RESEARCH PAPER

Comparative Evaluation of the Adjunctive Effect of Injectable Platelet Rich Fibrin (i-PRF), 970 nm Diode Laser on Post Operative Healing and Clinical Parameters for the Treatment of Chronic Periodontitis

Running title: Effect of injectable platelet rich fibrin (i-PRF), 970 nm diode laser on post operative healing. Type of manuscript: Original research.

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ABSTRACT

Introduction: Periodontal wound healing plays a crucial role following periodontal flap surgery; hence, a well-planned approach is essential to promote optimal healing and achieve improved clinical outcomes.

Objectives: To compare the adjunctive effect of injectable platelet rich fibrin (i-PRF), 970 nm diode laser on post-operative healing and clinical parameters in open flap debridement (OFD) for the treatment of chronic periodontitis.

Methods: Ten patients diagnosed with chronic periodontitis aged between 25-55 years were divided into three groups to assess different treatment modalities. Group A undergone OFD, Group B undergone OFD along with i-PRF, Group C undergone OFD along with 970 nm diode laser. Patient-related parameters VAS score for pain and early wound healing score (EHS) for healing were evaluated at 24 hours, 3rd day- and 7th day- post-surgery. Clinical parameters such as plaque index (PI), gingival index (GI), probing pocket depth (PPD), and clinical attachment level (CAL) were evaluated at baseline, 1 month- and 3 months post-surgery.

Results: Statistical analysis revealed that all parameters improved significantly across all treatment groups .Group C, treated with OFD along with the use of diode laser, showed substantial improvement in parameters such as VAS score, EHS, PPD and CAL over Group A, B.

Conclusion: The present study found that adjunctive application of i-PRF, diode laser in OFD improved clinical outcomes as compared to OFD alone. However, findings of this study may need further validation on large sample size, longer duration and other outcomes in the treatment of chronic periodontitis.

Keywords: periodontal disease; wound healing; open flap debridement; injectable platelet rich fibrin; diode laser.

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Introduction

Periodontal wound healing is dynamic and regulated by a number of signalling molecules and events. Haemostasis, coagulation, inflammation, cell proliferation, wound maturation, and other processes all overlap during wound healing. The migration and propagation of the target cells into the sites of wound are controlled by various growth factors (GFs) and

cytokines.[1] The growth factors favour wound healing by advancing these events and by enhancing angiogenesis and periodontal regeneration. Various platelet concentrates have been used in periodontal surgeries to enhance post operative healing and to achieve periodontal regeneration.[2,3]

Injectable platelet-rich fibrin (i-PRF), a liquid derivative of platelet-rich fibrin (PRF), prepared from patient's own blood, with lower centrifugation speeds is explored as an adjunct to OFD to enhance healing through better delivery of growth factors, improved soft tissue closure, reduced inflammation, and possibly improved bone regeneration.[4] Adjunctive use of ~970-980 nm diode lasers (e.g. Sirona 970 nm) with OFD shows promising results in improving several postoperative outcomes in such as: reduced pocket depth, gain in attachment, improved wound healing, less pain and inflammation in early postoperative days. The strongest benefits seem to be in the early healing period (first few days/weeks), and for soft tissue healing and patient comfort. Thus, this study evaluated and compared the effects of injectable platelet rich fibrin (i-PRF), 970nm diode laser as an adjunct to open flap debridement on post-operative healing and clinical parameters for the treatment of chronic periodontitis.

Material and Methods

A prospective, split-mouth clinical controlled trial was conducted which was approved by the institutional ethical committee which involved ten systemically healthy patients diagnosed with chronic periodontitis. A total of 30 quadrants were randomly allocated into three equal groups (10 quadrants in each group). Medically healthy patients aged 25–55 years with persistent PPD ≥5 mm and CAL ≥4 mm, capable of maintaining adequate oral hygiene and willing to participate were selected for the study.

Patients with uncontrolled systemic diseases, history of periodontal surgery within the past six months, pregnant or lactating women were excluded. Pain and early wound healing were evaluated using the Visual Analogue Scale (VAS)[5] and Early Wound Healing Score (EHS)[6] at 24 hours, 3rd day, and 7th day post-surgery.

