Platelet-rich fibrin in endodontics

Dr. Edward S. Lee discusses a tissue-engineering material with a variety of applications

Introduction

Platelet-rich fibrin (PRF) is a bioactive material made from the centrifugation of a patient's whole blood. It is a second-generation platelet concentrate first described by Choukroun[1] and is used to accelerate soft and hard tissue healing. This simplified and cost-effective chairside procedure results in a resorbable fibrin matrix enriched with platelets and leukocytes. PRF provides a rich source of growth factors, including platelet-derived growth factors (PDGFs), transforming growth factors (TGFs), vascular endothelial growth factor (VEGF), and insulin-like growth factor (IGF).[2] The growth factors are slowly released during the course of the healing process.[3] Because of the unique character of PRF, it is used as a tissue-engineering material with a wide range of dental applications.[4,5] PRF is currently recommended as a scaffold material for regenerative endodontics.[6]

The following is a case study for its application in endodontics. Benefits and other applications are also discussed.

Case study

A 67-year-old female patient presented with mild discomfort and swelling around tooth No. 14. Her medical history was noncontributory. Teeth Nos. 12, 13, and 15 had been extracted more than 15 years previously and the area restored with a fixed bridge from teeth Nos. 11 to No. 14. The radiograph revealed lateral bone loss around the mesial buccal root with a 9 mm periodontal probing with probing WNL on other sites around the tooth. The patient was informed that she had a vertically fractured mesial buccal root (Figure 1). Treatment options were discussed, including extraction and replacement with implants or a removable partial denture. The patient decided to do a mesial buccal root amputation procedure and save the existing tooth and the bridge.

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Disclosure: Dr. Lee has no commercial interest in any of the products or companies mentioned in this article.

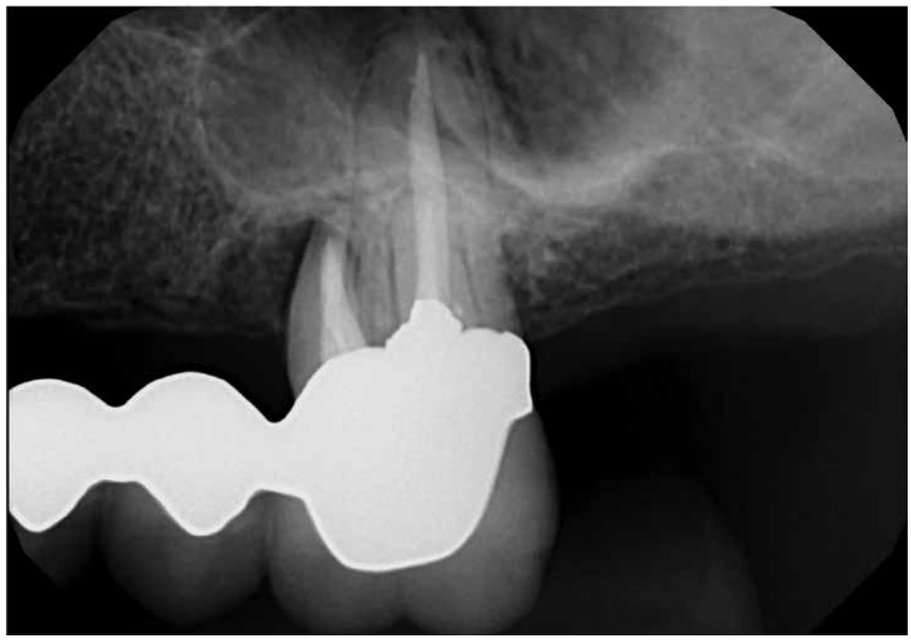

Figure 1: Preoperative radiograph showing bone loss around the mesial buccal root

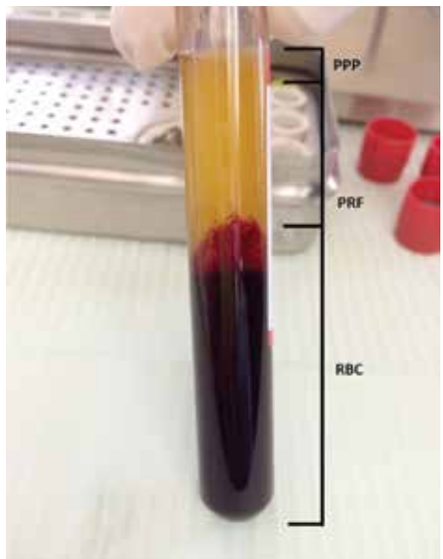

Figure 2: Whole blood after centrifugation demonstrating the separated layers

Figure 3: Separation of the PRF clot from the red blood cell layer

Venous blood was drawn from the patient's median cubital vein and collected in three 10 ml BD Vacutainer® (BD Worldwide) tubes without anticoagulants. The blood was immediately centrifuged at 1500 RPM for 10 minutes (MyRGF-I centrifuge, Boca Dental Supply, LLC). Three layers form in the tube:

1. The lower fraction contains the RBCs.
2. The middle fraction contains the PRF clot.
3. The upper fraction contains the acellular platelet poor plasma (PPP) (Figure 2).

The middle portion containing the PRF clot was cut and removed from the RBC layer (Figure 3). The PRF clot was compressed

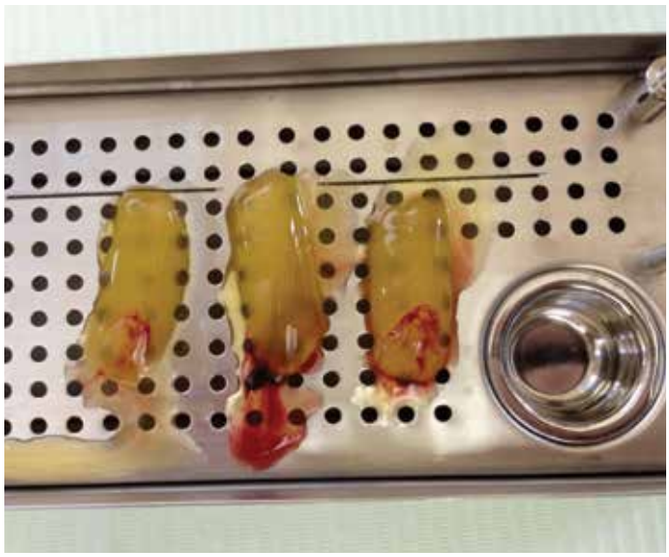

Figure 4: PRF prior to pressing in the processing box

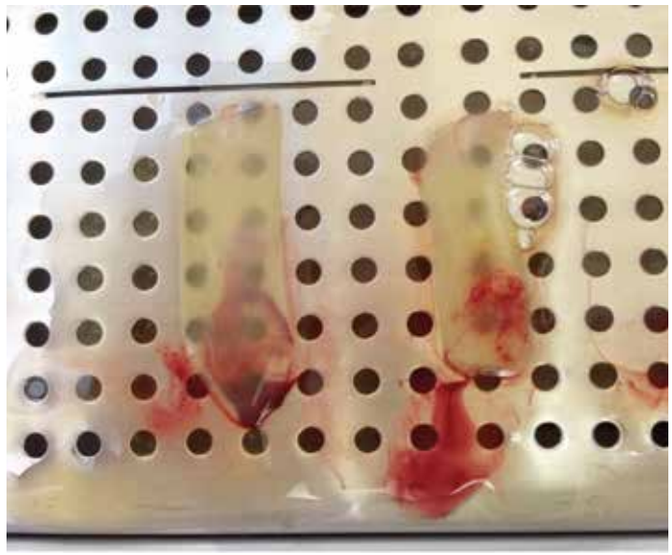

Figure 5: PRF pressed into membranes

> Because of the unique character of PRF, it is used as a tissue-engineering material with a wide range of dental applications.

to form a membrane using a membrane processing box (PRF MyRGF Box, Boca Dental Supply, LLC) (Figures 4, 5, 6). The liquid from the compressed membrane was collected and mixed with allograft bone (BoneBank Allograft, San Antonio, Texas). The collected liquid contains fibrin, which acts as a binder for the allograft bone that will be utilized and helps prevent graft migration from the intended site.

A full thickness trapezoidal flap with vertical releasing incisions mesial to No. 13 and distal to No. 14 was made. Upon reflection of the flap, a bone dehiscence over the mesial buccal root and a vertical root fracture were confirmed. A Lindemann bur was used to section the mesial buccal root at a supracrestal level, and a standard Class 1 root-end preparation was completed using ultrasonic instrumentation (ProUltra® Surgical Endo Tip, Dentsply Tulsa). The root was filled using a dentin bonding agent (Futurabond®, Voco Dental), a flowable composite (Virtuoso® Flowable, Denmat), and polished with rubber points (Figure 7). The allograft bone mixture was placed into the bony defect followed by coverage with

