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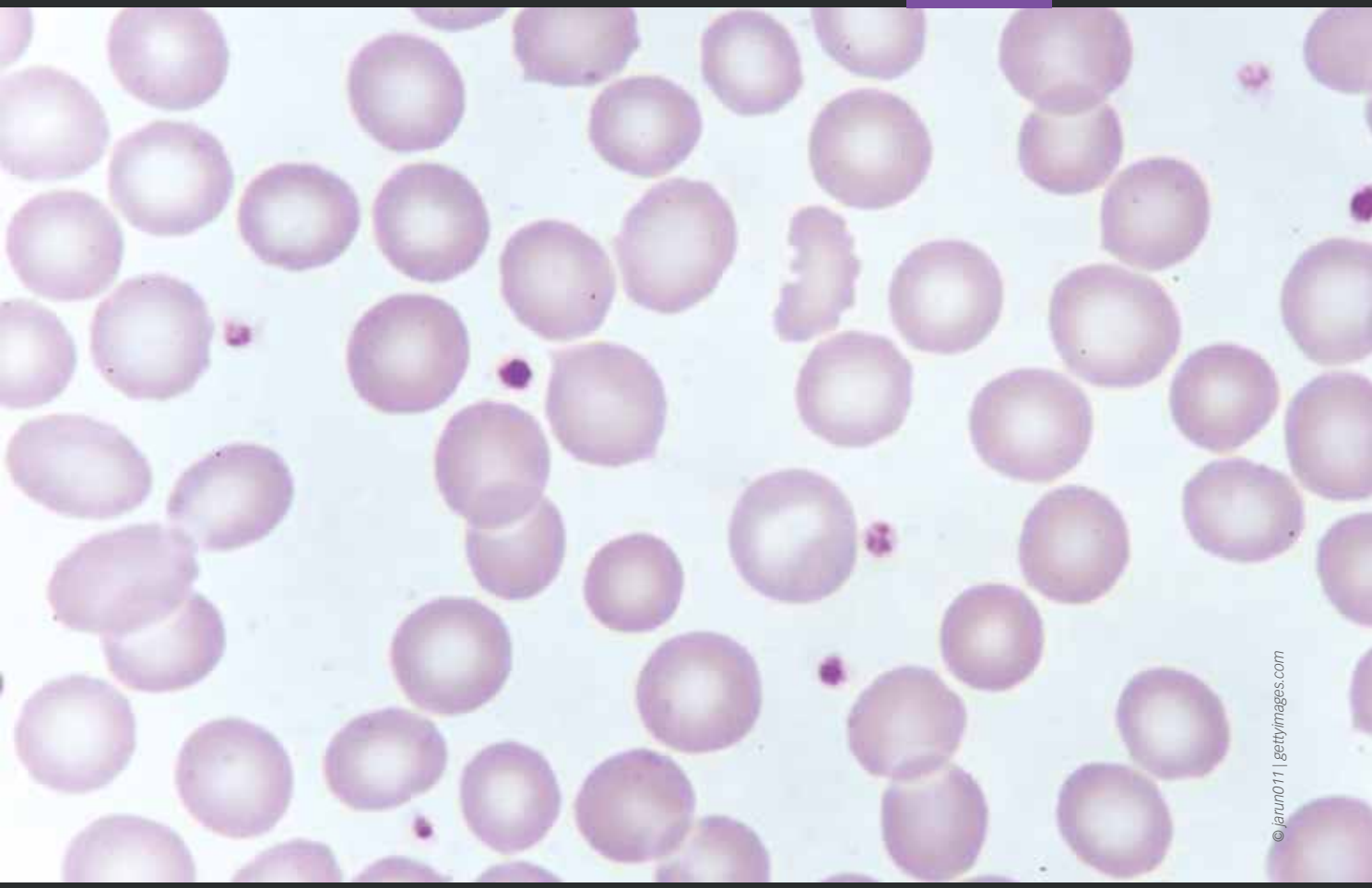

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Stick with it! Platelet concentrates for bone grafting and periodontal regeneration

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ABSTRACT

The aim of this course is to review the available evidence regarding the efficacy of platelet concentrates in enhancing soft- and hard-tissue healing in periodontal therapy and establish best protocols for their implementation in dental practices.

