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Review

Advanced platelet rich fibrin in periodontal regeneration

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Abstract: Regenerating periodontal tissue is the main goal of periodontal therapy. Periodontal tissue regeneration involves the development of new bone, cement, and periodontal ligaments on damaged tooth root surfaces in order to restore anatomy and function. In order to further enhance PRF (Platelet rich fibrin) and develop advanced platelet-rich fibrin, a slower rotating speed is proposed (A-PRFs). Cell dispersion is affected by centrifugation rate. The majority of the leukocytes in the PRF are concentrated near the bottom of the tube due to centrifugation rate. By switching the centrifugation process to 1,500 rpm for 14 minutes, granulocyte neutrophils and the fibrin matrix are more evenly distributed in the A-PRF created. Hence, a periodontal evaluation of this subject is required.

Keywords: centrifugation; growth factors; platelets; regeneration

1. Introduction

An inflammatory condition of the periodontal tissues known as periodontitis causes the affected teeth to become less stable, particularly the periodontal ligaments and the bone into which they are embedded. The predicted healing outcome after periodontal therapy is regeneration or repair. This is dependent on two important occurrences: the availability of the required cell types and the presence or absence of the signals required to draw in and activate the cells. Clot development starts the process of healing any wound, which is then followed by the proliferative and maturative stages. Growth factors aid wound healing by encouraging cell migration (chemotaxis), cell proliferation (mitogenesis), and the development of new blood vessels (angiogenesis) [1].

Platelet rich fibrin (PRF) is considered as a platelet concentrate of 2nd generation evolved by Choukroun et al. (2001) [2]. It is centrifuged blood with lack of any other inclusions and avoid using

any type of biochemical blood handling. PRF contains vascular endothelial growth factor (VEGF), transforming growth factor β-(TGFβ-1), and platelet derived growth factor (PDGF). The new modifications of PRF preparation lead to evolution of Advanced platelet rich fibrin (A-PRF). For getting more growth factor in A-PRF, there is minimum G forces as compared to PRF [3]. Because polymerization happens naturally, no bovine thrombin is needed. When compared to other platelet concentrates, it demonstrates prolonged growth factor release. High elasticity and flexibility can be found in A-PRF membrane. A-PRF is prepared by adhering to the 14-minute centrifugation time and 1500 rpm spinning rate technique. It consists of hematopoietic stem cells, T and B lymphocytes, and more (HSCs). The monocytes needed for bone production are more concentrated in it and are distributed further in an equivalent manner. The platelets are distributed equally across the entire clot as well [4].

2. Properties of A-PRF

Researcher are looking to mix bone grafts and platelet concentrates containing a range of growth factors in periodontal regenerative surgery to enhance the ability of local bone induction and tissue healing in an effort to increase the effectiveness of periodontal regeneration therapy. Among them, A-PRF the most recent generation of autologous platelet concentrate, is high in autologous growth factors that encourage cell migration and proliferation, which can speed up tissue remodelling and new angiogenesis. Results from A-PRF have been superior to those from PRP (Choukroun et al. 2006) [5]. This biomaterial, which is based on the low speed centrifugation concept (LSCC), provides macrophages in addition to growth factors to support the sustainability of A-PRF for a duration of 7 to 28 days. A-PRF favours a higher growth factor release than conventional PRF, and this may have a direct impact on tissue regeneration by boosting levels of collagen mRNA and fibroblast migration and proliferation [6].

There were more neutrophils and PRF. According to studies, gel-like A-PRF contains collagen fibres that are nearly in their physiological state. These collagen fibres can serve as a natural component that induces vascularization, supports the immune system, and serves as a three-dimensional scaffold for cell proliferation. TGF-, VEGF, and other growth factors can promote angiogenesis, inhibit osteoclasts, aid in the migration and proliferation of gingival fibroblasts, and create an environment that is conducive to the regeneration and repair of injured tissue. A-PRF generates significantly more of the chemotactic molecules CCL-5 and eotaxin, as well as the growth factors TGF-, PDGF, and VEGF than does conventional PRF [3].

The process of angiogenesis, which promotes endothelial cell migration and proliferation and maintains the creation of blood vessels, depends heavily on VEGF. By promoting osteoblast migration, proliferation, and differentiation, VEGF also aids in bone production. In order to promote bone regeneration, PDGF stimulates osteoblast precursor cells and aids in tissue repair [7]. TGF gathers osteoblast precursor cells, promotes osteoblast development, and boosts mesenchymal cell proliferation [8]. Furthermore, A-PRF contains more neutrophils than normal. Despite the identical total number of leukocytes, these inflammatory cells aid in the differentiation of monocytes and macrophages. A-PRF is a great medium for forming new vessels and repairing damaged tissue.

Figure 1. Centrifugation Machine used for preparation of A-PRF.

