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Low level laser therapy for suprabony defects: A clinical study in India

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Abstract:
Periodontal flap surgery effectively manages suprabony periodontal defects; however, adjunctive therapies may further improve healing and clinical outcomes. Therefore, it is of interest to assess the effectiveness of low-level laser therapy (LLLT) as an adjunct to flap surgery in 30 patients with chronic periodontitis. Clinical parameters, including plaque index, gingival index, probing pocket depth and clinical attachment level, were evaluated at baseline and after 3 and 6 months. Both groups showed significant improvement, whereas the LLLT group showed significantly greater reductions in plaque index, gingival index and probing pocket depth, together with greater clinical attachment level gain ($p < 0.001$). Thus, adjunctive LLLT enhances periodontal healing and improve the effectiveness of conventional periodontal flap surgery.

Keywords: Low-level laser therapy (LLLT), periodontal flap surgery, chronic periodontitis, suprabony defects, periodontal healing

Background:
Periodontitis is a chronic multifactorial inflammatory disease of the tooth-supporting tissues, initiated by a dysbiotic microbial biofilm and mediated by a dysregulated host immune response **[1].** It is characterized by progressive loss of periodontal attachment and alveolar bone, resulting in periodontal pocket formation and tooth-supporting tissue destruction **[1, 2]**. If left untreated, the disease may ultimately lead to tooth loss. Globally, severe periodontitis affects approximately 796 million individuals, representing a substantial public health burden **[3].** The interaction between dysbiosis in the subgingival microbial community and an exaggerated immune response results in the release from cells of various inflammatory mediators such as IL-1β, prostaglandins, TNF-α and MMP. These mediators will also induce metabolic activities in tissue-supporting connective and bone, thereby facilitating the destruction of the periodontium **[2]**. Suprabony periodontal defects are characterized by the base of the periodontal pocket being located coronal to the alveolar crest and are commonly associated with horizontal bone loss. Although they exhibit limited regenerative potential compared with intrabony defects, their management is essential to prevent disease progression and maintain periodontal stability **[4].** Scaling and root planing (SRP) remains the foundation of periodontal therapy; however, surgical intervention is often required in moderate-to-severe cases with persistent deep pockets **[4, 5].** Conventional flap surgery facilitates thorough debridement and removal of inflamed tissues. Nevertheless, post-operative inflammation, delayed healing and residual bacterial contamination remain significant clinical concerns. Over the decades, advances in periodontology such as lasers, microsurgery, regenerative biomaterials and minimally invasive treatments have produced improved outcomes. Among these advances, laser-assisted periodontal therapy has become increasingly popular because of its bactericidal, anti-inflammatory, hemostatic and biostimulatory properties **[6].** LLLT (Low-Level Laser Therapy), also known as low-energy laser therapy (photobiomodulation therapy, cold laser therapy, or soft laser therapy), applies low-power light irradiation to stimulate the cellular activity while avoiding heat damage to living tissue. LLLT will consist of using wavelengths that range from about 650 to 1000 nanometres-the effects of which are caused by photochemical changes in the tissue. Unlike other lasers that utilize a high level of energy to cause tissue alteration, the laser (LLLT) will stimulate tissue repair mechanisms and metabolic processes **[6, 7].** The mechanism of action by which LLLT has biological effects is intrinsic to increased mitochondrial function and adenosine triphosphate (ATP) production. When being used as an adjunctive therapy to conventional flap surgery for periodontal defects, LLLT has been shown to improve wound healing, decrease post-operative pain, enhance clinical attachment gains and result in greater probing depth decreases **[7, 8].** Therefore, it is of interest to evaluate the clinical benefits of adjunctive low-level laser therapy (LLLT) when used with conventional periodontal flap surgery in the treatment of suprabony periodontal defects.