EDUCATIONAL OBJECTIVES

Upon completion of this course, the dental professional should be able to:

1. Identify the different platelet-concentrate products available, preparation technique and protocols, and different types of resultant concentrates obtained.
2. Discuss the effect of platelet concentrates on the different cells involved in periodontal regeneration.
3. Select the appropriate preparation protocol to achieve good and predictable results with platelet concentrates in periodontal regeneration.
4. Determine which specific cases are appropriate to achieve good and predictable results with platelet concentrates in periodontal regeneration.
5. Discern differences in outcomes between using platelet concentrates alone or as an adjunct with available biomaterials.

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INTRODUCTION

Periodontitis is a highly prevalent oral disease among US adults; approximately 42% of individuals in the US over 30 years of age have destructive periodontitis.[1] Periodontitis is caused by initial exposure to microorganisms and their by-products in bacterial plaque biofilm, which results in the progressive destruction of the supporting soft and hard tissues around the teeth due to the resultant host immuno-inflammatory response.[2] The aim of regenerative periodontal therapy is the functional regrowth of hard and soft tissues of the periodontium destroyed by the inflammatory disease.[3] Periodontal regeneration is defined histologically as the formation of new alveolar bone, functionally oriented periodontal ligament, and cementum at a previously diseased root surface. Achieving true periodontal regeneration following traditional regenerative procedures is dependent upon patient and site-related factors, and, in many cases, complete regeneration of all destroyed tissue is not predictable due to the complexity of the wound-healing events and stabilization of the tissues.[4]

Platelet concentrates (PCs) obtained from autogenous blood extraction followed by a centrifugation process have emerged as potential regenerative biomaterials. These PCs include platelet-rich plasma (PRP) and platelet-rich fibrin (PRF).[5] Because these tissues are produced from the patient's own blood harvested after venipuncture, the availability and patient acceptance of PCs has drawn significant interest. These materials generally contain increased concentrations of the growth factors and cytokines that are present at physiologic levels in platelets in vivo. These materials may contain biological scaffolds that can induce release of such growth factors and cytokines, including platelet-derived growth factor (PDGF), transforming growth factor-β (TGF-β), bone morphogenetic protein-2 (BMP-2), vascular endothelial growth factor (VEGF), and others. Additionally, PCs may act as carriers for particulate bone materials.[6,7]

Different techniques, preparation protocols, and centrifugation processes for PCs have been developed in the last 20 years, and their usage has become confusing for clinicians due to the high number of products available.

Periodontitis results in the destruction of the periodontal apparatus, resulting in loss of cementum, periodontal ligament, and alveolar bone. Regenerative therapy allows the reconstitution of lost components of the periodontal attachment apparatus and function that was lost due to periodontal tissue destruction.[8] Over the past decades, several clinical studies have been focused on the development of innovative methods and products for the correction of periodontal defects. Various biomaterials based on endogenous regenerative technology in addition to autogenous and allogenic bone grafts have been used for periodontal regeneration,[9] but there is not a single graft or regenerative material that is considered a gold standard in the treatment of all periodontal defects.

Over the last 20 years, PCs have been developed as a potential autologous regenerative material to enhance tissue engineering, used alone or as a scaffold for other graft materials.[5] PCs are autologous blood extracts obtained by centrifugation. First-generation PCs included platelet-rich fibrin plasma and plasma rich in growth factors (PRGF). These materials have been used in various medical fields, but may have some limitations, including complex preparation that requires anticoagulants that lead to rapid fibrin polymerization and a resultant weak fibrin network.[6] Second-generation PCs were introduced in the 2000s by Choukroun and coworkers, and include PRF, which does not require any anticoagulant or additives in the preparation, thus making it simpler and less expensive to use. PRF is a bioactive construct rich in leukocytes that may stimulate stem cells in the local environment through differentiation and proliferation.[7] Because PRF includes a fibrin network allowing for extended release of growth factors and cytokines during the initial healing phase, it has been used in oral regenerative procedures to enhance healing.[10,11] As preparations, properties, and regenerative potential of PCs differ considerably, it is important for clinicians to be able to differentiate between these products and understand the advantages of introducing platelet concentrates into their practices.

