ISSN 0973-2063 (online) 0973-8894 (print)
Bioinformation 22(10): 6177-6181 (2026)
©Biomedical Informatics (2026)

BIOINFORMATION
Discovery at the interface of physical and biological sciences
BIOMEDICAL INFORMATICS
www.bioinformation.net
Volume 22(10)
Research Article

Received October 1, 2026; Revised October 31, 2026; Accepted October 31, 2026, Published October 31, 2026
DOI: 10.6026/973206300226177

SJIF 2026 (Scientific Journal Impact Factor for 2026) = 8.478
2022 Impact Factor (2023 Clarivate Inc. release) is 1.9

Declaration on Publication Ethics:
The author's state that they adhere with COPE guidelines on publishing ethics as described elsewhere at https://publicationethics.org/. The authors also undertake that they are not associated with any other third party (governmental or non-governmental agencies) linking with any form of unethical issues connecting to this publication. The authors also declare that they are not withholding any information that is misleading to the publisher in regard to this article.

Declaration on official E-mail:
The corresponding author declares that lifetime official e-mail from their institution is not available for all authors

License statement:
This is an Open Access article which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly credited. This is distributed under the terms of the Creative Commons Attribution License

Comments from readers:
Articles published in BIOINFORMATION are open for relevant post publication comments and criticisms, which will be published immediately linking to the original article without open access charges. Comments should be concise, coherent and critical in less than 1000 words.

Disclaimer:
Bioinformation provides a platform for scholarly communication of data and information to create knowledge in the Biological/ Biomedical domain after adequate peer/editorial reviews and editing entertaining revisions where required. The views and opinions expressed are those of the author(s) and do not reflect the views or opinions of Bioinformation and (or) its publisher Biomedical Informatics. Biomedical Informatics remains neutral and allows authors to specify their address and affiliation details including territory where required.

Edited by Vini Mehta
E-mail: vmehta@statsense.in
Citation: Maria *et al.* Bioinformation 22(10): 6177-6181 (2026)

Regenerative outcomes of A-PRF+ combined with nanocrystalline HA/β-TCP in intrabony defects

Mishul Maria*, Richa Agrawal, Himanshu Khashu, Ajay Chouksey, Megha Tripathi & Shreya Sahu

Department of Periodontology, Mansarovar Dental College, Bhopal, Madhya Pradesh, India; *Corresponding author

Affiliation URL:
https://www.mansarovardentalcollege.com

Author contact:
Mishul Maria - E-mail: mishuldavis123@gmail.com
Richa Agrawal - E-mail: dr.richa.gargava12@gmail.com
Himanshu Khashu - E-mail: himanshukhashu2310@gmail.com
Ajay Chouksey - E-mail: success.in.bds@gmail.com

ISSN 0973-2063 (online) 0973-8894 (print)
Bioinformation 22(10): 6177-6181 (2026)
©Biomedical Informatics (2026)

Megha Tripathi - E-mail: meghatripathi494@gmail.com
Shreya Sahu - E-mail: sahushreya029@gmail.com

Abstract:
Periodontal intrabony defects present a regenerative challenge because the destruction of periodontal supporting tissues may limit predictable restoration. Therefore, it is of interest to evaluate the regenerative potential of nanocrystalline hydroxyapatite/β-tricalcium phosphate (HA/β-TCP) used alone or combined with advanced platelet-rich fibrin plus (A-PRF+) for periodontal intrabony defects. Clinical and radiographic outcomes were evaluated over 6 months. Both treatment approaches produced significant periodontal improvement. The adjunctive use of A-PRF+ resulted in greater pocket depth reduction, clinical attachment gain and radiographic bone fill. Thus, data shows that A-PRF+ enhances the regenerative performance of HA/β-TCP in periodontal therapy.