Materials and Methods:
The present clinical study was conducted in the Department of Periodontology at Chhattisgarh Dental College and Research Institute, Rajnandgaon, after obtaining ethical clearance from the Institutional Ethical Committee. Written informed consent was obtained from all participants prior to commencement of

treatment. A total of 30 patients diagnosed with moderate to severe chronic periodontitis associated with suprabony periodontal defects were selected from the outpatient department. Patients aged between 30 and 45 years with probing pocket depth (PPD) ≥5 mm were included in the study. Individuals with systemic diseases, smoking habits, alcohol consumption, pregnancy, lactation, recent antibiotic therapy and previous periodontal surgery were excluded. All participants underwent Phase I periodontal therapy, including oral hygiene instructions, supragingival and subgingival scaling and root planing using ultrasonic scalers and Gracey curettes. Participants meeting the inclusion criteria after re-evaluation were randomly divided into two groups of 15 subjects each by means of a coin-flip method.

[1] **Group I (Control Group):** Conventional flap surgery alone
[2] **Group II (Test Group):** Conventional flap surgery with adjunctive low-level laser therapy

Clinical parameters assessed included Plaque Index (PI), Gingival Index (GI), Probing Pocket Depth (PPD) and Clinical Attachment Level (CAL) **[9].** Measurements were recorded at baseline, 3 months and 6 months. After administering local anaesthesia (2% lignocaine), surgeries were performed under aseptic conditions. Conventional flap surgery was performed by giving crevicular incisions were placed and full-thickness mucoperiosteal flaps to gain access to root surfaces and osseous defects. Through debridement with curettes and flap were repositioned using non-absorbable sutures. Following flap debridement, patients in Group II received adjunctive low-level laser therapy. A 976-nm diode laser with a power output of 1.5 W was applied to the internal surface of both flaps using controlled overlapping horizontal movements extending from the coronal flap margin to the apical portion of the labial/buccal & lingual/palatal flaps. Then the flap was repositioned using non-absorbable sutures. Post-operative instructions were given and medications were prescribed to both groups. Patients were recalled after one week for suture removal and monitored throughout the study duration. Statistical analysis was performed using SPSS software version 23.0. Within-group comparisons over time were evaluated using paired t-tests, while between-group comparisons at each time point were assessed using unpaired (independent samples) t-tests. Change scores (delta values) were computed as the difference between baseline and follow-up values to quantify the magnitude of improvement and these were compared between groups using unpaired t-tests. Effect sizes were calculated using Cohen's d to determine the practical significance and magnitude of between-group differences for the primary outcome variables. Pearson correlation analysis was employed to explore the relationship between plaque accumulation and gingival inflammation. Finally, a responder analysis using Fisher's exact test was conducted to assess the proportion of patients achieving a clinically meaningful threshold of probing depth reduction (≥2 mm) at 6 months. Statistical significance was considered at $p<0.05$.

Results:

The demographic characteristics of the study participants, including age and sex distribution, are presented in **Table 1**. Both groups comprised an equal number of participants (n=15 per group), ensuring balanced allocation. The mean age of participants in Group I (conventional flap surgery) was 38.87 ± 4.12 years, while the mean age in Group II (flap surgery with adjunctive LLLT) was 35.27 ± 4.10 years. Regarding sex distribution, Group I comprised 10 males and 5 females, while Group II comprised 8 males and 7 females. Both groups showed significant improvements within the group in all clinical parameters (PI, GI, PD and CAL) from baseline to 3 months and from baseline to 6 months (all $p<0.001$) presented in **Table 2**. Significant improvements were also observed between 3 and 6 months in both groups, indicating progressive and sustained healing. The between-group differences at both 3-month and 6-month follow-up assessments: Group II (LLLT adjunct) showed significantly superior outcomes compared to Group I (conventional surgery alone) for all clinical parameters. For PI and GI, between-group differences were highly significant at both time points ($p<0.001$). For PD, the differences were significant at 3 months ($p=0.037$) and more so at 6 months ($p=0.004$). For CAL, differences were significant at 3 months ($p=0.003$) and highly significant at 6 months ($p<0.001$), as shown in **Table 3**. Change Score Analysis shows the magnitude of improvement from baseline to both 3 months and 6 months was significantly greater in Group II across all parameters (all $p<0.001$), with the between-group differences in change scores widening from 3 to 6 months. Large effect sizes were observed at 6 months for both primary outcomes (Cohen's d = -1.17 for PD; d = -1.61 for CAL), indicating robust and clinically meaningful between-group separation. The pooled positive correlation between PI and GI at 6 months ($r=0.613$, $p<0.001$) was found to be an artifact of between-group differences, as within-group correlations were non-significant. The responder analysis shows dramatically higher proportion of patients in Group II achieved a clinically meaningful PD reduction (≥2 mm) compared to Group I (100% vs. 33.3%, $p<0.001$, risk ratio = 3.00).

