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Clinico-radiographic evaluation of titanium-PRF versus collagen membrane in Grade II furcation defects

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Abstract:
Grade II furcation defects present a significant regenerative challenge due to their complex anatomy. Therefore, it is of interest to compare the clinical and radiographic efficacy of nanocrystalline hydroxyapatite (ncHA) combined with either a collagen membrane or titanium-prepared platelet-rich fibrin (T-PRF) membrane in the treatment of Grade II furcation defects. Forty patients were randomly allocated to receive open flap debridement with ncHA and either a collagen membrane or T-PRF membrane. Both groups showed significant improvements in clinical and radiographic parameters at 6 months ($p < 0.001$), with no significant intergroup differences. Thus, T-PRF showed regenerative outcomes comparable to collagen membrane and may serve as a reliable, cost-effective autologous alternative for periodontal regeneration.

Keywords: Grade II furcation defect, nanocrystalline hydroxyapatite, titanium-prepared platelet-rich fibrin, collagen membrane

Background:
Periodontal diseases are chronic inflammatory conditions affecting the supporting structures of teeth, potentially resulting in progressive tissue destruction and tooth loss **[1]**. The primary objective of periodontal therapy is to arrest disease progression and regenerate lost periodontal tissues. However, conventional treatments, including scaling and root planing and open flap debridement (OFD), primarily achieve tissue repair rather than true periodontal regeneration **[2]**. Consequently, regenerative approaches have gained importance in managing advanced periodontal defects. Grade II furcation defects represent a significant therapeutic challenge due to complex root anatomy, limited accessibility for debridement and increased susceptibility to plaque accumulation and attachment loss **[3]**. Although OFD facilitates adequate debridement, its regenerative outcomes remain unpredictable, highlighting the need for adjunctive regenerative materials **[4]**. Nanocrystalline hydroxyapatite (n-HA), owing to its similarity to natural bone mineral, excellent biocompatibility and osteoconductive properties, has emerged as a promising bone graft material **[5]**. Guided tissue regeneration (GTR) membranes are frequently combined with bone grafts to prevent epithelial down growth and promote selective cellular repopulation. Collagen membranes are widely used because of their biocompatibility, hemostatic properties, clot stabilization and biodegradability, eliminating the need for a second surgical procedure **[6]**. Combining bone grafts with barrier membranes has demonstrated favourable outcomes in Grade II furcation defects **[7]**. Platelet-rich fibrin (PRF) is a second-generation platelet concentrate containing platelets, leukocytes, cytokines and growth factors within a fibrin matrix. It promotes angiogenesis, wound healing, graft stabilization and tissue regeneration through sustained growth factor release **[8]**. Titanium-prepared platelet-rich fibrin (T-PRF), developed using medical-grade titanium tubes, demonstrates a dense fibrin network and favourable cellular entrapment, potentially enhancing periodontal wound healing and regeneration **[9]**. Considering the regenerative potential of these biomaterials, the present study aims to compare the clinical and radiographic outcomes of nanohydroxyapatite bone graft combined with T-PRF membrane versus collagen membrane in the treatment of Grade II furcation defects **[10]**. Therefore, it is of interest to compare the clinical and radiographic outcomes of nanohydroxyapatite bone graft combined with T-PRF membrane versus collagen membrane in the treatment of Grade II furcation defects.

Materials and Methods:
Study design:
The present study is a randomized, controlled, parallel-arm clinico-radiographic interventional trial with a follow-up period of 6 months. The study aimed to compare the efficacy of T-PRF membrane and collagen membrane used in combination with NcHA bone graft in the management of Grade II furcation defects. The study protocol was approved by the Institutional Ethics Committee and the trial was registered under the Clinical Trial Registry of India (CTRI No. CTRI/2025/05/086688). The study was conducted from June 2024 to April 2026 in the Department of Periodontology and Oral Implantology, SMBT Dental College and Hospital, Sangamner.