Periodontal parameters assessed using a UNC-15 periodontal probe included Plaque Index (PI)[7] , Gingival Index (GI)[7] , Probing Pocket Depth (PPD)[8] , and Clinical Attachment Level (CAL)[8] at baseline, 1 month, and 3 months post-operatively. All patients underwent full-mouth scaling and root planing and were instructed on proper oral hygiene measures prior to surgery.

The surgical procedure included the following: intraoral antisepsis was performed using 0.2% chlorhexidine digluconate and extraoral antisepsis using 5% povidone-iodine solution. Local anaesthesia was achieved using 2% lignocaine hydrochloride with adrenaline (1:80,000).Crevicular incisions were placed, and full thickness mucoperiosteal flaps were reflected.

Thorough debridement was carried out using Gracey curettes. In Group A, conventional OFD was performed [Fig.A]. In Group B, i-PRF was applied to the inner surface of the reflected flap following OFD [Fig.B]. In Group C, a 970 nm diode laser (1.5 W, 320-µm fibre optic tip) was used in continuous mode with horizontal overlapping strokes in a corono-apical direction for 10 seconds per tooth, avoiding contact with bone and tooth surfaces [Fig.C]. Flaps were repositioned and sutured using 3-0 non-resorbable black braided silk sutures.

Post-operative instructions were provided to all patients. Antibiotics and analgesics were prescribed. Patients were advised to avoid brushing or flossing the surgical site until suture removal and to rinse with 0.2% chlorhexidine mouthwash twice daily for two weeks starting 24 hours post-surgery. Sutures were removed after 7–10 days. Patients were recalled at 1 and 3 months for reinforcement of oral hygiene measures, professional maintenance, clinical recordings, and photographic documentation.

Fig.A: (a) Full thickness flap reflection (b) Full thickness flap reflection and debridement. (c) Interrupted sutures placed. (d) 24 hours post-surgery. (e) 3rd day post-surgery. (f) 7th day post-surgery.

Fig. B: (a) injectable platelet rich fibrin (b) application of i-PRF (c) Interrupted sutures placed. (d) 24 hours post-surgery. (e) 3rd day post-surgery. (f) 7th day post-surgery.

Fig. C: (a) Flap reflection (b) lasing of the flap with diode laser (c) Interrupted sutures placed. (d) 24 hours post-surgery. (e) 3rd day post-surgery. (f) 7th day post-surgery.

Statistical analysis

The data were summarised in Mean ± SD (standard deviation). Groups were compared by repeated measures two factor (period x group) analysis of variance (RM ANOVA) and the significance of mean difference within (intra) and between (inter) the groups was done by Tukey's HSD (honestly significant difference) post hoc test after ascertaining normality by Shapiro-Wilk's test and homogeneity of variance between groups by Levene's test. A two-tailed (α=2) $P < 0.05$ was considered statistically significant. Analysis was performed on SPSS software (Windows version 22.0).

Results

Total 30 quadrants of 10 systemically healthy (ASA I and II) patients, age between 25-55 yrs (mean ± SD: 35.50 ± 9.96 and median: 31 yrs) of both genders (female=3 and male=7), who diagnosed with chronic periodontitis (stage I/II/III/IV) and seeking for periodontal flap surgery with persistent pocket probing depth (PPD) ≥5 mm and clinical attachment level (CAL) ≥4 mm were recruited from the out patient pool attending the Out Patient Department (OPD) of Periodontology, Sardar Patel Post Graduate Institute of Dental and Medical Sciences (SPPGIDMS), Lucknow, U.P., India.

The quadrants were randomized equally into three groups and surgically treated with OFD (*Group A, n=10*), OFD + i-PRF (*Group B, n=10*) and OFD+LASER (*Group C, n=10*) using split-mouth design. The primary outcome measures of the study were pain and early healing index (EHI). The secondary outcome measures of the study were clinical parameters viz. plaque index (PI), gingival index (GI), probing pocket depth (PPD) and clinical attachment level (CAL). The pain and EHI were assessed at 24 hrs, day 3 and day 7 post treatments. The PI, GI, PPD and CAL were assessed at pre treatment (baseline) and 1 and 3 month post treatment. The pain was assessed using visual analogue scale (VAS) (0-10 cm scale, 0 representing no pain and 10 representing the worst/unbearable pain). The PD and CAL were measured in millimetre (mm).

The objective of the study was to compare the efficacy of three treatment groups (Group A, Group B and Group C and Group D) on outcome measures (VAS, EHI, PI, GI, PPD and CAL) over the periods.