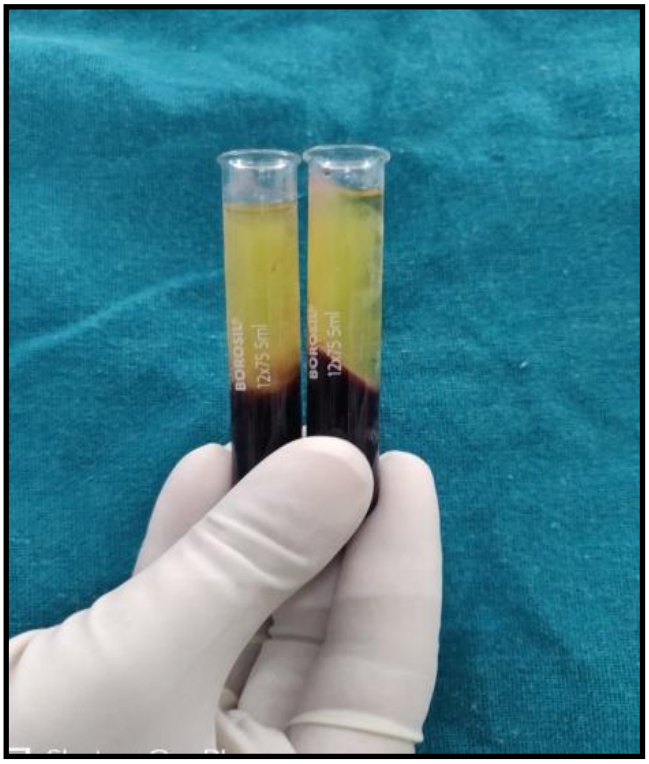

Figure 2. Advanced platelet rich fibrin.

3. Advantages

It is simple, safe and inexpensive process which required patient's own blood. It accelerates the wound healing and minimizes the discomfort [9].

4. Evidence of A-PRF in Periodontal regeneration

4.1. In vitro studies

Pitzurra et al. (2019) [10]. The efficacy of leukocyte-platelet-rich fibrin (L-PRF) and (A-PRF+) to promote the proliferation and migration of periodontal fibroblasts in vitro was examined. The researchers arrived to the conclusion that both L-PRF and A-PRF+ stimulate periodontal fibroblast migration and proliferation, with A-PRF+ maintaining artificial wound closure for a longer amount of time than L-PRF.

Nguyen et al. (2022) [11]. based on the in-vitro release of growth factors, examined the effects of a mixture of A-PRF and xenogenic bone replacement material (XBSM) on the proliferation and migration of human periodontal ligament stem cells (hPDLSCs). According to the findings, 20% APRF+XBSM greatly raised hPDLSC proliferation compared to treatments with 4% and 100% APRF+XBSM at different time periods. The authors came to the conclusion that combining APRF with XBSM releases growth factors, such as PDGF-AB and VEGF, for up to 7 days. The scientists came to the conclusion that APRF+XBSM would be useful for healing and periodontal regeneration as a result of the fact that APRF+XBSM further encouraged the proliferation and migration of hPDLSCs in vitro.

4.2. Animal studies

Masahiro et al. (2019) [12]. clarified how advanced PRF (A-PRF) affected the growth of bone in tooth sockets after extraction in beagle dogs. In this investigation, six female beagle dogs with clinically sound periodontal tissues were employed. Compared to the A-PRF group, bone development in the control group was inferior. At 30 days after extraction, dense bone growth was seen in the extraction socket of the A-PRF group. The authors came to the conclusion that A-PRF administration may increase new bone development and may speed up bone growth. By boosting osteoblast activity, A-PRF induced bone growth more quickly than a self-limiting process and may be helpful for bone production in clinical medicine.

4.3. Human clinical studies

Upadhyay et al. (2020) [4]. evaluated and compared PRF and A-PRF in the treatment of human periodontal infrabony defects (IBDs) both clinically and radiographically. Twenty-eight patients having IBDs were divided into Group A (PRF) and Group B (A-PRF). Comparison between both groups revealed statistically insignificant differences. Authors came to conclusion that individually, both the materials have shown promising results. Statistically, PRF group (Group A) showed better treatment outcome in terms of bone fill and A-PRF group (Group B) in terms of soft tissue healing.

Csifó-Nagy et al. (2021) [13]. clinically evaluated enamel matrix derivative regeneration of intrabony defects following treatment with a new generation of platelet-rich fibrin (A-PRF+) (EMD). Thirty intrabony defects were treated randomly with either A-PRF+ (test, n=15) or EMD (control, n=15) in 18 patients (9 men, 9 women). The new generation platelet-rich fibrin appears to be equally therapeutically effective as EMD during surgical therapy of intrabony defects, according to the authors' findings. Clinical outcomes from A-PRF+ or EMD treatment were consistent. A-PRF+, an autologous human product, can have a beneficial effect on periodontal repair.

