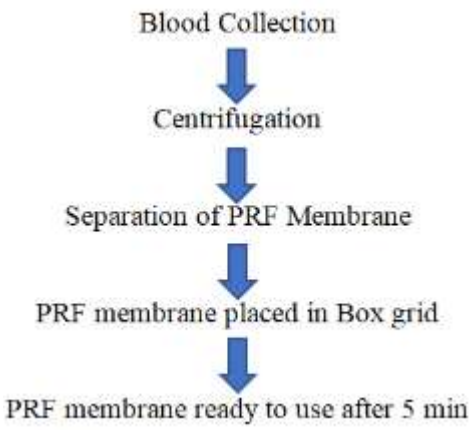
There are various centrifugation protocols that are currently being used.

Type of Prf	Centrifugation Protocol
L-PRF (leukocyte)	2700 rpm for 12 mins
T-PRF (titanium)	2700 rpm for 12 mins
A-PRF (advanced)	1500 rpm for 14 mins
I-PRF (injectable)	700 rpm for 3-4 mins
CGF(conc. growth factor)	2400-2700 rpm for 12 mins
AFG(autologous fibrin glue)	2400-2700 rpm for 2 mins

The initial protocol for PRF production, introduced by Choukroun et al. in 2001, required 10 mL of blood sample to be collected without anticoagulant in glass-coated plastic tubes, which is immediately subject to centrifugation at 2,700 rpm (around 400 g) for 12 min. The obtained PRF is usually termed as Choukroun's PRF or leukocyte and PRF (L-PRF). However, in the last few years, the PRF protocol underwent several modifications. These protocols led to the formation of various products with different biology and potential uses.

It can be made in a single step and does not require any additional ingredients. Since it is well-known that high centrifugal forces shift cells to the bottom of the tube, it was proposed that decreased centrifugation speed may prevent cell loss and increase leukocytes number in the PRF matrix. Advanced PRF (A-PRF) was provided by using reduced centrifugal force of 1,500 rpm (230 g) for 14 min and glass-based vacuum tubes. Production of A-PRF may also be obtained by using the same time of centrifugation (14 min) but with a centrifugation speed of 1,300 rpm (200 g), as was suggested later. The obtained A-PRF is richer in the total number of viable cells compared to the L-PRF. Among them, increase in the number of neutrophils, lymphocytes, and platelets was observed. The presence of immune cells influences the differentiation and maturation of macrophages. This may lead to bone and soft tissue regeneration, mainly through the growth factors released from macrophages.[11]

Steps of Obtaining PRF [12,13]



Characteristics and Composition of PRF

PRF technology draws on the following three fundamental principles and biological processes of haemostasis and wound healing.

PRINCIPLE 1: The presence of a fibrin matrix at the surgical site acts as a scaffold for recruiting and migration of cells (epithelial, fibroblast, endothelial) throughout the wound healing and reparation process.

PRINCIPLE 2: Platelets, leukocytes neutrophils and monocytes within the fibrin matrix (release) secrete growth factors and chemotactic proteins that recruit epithelial, fibroblast, and endothelial cells to the surgical site to facilitate wound healing and reparation.

PRINCIPLE 3: Angiogenesis (neovascularization) relies on a fibrin matrix (extracellular matrix) and stimulation of endothelial cell recruitment through growth factors.[14,15]

Applications of PRF in Dentistry

Oral and Maxillofacial Surgery - [16]	• Filling material in avulsion sockets, bony defects etc. • Bone augmentation in sinus lifts for posterior maxilla for implants • Ridge preservation • Guided bone regeneration
Endodontics - [17]	• In treatment of open ape • For regeneration of pulp-dentin complex • In combination with MTA for apexification procedures • In regenerative pulpotomy • To fill in bony defect after periapical surgeries like root
Periodontics - [18]	• For treatment of intra-bony defects • For treatment of gingival recession • Guided tissue regeneration • Periapical lesions
Tissue Engineering - [19]	• For in vitro cultivation of human periosteal cells for bone tissue Engineering

Advantages of PRF Over PRP

1. Simple and cost-effective method of preparation of PRF
2. Eliminates the use of bovine thrombin and thereby reduces the chances of cross infection.[20]
3. An in-vitro study showed that PRF is superior to PRP, considering the expression of alkaline phosphatase and induction of mineralization, caused markedly by release of TGF-β1and PDGF-AB [21].