PERIODONTAL REGENERATION THERAPY

What is true periodontal regeneration? Periodontal regeneration is defined histologically as the complete restoration of the destroyed attachment apparatus, including formation of new bone, cementum, and functionally oriented periodontal ligament on a previously diseased root surface,[8] in order to improve tooth stability, reduce disease progression, and provide resistance to subsequent periodontal tissue breakdown.[3] Periodontal regeneration requires selective cell repopulation of the root surface and neighboring areas to allow for the formation of the required tissues.[12] It is generally thought that pluripotent stem cells within the periodontal ligament give rise to a granulation tissue with the potential to form new cementum, periodontal ligament, and alveolar bone.[13]

What types of cells participate in the wound-healing process? Periodontal regeneration is a complex process that requires highly coordinated molecular and biological orchestration, involving a number of different cell types and cell-stromal interactions. It occurs as a result of the ability of cementoblasts, periodontal ligament cells, and osteoblasts to form a new periodontium.[14] Growth factor molecules are involved in the regeneration of periodontium. They act on specific receptors at specific time periods during wound healing, activating signaling cascades that lead to cell proliferation, differentiation, and tissue synthesis.[15] Melcher postulated that periodontal healing at root surfaces could be dependent on the four possible cell types that predominate the wound site.[16] The downgrowth of epithelial cells (E) results in a long junctional epithelium attachment. The proliferation of connective tissue (CT) may result in connective tissue adhesion and root resorption. The predominance of bone cells (B) as osteoblasts results in root resorption and/or ankylosis. The ingress of periodontal ligament (PDL) mesenchymal stem cells

and perivascular cells from the bone may result in true periodontal regeneration.

REGENERATIVE TECHNIQUES

Myriad techniques have been successfully employed to achieve periodontal regeneration. Some of the most used techniques include guided tissue regeneration (GTR), bone-replacement grafts, and biologically active regenerative materials.[17] Bone grafts are often used alone or in conjunction with GTR as they act as a space maintainer and a scaffold, providing a framework for migration of cell types required for regeneration. Bone substitutes include autografts (from the same patient), allografts (from another individual of the same species), xenografts (from a source of a different species), or alloplastic materials (from an inert synthetic source).[18]

GTR allows for the exclusion of epithelial cell downgrowth, prioritizing repopulation of the defect with mesenchymal stem cells from the periodontal ligament. This is achieved through the use of barrier membranes for cell occlusion to exclude epithelial cells that proliferate at a faster rate than mesenchymal cells. Specifically, membranes allow for the differentiation and proliferation of periodontal ligament stem cells and their subsequent migration and repopulation of the various cell types into the defect and subsequent regeneration of lost tissue types.[19]

Growth factors—i.e., biomimetic materials—may be used as adjunctive means to achieve regeneration. Some growth factors used in periodontal regeneration include: recombinant platelet-derived growth factor-BB (rhPDGF-BB), bone morphogenetic proteins (recombinant bone morphogenetic protein-2 [rhBMP-2] and BMP-7), enamel matrix derivatives (EMD), fibroblast growth factor 2 (FGF-2), and PCs.[9] PCs differ from individual growth factors used in regeneration in that they contain numerous physiologic growth factors that are normally present during wound healing and superphysiologic concentrations. These growth factors bind to specific receptors on the cell surface to activate transcription factors that enhance cell growth, migration, and differentiation, as well as stimulation of new blood vessel formation.[9,13]

PLATELET CONCENTRATES

Platelets are indispensable for hemostasis and are a source of growth factors. Their alpha granules contain PDGF, VEGF, insulin-like growth factor (IGF), and TGF-β.[20,21]

Historic and current use in medical and dental applications: PCs were originally used in transfusion medicine in the 1970s to treat and prevent hemorrhage due to severe thrombocytopenia.[22,23] Subsequently, the first-generation PC, PRP was used as a fibrin glue that could seal wounds and stimulate healing, but its use was limited due to the complexity of preparation and financial considerations.[23] In the 1990s and early 2000s, it was recognized that PCs were a reservoir for growth factors and might aid in stimulating cell proliferation, matrix remodeling, and angiogenesis.

While widespread use of PCs has been seen across many disciplines of medicine, an excellent example of the potential of PCs to improve postoperative healing is derived from their use in the treatment of nonhealing wounds.[23,24] Observational studies have shown a significant improvement in nonresponsive wounds (such as diabetic ulcers) actively healing due to PRP therapy.[25] Furthermore, the use of PCs for orthopedic treatment at minimally vascularized sites—such as tendinopathies, chondropathies, and osteoarthritis—demonstrates their capacity to potentially modulate inflammation and angiogenesis.[26]

The use of PCs has widely expanded in the field of dentistry for oral reconstruction procedures. These include extraction socket preservation, osseous regeneration, periapical surgery, intrabony defect repair, furcation defect repair, guided bone regeneration, sinus floor elevation, implant therapy, and gingival recession. They have also been used to treat osteonecrosis of the jaw.[25,26]