Keywords: Advanced platelet-rich fibrin plus (A-PRF+), β-tricalcium phosphate (β-TCP), periodontal intrabony defects, plaque index (PI), clinical attachment level (CAL), probing pocket intensity (PPD), gingival index (GI), hydroxyapatite (HA)

Background:
Periodontal disease is a long-standing inflammatory disorder caused with the aid of microorganism, that regularly leads to site precise breakdown of the tooth supporting tissues which proceeds to periodontitis which is a complicated, multifactorial polymicrobial ailment and it suggests gingival inflammation, periodontal pocket formation, in conjunction with lack of attachment that impacts the periodontium. So, the principle aim of periodontal therapy is to get rid of the infection, forestall the disease from advancing and also inspire a type of regrowth of the destroyed periodontal structures. Exceptional regenerative procedures-bone grafting, gentle tissue grafting, guided tissue regeneration and distinct combinations of those-have been used, to attain results which might be extra or less predictable. In terms of graft substances, among autogenous, allogenic and alloplastic substitutes, (HA) receives lots of attention because it is biocompatible, risk-free, suggests osteoconductivity, osteophilicity and it resembles natural bone mineral pretty carefully. SYBOGRAF Plus, that's an artificial nanocrystalline HA combined with (β-TCP), is bioresorbable, relatively porous and osteoconductive and it indicates beneficial regenerative overall performance in intrabony defects **[1–3].** Then there are platelet derivatives, inclusive of platelet-rich plasma and PRF, which have produced encouraging results for socket healing, root preservation and intrabony defect control, broadly speaking by means of boosting increase factors and helping tissue restore. Currently, advanced platelet-rich fibrin (A-PRF) became the ahead the usage of lower centrifugation speeds and then, it's modified version A-PRF+, prepared at 1300 rpm for 8 mins, affords a fair more potent growth factor launch profile. A-PRF+ makes a flexible fibrin framework, able to cytokine trapping and cell migration **[4, 5]** and additionally it suggests accelerated release of TGF-β1, PDGF, VEGF, IGF and EGF as compared to earlier PRF generations **[5, 6]**, thereby enhancing regenerative potential **[7]**. Therefore it is of interest to evaluate the regenerative properties of APRF+ along with the HA/β-TCP for periodontal regeneration.

Materials and Methods:
Ethics statement:
The research protocol acquired approval from the Institutional Ethics Committee (assignment Code: MDC.P.85; Ref. No. MDC/IEC/2024/355J). Earlier than enrollment, all individuals were provided with an in depth about the methodology in their desired language, prior to the treatment, written informed consent become received from every participant.

Participants:
A complete of 10 people looking for treatment at the outpatient of the branch of Periodontology, were enrolled in the study. A detailed patient assessment was carried out using a structured case record form specifically developed for the study. This form captured information related to the participant's medical background, systemic health, oral condition and general health status. People identified with periodontal intrabony defects had been screened for eligibility. The presence of intrabony defects on examination showing a PPD of 6 mm or more, supplemented by way of radiographic proof of vertical alveolar bone loss. The population comprised systemically wholesome adults aged among 20 and 55 years who exhibited at least two non-contiguous teeth with probing depths of ≥6 mm and radiographically confirmed intrabony periodontal defects. Exclusion standards protected a history of antibiotic use inside the preceding six months, management of medications that could adversely affect gentle tissue repair, pregnancy or breastfeeding, the presence of any uncontrolled systemic disorder and habits including smoking, alcohol intake, or tobacco use in any form.

Study design and settings:
The intrabony defect sites within the examination have been categorized into similar sized treatment groups:
[1] Group A - Intrabony defects was randomly treated with SYBO GRAF PLUS with SRP
[2] Group B – Intrabony defects was treated with APRF+ in conjunction with SYBOGRAF PLUS with SRP
The scientific parameters were recorded at baseline, three months and six months following treatment. Measurements had been received the use of a UNC-15 periodontal probe. To ensure reproducibility and reduce measurement variability, custom designed occlusal stents had been fabricated on look at casts and applied throughout all clinical opinions. The following medical

indices were assessed:
[1] Gingival Bleeding Index (Löe and Silness, 1963) **[8]**
[2] Plaque Index (Silness and Löe, 1964) **[9]**
[3] Probing Pocket depth (PPD)
[4] clinical Attachment degree (CAL)

Radiographic assessment was achieved at baseline, 3 months and 6 months to assess changes inside the intrabony defects. Standardized radiographic images were analyzed by identifying specific anatomical reference points within the defect area. The landmarks used for radiographic measurements included **[10]**.

Data collection:
The sample size was calculated on the basis of the result of Yewale *et al.* **[3]** the change in width of socket at 3 mm showed the minimum significant difference. Therefore it is calculated on the basis of mean between these groups with the help of formula given by Rosner Bernard. The minimum sample size for each group was calculated 9. Therefore we had included 10 samples in each group.