Table 1: Demographic characteristics (Age, Sex) and group comparability

Variable	Group I (Conventional flap)	Group II (Flap + LLLT)	p value
Age(years), Mean ± SD	38.87 ± 4.12	35.27 ± 4.10	0.023
Sex (M/F), n	10/5	8/7	0.709

Table 2: Intra-group evaluation of clinical periodontal parameters at baseline, 3 months and 6 months

Clinical Parameters	Group	Baseline Mean ± SD	3 Months Mean ± SD	6 Months Mean ± SD	p (Baseline vs 3M)	P (Baseline vs 6M)	P (3M vs 6M)

PI	Group I	2.27 ± 0.18	1.66 ± 0.19	1.28 ± 0.18	<0.001	<0.001	<0.001
	Group II	2.16 ± 0.17	1.19 ± 0.20	0.72 ± 0.22	<0.001	<0.001	<0.001
GI	Group I	2.20 ± 0.22	1.60 ± 0.22	1.30 ± 0.24	<0.001	<0.001	<0.001
	Group II	2.04 ± 0.26	1.13 ± 0.29	0.64 ± 0.32	<0.001	<0.001	<0.001
PPD	Group I	5.97 ± 0.77	4.59 ± 0.86	4.10 ± 0.93	<0.001	<0.001	<0.001
	Group II	6.04 ± 0.69	3.94 ± 0.75	3.15 ± 0.68	<0.001	<0.001	<0.001
CAL	Group I	8.01 ± 0.66	6.98 ± 0.75	6.37 ± 0.72	<0.001	<0.001	<0.001
	Group II	7.97 ± 0.59	6.16 ± 0.62	5.21 ± 0.72	<0.001	<0.001	<0.001

Table 3: Inter-group comparison of mean clinical periodontal parameters at different time intervals

Clinical parameter	Time point	Group I Mean ± SD	Group II Mean ± SD	p (between groups)
Plaque Index (PI)	Baseline	2.27 ± 0.18	2.16 ± 0.17	0.111
	3 Months	1.66 ± 0.19	1.19 ± 0.20	<0.001
	6 Months	1.28 ± 0.18	0.72 ± 0.22	<0.001
Gingival Index (GI)				
	Baseline	2.20 ± 0.22	2.04 ± 0.26	0.091
	3 months	1.60 ± 0.22	1.13 ± 0.29	<0.001
	6 months	1.30 ± 0.24	0.64 ± 0.32	<0.001
Probing Depth (PD)	Baseline	5.97 ± 0.77	6.04 ± 0.69	0.786
	3 Months	4.59 ± 0.86	3.94 ± 0.75	0.037
	6 Months	4.10 ± 0.93	3.15 ± 0.68	0.004
Clinical Attachment Level (CAL)	Baseline	8.01 ± 0.66	7.97 ± 0.59	0.862
	3 Months	6.98 ± 0.75	6.16 ± 0.62	0.003
	6 Months	6.37 ± 0.72	5.21 ± 0.72	<0.001

Discussion:

LLLT has gained attention in periodontal therapy because of its anti-inflammatory, analgesic, antimicrobial and biostimulatory effects. It promotes fibroblast proliferation, collagen synthesis, angiogenesis and tissue remodeling while reducing the production of pro-inflammatory mediators, thereby enhancing periodontal wound healing **[6, 7].** The present clinical study evaluated the effectiveness of adjunctive low-level laser therapy (LLLT) combined with conventional flap surgery in the management of suprabony periodontal defects. Both treatment groups demonstrated statistically significant improvements in all clinical parameters, including Plaque Index (PI), Gingival Index (GI), Probing Pocket Depth (PPD) and Clinical Attachment Level (CAL), from baseline to the 3- and 6-month follow-up periods. However, the group II treated with adjunctive LLLT exhibited greater reductions in inflammatory parameters and superior periodontal healing outcomes compared with conventional flap surgery alone. At six months, Group II (flap surgery with adjunctive LLLT) showed greater reductions in plaque accumulation, gingival inflammation and probing depths, along with higher clinical attachment gain than Group I. The enhanced clinical outcomes observed in the laser-treated group may be attributed to the photobiomodulatory effects of LLLT, which stimulate cellular metabolism, improve microcirculation and promote tissue repair. The findings of the present study are consistent with those reported by Kolamala *et al.* (2022) **[10]**, who observed significant clinical improvements following laser-assisted open flap debridement compared with conventional therapy. Similar results were reported by Aena *et al.* (2015) **[11]**, who showed greater reductions in plaque scores, bleeding indices, probing depths and improved attachment gain in laser-treated sites. Patila *et al.* (2022) **[12]** also concluded that diode laser therapy can serve as an effective adjunct or alternative to conventional periodontal surgery in patients with generalized periodontitis. Furthermore, Silviya *et al.* (2022) **[13]** reported that LLLT combined with single-flap surgery enhanced early wound healing and improved CAL gain and PPD reduction. Likewise, Saha *et al.* (2023) **[14]** showed significant reductions in red complex periodontal pathogens and superior clinical outcomes in laser-treated sites, supporting the antimicrobial benefits of diode laser therapy. However, not all studies have reported superior clinical outcomes with adjunctive laser therapy. Soni *et al.* (2025) **[15]** found no significant intergroup differences in several clinical and biochemical parameters following LLLT, although improvements in PPD and inflammatory markers were observed. Similarly, Gupta *et al.* (2024) **[16]** reported significant enhancement in wound healing with LLLT but no statistically significant differences in major clinical parameters compared with conventional flap surgery alone. The present study findings are consistent with those of Nguyen *et al.* (2025) **[17]** who showed that laser-assisted modified widman flap surgery significantly improved probing pocket depth reduction, clinical attachment gain and periodontal healing compared with conventional flap surgery. Psg *et al.*

(2025) **[18]** showed that adjunctive LLLT combined with minimally invasive flap surgery resulted in superior probing depth reduction, clinical attachment gain, radiographic bone fill and early wound healing compared with conventional surgery. These findings corroborate the systematic review and meta-analysis by Hu *et al.* (2024) **[19]**, which concluded that adjunctive diode laser therapy enhances periodontal wound healing and significantly improves probing depth reduction and clinical attachment level following periodontal flap surgery. Hegde *et al.* (2026) **[20]**, in a systematic review and network meta-analysis, reported that adjunctive laser therapy during periodontal flap surgery improved post-operative comfort, early wound healing and probing depth reduction compared with conventional flap surgery, although improvements in clinical attachment level, plaque index and gingival index were not consistently significant. The primary limitation was the relatively small sample size, which may restrict the generalizability of the findings to a broader population. A larger sample size would provide greater statistical power and improve the reliability of the conclusions drawn. The study evaluated clinical parameters such as Plaque Index, Gingival Index, Probing Pocket Depth and Clinical Attachment Level for soft tissue healing analysis, whereas radiographic evaluation of bone fill, histological assessment and biochemical analysis of inflammatory markers could have been performed to better determine the exact regenerative potential and underlying biological mechanisms of low-level laser therapy.

Conclusion:

Conventional flap surgery with low-level laser therapy effectively treated suprabony periodontal defects. Adjunctive low-level laser therapy showed statistically significant improvements over conventional flap surgery. Thus, it help serve as a safe and effective adjunct for achieving better periodontal outcomes.

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