Case Report

Enhancing clinical outcomes of regenerative periodontal treatment in periodontitis stage II grade B using platelet-rich fibrin: a case report

Noormaya Sari[1*]
Christianie Christianie[2]

[1]Specialist program of Periodonsia, Faculty of Dentistry, Universitas Gadjah Mada, Yogyakarta, Indonesia
[2]Department of Periodonsia, Faculty of Dentistry, Universitas Gadjah Mada, Yogyakarta, Indonesia

* Correspondence:
noormayasari83@gmail.com

Received: 6 September 2025
Revised: 20 October 2025
Accepted: 22 November 2025
Published: 30 November 2025
DOI: 10.24198/pjd.vol37no3.62750

p-ISSN 1979-0201
e-ISSN 2549-6212

Citation:
Sari, N. Christianie, C. Enhancing clinical outcomes of regenerative periodontal treatment in periodontitis stage II grade B using platelet-rich fibrin: a case report Padjadjaran J. Dent, November. 2025; 37(3): 440-447.

ABSTRACT

Introduction: Periodontitis is a complex, multifactorial inflammatory disease of tooth-supporting tissues that can impair quality of life if left untreated. Therefore, treatment that can improve good clinical outcomes and last for a long time is needed. This case report aims to present the periodontal regenerative therapy of a patient with stage 3 grade B periodontitis using platelet-rich fibrin (PRF) combined with bovine bone graft and pericardium membrane. **Case report**: A 36-year-old female patient presented for treatment of her lower anterior teeth. She complained of gum bleeding, tooth mobility and discomfort when chewing food for one year. Clinical examinations showed deep periodontal pockets and alveolar bone loss up to half the length of the root of teeth 31 and 41. After the initial phase treatment, which comprises scaling and root planning, teeth contact point repairment, extra coronal fiber splint installation and occlusal adjustment are performed. The surgical phase treatment of regenerative therapy is then performed using PRF combined with bovine bone graft and pericardium membrane. **Conclusion:** Regenerative periodontal treatment using platelet-rich fibrin (PRF) combined with bovine bone graft and pericardium membrane is proven to improve clinical outcomes in pocket probing depth successful (PD) reduction, gain of clinical attachment level (CAL) and alveolar bone regeneration.

KEYWORDS

Keywords: regenerative, periodontal, treatment, platelet-rich, fibrin

INTRODUCTION

Periodontitis is a chronic inflammatory disease of the supporting tissues of the teeth.[1–3], with a prevalence of 62% in adults dentate worldwide.[4] This disease is initiated by pathogenic dental plaque that adheres to the tooth surface.[5,6] Severe periodontitis can impact decreasing chewing ability, nutritional status and quality of life.[2]

Treatment for early periodontitis can be done with an initial phase that comprises scaling and root planing. However, in the case of moderate and advanced periodontitis, initial treatment alone is not sufficient. Therefore, reducing and eliminating the causes of periodontal disease can be done with direct access to the periodontal defect, which surgical techniques can provide.[7]

In addition to conventional flap surgery, periodontal surgical treatment can be performed with regenerative therapy. Guided tissue regeneration (GTR), one of the regenerative surgery methods, is performed to regenerate lost periodontal tissue such as cementum, periodontal ligaments and bones lost during the

pathological process. The GTR technique using bone graft aims to stimulate new bone formation.[8,9] Various types of graft materials can be used, including xenograft. Xenograft is a bone graft material derived from animal donors, often used in regenerative periodontal therapy because of its ability to maintain volume due to its non-resorbable properties.[10]

Regenerative treatment aims to guide the reattachment of the epithelium to the coronal position, which will help the newly formed bone, cementum and periodontal ligament to re-form on the teeth surface. The guide is a physical barrier, a membrane that will prevent bacteria and gingival epithelial cells from attaching to the tooth surface.[11]

The ideal membrane used in GTR treatment must have the following capabilities: (a) biocompatible with periodontal tissue so that it will not cause an inflammatory reaction, (b) undergo degradation equivalent to the process of new tissue formation, and (c) physically adequate to prevent collapse when placed on a periodontal defect.[11] Various types of membrane barriers are used in GTR, generally divided into non-resorbable and resorbable membranes. The membrane barrier often used in regenerative periodontal surgical treatment is the resorbable membrane, which has advantages over the non-resorbable membrane because it does not require a second surgery to remove from the surgical area.[12,13]

