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Evaluating the Effect of Diode Laser as an Adjunct to Open Flap Debridement in Association with Photobiostimulation with 970nm Diode Laser in Treatment of Chronic Periodontitis: A Randomized Clinical Trial

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KEYWORDS

Periodontitis, Open Flap Debridement, 970nm Diode Laser, Photo-Biostimulation

ABSTRACT:

Background: To evaluate the effect of diode laser as an adjunct to open flap debridement in association with photo bio-stimulation with 970nm diode laser in the treatment of chronic periodontitis.

Material and Methods: Five subjects aged 25 - 55 years with moderate to severe chronic periodontitis, who required periodontal flap surgery, were randomized and included in this study. The present study is a prospective comparative study. It is categorized under a randomized control trial. All the subjects with 20 sites were randomly divided into 4 groups, which are as follows: **Group I** consisted of 5 sites for conventional flap surgery, **Group II** consisted of 5 sites for conventional flap surgery and laser, **Group III** consisted of 5 sites for conventional flap surgery along with laser and biostimulation, **Group IV** consisted of 5 sites for conventional flap surgery with biostimulation. The assessment of clinical parameters,probing pocket depth (PPD), clinical attachment loss (CAL), and visual analog scale (VAS) was evaluated at 3 months.

Result: The results of this study demonstrated a statistically significant improvement in clinical parameters such as probing pocket depth (PPD) reduction, clinical attachment level (CAL) gain, and reduced bleeding on probing (BOP) in the test group (OFD + 970 nm diode laser + PBM) compared to the control group (OFD alone). These findings support the adjunctive use of diode lasers in enhancing the clinical efficacy of periodontal therapy.

Conclusion: The adjunctive use of 970nm diode laser in combination with photo-biostimulation contributed to improved tissue repair and reduced postoperative inflammation.

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Introduction

Periodontitis is a multifaceted condition resulting from the dynamic interplay between infectious agents, like bacteria, and various host factors. Essentially, periodontal disease manifests when harmful bacteria in the oral cavity invade and inflame the tissues adjacent to the tooth, highlighting the critical importance of effective intervention and treatment. This interplay ultimately leads to the destruction of the vital structures supporting our teeth.(1) Total mechanical debridement is widely recognized as the "gold standard" in periodontal treatment; however, it fails to effectively eliminate microorganisms from the soft tissue walls of periodontal pockets. (2) Recent innovations in adjunctive therapies have introduced significant advancements, notably "therapeutic laser treatment," also referred to as "laser biostimulation." This non-surgical treatment decisively enhances tissue healing while substantially reducing inflammation, edema, and pain.(3) Laser-enhanced biostimulation effectively triggers intracellular metabolic changes, accelerating cell division, boosting proliferation rates, and facilitating the migration of fibroblasts, along with increased matrix production.(4) The action of lasers on dental hard and soft tissue, as well as bacteria, depends on the absorption of a laser by tissue chromophores (water, apatite minerals, and various pigmented substances) within the target tissue. The following are the possible mechanisms of laser action:

- Photothermal ablation: This occurs with high-powered lasers when used to vaporize or coagulate.
- Photomechanical ablation: Disruption of tissue due to a range of phenomena, including shock wave formation, cavitation, etc.
- Photochemical effects: Using light-sensitive substances to treat conditions such as cancer.(4)

Materials and Methods

Source of Sample and Study Period

The study group comprised of 5 systemically healthy patients who were diagnosed with chronic periodontitis, with ages ranging from 25 -55 years and who reported to the Outpatient Department of Periodontology, People's Dental Academy, Bhopal for the management of their periodontal condition.

Selection Criteria

Inclusion criteria:

- The patient should be within the age group of 25 – 55 years of age.
- Patients with chronic periodontitis with periodontal pocket depth ≥ 5mm.
- The patient should not have taken antibodies in the preceding 6 months for any periodontal-related problem or other systemic reason.
- Patients without any history of systemic diseases

Exclusion criteria:

- Pregnant women or lactating mothers.
- Diabetic and hypertensive patients.
- History of drug allergy.
- History of smoking will be excluded from the study population.

Presurgical Procedures

The participants received detailed information regarding their condition and treatment plan, and after explaining the aim of the project, written consent was obtained from the patient. All the patients received a hygienic treatment phase consisting of oral hygiene instructions, supragingival prophylaxis, and a nonsurgical procedure comprising thorough subgingival scaling and root planing ≥3 weeks before surgical treatment. All clinical parameters were recorded at baseline.