FIRST GENERATION OF PLATELET CONCENTRATES: PRP

What is PRP? PRP is a biological product defined as a portion of the plasma fraction of autologous blood with a platelet concentration above the baseline that was created by hematologists in the 1970s. It was initially used as a transfusion product to treat patients with thrombocytopenia.[27] Subsequently, PRP has been used in various medical fields and for oral surgical applications.[28] Additionally, the interest in the application of PRP in dermatology for tissue regeneration and wound healing has increased.[29] PRP contains a high concentration of platelets but a minimal amount of natural fibrinogen. The α granules within PRP release growth factors for approximately three to five days of platelet activation, which sustain their stimulation of the proliferative phase for seven days after release.[23]

Harvest technique: Venous blood is drawn from the patient, and sodium citrate dextrose is added as an anticoagulant to avoid platelet activation and degranulation. The tube is first spun in a centrifuge at a lower speed (soft spin), resulting in three distinct layers. From bottom to top, these layers include: 1) red blood corpuscle layer constituting 55% of total volume; 2) buffy coat or PRP, which contains platelet concentration and constitutes 5% of volume; and 3) the acellular plasma layer designated platelet-poor plasma (PPP), resulting in the remaining 40% of volume and made up mainly of fibrinogen. The top two layers are then transferred to a tube without anticoagulant, and a second centrifugation is performed at higher speed (hard spin),

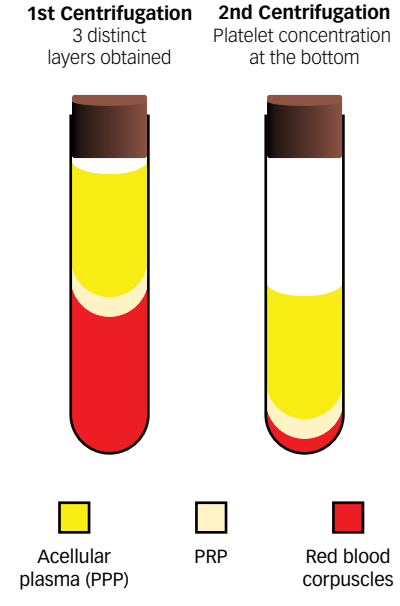

FIGURE 1: Platelet-rich plasma preparation

obtaining three layers (figure 1).

The PRP layer is then extracted and mixed with bovine thrombin and calcium chloride at the time of application. The addition of thrombin results in polymerization and then a fibrin matrix with hemostatic and adhesive properties.[6]

Advantages of PRP: PRP brings cytokines and growth factors to the treated site. It enhances osteoprogenitor cells in the host and bone graft and may mitigate inflammation and facilitate early tissue healing. It is highly biocompatible, with no risk of transmissible disease due to its being autologous.

Limitations of PRP: PRP has a complicated preparation process that requires anticoagulants or additives that lead to rapid fibrin polymerization and a resultant weak fibrin network and limited length of growth factor activation.

SECOND GENERATION OF PLATELET CONCENTRATES: PRF

What is PRF? PRF is an autogenous material that was first developed in France by Choukroun and coworkers in 2001 for specific use in oral and maxillofacial surgery. It has been shown to accelerate soft- and hard-tissue healing in intraoral applications.[6] Its advantages over PRP are ease of preparation/application, minimal expense, and lack of biochemical modification—i.e., bovine thrombin or anticoagulant is not required in preparation.[6] PRF is also called leukocyte- and platelet-rich fibrin (L-PRF) due to the high number of leukocytes found in this biomaterial.

Harvest technique: The PRF protocol is simplified and requires fewer exogenous materials when compared to preparation of PRP. Briefly, a blood sample is taken without anticoagulant in 10 ml tubes, which are immediately centrifuged at 2,700–3,000 rpm for 12–15 minutes.

The absence of anticoagulant results in the activation in a few minutes of most platelets within the blood sample in contact with the tube walls, and the release of the factors responsible for coagulation cascades. Fibrinogen is initially concentrated in the upper portion of the tube before the circulating thrombin transforms it into fibrin. A fibrin clot is then obtained in the middle of the tube, just between the red corpuscles at the bottom and acellular plasma at the top (figure 2). This clot contains stabilized healing and immunity-promoting factors that are present in the initial blood harvest.[6] It can be used as a clot or after compression as a membrane (figure 3).