Platelet-rich fibrin (PRF) was introduced by Choukroun et al.[7,14] It is the second generation of platelet concentrate, known as a biological autologous scaffold, clinically proven to improve the guided tissue regeneration outcomes in periodontal regeneration process. Various contents in PRF include platelet concentrate, different growth factors such as platelet derived growth factors (PDGF), the vascular endothelial growth factors (VEGF), transforming growth factors beta (TGF-β), insulin-like growth factor (IGF) and also fibrin, fibronectin, vitronectin and thrombospondin which are released slowly during the degradation process.[15–17]

Platelet-rich fibrin in periodontal regenerative surgery is believed to accelerate wound healing and reduce post-operative discomfort due to its growth factor content and anti-inflammatory and hemostatic effects. PRF as a scaffold, combined with other bone graft materials, aims to improve its physical and biological properties. Many recent RCT studies have shown that using PRF combined with bovine bone graft will improve clinical outcomes.[18]

This case report aims to present the periodontal regenerative therapy of a patient with stage 3 grade B periodontitis using platelet-rich fibrin (PRF) combined with bovine bone graft and pericardium membrane. The novelty of this case is the techniques of releasing the flap using a comb and preparing the PRF which is chopped into small pieces, combined with bovine bone graft, and covered with pericardium membrane. The uniqueness of this case is that the bone damage only occurred on the anterior lingual side of mandibula which may have occurred due to trauma from the occlusion.

Case Report

A 36-year-old female patient complained of the inner lower front gums that often bleed, sometimes swell, feel loose and are uncomfortable when chewing food. The patient has felt these complaints for approximately one year. No abnormalities were found during the extraoral examination. On intraoral examination, the anterior lingual gingiva of the lower jaw was reddish, edematous, and had a soft consistency.

There was a space between teeth 31 and 41, accompanied by grade 1 tooth mobility. Examination with a periodontal probe showed bleeding on teeth 31 and 41 during probing. The pocket depth on the mesiolingual of tooth 31 was 8 mm, midlingual 4 mm and distolingual 7 mm, and the pocket depth on tooth 41 was 7 mm on the mesiolingual, 4 mm on the midlingual and 6 mm on the distolingual.

The results of the panoramic radiographic examination showed that there was alveolar bone loss up to half the length of the roots of teeth 31 and 41 (figure 1B). Based on the examination that was done, the patient's diagnosis was chronic periodontitis stage 3 grade B.

The treatment plan given to the patient included dental health education, scaling and root planing, repair of the contact point between teeth 31 and 41, installation of extracoronal fiber splints and occlusal adjustment as the initial phase, as seen in the figure 1A. The treatment then continued with the surgical phase in the form of regenerative periodontal surgical treatment, which was then followed by the maintenance phase. In this case, the patient's prognosis was good because the patient was still young; the patient was cooperative; the etiological factors could be controlled; and there were no accompanying systemic diseases.

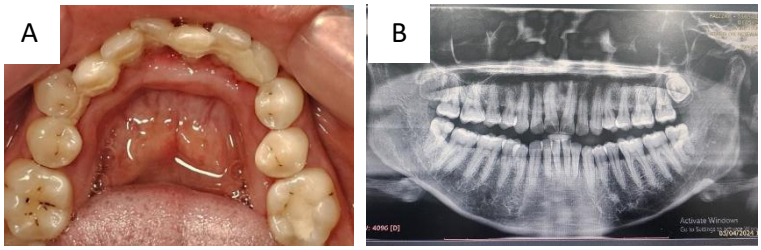

Figure 1. A. Intraoral condition after initial treatment, B. panoramic radiograph of initial condition.

On the first visit, after anamnesis, extraoral and intraoral examination and supporting radiographic examination, the patient was given initial treatment including scaling and root planing, contact point repair between teeth 31 and 41, installation of extracoronal fiber splint and occlusal adjustment. The patient was informed about her disease, the next treatment plan, and how to maintain her dental health properly.

On the next visit, after the patient had signed the informed consent, asepsis of the surgical area was performed using povidone iodine. Furthermore, infiltration anesthesia was performed on the vestibule and lingual of the teeth 31, 32, 41 and 42. After the surgical area was anesthetized, an intrasulcular incision was performed on teeth 31,32,41 and 42 using a 15-c blade.