Primary outcome measures

The post treatment (24 hrs, day 3 and 7) VAS and EHI score of three groups (Group A, Group B and Group C) is summarised in Table 1 and also shown in Fig. 1. In all groups, the mean VAS score show linear decrease after the treatment whereas EHI score show liner increase. The decrease in mean VAS and increase in EHI score of Group C was higher than both Group A and Group B.

Intra group comparison showed significant ($P < 0.001$) decrease in VAS score at both day 3 and 7 as compared to 24 hrs in all groups (Table 2). Further, in all groups, it also showed significant ($P < 0.001$) decrease at day 7 as compared to day 3. In contrast, EHI score showed significant ($P < 0.001$) increase at both day 3 and 7 as

compared to 24 hrs, and day 7 as compared to day 3 in all groups.

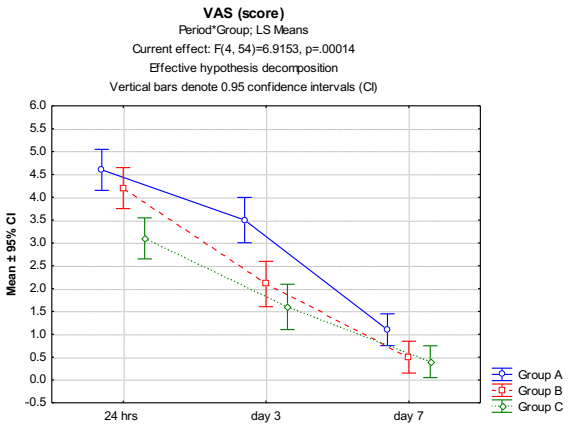
Similarly, inter group comparison showed significant ($P < 0.05$ or $P < 0.001$) decrease in VAS score of Group C as compared to both Group A and Group B at 24 hrs (Table 3). Further, at day 3, it also showed significant ($P < 0.01$ or $P < 0.001$) decrease in VAS score of both Group B and Group C as compared to Group A. In contrast, mean EHI score showed significant ($P < 0.01$) increase in Group C as compared to Group A at day 3.

At final evaluation (i.e. at day 7), the mean decrease in VAS score of Group C was found 63.6 and 20.0% higher as compared to Group A and Group B, respectively. Similarly, the mean increase in EHI score of Group C was found 8.8 and 4.4% higher as compared to Group A and Group B, respectively.

Table 1: Post treatment VAS and EHI score of three groups over the periods

Variable	Assessment period	Group A (n=10)	Group B (n=10)	Group C (n=10)
VAS (score)	24 hrs	4.60 ± 0.97	4.20 ± 0.42	3.10 ± 0.57
	day 3	3.50 ± 0.97	2.10 ± 0.74	1.60 ± 0.52
	day 7	1.10 ± 0.57	0.50 ± 0.53	0.40 ± 0.52
EHI (score)	24 hrs	3.90 ± 0.88	4.00 ± 0.67	4.30 ± 0.67
	day 3	6.30 ± 0.67	6.90 ± 0.88	7.50 ± 0.53
	day 7	8.30 ± 0.48	8.70 ± 0.48	9.10 ± 0.32

The post treatment VAS and EHI score of three groups were summarised in Mean ± SD.



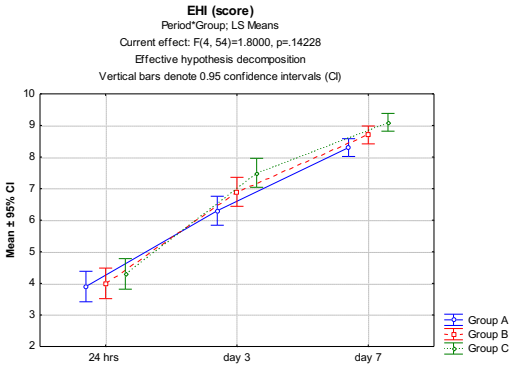


Fig. 1. Post treatment mean VAS and EHI scores of three groups over the periods.