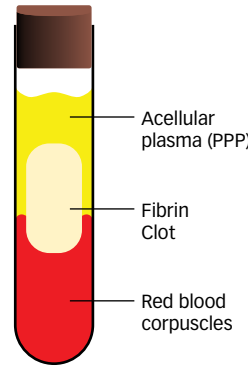

FIGURE 2: Platelet-rich fibrin resultant

FIGURE 3: Platelet-rich fibrin membrane

Advantages of PRF: PRF results from a natural and progressive polymerization occurring during the centrifugation process and does not require any anticoagulant/additive in the preparation, making it simpler and less expensive to use than first-generation PCs. The increased incorporation of circulating leukocytes and cytokines that may stimulate stem cells' differentiation and proliferation into the fibrin matrix provides a better structural integrity and has a positive effect in accelerating the healing process.[7] Its natural fibrin architecture may result in slow release of growth factors and matrix glycoproteins (e.g., thrombospondin, fibronectin, vitronectin) for seven or more days.[20] PRF can be used as a clot or formed as a membrane capable of covering and protecting the wound site, as well as to entrap active molecules and cells.[20]

Limitations of PRF: Reported limitations of PRF include low quantity and a required immediate use after preparation, because it can lose the structural integrity by shrinkage

TABLE 1: ADVANTAGES AND LIMITATIONS OF PRP AND PRF

PRP advantages

- Promotes cytokines and growth factors at site of surgery
- Autologous retrieval, promotes angiogenesis and quicker wound healing
- Multiple commercially available PRP concentrating systems
- Relatively less expensive than other biomaterials

PRP limitations

- Potential for infection transmission/allergic reaction due to use of bovine thrombin/calcium chloride
- Requires preparation time (>30 minutes) with multiple steps
- Rapid release of growth factors rather than gradual release

PRF advantages

- Low cost, quick preparation process (<15 minutes), easy handling
- No need for bovine thrombin and anticoagulants, has fibrin matrix
- Promotes favorable healing due to slow polymerization
- Aids in hemostasis, supportive effect to immune system due to containment of leukocytes
- Gradual release of growth factors

PRF limitations

- Amount available can be low due to autologous blood
- Speed in handling is critical after collection to avoid premature clotting

due to dehydration.[30] The leukocytes that are present may adversely alter its biologic properties, and bacterial contamination occurs on storage.[7]

Table 1 summarizes the advantages and limitations for clinical use of each of these classes of PCs.

Clinical indications of PCs in oral and maxillofacial surgery: PCs have been widely used in the dental surgical practice. PRP demonstrated significant increases in bone regeneration in a clinical experiment by Marx et al. in 1998.[18] Since then, many clinical studies have been conducted to reveal the effects of PRP and PRF on tissue regeneration in the oral and maxillofacial regions. The indications of PRF are numerous, including, for example, improvement in soft-tissue healing[31] and bone graft protection and remodeling.[32] It has shown promising results when used during a ridge-preservation procedure after tooth extraction, soft-tissue grafting, sinus augmentation and ridge augmentation prior to dental implants, as a membrane protection, or in combination with other biomaterials in stimulating tissue regeneration.[33]

REVIEW OF PCS IN PERIODONTAL REGENERATION

PCs have been used in various surgical procedures and showed promising results. Because of the potential of improvement in soft- and hard-tissue healing, PCs were also used for the treatment of periodontal defects.

PCs—cellular-level effects for regeneration: Growth factors released by PCs play an important role in wound healing.[20,24] The main growth factors released are: PDGF, TGF-β, VEGF, epithelial growth factor (EGF), insulin-like growth factor (IGF-1), and basic fibroblast growth factor (bFGF), as well as blood proteins known to act as cell adhesion molecules for osteoconduction (e.g., fibrin, fibronectin, vitronectin).[20,21] The results of in vitro studies on the effects of PCs are controversial, demonstrating equivocal effects of PCs on the proliferation and differentiation of fibroblasts[34] and osteoblasts.[35,36] More recently, osteoprotegerin (OPG), which inhibits osteoclast formation, was found to be upregulated by PRF in vitro, and alkaline phosphatase (ALP) expression was elevated in the presence of PRF. These findings may indicate that PRF could contribute to the differentiation of PDL fibroblasts into osteoblasts.[27] PRF has also been shown to increase PDL cell, gingival fibroblast, and osteoblast proliferation.[28] PCs may have antimicrobial properties: PRP and PRF were shown to inhibit the bacterial growth of ***P. gingivalis*** and ***A. actinomycetemcomitans*** for more than 24 hours in vitro.[37] Preliminary research suggests that PRP may suppress long-term expression of pro-inflammatory cytokines and therefore limit chronic inflammation.[38]

Efficacy of PRP versus PRF: First-generation PCs (introduced in the 1970s) have been used for a longer period of time than the second-generation PCs (introduced in 2001), thus more research was performed on first-generation PCs.