After that, a full-thickness elevation flap was performed using a periosteal elevator from the edge of the incision to the alveolar bone defect. Then, debridement was performed using a Gracey curette to remove granulation and necrotic tissue on the root's surface, and the remaining subgingival calculus was cleaned using a scaler. The surgical area was then irrigated using saline solution, as seen in figure 2.

Figure 2. A. Intrasulcular incision, B. flap elevation until the bone defect area was exposed, C. removing the granulation and necrotic tissue.

After the surgical area was cleaned, PRF was prepared by taking 20 ml of the patient's blood, which was then centrifuged at 2700 rpm for 12 minutes. Before the bone graft was applied, EDTA gel was first applied to the root's surface for 2 minutes. Bovine bone graft from the TiOSS brand of South Korea with granule size 0,5-1,2 mm was applied to the root's surface, followed by PRF membrane chopped into small pieces, then covered with pericardium membrane (BATAN).

After that, the flap was repositioned until the entire surgical area was closed and fixed with sutures using the vertical mattress technique using nylon thread 5.0. Then, the surgical area was closed using a periodontal dressing. The patient was then given an antibiotic, analgesic, mouthwash medication, and post-operative education. The patient was also instructed to come for control at one week, two weeks, one month, 3 months and 6 months after surgery (figure 3).

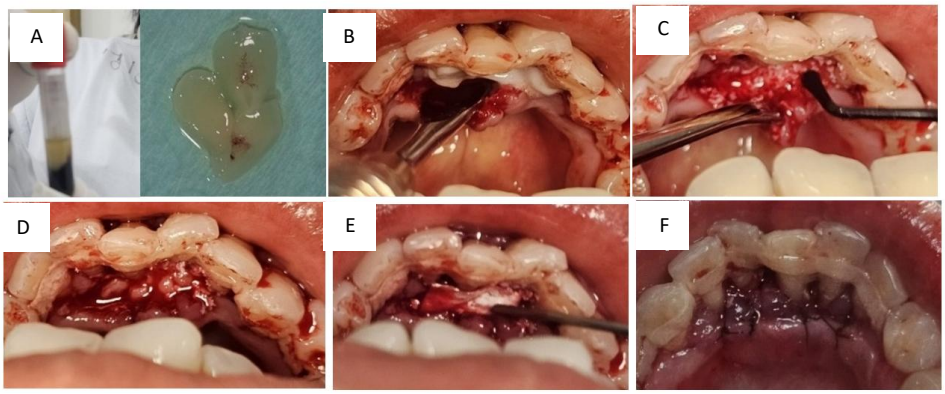

Figure 3. A. Platelet-rich fibrin ready to be applied, B. EDTA application for 2 minutes, C. application of bovine bone graft to the defect area after flap releasing, D. PRF, chopped into small pieces combined with bovine bone graft, E. application of the pericardium membrane, F. surgery area after suturing.

The patient came for a control one week after surgery. The patient did not complain of any pain in the post-surgery area. After removing the periodontal dressing, the post-surgery area was still reddish, and the suturing was still intact. The patient was instructed to continue using her mouthwash and maintain oral hygiene. The patient came back for control two weeks after surgery (figure 4). The patient also did not complain of any pain.

The post-surgery area still looked slightly reddish. The sutures were removed, and the patient was instructed to return for control. The patient returned for a visit one month after surgery and did not complain of pain or soreness. Intraoral examination showed that the gingiva was coral pink with a firm consistency, indicating that the patient's gingiva had healed entirely.

Figure 4. A. Clinical condition two weeks after surgery, B. one month after surgery C. 6 months after surgery

The patient then returned for control 3 months after surgery. The patient had no complaints in the post-surgery area. At this visit, pocket depth and clinical attachment level were examined using a periodontal probe. The patient was then given maintenance phase treatment. The patient then returned for control 6 months after surgery. The patient had no complaints in the post-surgery area and said she was satisfied with the result of the periodontal surgery. At this visit, pocket depth and clinical attachment level were also examined. Supporting radiographic examinations were performed to see wound healing and bone fill in the root teeth of 31 and 41. The results showed a significant decrease in pocket depth (PD), increased clinical attachment level (CAL), and increased bone fill in

the coronal portion of the root's teeth 31 and 41. The measurement results are presented in the table below:

Table 1. Pocket probing depth (PB) and clinical attachment level measurement (CAL) (in mm)

	Element 31			Element 41		
Pocket probing depth	ML	L	DL	ML	L	DL
Initial	8	4	7	7	4	6
3 months	2	1	2	3	2	2
6 months	2	1	2	2	2	2
Clinical attachment level	ML	L	DL	ML	L	DL
Initial	5	1	4	4	1	3
3 months	-	-	-	-	-	-
6 months	-	-	-	-	-	-

Note: ML (mesio lingual), L (midlingual), DL (disto lingual)

The difference in the patient's radiographs from the initial condition compared to the final condition is shown in the figure 5.

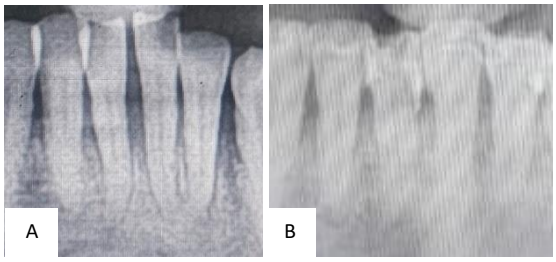

Figure 5. Comparison of the initial condition radiograph A. with the final condition B.

DISCUSSION

Periodontitis in this patient occured due to the accumulation of plaque and calculus exacerbated by the malposition of teeth 31 and 41, causing traumatic occlusion, tooth mobility and pathological tooth migration (figure 1). This is consistent with numerous previous studies that suggested that primary etiology of periodontitis is biofilms, plaque and calculus. However, this condition can be exacerbated by other predisposing factors, such as trauma from occlusion and poor tooth alignment. Initial phase treatment comprises scaling and root planing, contact point repairment, installation of extracoronal fiber splints and occlusion adjustment to eliminate the etiology of periodontitis so that the next phase of treatment could be carried out. The patient was willing to undergo orthodontic treatment after undergoing periodontal surgical treatment, so the patient's main complaints, such as frequent bleeding gums, swelling and tooth mobility, could be resolved first.

Periodontal flap surgery aims to facilitate access and increase operator visibility. Therefore, the operator can freely perform debridement in the bone defect area to completely clean necrotic and granulation tissue on the cementum and root surface. It is expected to eliminate the accumulation of pathogenic bacteria in the defect area. In this case, the periodontal flap surgical procedure stages are shown in Figures 2 to 3. Previous research has shown that an open flap surgery technique in periodontitis treatment will improve visibility and access to the pathological area. But in this case, the treatment not only focused on access and visibility of the defect but also on other factors, such as the addition on bone graft and membrane materials, as well as the flap return technique to accelerate and improve postoperative healing.

One strategy to accelerate the wound healing process is to increase and expedite the release of growth factors, promoting healing in bone defects and

periodontal regeneration. A simple way to achieve this goal is to activate the local release of platelet-derived growth factors obtained by applying platelet-rich fibrin (PRF). Various growth factors contained in PRF are released in the early stages of tissue healing and last longer in the periodontal tissue[14,19], so that they can increase the process of angiogenesis, proliferation and differentiation of osteoblast cells.[20]

In this case, the use of PRF in combination with bovine bone graft and pericardium membrane has been shown to provide decrease in pocket probing depth from 8 mm (ML), 4 mm (L) and 7 mm (DL) into 2 mm (ML), 1 mm (L) and 2 mm (DL) at teeth 31, also decrease in pocket probing depth from 7 mm (ML), 4 mm (L) and 6 mm (ML) into 2 mm (L), 2 mm (L) and 2 mm (DL) at teeth 41 and gain in clinical attachment level after 3 months and 6 months post surgery control (table 1).

This result is also in accordance with the results of previous studies, which stated that the addition of PRF to periodontal flap surgery will increase the reduction in probing depth and gain in clinical attachment level compared to flap surgery without the addition of PRF.[21–23] In this case, the patient also reported minimal post-surgery pain as indicated by the absence of complaints during post-surgery control. This may occur because the PRF content contains growth factors and has an anti-inflammatory effect to reduce post-surgery discomfort.[18]

In regenerative procedures, xenograft has been proven successful in treating intrabony defects. Bovine-derived xenograft (BDX) is obtained through a controlled, low-heat chemical extraction process. The surface area, porosity, crystal size and calcium to phosphate ratio of BDX are almost similar to those of human cancellous bone. Bovine-derived xenograft has osteoconductive properties and is well integrated into the bone. Bovine-derived xenograft can be reabsorbed for a long time, so that it can last longer in the defect area, protect the viability of the buccal bone plate, act as a filler that holds blood clots and as an osteoconductive medium for blood vessels so that stem cells and growth factors from PRF can adhere well.