Preparation of A-PRF+:
For sites assigned to the test group, A-PRF+ was prepared immediately before surgery using a standardized PRF preparation kit. Venous blood was collected from the antecubital vein into sterile A-PRF+ tubes without anticoagulants and centrifuged according to the recommended protocol. Centrifugation produced three distinct layers: platelet-poor plasma (PPP), the intermediate platelet-rich fibrin (PRF) clot and the red blood cell fraction. The PRF clot was carefully separated while maintaining its integrity and used in gel form for regenerative therapy **[11]** after achieving adequate local anesthesia using nerve block and local infiltration techniques, intracrevicular incisions were made on the buccal and lingual/palatal aspects, extending at least one tooth mesial and distal to the defect. Full-thickness mucoperiosteal flaps were reflected to provide adequate access, followed by meticulous debridement of granulation tissue and root planing. Defects allocated to Group A received a combination of A-PRF+ and Sybograf graft material, whereas Group B defects were treated with Sybograf alone. The flaps were repositioned, secured with sutures and protected with a periodontal dressing to promote uneventful healing.

Results:
At baseline, both groups showed comparable clinical conditions with no statistically significant differences ($p > 0.05$). The mean Plaque Index (PI) was 2.18 ± 0.32 in Group A and 2.20 ± 0.29 in Group B, Gingival Index (GI) was 2.10 ± 0.28 and 2.12 ± 0.30, Probing Pocket Depth (PPD) was 7.20 ± 0.74 mm and 7.15 ± 0.70 mm and Clinical Attachment Level (CAL) was 8.05 ± 0.68 mm and 8.00 ± 0.72 mm, respectively. At the 3-month follow-up, both groups showed marked clinical improvement. The mean PI reduced to 1.12 ± 0.24 in Group A and 1.05 ± 0.21 in Group B, with no significant intergroup difference ($p = 0.49$). However, Group B showed significantly better outcomes in GI (0.82 ± 0.19 vs. 1.08 ± 0.22; $p = 0.011$), PPD (4.10 ± 0.58 mm vs. 4.82 ± 0.61 mm; $p = 0.023$) and CAL (4.68 ± 0.52 mm vs. 5.62 ± 0.59 mm; $p = 0.001$) compared with Group A. At the 6-month evaluation, further improvements were observed in both groups. The PI decreased to comparable levels, while Group B continued to exhibit significantly lower GI (0.38 ± 0.12 vs. 0.62 ± 0.15; $p = 0.001$), PPD (3.05 ± 0.46 mm vs. 3.92 ± 0.54 mm; $p = 0.001$) and CAL (3.42 ± 0.45 mm vs. 4.58 ± 0.50 mm; $p = 0.001$) than Group A. Overall, although both treatment modalities produced significant clinical improvements, the adjunctive use of A-PRF+ with nanocrystalline HA + β-TCP yielded superior periodontal healing and clinical outcomes compared with nanocrystalline HA + β-TCP alone **(Table 1).** On the 3-month follow-up, the implied radiographic bone fill recorded in group A became 1.75 ± 0.32 mm, while group B tested a better mean of 2.58 ± 0.36 mm. statistical evaluation discovered a big difference between the two groups($t = 5.44$, $p = 0.001$), indicating advanced bone regeneration in group B during the early recovery segment.at the 6-month evaluation, the mean radiographic bone fill extended to 2.83 ± 0.40 mm in group A and 3.93 ± 0.45 mm in group A. the intergroup comparison endured to reveal a statistically considerable difference ($t = 5.77$, $p = 0.001$), with group B displaying a greater defect fill. Those results suggest that the adjunctive use of A-PRF+ become related to more desirable radiographic bone formation and stepped forward regenerative effects in comparison with graft alone **(Table 2).**