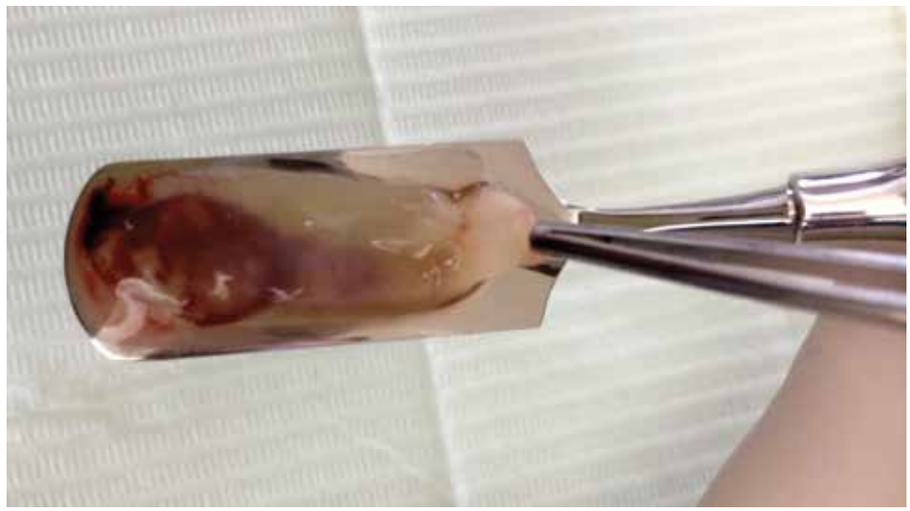

Figure 6: PRF ready to be delivered

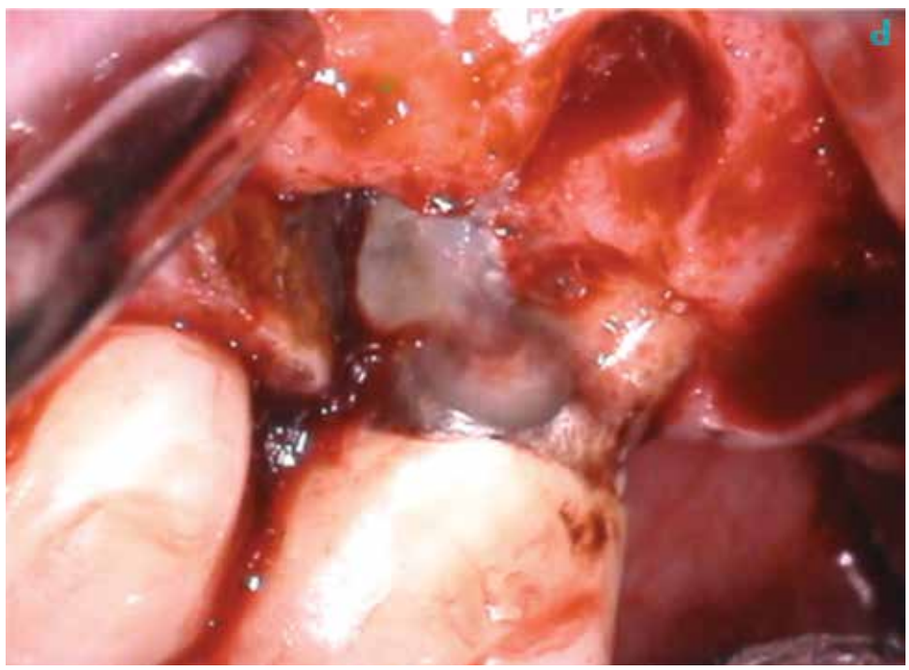

Figure 7: Mesial buccal root resected and filled with composite

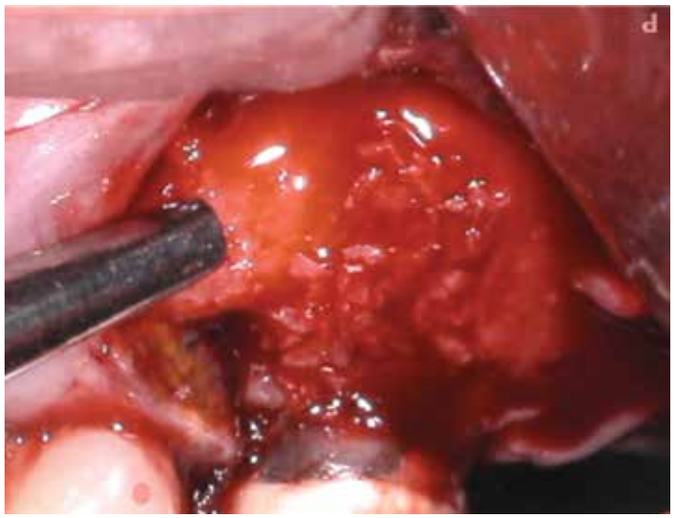

Figure 8: Allograft bone mixed with PRF liquid. The PRF liquid is a fibrin adhesive binder and prevents the graft material from migrating