PRP is considered more expensive, time-consuming, and harder to manipulate than L-PRF, and the dense fibrin network in L-PRF provides a resistant matrix with increased biomechanical properties[30] that enables L-PRF to be used as a sole material in periodontal regeneration, whereas PRP can be used only as a surgical adjuvant.

Moreover, the platelet count in L-PRF is significantly higher than the one in PRP, and a high number of platelets in PRP can have an inhibitory effect on cell growth and a cytotoxic effect, whereas there was no reported cytotoxicity of PRF in in vitro studies.[39,40]

Finally, growth factor availability is different between first- and second-generation PCs. PRP will release multiple growth factors for seven days (with the majority of the release on the first day), while PRF will release growth factors for 21 days (with the peak at the seventh day).[23] It should be noted that differences have also been seen between the qualities of platelet concentrates dependent upon preparation techniques. The importance of utilizing a calibrated centrifuge and following protocols for the individual PC material chosen is critical to achieving optimal results and outcomes.[41]

Further studies should focus on the biological and clinical effects of second-generation PCs, but available literature suggests that L-PRF might provide some advantages over PRP.

TREATMENT OF INTRABONY DEFECTS

PC alone versus PC as an adjunct to traditional regenerative procedures: Multiple studies evaluated and compared the clinical outcomes of PCs alone or as an adjunct to traditional regenerative procedures.[5] L-PRF and PRP alone have been compared to open-flap debridement (OFD). L-PRF and PRP both demonstrated statistically significant reduction in probing depth, clinical attachment level (CAL) gain, and radiographic bone fill when compared to OFD.[5,42] When combined with other grafting materials, PRP and L-PRF demonstrated improved CAL gain, probing depth (PD) reduction, and radiographic bone fill.[5,33] However, when PCs were used as adjunctive biomaterials with GTR and bone replacement grafting, L-PRF demonstrated additional benefit whereas PRP did not.[5] It should be noted that enamel matrix derivatives (EMD) were shown to be superior to L-PRF with regard to radiographic defect resolution.[43] A recent systematic review concluded that PCs can be beneficial as an adjunct to treatment of intrabony defects except when GTR or EMD are performed; however, site, patient, and PC characteristics may influence outcomes.[44]

TREATMENT OF FURCATION DEFECTS

PC alone versus PC as adjunct to traditional regenerative procedures: A limited number of studies have evaluated the clinical advantage of using PCs for the treatment of furcation defects.

PRP and L-PRF alone have been compared to OFD for the treatment of class II furcations. Both showed a small but significant improvement in horizontal CAL gain, vertical CAL gain, and PD reduction compared to OFD alone, but the gingival margin did not show any improvement with the use of PCs.[45]

When combined with bone grafting materials, PRP and L-PRF demonstrated a significant improvement only in the horizontal CAL. However, a slight improvement of the vertical CAL was detecte, and no changes in PD were found.[46]

PC USE IN SINUS GRAFTING

Various grafting materials have been successful in sinus augmentation. Histologic studies demonstrating new bone formation

after initial healing and bone-to-implant contact have demonstrated improved outcomes when adjunctive PCs are used in combination with bone allografts.[47,48]

PC USE IN LATERAL RIDGE AUGMENTATION AND SOCKET GRAFTING/RIDGE PRESERVATION

PCs have been used to augment soft- and hard-tissue healing during lateral ridge augmentation and ridge preservation after tooth extraction.[49,50] The use of autologous PCs has demonstrated improved volumetric bone fill when compared to natural healing in extraction sockets after tooth extraction.[49] Furthermore, the adjunctive use of PCs has demonstrated improved early healing compared to graft alone in both socket healing and for lateral ridge augmentation.[51,52] Of particular interest, an emerging technique utilizing an L-PRF block technique with particulated L-PRF-derived membrane has demonstrated significant volumetric gain with minimal resorption rates.[53,54] Lastly, patient-reported postoperative outcomes demonstrate a patient preference for adjunctive PC use, indicating a role in initial postoperative healing.[49,55]

CONCLUSION

There has been an increasing interest in the use and benefits of PCs in the last few years. They have been shown to improve the clinical and radiographic outcomes of regenerative therapy as sole materials or in combination with bone grafting materials, but there were no discernable benefits when used with GTR or compared to EMD. Moreover, postsurgical discomfort was reported to decrease with the use of PCs. Standardization of the protocol is needed to obtain optimal results, and long-term studies are needed to validate specific treatment options.