Table 1: Comparison of the PI, GI, PPD and RAL at different timelines

Clinical Parameter	Time Interval	Group A (Mean ± SD)	Group B (Mean ± SD)	t-value	p-value
Plaque Index (PI)	Baseline	2.18 ± 0.32	2.20 ± 0.29	0.15	0.88#
	3 months	1.12 ± 0.24	1.05 ± 0.21	0.69	0.49#
	6 months	0.72 ± 0.18	0.68 ± 0.16	0.52	0.60#
Gingival Bleeding Index (GBI)	Baseline	2.10 ± 0.28	2.12 ± 0.30	0.15	0.87#
	3 months	1.08 ± 0.22	0.82 ± 0.19	2.82	0.011*
	6 months	0.62 ± 0.15	0.38 ± 0.12	3.95	0.001*
Probing Pocket Depth (PPD) (mm)	Baseline	7.20 ± 0.74	7.15 ± 0.70	0.16	0.86#
	3 months	4.82 ± 0.61	4.10 ± 0.58	2.49	0.023*
	6 months	3.92 ± 0.54	3.05 ± 0.46	3.87	0.001*
Clinical Attachment Level (CAL) (mm)	Baseline	8.05 ± 0.68	8.00 ± 0.72	0.15	0.87#
	3 months	5.62 ± 0.59	4.68 ± 0.52	3.77	0.001*
	6 months	4.58 ± 0.50	3.42 ± 0.45	5.45	0.001*

Student t test, #Non-Significant, * Significant

Table 2: Intergroup comparisons of radiographic bone fill at 3 and 6 months

Time Interval	Group A (HA + β-TCP)Mean ± SD (mm)	Group B (HA + β-TCP + A-PRF+)Mean ± SD (mm)	t-value	p-value

3 months	1.75 ± 0.32	2.58 ± 0.36	5.44	0.001*
6 months	2.83 ± 0.40	3.93 ± 0.45	5.77	0.001*

` Student t test, #Non-Significant, * Significant

Discussion:

The present randomized controlled clinical study assessed the regenerative overall performance of a biphasic calcium phosphate graft composed of HA and β-TCP, each as a standalone treatment and together with A-PRF+, for the management of periodontal intrabony defects in people with chronic periodontitis. Scientific and radiographic critiques revealed sizable improvements in PPD, CAL and disorder fill in both treatment GROUPS when in comparison with baseline measurements, showing the regenerative capability of the graft material. Nevertheless, sites handled with the blended method of A-PRF+ and biphasic calcium phosphate exhibited notably extra upgrades, suggesting that the biological interest of platelet concentrates enhances periodontal wound recovery and tissue regeneration. The superior clinical outcomes observed in the A-PRF+ group are consistent with the systematic review by Reshma *et al.* (2022) **[12],** which reported that platelet concentrates improve periodontal regeneration through sustained release of growth factors that enhance angiogenesis, collagen synthesis and osteogenesis, leading to improved attachment gain and bone regeneration. In addition, Mallappa *et al.* (2022) **[13],** who reported significantly greater probing depth reduction, attachment gain and radiographic bone regeneration when an A-PRF block combined with nanohydroxyapatite was used compared with nanohydroxyapatite alone. The authors attributed these benefits to the synergistic regenerative effects of the fibrin matrix and osteoconductive scaffold A-PRF+ is characterized via an excessive awareness of platelets and leukocytes entrapped inside a strong fibrin matrix, which serves as a reservoir for the slow release of key growth elements, consisting of platelet-derived increase component (PDGF), transforming growth element-beta (TGF-β), vascular endothelial growth aspect (VEGF) and insulin-like boom element (IGF). The present findings are consistent with Rithesh *et al.* (2025) **[14],** who reported that combining injectable platelet-rich fibrin with synthetic nanocrystalline hydroxyapatite significantly improved probing depth reduction, clinical attachment gain and radiographic bone fill compared with graft alone. These benefits were attributed to sustained growth factor release, enhanced angiogenesis and accelerated periodontal regeneration. Similarly, Pavani *et al.* **[15]** showed substantially greater defect fill and bone regeneration with the blended use of PRF and β-TCP, as assessed via cone-beam computed tomography (CBCT). Furthermore, a 2026 meta-analysis by Li *et al.* **[16]** reported that platelet-rich fibrin combined with hydroxyapatite significantly improved probing depth, clinical attachment, plaque index and gingival index in periodontal intrabony defects, while also noting that the available evidence was limited in number and quality. Extra investigations by using Abdulrahman *et al.* **[17],** Kavitha *et al.* **[18]** and Arora *et al.* **[19]** in addition corroborated the useful consequences of combining platelet concentrates with β-TCP-based totally grafts. These authors attributed the regenerative effects to the continuous launch of increase factors greater cellular responses and progressed structural stability of the fibrin scaffold in the course of the recovery procedure. Radiographic evaluations conducted have validated notably greater bone regeneration in defects receiving A-PRF+ alongside the graft material. The superior clinical outcomes observed in the present study are supported by the long-term randomized clinical trial published in 2026, which showed that A-PRF+ produced stable probing depth reduction and clinical attachment gain comparable to enamel matrix derivative over five years. These findings reinforce the regenerative potential of A-PRF+ as a biologically active autologous material capable of promoting predictable periodontal healing **[20].** Despite the fact that both treatment methods led to meaningful scientific as well as radiographic enhancements, the notably superior effects performed within the A-PRF+ group emphasize the advantages of combining osteoconductive graft materials with biologically energetic adjuncts. Rathod *et al.* (2023) **[21]** similarly evaluated nanocrystalline hydroxyapatite and HA + β-TCP, both used with A-PRF and reported significant clinical and radiographic improvements at 6 months, with no significant difference between the two biomaterials. Suwondo *et al.* **[22]** also reported greater probing depth and relative attachment loss reduction with A-PRF compared with PRF in infrabony pockets. These findings provide additional support for the use of platelet-derived fibrin as an adjunct to osteoconductive graft materials in periodontal intrabony defects.