Table 2: For each group, comparison (*P* value) of difference in post treatment mean VAS and EHI score between the periods by Tukey test

Variable	Comparison	Group A		Group B		Group C	
		Mean diff.	*P* value	Mean diff.	*P* value	Mean diff.	*P* value
VAS (score)	24 hrs vs. day 3	1.10	< 0.001	2.10	< 0.001	1.50	< 0.001
	24 hrs vs. day 7	3.50	< 0.001	3.70	< 0.001	2.70	< 0.001
	day 3 vs. day 7	2.40	< 0.001	1.60	< 0.001	1.20	< 0.001
EHI (score)	24 hrs vs. day 3	2.40	< 0.001	2.90	< 0.001	3.20	< 0.001
	24 hrs vs. day 7	4.40	< 0.001	4.70	< 0.001	4.80	< 0.001
	day 3 vs. day 7	2.00	< 0.001	1.80	< 0.001	1.60	< 0.001

diff: difference.

Table 3: For each period, comparison (*P* value) of difference in post treatment mean VAS and EHI score between the groups by Tukey test

Variable	Comparison	24 hrs		day 3		day 7	
		Mean diff.	*P* value	Mean diff.	*P* value	Mean diff.	*P* value
VAS (score)	Group A vs. Group B	0.40	0.917	1.50	0.001	1.10	0.551
	Group A vs. Group C	1.40	< 0.001	1.90	< 0.001	0.50	0.343
	Group B vs. Group C	0.60	0.016	0.70	0.764	0.10	1.000
EHI (score)	Group A vs. Group B	0.10	1.000	0.60	0.495	0.40	0.898
	Group A vs. Group C	0.40	0.898	1.20	0.003	0.80	0.145
	Group B vs. Group C	0.30	0.980	0.60	0.495	0.40	0.898

diff: difference.

Secondary outcome measures

The pre (baseline) and post treatment (1 and 3 month) clinical parameters (PI, GI, PPD and CAL) of three groups (Group A, Group B and Group C) is summarised in Table 4 and also depicted in Fig. 2. After treatment, mean clinical parameters showed similar trend, decreased comparatively at 1 month then increase at 3 month in all groups. Further, at the end of treatment (i.e. 3 month post surgery), the mean PI and GI score remained higher whereas mean PPD and CAL remained lower as compared to baseline in all groups. Intra group comparison showed significant ($P < 0.05$ or $P < 0.01$ or $P < 0.001$) decrease in clinical parameters at 1 month while significant ($P < 0.05$ or $P < 0.01$ or $P < 0.001$) increase at 3 month as compared to baseline in all groups except GI in Group C (Table 5). Further, in all groups, clinical parameters showed significant ($P < 0.01$ or $P < 0.001$) increase at 3 month as compared to 1 month except PPD and CAL in Group C.

Inter group comparison showed significant ($P < 0.01$ or $P < 0.001$) decrease in GI, PPD and CAL of Group C as compared to both Group A and Group B at 3 month (Table 6). Further, both PPD and CAL also showed significant ($P < 0.001$) decrease in Group C as compared to both Group A and Group B at 1 month. Moreover, both PPD and CAL also showed significant ($P < 0.05$) decrease in Group B as compared to Group A at 3 month.

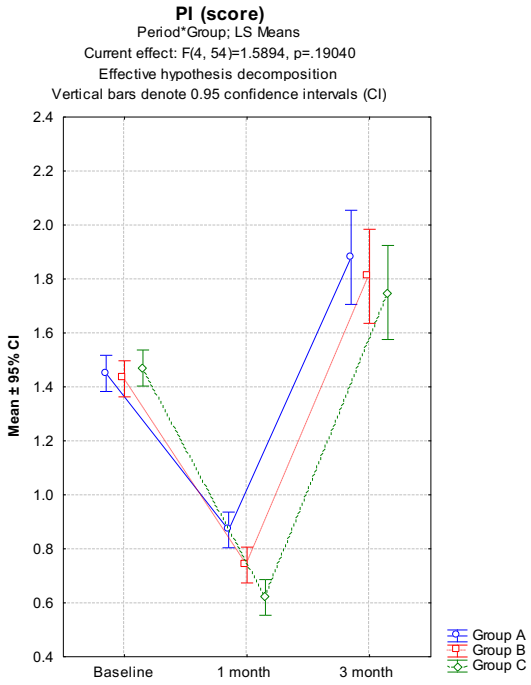
Further, at final evaluation (i.e. at the end of the treatment), the net mean increase (i.e. mean change from baseline to 3 month) in PI score of Group C (16.0%) was found 6.9 and 5.0% lower as compared to Group A (22.9%) and Group B (21.0%), respectively. Similarly, the net mean increase in GI score of Group C (3.4%) was found 21.4 and 18.7% lower as compared to Group A (24.8%) and Group B (22.1%), respectively. In contrast, the net mean decrease in PPD of Group C (69.3%) was found 28.2 and 21.6% higher as compared to Group A (41.1%) and Group B (47.7%), respectively. Similarly, the net mean decrease in CAL of Group C (68.4%) was found 28.5 and 20.9% higher as compared to Group A (39.9%) and Group B (47.5%), respectively.