Surgical Procedures

All 5 subjects with 20 sites were randomly divided into 4 groups. Each arch was randomly assigned to receive open flap debridement (OFD) alone or in combination with 970nm soft tissue diode laser, or in combination with photo-biostimulation (PBM) and photo-biostimulation alone.

Conventional Open Flap Debridement (Group I)

Aperiodontal flap incision was made with a no. 15 blade, and the flap was raised using a periodontal elevator. After the removal of fibrous and granulomatous tissues, complete scaling and root planning on root surfaces was performed by using Gracey Curettes. The flap was re-adapted and sutured with 3.0 silk.(8)

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Conventional open flap debridement along with diode laser (Group II)

On the contralateral side, the complete surgical procedure was carried out by a 970 nm soft tissue diode laser. In this group after the conventional flap debridement was carried out by performing a crevicular incision and raising the flap using a periosteal elevator, followed by complete removal of fibrous and granulomatous tissues in the interproximal areas. After the root debridement is done, 2-3 mm from the margin on the outer epithelium of the flap was de-epithelialized to prevent early proliferation and migration of the epithelial cells towards the sulcus and assist in better healing and attachment gain.The flaps were readapted and sutured in the same manner as the conventional OFD side.[8]

Conventional open flap debridement along with diode laser and photobiostimulation (Group III)

The sites in this group would primarily undergo the conventional open flap debridement similar to Group I in addition, the flap raised would be undergoing de-epithelialization to prevent early proliferation and migration of the epithelial cells towards the sulcus and assist in better healing and attachment gain.The inner epithelium of the raised periodontal flap was irradiated by a photo-biostimulation of laser that provides better postsurgical healing.[5]

Conventional open flap debridement along with photobiostimulation (Group IV)

In this group, conventional open flap debridement is carried out similarly as seen in group I, but in addition, the elevated periodontal flap is irradiated using a biostimulation mode in a soft tissue diode laser.[3]

Result

All patients were treated without any side effects, and clinical treatment outcome measurements were evaluated at baseline and 3-month recalls.

Bleeding On Probing (BOP)

Baseline Observations:

All groups (Groups I, II, III, and IV) had a BOP score of 100%, indicating uniform initial conditions across all treatment modalities.

Observations at 3 Months

Time Point	**Group I (Conventional Flap Surgery)**	**Group II (Conventional + Laser)**	**Group III (Conventional + Laser + Biostimulation)**	**Group IV (Conventional + Biostimulation)**	**F-Statistic**	**p-Value**
Baseline	100% (100.0 - 100.0)	100% (100.0 - 100.0)	100% (100.0 - 100.0)	100% (100.0 - 100.0)	.	.
3 Months	61.7% ± 5.62 (57.68 - 65.72)	29.7% ± 2.31 (28.05 - 31.35)	28.4% ± 2.27 (26.78 - 30.02)	59.6% ± 3.47 (57.12 - 62.08)	246.803	.000*

Group I (Conventional Flap Surgery) showed a reduction to 61.7% with a standard deviation of 5.62, from baseline reading of 100% of the patients showing bleeding on probing, depicting 38.3% of cases showing a positive result, suggesting a moderate decrease in BOP, whereas Group II (Conventional + Laser) and Group III (Conventional + Laser + Biostimulation) demonstrated significantly better outcomes, with reductions to 29.7% and 28.4% from the baseline reading of 100% of patients showing bleeding on probing, depicting 70% and 71%, of cases with substantially better outcome respectively. These groups exhibited the most substantial improvements, indicating consistent and effective treatment outcomes. Group IV (Conventional + Biostimulation) patients showed a reduction to 59.6%, from baseline reading of 100% of patients showing bleeding on probing, depicting 40.4% of cases showing positive results, suggesting that an improvement, was less effective compared to Groups II and III but similar to Group I. A p-value of .000 in our

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study indicates a highly significant difference between the groups, with laser treatments (with or without biostimulation) showing the most effectiveness.

Pocket Probing Depth (PPD)

Baseline Observations

Time Point	**Group I (Conventional Flap Surgery)**	**Group II (Conventional + Laser)**	**Group III (Conventional + Laser + Biostimulation)**	**Group IV (Conventional + Biostimulation)**	**F-Statistic**	**p-Value**
Baseline	7.5 ± 0.53 (7.12 - 7.88)	7.1 ± 0.57 (6.69 - 7.51)	7.1 ± 0.32 (6.87 - 7.33)	6.9 ± 0.74 (6.37 - 7.43)	2.036	.126 (NS)
3 Months	5.6 ± 0.52 (5.23 - 5.97)	4.1 ± 0.32 (3.87 - 4.33)	3.8 ± 0.42 (3.50 - 4.10)	5.4 ± 0.52 (5.03 - 5.77)	40.562	.000*

At the baseline, the probing pocket depths were relatively similar across all groups, with Group IV (Conventional + Biostimulation) having a slightly lower mean PPD (6.9 mm) compared to the other groups. This suggests a marginal variation in initial PPD levels among the groups.