Conclusion:

A biologically based adjunct therapy using A-PRF+ with nanocrystalline HA + β-TCP are safe, cost-effective and highly clinically applicable for enhancing the periodontal regenerative therapy in chronic periodontitis patients. Considering the drawbacks of this study, (short time of evaluation and absence of histological evidence about newly formed bone), the use of A-PRF+ with nanocrystalline HA + β-TCP gave the most satisfactory clinical and radiographic results for intrabony defects.

References:

[1] Thapa N *et al. Int J Sci Res.* 2024 **13**:1063. [DOI: 10.21275/SR24918193319]
[2] Shaheen MY. *Saudi Dent J.* 2022 **34**:647. [PMID: 36570589]
[3] Yewale M *et al. J Oral Biol Craniofac Res.* 2021 **11**:225. [PMID: 33665072]
[4] El Bagdadi K *et al. Eur J Trauma Emerg Surg.* 2019 **45**:467. [PMID: 28324162]
[5] Sun J *et al. APL Bioeng.* 2022 **6**:031503. [PMID: 36061076]
[6] Simões-Pedro M *et al. Polymers (Basel).* 2022 **14**:1392. [PMID: 35406263]
[7] Jasser RA *et al. BMC Oral Health.* 2021 **21**:219. [PMID: 33926447]
[8] Löe H & Silness J. *Acta Odontol Scand.* 1963 **21**:533. [PMID: 14121956]

[9] Silness J & Löe H. *et al. Acta Odontol Scand.* 1964 **22**:121. [PMID: 14158464]
[10] Björn H *et al. Odontol Revy.* 1969 **20**:165. [PMID: 5259016]
[11] Csifó-Nagy BK *et al. BMC Oral Health.* 2021 **21**:580. [PMID: 34781955]
[12] Reshma AP *et al. J Indian Soc Periodontol.* 2022 **26**:425. [PMID: 36339393]
[13] Mallappa J *et al. J Indian Soc Periodontol.* 2022 **26**:359. [PMID: 35959304]
[14] Rithesh K *et al. J Indian Soc Periodontol.* 2025 **29**:169. [PMID: 40951743]
[15] Pavani MP *et al. J Indian Soc Periodontol.* 2021 25:138. [PMID: 33888946]
[16] Li L *et al. Clinics (Sao Paulo).* 2026 **81**:101035. [PMID: 42378866]
[17] Abdulrahman YA *et al. Clin Oral Investig.* 2022 **26**:6671. [PMID: 35876893]
[18] Kavitha M *et al. J Contemp Dent Pract.* 2022 23:1211. [PMID: 37125518]
[19] Arora S *et al. J Oral Biol Craniofac Res.* 2025 **21**:796. [PMID: 40636164]
[20] Csifó-Nagy BK *et al. Clin Oral Investig.* 2026 **30**:141. [PMID: 41870619]
[21] Aishwarya R *et al. J Contemp Dent Pract.* 2023 **24**:500. [PMID: 37622630]
[22] Suwondo CI *et al. Maj Kedokt Gigi Indones.* 2018 **4**:154. [DOI: 10.22146/majkedgiind.37414

Caveat Emptor is applicable among the literate community where required and possible. The publisher, its journal, editors and the internal/external reviewers take adequate steps to check, evaluate, correct, edit, revise and improve content where possible and required.