Study population and sample size:
A total of 40 systemically healthy patients aged between 25 and 60 years, diagnosed with chronic periodontitis and presenting with at least one mandibular Grade II furcation defect, were recruited for the study. Sample size estimation was performed using G*Power software version 3.1.9. **[2]**, with a confidence interval of 95%, alpha error of 5% and study power of 80%. The calculated sample size was 40 patients, with 20 sites allocated to each treatment group.

Inclusion criteria:
[1] Patients aged between 25 and 60 years diagnosed with moderate generalized periodontitis.
[2] Presence of at least one mandibular molar exhibiting Glickman's Grade II furcation defect with horizontal probing depth ≥3 mm and vertical probing depth ≥5 mm following Phase I periodontal therapy.
[3] Radiographic evidence of inter-radicular bone loss.

[4] Patients willing to undergo periodontal surgery and provide written informed consent.

Exclusion criteria:

[1] Any systemic illness known to influence periodontal healing.
[2] History of antibiotic therapy or medications affecting periodontal healing within the previous 6 months.
[3] Smoking habit, pregnancy, lactation, or malocclusion.
[4] Platelet count <1, 50,000/mm³.
[5] Tooth mobility ≥ Grade II.
[6] History of allergy to study-related medications.

Randomization and group allocation:

Following completion of Phase I therapy and re-evaluation after 4–6 weeks, eligible sites were randomly allocated using the manual lottery method into two groups:

[1] **Group I (Control Group):** Open Flap Debridement (OFD) + Nanocrystalline Hydroxyapatite (NcHA) bone graft + Collagen membrane.
[2] **Group II (Test Group):** Open Flap Debridement (OFD) + Nanocrystalline Hydroxyapatite (NcHA) bone graft + T-PRF membrane.

Presurgical therapy:

All patients underwent Phase I therapy consisting of full-mouth scaling and root planing along with reinforcement of oral hygiene instructions using the Modified Bass brushing technique. After 4–6 weeks, eligible sites were selected for surgery and customized acrylic stents were fabricated to standardize clinical measurements using UNC-15 and Nabers probes. Standardized intraoral periapical radiographs were obtained at baseline and 6 months using the paralleling cone technique with a radiographic grid for assessment of osseous defect fill. Before surgery, patients rinsed with 0.2% chlorhexidine, extraoral antisepsis was performed and local anesthesia was administered using 2% lignocaine with adrenaline (1:200,000). Full-thickness mucoperiosteal flaps were reflected, followed by thorough debridement and root planing of the furcation defects.

Group I (Control Group): OFD + ncha Bone Graft + Collagen Membrane:

Following defect debridement, ncHA bone graft (Sybograf®-Plus, Eucare Pharmaceuticals) was placed into the defect and adapted carefully without overpacking. A collagen membrane (Healiguide®) was then positioned over the graft material. The flaps were secured using interrupted sutures in the interproximal areas. In the midfacial area, the flap was repositioned to a coronal level and stabilized using sutures anchored to composite stops bonded to the enamel surface to enable adequate flap anchorage and post-operative stability. The surgical area was protected with a periodontal dressing to aid initial healing.

Group II (Test Group): OFD + ncha Bone Graft + T-PRF Membrane:

After debridement, the defect was grafted using NcHA bone graft (Sybograf®-Plus). T-PRF membrane preparation involved collection of 10 mL venous blood into sterile titanium tubes without anticoagulant, followed by centrifugation at 2800 rpm for 12 minutes. The obtained fibrin clot was separated from the red blood cell layer and compressed using a PRF box to obtain a membrane. The prepared T-PRF membrane was adapted over the graft material, followed by flap repositioning and suturing similar to the control group. Periodontal dressing was subsequently applied.

