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Platelet-Rich Plasma (PRP): Biological Basis and Expanding Clinical Applications

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ABSTRACT:

Platelet-rich plasma (PRP) has emerged as a promising therapeutic modality in regenerative medicine, dentistry, orthopaedics, and aesthetic practices. Derived from autologous blood, PRP is a concentration of platelets enriched with growth factors, cytokines, and bioactive proteins that stimulate tissue repair and regeneration. This article reviews the biological foundation of platelets and plasma, the evolution of PRP from discovery to clinical application, techniques for its preparation, and its wide-ranging therapeutic applications. Special attention is given to its role in orthodontics, temporomandibular joint disorders (TMDs) and cleft repair. The challenges in standardization of PRP protocols and the future prospects of its use in regenerative therapies are also discussed.

1. Introduction

The circulatory system plays a vital role in delivering oxygen, nutrients, hormones, and immune cells to tissues, while also removing waste products. Blood, a specialized connective tissue consisting of plasma and a cellular component that includes erythrocytes, leukocytes and platelets.[1]

Historically, platelets were mainly recognized for their role in haemostasis-rapidly responding to vascular injury by adhering, activating and aggregating to prevent excessive bleeding. However, over the last century, research has revealed their broader functions in immunity, angiogenesis, wound healing and tissue regeneration.[2] notably platelets have been found to store growth factors and cytokines that promote cellular migration, proliferation and differentiation, opening new possibilities for their therapeutic use. [3]

PRP an autologous blood concentrate developed in 1950's, is widely used in dentistry, orthopaedics and dermatology, with expanding applications in orthodontics, TMDs and cleft repair.[4,5] Emerging evidence supports its benefits in healing, recovery and complication reduction.[6] This review covers its biology, preparation, application and future prospects.

2. Platelets and Their Biological Role

Platelets are 2–4 µm fragments from megakaryocytes in the bone marrow, with a lifespan of 4–10 days. Their principal function is in haemostasis, where they form clots to prevent blood loss. Beyond this, they contribute in wound repair, innate immunity and tissue regeneration. Thrombopoiesis, regulated by thrombopoietin and cytokines like IL-3 and IL-11, control platelet production. During vascular injury, activated platelets release alpha granules and dense granules that contain platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-β), vascular endothelial growth factor (VEGF), and other mediators essential for healing.[1,2]

3. Platelet-Rich Plasma: Definition and Mechanism

Platelet-rich plasma (PRP) is plasma with a platelet count two to five times higher than normal blood. First used in

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transfusion medicine in the 1950s, it is now recognized for its regenerative capacity across medical fields.[7]

Activated PRP releases growth factors such as PDGF, TGF-β, VEGF, and IGF. These stimulate cell recruitment, angiogenesis, collagen production and extracellular matrix formation, accelerating tissue repair. Its autologous origin minimizes risks of immune reaction or disease transmission.[8] PRP degranulates platelets at injury sites, interacting with fibroblasts, endothelial cells and stem cells. Leukocytes may also be present, influencing antimicrobial and inflammatory responses.[9]

4.Preparation and Classification of PRP

PRP preparation involves centrifuging blood to separate its components, concentrating platelets in plasma while minimizing RBC contamination. Variations in centrifugation protocols such as spin speeds, time, temperature and anticoagulants choice result in significant variability in the final product. [10]

5.Methods of Preparation

1. <u>Open Method (Double-Spin):</u> Blood is centrifuged at low speed to separate RBCs from plasma and buffy coat. The plasma is then re-centrifuged at a higher speed, pelleting the platelets which are resuspended in a reduced plasma volume. While cost-effective and efficient in platelet concentrations, this method carries a higher risk of contamination due to exposure to the working environment and equipment such as pipettes or product-collection tubes.[12]

   Advantages of open method:

   - Double spin is the standard method of the preparation of PRP as confirmed by various studies and the American Association of Blood Banks technical manual

   Disadvantages of open method:

   - Vacutainers, designed for diagnostic use, are sterile but not guaranteed pyrogen or endotoxin-free, raising concerns for therapeutic applications. [11]
   - PRP contamination risk can be minimized by adhering to strict aseptic techniques, including preparation under laminar airflow. The physician should wear a face mask, sterile gloves and gown to prevent infection during blood product handling.