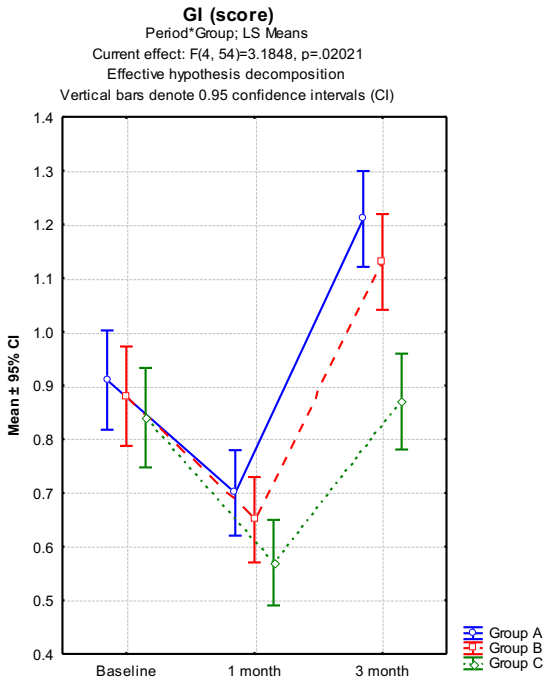
Table 4: Pre and post clinical parameters of three groups over the periods

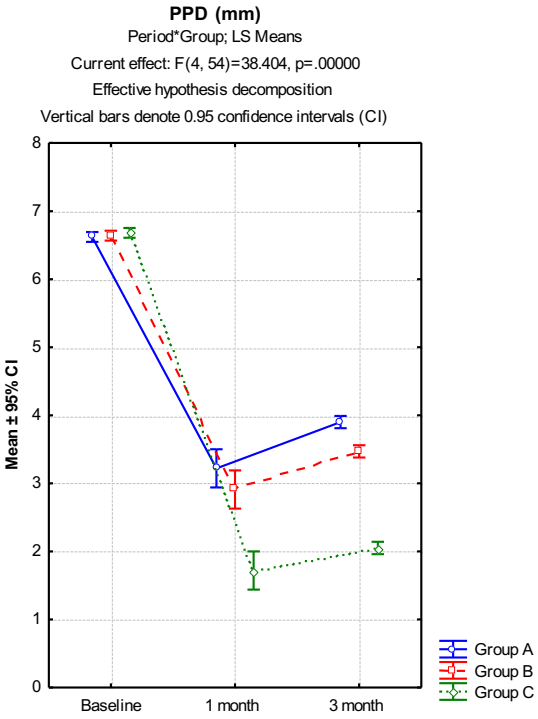
Variable	Assessment period	Group A (n=10)	Group B (n=10)	Group C (n=10)
PI (score)	Baseline	1.45 ± 0.12	1.43 ± 0.09	1.47 ± 0.09
	1 month	0.87 ± 0.09	0.74 ± 0.11	0.62 ± 0.10
	3 month	1.88 ± 0.30	1.81 ± 0.17	1.75 ± 0.31
GI (score)	Baseline	0.91 ± 0.18	0.88 ± 0.12	0.84 ± 0.12
	1 month	0.70 ± 0.18	0.65 ± 0.10	0.57 ± 0.07
	3 month	1.21 ± 0.13	1.13 ± 0.13	0.87 ± 0.15
PPD (mm)	Baseline	6.62 ± 0.13	6.64 ± 0.12	6.68 ± 0.08
	1 month	3.22 ± 0.46	2.91 ± 0.51	1.72 ± 0.30

	3 month	3.90 ± 0.08	3.47 ± 0.07	2.05 ± 0.22
CAL (mm)	Baseline	6.79 ± 0.31	6.71 ± 0.32	6.77 ± 0.24
	1 month	3.39 ± 0.63	2.96 ± 0.49	1.80 ± 0.31
	3 month	4.08 ± 0.34	3.52 ± 0.18	2.14 ± 0.27

The pre and post clinical parameters of three groups were summarised in Mean ± SD.