Zahid et al. (2019) [14]. A-PRF was examined for its potential as a regenerative biomaterial for bone regeneration and postoperative complications following extraction of an impacted third molar. This clinical experiment was a split-mouth, double-blind, randomised study. The study enrolled a total of 10 female patients with bilaterally impacted third molars. Visual comparisons revealed that on the seventh postoperative day, pain and swelling were much lower in the A-PRF group than in the control group. Between the two groups, there was no statistically significant difference in healing scores. The authors came to the conclusion that A-PRF might potentially be used as a biomaterial to lower the intensity of pain and swelling following third molar surgery. The authors proposed that to acquire more significant outcomes on periodontal regeneration, long-term trials with a bigger sample size and methodologically solid assessment tools are required.

Yüce et al. (2019) [15]. The application of APRF+ based on the low speed centrifugation concept (APRF+) in cases of delayed wound healing due to alveolar osteitis following extraction of the third molar in the mandible was examined. This randomised prospective controlled clinical examination was conducted on 40 patients between the ages of 18 and 40 years [female (55%) to male (45%)] three days following the excision of mandibular third molars of classes A and 1 according to the Pell-Gregory classification. Hard tissue and epithelium statistically recovered statistically more faster in the APRF+ application group than in the control group. The authors report that by promoting faster wound healing, the use of APRF+ in the management of alveolar osteitis has reduced patient discomfort and pain intensity.

Chekurthi et al. (2021) [16]. In order to repair gingival recession abnormalities, advanced platelet-rich fibrin (A-PRF) in conjunction with a coronally advanced flap (CAF) was examined for its clinical efficacy. In 18 instances, total root coverage was attained. GTH, CAL, WAG, and KTH all saw significant increases at six months. The average RES and VAS aesthetic scores were, respectively, 8.54 mm and 8.83 mm and 1.17 mm. The authors came to the conclusion that A-PRF could be employed as a therapy option for cases of recession.

Tadepalli et al. (2022) [17]. The therapeutic effectiveness of L-PRF and A-PRF combined with CAF in correcting anomalies of gingival recession was assessed and compared. For systemically healthy subjects with 30 Miller's class I or II gingival recession anomalies in their maxillary anteriors and premolars, treatment options comprised CAF + L-PRF or CAF + A-PRF. Between the therapy groups, there was no appreciable variation in the mean clinical indicators after six months. When compared to the mean baseline values, the CAF + L-PRF and CAF + A-PRF locations showed statistically significant improvement in all clinical parameters at 6 months. The authors' findings suggest that both L-PRF and A-PRF can effectively treat gingival recession in the maxilla.

Clark et al. (2018) [18] investigated how well A-PRF alone or in combination with freeze-dried bone allograft (FDBA) improved alveolar dimensional stability and vital bone growth during ridge preservation. A-PRF alone or combined with FDBA can be a promising biomaterial for ridge preservation, according to the authors' findings.

In the treatment of infrabony pockets, Suwondo et al. (2018) [19]. investigated the variations in periodontal tissue regeneration following the administration of A-PRF and PRF based on probing depth (PD), relative attachment loss (RAL), and alveolar bone height. 20 infrabony pockets were separated into two groups; 10 individuals from each group received treatment with OFD+A-PRF and OFD+PRF. On days 0, 30, and 90, measures of periodontal depth and RAL were taken. CBCT X-rays were used to measure bone height on days 0 and 90. According to the authors, applying A-PRF results in increased probing depth and a relative attachment loss reduction when compared to PRF, as well as an increase in bone height equal to that seen when treating infrabony pockets.

A-PRF use in various periodontal regeneration treatment modalities has been demonstrated by several researchers to produce better clinical results. A-PRF and bone grafts together have shown to significantly correct periodontal abnormalities clinically.

5. Conclusions

The autogenous nature of A-PRF makes it simple to use and manipulate. According to the studies in the literature stated above, A-PRF is utilised successfully and without any complications in the periodontal regeneration and healing process.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Conflict of interest

The authors declare no conflict of interest.