2. <u>Closed Method (Commercial Kits):</u> Blood is processed in sterile, sealed systems with specialized tubes or automated devices. These minimize contamination risk and improve reproducibility. Common approaches include:
   - Narrow-neck tube systems: Uses a special tube that has four parts-an extended top, a constricted centre (or the narrow neck), an expanded bottom, and a turn screw. This method elongates the buffy coat for easier platelet recovery.
   - Gel separator systems: Uses a polymer gel to separate plasma from RBCs and leukocytes. It is one of the most commonly available commercial kits for the preparation of PRP.
   - Automated cell separators: Provide precise control over platelet concentration but are more expensive.[12]

6.Factors Affecting PRP Yield

- Anticoagulants: Acid citrate dextrose (ACD-A) is preferred, as it maintains platelet viability and reduces premature activation compared with EDTA or heparin.[13]
- Centrifuge Parameters: Lower g-forces (100–300 g for 5–10 min) are recommended for the first spin, while higher g-forces (400–750 g for 10–15 min) are used for the second. Excessive force can prematurely activate platelets and release growth factors before application.[14]
- Blood Volume: Larger blood draws allow higher platelet yield; reducing plasma volume can proportionally increase platelet concentration.
- Activation: Calcium chloride or thrombin may be added to release growth factors rapidly, whereas in vivo application often relies on natural activation by collagen at the injury site.[15]

7.Classification of PRP

A widely accepted system proposed in 2009 divides PRP products based on leukocyte content and fibrin architecture:[16]

- Pure PRP (P-PRP): Lacks leukocytes, low-density fibrin.
- Leukocyte-rich PRP (L-PRP): Includes leukocytes, low-density fibrin.
- Pure Platelet-rich Fibrin (P-PRF): No leukocytes, high-density fibrin, exists as a gel.
- Leukocyte-rich PRF (L-PRF): Contains leukocytes, high-density fibrin, also gel form.

Additionally, the DEPA classification evaluates PRP based on:[17]

- Dose of injected platelets.
- Efficiency of production (platelet recovery rate).
- Purity relative to leukocytes and RBCs.
- Activation method used.

While PRP can be prepared using relatively simple techniques, variability in protocols and commercial systems creates significant heterogeneity. Standardization of methods and clearer classification criteria are essential for reproducible outcomes and for comparing results across clinical studies.

8.Clinical Applications of PRP

PRP has gained popularity for its regenerative and anti-inflammatory effects, promoting tissue repair beyond conventional treatment.[5,6,9] Its autologous origin reduces immune and disease transmission risks. Key therapeutic fields include:

1.Orthopaedics and Sports Medicine

PRP is effective for musculoskeletal conditions including tendinopathies and osteoarthritis promoting pain relief, improved function and tissue regeneration. Unlike corticosteroid injections that address symptoms, PRP promotes biological healing, especially in sports medicine.[18]

2.Dermatology and Aesthetic Medicine

In dermatology, PRP aids hair restoration, wound healing, scar revision and skin rejuvenation by boosting collagen synthesis and tissue elasticity. It also benefits chronic ulcers and burn scars by creating a microenvironment conducive to healing.[19,20]

3.Dentistry and Oral Surgery

PRP is increasingly used in periodontal regeneration, implantology, socket preservation and maxillofacial surgery. Studies have demonstrated combining PRP with bone grafts accelerates bone formation and reduces infection risk. In alveolar cleft repair, it improves flap adaptation, bone density and decreases complications.[21]

4.Orthodontics

Prolonged treatment can lead to complications such as root resorption, dental caries and reduced patient compliance. PRP offers a minimally invasive adjunct to shorten treatment time by accelerating tooth movement by enhancing bone remodelling processes.The biological basis lies in PRP's ability to increase osteoclastic activity and stimulate the release of cytokines and growth factors, which in turn accelerate bone turnover.[22] In human clinical trials, El-Timamy et al[23] observed faster tooth movement on PRP-injected sides during the first two months of treatment. Systematic reviews by Li et al[24] and Yao et al[25] suggest that PRP and platelet-rich fibrin (PRF) can provide short-term acceleration of orthodontic tooth movement (OTM), particularly in early treatment phases.

Compared to surgical methods like corticotomy and piezocision, PRP is associated with fewer side effects.[26] As an autologous product, it minimizes risks of immune reaction and infection. PRP represents a promising adjunct in orthodontics, with the potential to reduce treatment duration, enhance patient satisfaction, and lower risks associated with prolonged therapy. Further research is needed to optimize protocols including frequency, dosage and the choice between PRP and PRF.

5.Temporomandibular Disorders (TMDs)

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TMDs involve chronic pain and dysfunction of the temporomandibular joint. Intra-articular PRP injections have been shown to reduce pain, improve joint mobility, and stimulate cartilage regeneration.[27] While some studies report outcomes similar to arthrocentesis alone, repeated PRP applications appear to provide sustained analgesic benefits.[28,29,30]

6. Cleft Repair
In alveolar cleft grafting, PRP acts as both a fibrin sealant and a reservoir of growth factors, enhancing graft integration and bone regeneration.[31] Clinical studies have reported greater bone volume, reduced infection, and better healing when PRP is combined with autologous bone grafts.[32]

7. Other Applications

Beyond dentistry and orthopaedics, PRP has been applied in ophthalmology, cardiac surgery, plastic surgery and dermatology.[9,19,22] Its versatility lies in its ability to adapt to different tissue types, supporting angiogenesis, collagen deposition, and cell proliferation across diverse clinical settings. PRP has demonstrated clinical value across multiple medical disciplines.