Post-operative care:

Post-operatively, patients were prescribed amoxicillin 500 mg for 5 days, ibuprofen for pain control and advised to use 0.2% chlorhexidine mouth rinse twice daily for 2 weeks. Sutures were removed after 7–10 days and oral hygiene instructions were reinforced throughout the study period. Clinical parameters were reassessed at 3 and 6 months using customized acrylic stents for reproducibility, while radiographic evaluation was performed at 6 months using standardized IOPA radiographs. All patients were maintained on supportive periodontal therapy during follow-up.

Results:

Probing Pocket Depth (PPD) showed statistically significant reductions in both groups ($p < 0.001$). Group I decreased from 6.15 ± 0.99 mm at baseline to 3.25 ± 1.07 mm at 6 months, whereas Group II decreased from 6.25 ± 0.97 mm to 3.90 ± 0.91 mm **(Table 1)**. Relative Vertical Clinical Attachment Level (RVCAL) demonstrated significant improvement in both groups ($p < 0.001$). Group I improved from 10.00 ± 1.17 mm to 7.45 ± 1.28 mm, while Group II improved from 9.85 ± 0.88 mm to 7.60 ± 0.99 mm **(Table 2)**. Similarly, Relative Horizontal Clinical Attachment Level (RHCAL) significantly improved in both groups ($p < 0.001$), decreasing from 5.00 ± 1.08 mm to 1.50 ± 1.15 mm in Group I and from 4.70 ± 0.80 mm to 1.35 ± 1.14 mm in Group II **(Table 3).** Gingival Margin Level (GML) showed minimal changes at 3 and 6 months. Both groups demonstrated an increase to 4.60 mm at 6 months, with statistically significant intragroup changes observed in both groups **(Table 4)**. Radiographic Bone Level (RBL) showed significant improvement in both groups ($p < 0.001$). Group I decreased from 4.15 ± 0.67 mm to 2.40 ± 0.68 mm, corresponding to 42.17% improvement, whereas Group II decreased from 4.05 ± 0.60 mm to 2.70 ± 0.73 mm, corresponding to 33.33% improvement **(Table 5)**.

Table 1: Intragroup comparison of Probing Pocket Depth (PPD)

Group	Follow Up	Mean	SD	SE	% Change	t-Value	P-Value
Group I (Control)	Pre-Op	6.15	0.99	0.22	-		
	3 M	3.40	1.05	0.23	44.72	14.4568	0.0000

	6 M	3.25	1.07	0.24	47.15	29.0000	0.0000
Group II (Test)	Pre-Op	6.25	0.97	0.22	-		
	3 M	4.20	1.01	0.22	32.80	13.3578	0.0000
	6 M	3.90	0.91	0.20	37.60	21.4760	0.0000

*P> 0.05 – not significant difference *p< 0.05 – significant difference p<0.001 – highly significant; p value (pairwise) compared using paired student's t-test*

Table 2: Intragroup comparison of Relative Vertical Clinical Attachment Level (RVCAL)

Group	Follow Up	Mean	SD	SE	% Change	t-Value	P-Value
Group I (Control)	Pre-Op	10.00	1.17	0.26	-		
	3 M	7.20	1.40	0.31	28.00	17.9952	0.0000
	6 M	7.45	1.28	0.29	25.50	22.3424	0.0000
Group II (Test)	Pre-Op	9.85	0.88	0.20	-		
	3 M	7.80	1.06	0.24	20.81	11.1048	0.0000
	6 M	7.60	0.99	0.22	22.84	15.7552	0.0000

*P> 0.05 – not significant; *p< 0.05 – significant; p<0.001 – highly significant*

Table 3: Intragroup comparison of Relative Horizontal Clinical Attachment Level (RHCAL)

Group	Follow Up	Mean	SD	SE	% Change	t-Value	P-Value
Group I (Control)	Pre-Op	5.00	1.08	0.24	-		
	3 M	1.80	1.01	0.22	64.00	17.1694	0.0000
	6 M	1.50	1.15	0.26	70.00	22.7425	0.0000
Group II (Test)	Pre-Op	4.70	0.80	0.18	-		
	3 M	1.45	1.10	0.25	69.15	15.9637	0.0000
	6 M	1.35	1.14	0.25	71.28	17.1201	0.0000