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References

1. Chu C, Zhao X, Rung S, et al. (2022) Application of biomaterials in periodontal tissue repair and reconstruction in the presence of inflammation under periodontitis through the foreign body response: Recent progress and perspectives. *J Biomed Mater Res Part B* 110: 7–17. https://doi.org/10.1002/jbm.b.34891
2. Dohan DM, Choukroun J, Diss A, et al. (2006) Platelet-rich fibrin (PRF): a second-generation platelet concentrate. Part I: technological concepts and evolution. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 101: e37–e44. https://doi.org/10.1016/j.tripleo.2005.07.008

3. Ghanaati S, Booms P, Orlowska A, et al. (2014) Advanced platelet-rich fibrin: a new concept for cell-based tissue engineering by means of inflammatory cells. *J Oral Implantol* 40: 679–689. https://doi.org/10.1563/aaid-joi-D-14-00138
4. Upadhyay H, Bhattacharya H S, Agarwal M C, et al. (2020) Different regenerative responses of two platelet concentrates in the treatment of human periodontal infrabony defects: a clinico-radiographic study. *Contemp Clin Dent* 11: 217. https://doi.org/10.4103/ccd.ccd_7_19
5. Choukroun J, Diss A, Simonpieri A, et al. (2006) Platelet-rich fibrin (PRF): a second-generation platelet concentrate. Part IV: clinical effects on tissue healing. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 101: e56–e60. https://doi.org/10.1016/j.tripleo.2005.07.011
6. Fujioka-Kobayashi M, Miron RJ, Hernandez M, et al. (2017) Optimized platelet-rich fibrin with the low-speed concept: growth factor release, biocompatibility, and cellular response. *J periodontol* 88: 112–121. https://doi.org/10.1902/jop.2016.160443
7. Hu K, Olsen BR (2016) The roles of vascular endothelial growth factor in bone repair and regeneration. *Bone* 91: 30–38. https://doi.org/10.1016/j.bone.2016.06.013
8. Devescovi V, Leonardi E, Ciapetti G, et al. (2008) Growth factors in bone repair. *Chir Organi Mov* 92: 161–168. https://doi.org/10.1007/s12306-008-0064-1
9. Caruana A, Savina D, Macedo JP, et al. (2019) From platelet-rich plasma to advanced platelet-rich fibrin: biological achievements and clinical advances in modern surgery. *Eur J Dent* 13: 280–286. https://doi.org/10.1055/s-0039-1696585
10. Pitzurra L, Jansen IDC, de Vries TJ, et al. (2020) Effects of L-PRF and A-PRF+ on periodontal fibroblasts in in vitro wound healing experiments. *J Periodontal Res* 55: 287–295. https://doi.org/10.1111/jre.12714
11. Nguyen M, Nguyen TT, Tran HLB, et al. (2022) Effects of advanced platelet-rich fibrin combined with xenogenic bone on human periodontal ligament stem cells. *Clin Exp Dent Res* 8: 875–882. https://doi.org/10.1002/cre2.563
12. To M, Su C, Hidaka K, et al. (2019) Effect of advanced platelet-rich fibrin on accelerating alveolar bone formation in dogs: A histological and immunofluorescence evaluation. *Anat Sci Int* 94: 238–244. https://doi.org/10.1007/s12565-019-00479-1
13. Csifó-Nagy B K, Sólyom E, Bognár V L, et al. (2021) Efficacy of a new-generation platelet-rich fibrin in the treatment of periodontal intrabony defects: a randomized clinical trial. *BMC Oral Health* 21: 1–10. https://doi.org/10.1186/s12903-021-01925-1
14. Zahid TM, Nadershah M (2019) Effect of advanced platelet-rich fibrin on wound healing after third molar extraction: a split-mouth randomized double-blind study. *J Contemp Dent Pract* 20: 1164–1170. https://doi.org/10.5005/jp-journals-10024-2666
15. Yüce E, Kömerik N (2019) Potential effects of advanced platelet rich fibrin as a wound-healing accelerator in the management of alveolar osteitis: A randomized clinical trial. *Niger J Clin Pract* 22: 1189. https://doi.org/10.4103/njcp.njcp_27_19
16. Chekurthi S, Tadepalli A, Parthasarathy H, et al. (2022) Evaluation of clinical efficacy of advanced platelet-rich fibrin in the management of gingival recession defects: case series. *Clin Adv Periodontics* 12: 88–93. https://doi.org/10.1002/cap.10160
17. Tadepalli A, Chekurthi S, Kavassery Balasubramanian S, et al. (2022) Comparative evaluation of clinical efficacy of leukocyte-rich platelet-rich fibrin with advanced platelet-rich fibrin in management of gingival recession defects: a randomized controlled trial. *Med Princ Pract* 31: 376–383. https://doi.org/10.1159/000525560

18. Clark D, Rajendran Y, Paydar S, et al. (2018) Advanced platelet-rich fibrin and freeze-dried bone allograft for ridge preservation: a randomized controlled clinical trial. *J Periodontol* 89: 379–387. https://doi.org/10.1002/JPER.17-0466
19. Suwondo C I, Herawati D, Sudibyo S (2019) Effect of advanced platelet-rich fibrin applications on periodontal regeneration in infrabony pocket treatment. *Majalah Kedokteran Gigi Indonesia* 4: 154–160. https://doi.org/10.22146/majkedgiind.37414

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