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QUESTIONS

1. True periodontal regeneration is defined histologically as the complete restoration of the destroyed attachment apparatus, including formation of the following tissues on a previously diseased root surface, except:

A. Alveolar bone
B. Dentin
C. Cementum
D. Periodontal ligament

2. Regenerative techniques used in periodontal defects include:

A. Guided tissue regeneration (GTR)
B. Biologically active materials
C. Bone graft replacement + GTR
D. All of the above

3. All of the following are true about platelet concentrates (PCs), except:

A. PCs are obtained from autogenous blood extraction.
B. PCs may contain biological scaffolds that can induce release of such growth factors.
C. PCs include large amounts of all blood components, including red blood cells.
D. PC preparation requires venipuncture and centrifugation.

4. Which of the following are growth factors that are released by PCs?

A. Platelet-derived growth factor (PDGF)
B. Transforming growth factor-β (TGF-β)
C. Vascular endothelial growth factor (VEGF), and others
D. All of the above

5. Which of the following is in the first generation of platelet concentrates?

A. FGF
B. PRP
C. PRR
D. PRF

6. Platelet-rich plasma (PRP) requires approximately how much time for preparation?

A. 5 minutes
B. 15 minutes
C. 30 minutes
D. 60 minutes

7. The second generation of platelet concentrates was described by:

A. Marx in 1980
B. Choukroun in 2001
C. Dohan in 2010
D. Melcher in 1976

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QUESTIONS

8. All of the following are true about platelet-rich fibrin (PRF) except:

A. PRF is rich in leukocytes.
B. PRF membranes demonstrate cell-occlusive properties.
C. PRF may stimulate stem cells in the local environment through differentiation and proliferation.
D. PRF includes a fibrin network allowing for extended release of growth factors and cytokines.

9. Which platelet concentrate requires anticoagulant or additives in the preparation?

A. PRF
B. PPP
C. PRP
D. FGF

10. Platelet-rich plasma requires transfer of which layers of the initial centrifugation product to an anticoagulant-free tube?

A. Red blood corpuscle layer
B. Buffy coat
C. Acellular plasma layer
D. B and C

11. How many centrifugation cycles are needed to prepare PRF?

A. Two
B. One
C. Three
D. None

12. After centrifugation of PRF, the absence of anticoagulant results in:

A. Activation of platelets in contact with the tube walls
B. Release of the factors responsible for coagulation cascades
C. Fibrin clot formation in the central portion of the tube
D. All of the above

13. All of the following are noted advantages of PRF except:

A. Increased incorporation of cytokines, leukocytes, and stem cells in the fibrin matrix
B. Slower release of growth factors
C. Can be stored and used for several days
D. May improve soft-tissue healing

14. PRF is noted to have all of the following characteristics except:

A. Low cost and relatively quick (<15 minutes) preparation
B. Promotes a rapid release of growth factors
C. Preparation does not use thrombin or anticoagulants
D. Relatively slow polymerization

15. The limitations of PRF include:

A. Low quantity of material produced
B. Bacterial contamination can occur during storage
C. Dehydration may affect structural integrity and cause shrinkage
D. All of the above

16. In vitro studies demonstrate that PCs decrease proliferation and differentiation of fibroblasts. PRF has demonstrated upregulation of osteoprotegerin (OPG) and alkaline phosphatase expression.

A. Both statements are true.
B. The first statement is true; the second statement is false.
C. The first statement is false; the second statement is true.
D. Both statements are false.

17. Evidence of antimicrobial properties of PCs includes:

A. PRP and PRF inhibit bacterial growth of Pg and Aa for >24 hours in vitro.
B. PRP has demonstrated virucidal properties.
C. PRF reduces the adhesion and reproduction of T. denticola in vivo.
D. All of the above

18. Which value was not found to be improved with the usage of platelet concentrates in the treatment of furcation defects as a sole material?

A. Horizontal CAL
B. Vertical CAL
C. PD
D. Gingival margin position

19. When comparing PRP and PRF, all of the following are differences between these PCs except:

A. PRP is more expensive and time-consuming to prepare.
B. PRP has a higher platelet count than PRF.
C. PRF provides a resistant matrix with increased biomechanical properties.
D. PRF may be used as a sole material in periodontal regeneration.