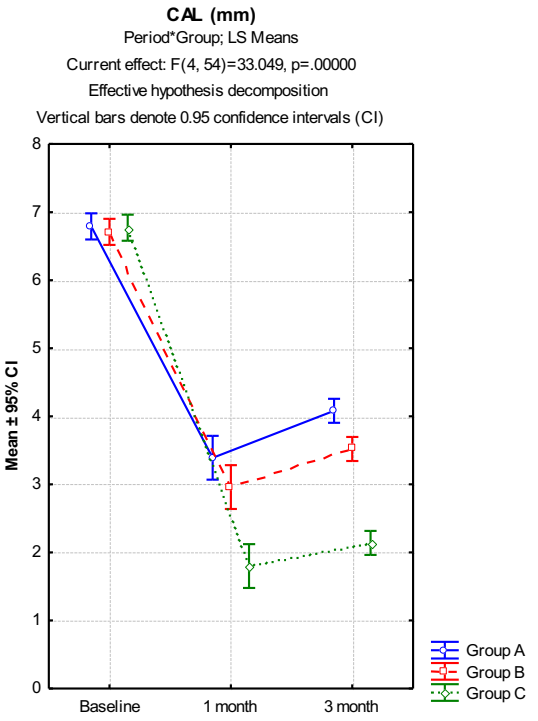


Fig. 2. Mean clinical parameters of three over the periods.

Table 5: For each group, comparison (*P* value) of difference in mean clinical parameters between the periods by Tukey test

Variable	Comparison	Group A		Group B		Group C	
		Mean diff.	*P* value	Mean diff.	*P* value	Mean diff.	*P* value
PI (score)	Baseline vs. 1 month	0.58	< 0.001	0.69	< 0.001	0.85	< 0.001
	Baseline vs. 3 month	0.43	< 0.001	0.38	< 0.001	0.28	0.015
	1 month vs. 3 month	1.01	< 0.001	1.07	< 0.001	1.13	< 0.001
GI (score)	Baseline vs. 1 month	0.21	0.025	0.23	0.010	0.27	0.001
	Baseline vs. 3 month	0.30	< 0.001	0.25	0.003	0.03	1.000
	1 month vs. 3 month	0.51	< 0.001	0.48	< 0.001	0.30	< 0.001
PPD (mm)	Baseline vs. 1 month	3.40	< 0.001	3.73	< 0.001	4.96	< 0.001
	Baseline vs. 3 month	2.72	< 0.001	3.17	< 0.001	4.63	< 0.001
	1 month vs. 3 month	0.68	< 0.001	0.56	0.001	0.33	0.168
CAL (mm)	Baseline vs. 1 month	3.40	< 0.001	3.75	< 0.001	4.97	< 0.001
	Baseline vs. 3 month	2.71	< 0.001	3.19	< 0.001	4.63	< 0.001
	1 month vs. 3 month	0.69	< 0.001	0.56	0.003	0.34	0.215

diff: difference.

Table 6: For each period, comparison (*P* value) of difference in mean clinical parameters between the groups by Tukey test

Variable	Comparison	Baseline		1 month		3 month	
		Mean diff.	*P* value	Mean diff.	*P* value	Mean diff.	*P* value
PI (score)	Group A vs. Group B	0.02	1.000	0.13	0.775	0.07	0.993
	Group A vs. Group C	0.02	1.000	0.25	0.052	0.13	0.775
	Group B vs. Group C	0.04	1.000	0.12	0.842	0.06	0.998
GI (score)	Group A vs. Group B	0.03	1.000	0.05	0.996	0.08	0.919
	Group A vs. Group C	0.07	0.962	0.13	0.441	0.34	< 0.001
	Group B vs. Group C	0.04	0.999	0.08	0.919	0.26	0.001
PPD (mm)	Group A vs. Group B	0.02	1.000	0.31	0.219	0.43	0.017
	Group A vs. Group C	0.06	1.000	1.50	< 0.001	1.85	< 0.001
	Group B vs.	0.04	1.000	1.19	< 0.001	1.42	< 0.001

	Group C						
CAL (mm)	Group A vs. Group B	0.08	1.000	0.43	0.204	0.56	0.030
	Group A vs. Group C	0.02	1.000	1.59	< 0.001	1.94	< 0.001
	Group B vs. Group C	0.06	1.000	1.16	< 0.001	1.38	< 0.001

diff: difference.