Previous studies' results have reported better healing using this graft material by showing the regeneration of cementum, periodontal ligament and alveolar bone.[24] In this case, it was seen in the bone filling around the defect area, where previously the bone damage reached half the length of the tooth root's surface. After 6 months of operation (post-operation), the bone filling appeared dense and filled up the coronal roots of teeth 31 and 41, as shown in Figure 5. This results are in line with previous research where the benefits of using bone grafts with PRF material began to be seen 6 to 12 months after surgery. In this case, the bone filling results were satisfactory which began to be seen from the first 6 months, where clinically teeth 31 and 41 no longer felt loose.

Bovine-derived xenograft can also be combined with a resorbable membrane barrier. In this case, the membrane barrier used was the pericardium membrane from BATAN (Figure 3E). In regenerative treatment, the pericardium membrane functions as a physical barrier. The pericardium membrane will prevent soft tissue migration towards the bone defect.[25] To improve bone regeneration, the bone must have a gap separated from the surrounding connective tissue.

This pericardium membrane will protect the bone defect and provide sufficient tissue for the bone to regenerate. In addition, the pericardium membrane also acts as a scaffold for the migration, proliferation and attachment of periodontal ligament fibroblasts, allowing growth factors release and maintaining blood flow supply to the defect zone to promote soft tissue and bone regeneration, so that the periodontal tissue regeneration process is achieved.[26-28] The wound healing process after periodontal flap surgery does not always result in the formation of new periodontal tissue, but instead only forms epithelial attachment (long junctional epithelium) on the tooth root surface. [29,30]

The regenerative treatment procedure performed in this case aimed to restore new periodontal tissue, including cementum, periodontal ligament and

alveolar bone. The use of bovine-derived bone graft and pericardium membrane combined with the addition of platelet-rich fibrin has been proven to provide good results as indicated by a reduction in pocket depth, gain in clinical attachment level and an increase in bone filling after 6 months of control.

The limitation of this case is a relatively short-term control period. Therefore, a longer-term control period is needed to ensure the long-term treatment success and to address any problems that may arise after the periodontal regenerative surgery that has been performed.

CONCLUSION

Periodontal regenerative therapy of a patient with stage 3 grade B periodontitis using platelet-rich fibrin (PRF) combined with bovine bone graft and pericardium membrane is effective. It provides good results as evidenced by decreased pocket probing depth, gain in clinical attachment level and the formation of new alveolar bone around the periodontal tissue. The implication of this case report is encouraging better management and treatment of chronic periodontitis.

Acknowledgement
We would like to express our gratitude to our supervisor for their guidance and support throughout the writing process.
Author Contributions: research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "Conceptualization, N.S. and C.; methodology, N.S.; software, N.S.; validation, N.S. and C.; formal analysis,N.S.; investigation, N.S.; resources, N.S.; data curation, N.S.; writing original draft preparation,N.S.; writing review and editing, N.S.; visualization, N.S.; supervision, C.; project administration,N.S.; funding acquisition, C. All authors have read and agreed to the published version of the manuscript.", please turn to the CRediT taxonomy for the term explanation. Authorship must be limited to those who have contributed substantially to the work reported.
Funding: This research received no external funding
Informed Consent Statement: Written informed consent has been obtained from the patient to publish this paper.
Data Availability Statement: Not applicable
Conflicts of Interest: the authors declare no conflict of interest in this case report.