9.Challenges and Limitations

Despite the expanding applications of platelet-rich plasma (PRP), several challenges hinder its universal acceptance in clinical practice.

1. Variability in Preparation Protocols
PRP composition varies with centrifugation parameters and activation methods while individual platelet counts and health also affects recovery and concentration.

2. Lack of Standardization
Commercial kits differ in efficiency, sterility, and cost, leading to significant heterogeneity in final products. Classification systems such as DEPA have been proposed, but are not universally adopted.

3. Dose and Efficacy Uncertainty
The optimal platelet concentration and dose remain debated. While higher platelet counts are generally associated with greater growth factor release, excessively concentrated PRP may paradoxically impair healing.

4. Short-Term vs. Long-Term Outcomes
PRP shows short-term benefits like healing and pain reduction but long-term effects are inconsistent. In orthodontics, accelerated tooth movement is typically seen early but may require repeated treatment to sustain.

5. Clinical Practicality
While PRP preparation is relatively simple, it requires equipment, trained personnel, and strict aseptic conditions.

Standardized protocols and rigorous trials are crucial to overcoming challenges and integrating PRP into evidence-based practice. With advancement in biotechnology and personalised approaches, PRP’s role in regenerative medicine is poised to expand, transforming dental and medical care.

Conclusion

Platelet-rich plasma represents a paradigm shift in regenerative therapy, harnessing the innate potential of platelets to promote tissue healing and regeneration. While significant progress has been made in its understanding and clinical use, challenges in standardization and evidence-based validation remain. Continued interdisciplinary research will determine the extent of PRP’s role in dentistry, orthopaedics, aesthetics, and beyond.

In conclusion, PRP is more than a clinical adjunct—it is an evolving therapeutic platform with the capacity to reshape patient care. Continued interdisciplinary research and standardization will determine how fully this potential is realized in everyday practice.

Refrences

1. Farley A, Hendry C, McLafferty E. Blood components. Nursing Standard (through 2013). 2012 Nov 28;27(13):35.
2. Barrer MJ, Ellison N. Platelet function. Anesthesiology. 1977 Mar 1;46(3):202-11.
3. Stassen JM, Nyström Å. A historical review of hemostasis, thrombosis, and