Advantages and Shortcomings of PRF [22,23,24]

Advantages

- It is completely an autologous product
- Minimizes blood manipulation without biochemical handling
- It requires no bovine thrombin, since polymerization occurs naturally
- PRF fibrin matrix contains growth factors, leukocytes & cytokines involved in healing process.
- It shows extended growth factor release compared to other platelet concentrates
- PRF membrane possesses high flexibility, elasticity and is simple and in expensive procedure

Shortcomings

- The success of PRF depends on the speed of blood handling
- PRF membrane should be used immediately since the structural integrity modulates over time
- Storage of PRF membrane is not possible due to potential bacterial contamination and dehydration
- Since an autologous product, the quantity of PRF is low, so can't be used in gen. surgery.

Conclusion

The concept of generating a cell-seeded fibrin matrix solely by drawing the patient's own blood and centrifuging for 8-14 minutes is truly revolutionary in terms of clinical practicability, as it can be done quickly at the chairside. The future of PRF and its applications in clinical dentistry, particularly in soft tissue and bone regeneration, has enormous therapeutic implications; however, developing and strengthening its role in dentistry is contingent on its coherence and scientific clarity. To validate and standardize PRF processes and improve therapeutic outcomes, independent and robust scientific studies are required.

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Legend Figures

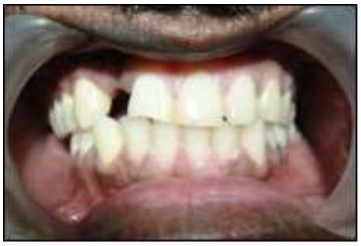

Fig.1: Pre-Operative – Frontal

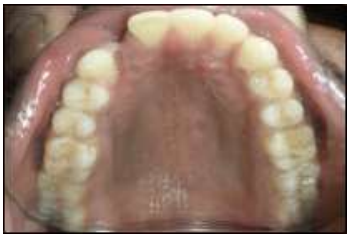

Fig 2: Pre-Operative – Upper Occlusal

Fig 3: Pre-Operative – Lower Occlusal

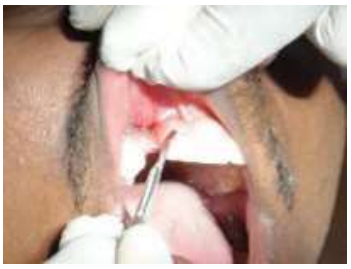

Fig 4: Incision

Fig 5: Flap Reflection

Fig. 6: Pilot Drill

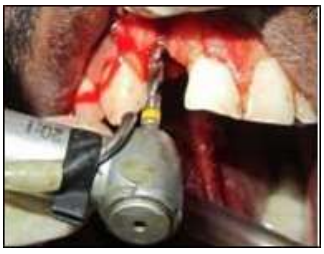

Fig. 7: Final Drill

Fig 8. Implant

Fig. 9: Implant Placement

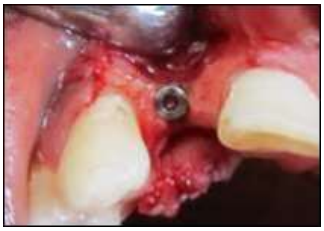

Fig. 10: Covered with Cover Screw

Fig. 11: Centrifuge Machine

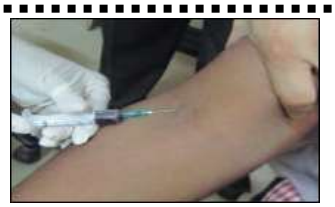

Fig. 12: Blood Collection

Fig. 13: Centrifuged Sample

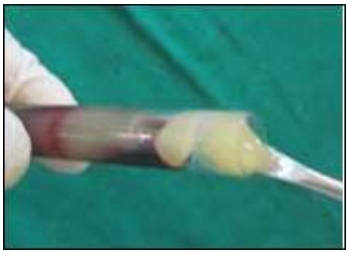

Fig. 14: Extracting PRF

Fig. 15: Placement of Graft &PRF Membrane

Fig.16: Flap Sutured

Fig. 17: Provisional Prosthesis

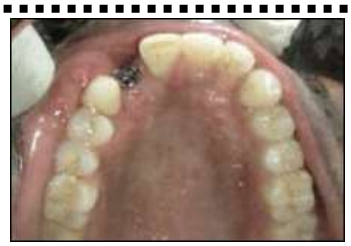

Fig. 18: Gingival Former

Fig. 19: Abutment 15^0

Fig 20: Final PFM Crown Luted