REFERENCES

1. Preshaw PM, Taylor JJ, Jaedicke KM, De Jager M, Bikker JW, Selten W, et al. Treatment of periodontitis reduces systemic inflammation in type 2 diabetes. J Clin Periodontol. 2020;47(6):737–46. https://doi.org/10.1111/jcpe.13274
2. Wu CZ, Yuan YH, Liu HH, Li SS, Zhang BW, Chen W, et al. Epidemiologic relationship between periodontitis and type 2 diabetes mellitus. BMC Oral Health. 2020;20(1):1–15. https://doi.org/10.1186/s12903-020-01180-w
3. Kolte R, Kolte A, Bawankar P, Bajaj P. Effect of nonsurgical periodontal therapy on metabolic control and systemic inflammatory markers in patients of type 2 diabetes mellitus with stage III periodontitis. Contemp Clin Dent. 2023;(14):45–51. https://doi.org/10.4103/ccd.ccd_514_21
4. Villoria GEM, Fischer RG, Tinoco EMB, Meyle J, Loos BG. Periodontal disease: A systemic condition. Periodontol 2000. 2024;(96):7–19. https://doi.org/10.1111/prd.12616
5. Rahim A, Hassan S, Ullah N, Noor N, Ahmed, Rafique R, et al. Association and comparison of periodontal and oral hygiene status with serum HbA1c levels: a cross-sectional study. BMC Oral Health. 2023;23(1):1–9. https://doi.org/10.1186/s12903-023-03042-7
6. Chung WC, Huang CF, Feng SW. Clinical Benefits of Minimally Invasive Non-Surgical Periodontal Therapy as an Alternative of Conventional Non-Surgical Periodontal Therapy—A Pilot Study. Int J Environ Res Public Health. 2022;19(12). https://doi.org/10.3390/ijerph19127456
7. Newman MG, Cochran DL. Clinical Evaluation of the Implant Patient. Carranza's Clinical Periodontology. 2019. 635-648 p.
8. Stavropoulos A, Bertl K, Spineli LM, Sculean A, Cortellini P, Tonetti M. Medium- and long-term clinical benefits of periodontal regenerative/reconstructive procedures in intrabony defects: Systematic review and network meta-analysis of randomized controlled clinical studies. J Clin Periodontol. 2021;48(3):410–30. https://doi.org/10.1111/jcpe.13409
9. Stavropoulos A, Bertl K, Sculean A, Kantarci A. Regenerative Periodontal Therapy in Intrabony Defects and Long-Term Tooth Prognosis. Dent Clin North Am. 2022;66(1):103–9. https://doi.org/10.1016/j.cden.2021.09.002
10. Miron RJ. Optimized bone grafting. Periodontology 2000. 2024;94(1):143-160. https://doi.org/10.1111/prd.12517
11. Kormas I, Pedercini A, Alassy H, Wolff LF. The Use of Biocompatible Membranes in Oral Surgery: The Past, Present & Future Directions. A Narrative Review. Membranes (Basel). 2022;12(9):1–14. https://doi.org/10.3390/membranes12090841
12. Kim K, Su Y, Kucine AJ, Cheng K, Zhu D. Guided Bone Regeneration Using Barrier Membrane in Dental Applications. ACS Biomater Sci Eng. 2023;9(10):5457–78. https://doi.org/10.1021/acsbiomaterials.3c00690
13. Bianchi S, Bernardi S, Simeone D, Torge D, Macchiarelli G, Marchetti E. Proliferation and Morphological Assessment of Human Periodontal Ligament Fibroblast towards Bovine Pericardium Membranes: An In Vitro Study. Materials (Basel).