*P> 0.05 – not significant; *p< 0.05 – significant; p<0.001 – highly significant*

Table 4: Intragroup comparison of Gingival Margin Level (GML)

Group	Follow Up	Mean	SD	SE	% Change	t-Value	P-Value
Group I (Control)	Pre-Op	4.30	1.08	0.24	-		
	3 M	4.35	1.35	0.30	-1.16	-0.2945	0.7715
	6 M	4.60	1.19	0.27	-6.98	-2.8536	0.0102
Group II (Test)	Pre-Op	4.40	1.10	0.24	-		
	3 M	4.25	1.37	0.31	3.41	0.9002	0.3793
	6 M	4.60	1.10	0.24	-4.55	-2.1794	0.0421

*P> 0.05 – not significant; *p< 0.05 – significant; p<0.001 – highly significant*

Table 5: Intragroup comparison of Radiographic Bone Level (RBL)

Group	Follow Up	Mean	SD	SE	% Change	t-Value	P-Value
Group I (Control)	Pre-Op	4.15	0.67	0.15	42.17	17.6163	0.0000
	6 M	2.40	0.68	0.15			
Group II (Test)	Pre-Op	4.05	0.60	0.14	33.33	8.1021	0.0000
	6 M	2.70	0.73	0.16			

*P> 0.05 – not significant; *p< 0.05 – significant; p<0.001 – highly significant*

Discussion:

Furcation defects remain challenging to regenerate because of their complex anatomy and limited accessibility. The present study demonstrated significant clinical attachment gain and radiographic bone fill in both groups following OFD with nanohydroxyapatite (n-HA), combined with either T-PRF or collagen membrane. However, intergroup differences were not statistically significant for most regenerative parameters. Sneha *et al.* (2021) **[11]** reported significant clinical and radiographic improvements following PRF and collagen-based regenerative treatment of Grade II furcation defects. Similarly, the present study showed favourable healing in groups, supporting the regenerative potential of biological and barrier membranes. Nair *et al.* (2022) **[12]** evaluated n-HA with injectable PRF in Grade II furcation defects and reported significant improvements in clinical parameters and radiographic bone fill, with comparatively greater improvement in the combined treatment group. These findings support the potential of combining n-HA with platelet-derived growth factors, consistent with the favourable outcomes observed in our T-PRF group.

Subhadarsanee *et al.* (2023) **[13]** compared PRF matrix and collagen membranes with DFDBA and reported improvement in both groups, with greater defect resolution in the PRF matrix group. Similarly, our study showed significant improvement with both membranes, although the intergroup differences were not statistically significant. Patel *et al.* (2023) **[14]** reported significant improvements in PPD, RVCAL, RHCAL and radiographic defect depth following PRF with or without demineralized bone matrix. Their findings support the regenerative potential of PRF-based combinations, corresponding with the significant clinical and radiographic improvements observed in the present study. Harshavardhana *et al.* (2024) **[15]** evaluated PRF as a barrier membrane with hydroxyapatite in Grade II furcation defects and reported better healing and bone fill in the combined treatment group. In comparison, our study showed greater numerical bone fill in Group I (42.17%) than Group II (33.33%), although the intergroup difference was not statistically significant (p = 0.188).

Differences in graft composition, membrane preparation and study methodology may explain the variation in outcomes.

Conclusion:
Both OFD + NcHA collagen membrane and OFD + NcHA + T-PRF membrane showed significant clinical and radiographic improvements in Grade II furcation defects. Both modalities showed comparable regenerative outcomes, suggesting T-PRF as a potential alternative to collagen membranes. Further long-term studies with larger sample sizes are warranted to validate these findings.

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