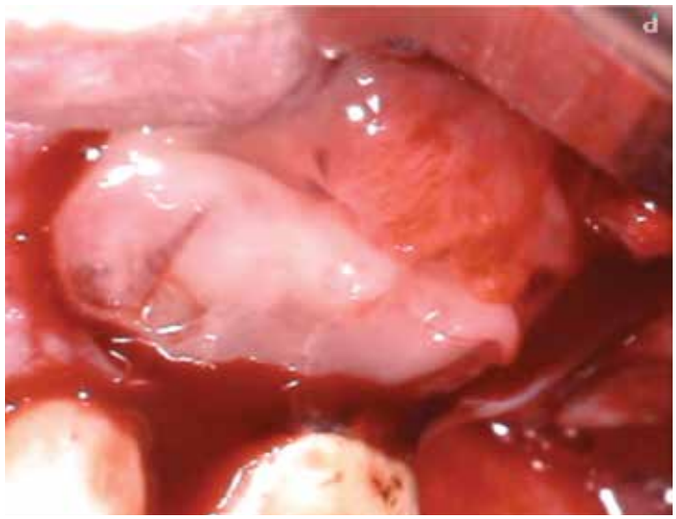

Figure 9: Several pieces of PRF membranes are layered over the allograft bone mixture

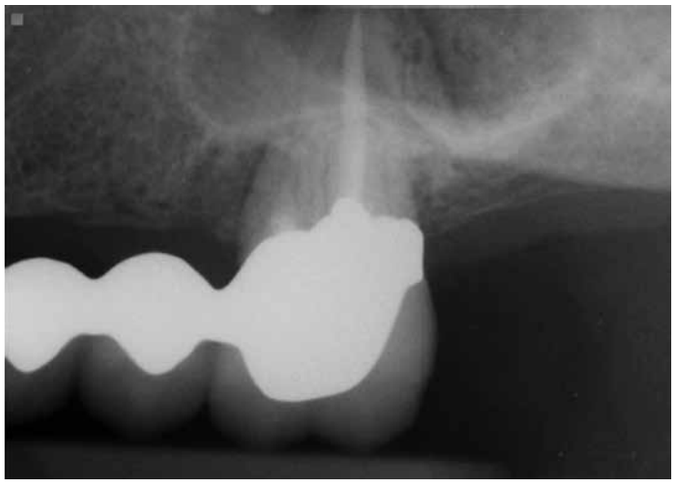

Figure 10: Immediate postoperative radiograph demonstrating resection of the affected root, retrofill of the orifice, and grafting of the osseous defect

Figure 11: 1-month postoperative healing. There is minimal recession around the amputated mesial buccal root area

PRF membranes (Figures 8 and 9). Figure 10 shows the immediate postoperative radiograph. The sutures were removed after 1 week with minimal to no pain reported by the patient after the procedure.

Figure 11 shows the 1-month healing. The area is healing with very little recession around the root amputation site. Figures 12 and 13 show the area after 7 months of healing. The bone has filled in, and the gingival architecture is excellent with no inflammation.

Discussion

Platelets play a crucial role not only in hemostasis but also in the wound-healing process.[7] Growth factors contained within the α-granules of the platelets help regulate hard and soft tissue repair. These growth factors include platelet-derived growth factors (PDGFs), transforming growth factors (TGFs), vascular endothelial growth factor