antithrombotic therapy. Annals of plastic surgery. 1997 Sep 1;39(3):317-29.
4. Andia I, Abate M. Platelet-rich plasma: underlying biology and clinical correlates. Regenerative medicine. 2013 Sep;8(5):645-58.
5. Carlson NE, Roach Jr RB. Platelet-rich plasma: clinical applications in dentistry. The Journal of the American Dental Association. 2002 Oct 1;133(10):1383-6.
6. Lynch MD, Bashir S. Applications of platelet-rich plasma in dermatology: a critical appraisal of the literature. Journal of Dermatological Treatment. 2016 May 3;27(3):285-9.
7. KINGSLEY, C. Blood Coagulation: Evidence of an Antagonist to Factor VI in Platelet-Rich Human Plasma. *Nature* **173**, 723–724 (1954).
8. Barrett KE, Barman SM, Yuan J, Brooks HL. Ganong's review of medical physiology. Mcgraw Hill Professional; 2019 Jan 21.
9. Smith RG, Gassmann CJ, Campbell MS. Platelet-rich plasma: properties and clinical applications. J Lanc Gen Hosp. 2007 Jul;2(2):73-7.
10. Perez AG, Lana JF, Rodrigues AA, Luzo AC, Belangero WD, Santana MH. Relevant aspects of centrifugation step in the preparation of platelet-rich plasma. International Scholarly Research Notices. 2014;2014(1):176060.
11. Newhall KJ, Diemer GS, Leshinsky N, Kerkof K, Chute HT, Russell CB, Rees W, Welcher AA, Patterson SD, Means GD. Evidence for endotoxin contamination in plastic Na+-heparin blood collection tube lots. Clinical chemistry. 2010 Sep 1;56(9):1483-91.
12. Dashore S, Chouhan K, Nanda S, Sharma A. Preparation of platelet-rich plasma: National IADVL PRP taskforce recommendations. Indian dermatology online journal. 2021 Nov 1;12(Suppl 1):S12-23.
13. Lei H, Gui L, Xiao R. The effect of anticoagulants on the quality and biological efficacy of platelet-rich plasma. Clinical biochemistry. 2009 Sep 1;42(13-14):1452-60.
14. Bausset O, Giraudo L, Veran J, Magalon J, Coudreuse JM, Magalon G, Dubois C, Serratrice N, Dignat-George F, Sabatier F. Formulation and storage of platelet-rich plasma homemade product. BioResearch open access. 2012 Jun 1;1(3):115-23.
15. Cavallo C, Roffi A, Grigolo B, Mariani E, Pratelli L, Merli G, Kon E, Marcacci M, Filardo G. Platelet-rich plasma: the choice of activation method affects the release of bioactive molecules. BioMed research international. 2016;2016(1):6591717.
16. Ehrenfest DM, Rasmusson L, Albrektsson T. Classification of platelet concentrates: from pure platelet-rich plasma (P-PRP) to leucocyte-and platelet-rich fibrin (L-PRF). Trends in biotechnology. 2009 Mar 1;27(3):158-67.
17. Magalon J, Chateau AL, Bertrand B, Louis ML, Silvestre A, Giraudo L, Veran J, Sabatier F. DEPA classification: a proposal for standardising PRP use and a retrospective application of available devices. BMJ open sport & exercise medicine. 2016 Feb 1;2(1): e000060.
18. Lee KS, Wilson JJ, Rabago DP, Baer GS, Jacobson JA, Borrero CG. Musculoskeletal applications of platelet-rich plasma: fad or future? American Journal of Roentgenology. 2011 Mar;196(3):628-36.
19. Emer J. Platelet-rich plasma (PRP): current applications in dermatology. Skin therapy letter. 2019 Sep 1;24(5):1-6.
20. Lynch MD, Bashir S. Applications of platelet-rich plasma in dermatology: a critical appraisal of the literature. Journal of Dermatological Treatment. 2016 May 3;27(3):285-9.
21. Applications of prp in dental procedures. Dr. Dasari Ramya, Dr. Polishetty Shiva krishna, Dr. H Aparna Latha, Dr. Vatsalya Kommalapati
22. Smith RG, Gassmann CJ, Campbell MS. Platelet-rich plasma: properties and clinical applications. J Lanc Gen Hosp. 2007 Jul;2(2):73-7.
23. El-Timamy A, El Sharaby F, Eid F, El Dakroury A, Mostafa Y, Shaker O. Effect of platelet-rich plasma on the rate of orthodontic tooth movement: a split-mouth randomized trial. The Angle Orthodontist. 2020 May 1;90(3):354-61.
24. Li Z, Zhou J, Chen S. The effectiveness of locally injected platelet-rich plasma on orthodontic tooth movement acceleration: A systematic review of animal studies. The Angle Orthodontist. 2021 May 1;91(3):391-8.

25. Yao K, Wu Y, Cai J, Wang Y, Shen Y, Jing D, Zhao Z. The effect of platelet-rich concentrates on orthodontic tooth movement: A review of randomized controlled trials. Heliyon. 2022 Sep 1;8(9).
26. Nimeri G, Kau CH, Abou-Kheir NS, Corona R. Acceleration of tooth movement during orthodontic treatment-a frontier in orthodontics. Progress in orthodontics. 2013 Dec;14:1-8.
27. Sikora M, Sielski M, Chęciński M, Chęcińska K, Czerwińska-Niezabitowska B, Chlubek D. Patient-Reported Quality of Life versus Physical Examination in Treating Temporomandibular Disorders with Intra-Articular Platelet-Rich Plasma Injections: An Open-Label Clinical Trial. International Journal of Environmental Research and Public Health. 2022 Oct 15;19(20):13299.
28. Hegab AF, Abd Al Hameed HI, Hassaneen AM, Hyder A. Synergistic effect of platelet rich plasma with hyaluronic acid injection following arthrocentesis to reduce pain and improve function in TMJ osteoarthritis. Journal of Stomatology, Oral and Maxillofacial Surgery. 2023 Feb 1;124(1):101340.
29. Singh AK, Sharma NK, Kumar PN, Singh S, Mishra N, Bera RN. Evaluation of arthrocentesis with and without platelet-rich plasma in the management of internal derangement of temporomandibular joint: a randomized controlled trial. Journal of Maxillofacial and Oral Surgery. 2021 Jun 20:252-7.
30. Parlawar AN, Mundada BP. Enhancing Pain Relief in Temporomandibular Joint Arthrocentesis: Platelet-Rich Plasma and Hyaluronic Acid Synergy. Cureus. 2023 Sep;15(9).
31. Gupta C, Mehrotra D, Mohammad S, Khanna V, Singh GK, Singh G, Chellappa AA, Passi D. Alveolar bone graft with Platelet Rich Plasma in cleft alveolus. Journal of oral biology and craniofacial research. 2013 Jan 1;3(1):3-8.
32. El-Anwar MW, Nofal AA, Khalifa M, Quriba AS. Use of autologous platelet-rich plasma in complete cleft palate repair. The Laryngoscope. 2016 Jul;126(7):1524-8.