Discussion

The primary objective in the management of chronic periodontitis is to promote repair and where feasible, the regeneration of periodontal tissues. Open Flap Debridement (OFD) alone or along with several other adjunctive have been proposed for the treatment of chronic periodontitis, including growth factors, platelet concentrates, diode lasers and hyaluronic acid, which have resulted in reduced periodontal pockets, clinical attachment loss, and repair of periodontium. Post-operative pain was evaluated through the VAS scale and showed a consistent and statistically significant decrease across all groups, with clear differences in the magnitude of reduction among the treatment modalities. The mean VAS scores demonstrated a linear decline from 24 hours to day 7 in all four groups; however, this reduction was most pronounced in Group C followed sequentially by Group B and Group A.

The overall findings indicated that although all treatment groups showed a statistically significant reduction in pain over time, the adjunctive use of a 970-nm diode laser produced the most pronounced and consistent analgesic effect. This effect is likely due to its photobiomodulatory action on inflammatory mediators and tissue healing processes. These results are consistent with the study by Sanz-Moliner et al. (2013)[9], which reported that patients treated with a diode laser experienced less postoperative pain, edema, and tissue inflammation compared to those undergoing conventional surgery alone.

The adjunctive use of a 970-nm diode laser showed enhanced early wound healing, as indicated by higher EHS scores, likely due to its bactericidal, hemostatic, and photobiomodulatory properties. Sanz-Moliner et al. [9] reported that diode lasers help reduce postoperative inflammation and facilitate smoother wound margins. Similarly, Hassan AAA et al.[10] observed that platelet-rich fibrin promotes faster epithelialization and improves donor site healing. Yadwad KJ et al.[11] further demonstrated that diode lasers significantly enhance both clinical and microbiological outcomes in periodontitis, supporting the observed early healing benefits. Collectively, these findings suggest that both laser therapy and biologic adjuncts accelerate early tissue repair, with laser therapy exhibiting the most pronounced effect.

Saglam M et al. (2014)[12] demonstrated that the use of a diode laser leads to greater bacterial reduction and improved gingival healing, underscoring its role in maintaining sustained control over inflammation. These findings support the present study's observation of prolonged gingival index stability in the diode laser group. Padrón-Molina et al. [13] reported that combining platelet-rich fibrin with open flap debridement enhances probing pocket depth reduction and clinical attachment gain, owing to the growth factor–rich fibrin matrix that promotes cell migration. Additionally, Carosi et al.[14] emphasized that diode lasers facilitate pocket de-epithelialization, decrease bacterial load, and promote soft tissue healing through photothermal and biostimulatory effects, thereby contributing to sustained and clinically significant improvements in probing pocket depth.

Rathod A et al.[15] reported that adjunctive diode laser therapy achieved greater probing depth reduction and clinical attachment gain compared to open flap debridement alone, attributing these improvements to enhanced bacterial reduction and more effective decontamination of periodontal pockets. Gollapudi M et al.[16] emphasized the regenerative potential of injectable platelet-rich fibrin (i-PRF), noting its sustained release of growth factors, promotion of angiogenesis, stimulation of collagen synthesis, and overall enhancement of both soft and hard tissue healing. Similarly, Khan F et al. [17] demonstrated that the addition of diode laser therapy to periodontal flap surgery resulted in improved clinical attachment gain through its antibacterial effects, promotion of angiogenesis, and haemostatic properties, while also reducing postoperative pain.

Conclusion

Our study observed a significant improvement in all clinical parameters resulting in lesser post-operative pain and discomfort and faster and effective periodontal wound healing and regeneration. There was a significant difference seen in all the

experimental groups, proving that all the three adjunctive agents are effective when compared to the conventional open flap debridement for the surgical periodontal therapy. The present study suggested that the use of i-PRF, 970nm diode laser as adjunctive to open flap debridement added to the healing potential of the procedure in both patient-related and clinical aspects.

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