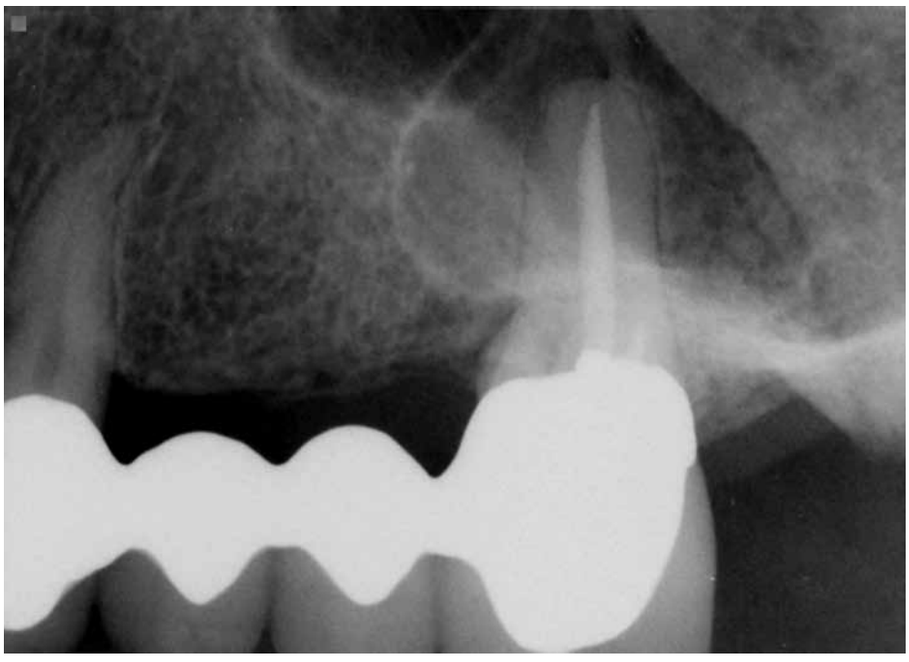

Figure 12: Radiograph at 7-month recall demonstrating good bone-fill at the resected and grafted mesial buccal root area

Figure 13: 7-month recall shows good gingival architecture. The tissues have filled in, and there is no recession around the amputated root. Full gingival contours minimize food impaction and help with daily home care.

(VEGF), and insulin-like growth factor (IGF). Leukocytes found in PRF also release growth factors, including TGFβ-1 and VEGF.[3] The growth factors help promote cell migration, attachment, differentiation, and proliferation.[2]

Leukocytes cytokines, such as IL-1, IL-4, IL-6, and TNF-α, are also contained within PRF and help with immune and inflammatory regulation.[8]

PRF produces a significantly higher concentration of platelets and fibrin when compared to the initial input of whole blood volume.[9] Growth factors within PRF are slowly and continuously released during healing.[3]

A key feature of the PRF process is the slow polymerization of fibrinogen into fibrin during centrifugation. A fine and flexible fibrin network forms resulting in an architecture that is characterized as a less rigid framework.[10] PRF is a flexible, elastic, and resilient biomaterial able to support cytokines enmeshment and cellular migration.[11]

The high tear elastic modulus of PRF makes it suturable and functions much like a fibrin bandage.[12] This helps promote wound closure and mucosal healing.

The compressed PRF liquid contains growth factors[13] and proteins such as vitronectin and fibronectin.[2] The PRF liquid can be mixed with allograft bone to help improve the handling characteristics of the graft and prevent graft migration during the healing process.

PRF is a more simplified technique compared with platelet rich plasma (PRP). PRP is a first-generation platelet-concentrate technique involving the use of anticoagulants, multiple centrifugation cycles, and surgical additives.[14] The low-density fibrin network, short duration of growth factor release, potential allergic reaction to bovine thrombin additive, and cost make PRP much less attractive when compared to PRF.

Minsk and Polson[15] suggested that root resection can be a valuable procedure when the tooth in question has a very high strategic value or when there are specific problems that cannot be solved by other therapeutic approaches. Teeth in proximity to anatomic landmarks, such as the maxillary sinus, can be treated safely by root resection therapy.

In this case study, bone grafting the root area after the mesial buccal root amputation helped maintain bone height and prevent ridge deficiency. The tooth has no mobility, and crestal bone levels are excellent in the months following the procedure. The 7-month follow-up shows good bone healing with full gingival architecture resulting in minimal food impaction and easier homecare.

Other applications of PRF in endodontics include regenerative endodontics,[6] sinus membrane repair,[16] perforation repair procedures,[17] hard/soft tissue grafting of large defects, and socket preservation procedures.[4,18,19, 20]

Conclusion

Regenerative endodontics is a tissue-engineering process that requires the following three elements to succeed:

1. Scaffold
2. Growth factors
3. Stem cells[21]

PRF provides a 100% bio-compatible, natural scaffold enriched with growth factor that can help with the proliferation and differentiation of human dental pulp cells.[22]

Further research and clinical trials are needed to understand the benefits and applications of PRF in endodontics. EP

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