20. PRP will release growth factors for ___ days, with the majority of the release occurring on the first day.

A. 3
B. 5
C. 7
D. 10

21. PRF releases growth factors over ___ days with the peak at day ___.

A. 21, 7
B. 30, 10
C. 45, 21
D. 100, 25

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QUESTIONS

22. At intrabony defects, when compared to open-flap debridement:

A. PRF and PRP demonstrated a reduction in CAL.
B. PRF and PRP demonstrated increased radiographic bone fill.
C. PRF and PRP demonstrated improved CAL gain.
D. All of the above

23. At intrabony defects, when PCs are added to bone replacement graft materials:

A. PRF and PRP demonstrated a reduction in CAL.
B. PRF and PRP demonstrated a reduction in PD.
C. PRF and PRP demonstrated increased radiographic bone fill.
D. All of the above

24. At intrabony defect sites treated with guided tissue regeneration, PRF but not PRP provided additional clinical benefit. Enamel matrix derivative was shown to be superior to PRF with regard to radiographic defect resolution.

A. Both statements are true.
B. The first statement is true; the second statement is false.
C. The first statement is false; the second statement is true.
D. Both statements are false.

25. A recent systematic review suggests that PCs may be beneficial as an adjunctive treatment for intrabony defects. However, it noted that outcomes may be influenced by:

A. Site-specific characteristics
B. Patient-specific characteristics
C. PC-specific characteristics
D. All of the above

26. At class II furcation defects, the use of PCs compared with OFD has demonstrated all of the following except:

A. PRP and L-PRF demonstrated improvement in gingival margin position.
B. PRP and L-PRF demonstrated CAL gain.
C. PRP and L-PRF demonstrated vertical CAL gain.
D. PRP and L-PRF demonstrated PD reduction compared to OFD.

27. At class II and class III furcation defects, when combined with bone replacement grafting materials, PRP and PRF demonstrated significant improvement in horizontal CAL. At class II and class III furcation defects, adjunctive use of PCs demonstrated improved PD when compared with bone grafts alone.

A. Both statements are true.
B. The first statement is true; the second statement is false.
C. The first statement is false; the second statement is true.
D. Both statements are false.

28. Sinus augmentation is a successful procedure to facilitate dental implant procedures. When PCs are used in conjunction with bone replacement grafts, clinical findings include:

A. Improved histologic new bone formation
B. Improved implant survival
C. Improved histologic bone-to-implant contact
D. Improved implant placement torque values

29. Histologic studies demonstrating new bone formation after initial healing and bone-to-implant contact have demonstrated improved outcomes when adjunctive platelet concentrates are used in combination with bone allografts. Patient-reported postoperative outcomes demonstrate patient preference for adjunctive platelet concentrate use, indicating a role in initial postoperative healing.

A. Both statements are true.
B. The first statement is true; the second statement is false.
C. The first statement is false; the second statement is true.
D. Both statements are false.

30. Adjunctive use of platelet concentrates for postextraction ridge preservation augmentation has demonstrated all of the following clinical and histological outcomes except:

A. Improved volumetric bone fill
B. Early new bone formation and maturation
C. Increased implant survival at grafted sites
D. Improved initial postoperative healing

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ANSWER SHEET

Stick with it!

Platelet concentrates for bone grafting and periodontal regeneration

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EDUCATIONAL OBJECTIVES

1. Identify the different platelet-concentrate products available, preparation technique and protocols, and different types of resultant concentrates obtained.
2. Discuss the effect of platelet concentrates on the different cells involved in periodontal regeneration.
3. Select the appropriate preparation protocol to achieve good and predictable results with platelet concentrates in periodontal regeneration.
4. Determine which specific cases are appropriate to achieve good and predictable results with platelet concentrates in periodontal regeneration.
5. Discern differences in outcomes between using platelet concentrates alone or as an adjunct with available biomaterials.

COURSE EVALUATION

1. Were the individual course objectives met?

Objective #1:		Objective #2:		Objective #3:		Objective #4:		Objective #5:	
Yes	No	Yes	No	Yes	No	Yes	No	Yes	No

Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

2. To what extent were the course objectives accomplished overall?	5	4	3	2	1	0
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12. If any of the continuing education questions were unclear or ambiguous, please list them.

_____

13. Was there any subject matter you found confusing? Please describe.

_____

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3.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	18.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
4.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	19.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
5.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	20.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
6.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	21.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
7.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	22.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
8.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	23.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
9.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	24.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
10.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	25.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
11.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	26.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
12.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	27.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
13.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	28.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
14.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	29.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
15.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	30.	Ⓐ	Ⓑ	Ⓒ	Ⓓ

PLEASE PHOTOCOPY ANSWER SHEET FOR ADDITIONAL PARTICIPANTS.

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