2022;15(23). https://doi.org/10.3390/ma15238284
14. Wang X, Zhang Y, Choukroun J, Ghanaati S, Miron RJ. Effects of an injectable platelet-rich fibrin on osteoblast behavior and bone tissue formation in comparison to platelet-rich plasma. Platelets. 2018;29(1):48–55. http://dx.doi.org/10.1080/09537104.2017.1293807
15. Abdulrahman YA, Hosny MM, Elfana A, Fawzy El-Sayed KM. Clinical and radiographic evaluation of low-speed platelet-rich fibrin (PRF) for the treatment of intra-osseous defects of stage-III periodontitis patients: a randomized controlled clinical trial. Clin Oral Investig. 2022;26(11):6671–80. https://doi.org/10.1007/s00784-022-04627-2
16. Mijiritsky E, Assaf HD, Peleg O, Shacham M, Cerroni L, Mangani L. Use of PRP, PRF and CGF in periodontal regeneration and facial rejuvenation-a narrative review. Biology (Basel). 2021;10(4):1–23. https://doi.org/10.3390/biology10040317
17. Bilgen F, Ural A, Bekerecioglu M. Platelet-rich fibrin: An effective chronic wound healing accelerator. J Tissue Viability. 2021;30(4):616–20.https://doi.org/10.1016/j.jtv.2021.04.009
18. Arora M, McAulay N, Farag A, Natto ZS, Lu J, Albuquerque R, et al. The Effectiveness of Platelet Rich Fibrin in Alveolar Ridge Reconstructive or Guided Bone Regenerative Procedures: A Systematic Review and Meta-Analysis. J Dent. 2025;153:1–11. https://doi.org/10.1016/j.jdent.2024.105548
19. Csifó-Nagy BK, Sólyom E, Bognár VL, Nevelits A, Dőri F. Efficacy of a new-generation platelet-rich fibrin in the treatment of periodontal intrabony defects: a randomized clinical trial. BMC Oral Health. 2021;21(1):1–10. https://doi.org/10.1186/s12903-021-01925-1
20. Baca-Gonzalez L, Serrano Zamora R, Rancan L, González Fernández-Tresguerres F, Fernández-Tresguerres I, López-Pintor RM, et al. Plasma rich in growth factors (PRGF) and leukocyte-platelet rich fibrin (L-PRF): comparative release of growth factors and biological effect on osteoblasts. Int J Implant Dent. 2022;8(1). https://doi.org/10.1186/s40729-022-00440-4
21. Miron RJ, Moraschini V, Fujioka-Kobayashi M, Zhang Y, Kawase T, Cosgarea R, et al. Use of platelet-rich fibrin for the treatment of periodontal intrabony defects: a systematic review and meta-analysis. Clin Oral Investig. 2021;25(5):2461–78. https://doi.org/10.1007/s00784-021-03825-8
22. Al Qabbani A, Al Kawas S, Razak NHA, Al Bayatti SW, Enezei HH, Samsudin AR, et al. Three-Dimensional Radiological Assessment of Alveolar Bone Volume Preservation Using Bovine Bone Xenograft. J Craniofac Surg. 2018;29(2):e203–9. https://doi.org/10.1097/SCS.0000000000004263
23. Mubarak R, Adel-Khattab D, Abdel-Ghaffar KA, Gamal AY. Adjunctive effect of collagen membrane coverage to L-PRF in the treatment of periodontal intrabony defects: a randomized controlled clinical trial with biochemical assessment. BMC Oral Health. 2023;23(1):1–12. https://doi.org/10.1186/s12903-023-03332-0
24. Kumaran SL, Periakaruppan SP. Efficacy of Bovine-derived Xenograft and Minimally Invasive Surgical Technique in the Treatment of Human Periodontal Intrabony Defects- A Systematic Review and Meta-analysis. Asian J Pharm Res Heal Care. 2022;14(1):48.
25. Bornert F, Herber V, Sandgren R, Witek L, Coelho PG, Pippenger BE, et al. Comparative barrier membrane degradation over time: Pericardium versus dermal membranes. Clin Exp Dent Res. 2021;7(5):711–8. https://doi.org/10.1002/cre2.414
26. Ausenda F, Rasperini G, Acunzo R, Gorbunkova A, Pagni G. New perspectives in the use of biomaterials for periodontal regeneration. Materials (Basel). 2019;12(13). https://doi.org/10.3390/ma12132197
27. Rojas, M.A.; Marini, L.; Russo, P.; Blardi, V.; Schmidlin, P.R.; Pilloni, A. Clinical Pilot Series of Non-Self-Contained Periodontal Infrabony Defects Treated with a Slowly Resorbable Bovine Pericardium Membrane in Combination with Low-Temperature-Treated Decellularized Bovine Bone Particles. Dent. J. 2021, 9, 110. https://doi.org/10.3390/dj9100110
28. Dasuki N, Taib Z, Berahim et al. Bovine Pericardium Membrane as a Barrier Material for Periodontal Tissue Regeneration: A Retrospective Study. JHSMR. 2025;43(5)
29. Fraser D, Caton J, Benoit DSW. Periodontal Wound Healing and Regeneration: Insights for Engineering New Therapeutic Approaches. Front Dent Med. 2022;3:1–24. https://doi.org/10.3389/fdmed.2022.815810
30. Ward E. A Review of Tissue Engineering for Periodontal Tissue Regeneration. J Vet Dent. 2022;39(1):49–62. https://doi.org/10.1177/08987564211065137