Observations at 3 Months

Group I patients (Conventional Flap Surgery) had a mean PPD of 5.6 mm as compared to baseline readings of 7.5mm with a standard deviation of 0.52 mm, indicating a reduction in pocket depth by 1.9 mm whereas Group II (Conventional + Laser) and Group III (Conventional + Laser + Biostimulation) patients showed more significant reductions with mean PPDs of 4.1 mm and 3.8 mm, as compared to the baseline reading of 7.1 mm, showing reduction of pocket probing depth (PPD) by 3 mm and 3.3 mm, respectively. These groups exhibited the greatest improvements, suggesting that laser treatment, both alone and combined with biostimulation, is highly effective. Group IV patients (Conventional + Biostimulation) had a mean PPD of 5.4 mm, indicating improvement in reduction pocket probing depth by 1.9 mm though it was less as compared to Groups II and III.

A p-value of .000* indicates a highly significant difference in treatment effects among the groups, highlighting the efficacy of treatments involving lasers.

Clinical Attachment Level (CAL)

Baseline Observations

At the baseline, the clinical attachment levels were fairly similar across all groups. The slight variations in means, with Group III having the highest mean CAL of 8.1 mm and Group IV the lowest at 7.8 mm, indicate a small initial difference in clinical attachment levels among the groups.

Observations at 3 Months:

Time Point	**Group I (Conventional Flap Surgery)**	**Group II (Conventional + Laser)**	**Group III (Conventional + Laser + Biostimulation)**	**Group IV (Conventional + Biostimulation)**	**F-Statistic**	**p-Value**

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Baseline	8.0 ± 0.67 (7.52 - 8.48)	7.9 ± 0.74 (7.37 - 8.43)	8.1 ± 0.57 (7.69 - 8.51)	7.8 ± 0.42 (7.50 - 8.10)	.448	.720 (NS)
3 Months	5.9 ± 0.57 (5.49 - 6.31)	4.2 ± 0.42 (3.90 - 4.50)	4.4 ± 0.52 (4.03 - 4.77)	6.1 ± 0.32 (5.87 - 6.33)	45.077	.000*

Group I patients (Conventional Flap Surgery) exhibited a mean CAL of 5.9 mm with a standard deviation of 0.57 mm, indicating a reduction in CAL. Group II patients (Conventional + Laser) and Group III patients (Conventional + Laser + Biostimulation) showed significant improvements with mean CALs of 4.2 mm and 4.4 mm, respectively. These results suggest that treatments involving lasers, whether combined with biostimulation or not, are more effective in improving CAL. Group IV patients (Conventional + Biostimulation) displayed a mean CAL of 6.1 mm, indicating less effectiveness in improving CAL compared to laser-involved treatments. A p-value of .000* highlights a significant difference among the groups, particularly pointing out the effectiveness of laser treatments.

Visual Analog Scale (VAS)

Pre-operative Observations

Group I patients (Conventional Flap Surgery) and Group IV patients (Conventional + Biostimulation) reported high pre-operative VAS pain scores of 61.7 and 59.6, respectively, with relatively tight confidence intervals, indicating consistent and considerable pain levels across patients in these groups. Group II (Conventional + Laser) and Group III (Conventional + Laser + Biostimulation) exhibited significantly lower pre-operative VAS scores of 29.7 and 28.4, respectively. The lower scores in these groups indicate either distinct initial pain perceptions or more effective pre-operative management when compared to Groups I and IV patients. A p-value of .000* indicates a highly significant difference among the groups pre-operatively, with Groups II and III demonstrating substantial benefits likely due to the addition of laser treatments.

Post-operative Observations

Post-operatively, Group I patients showed a reduction in pain to a VAS score of 54.0, reflecting some pain relief following conventional treatment. Group II and Group III patients continued to show superior outcomes with VAS scores further reduced to 26.8 and 24.3, respectively. These low scores post-operatively underscore the ongoing effectiveness of treatments involving lasers, with or without biostimulation, in managing and reducing pain. Group IV patients reported a post-operative VAS score of 50.3, which, while improved from pre-operative levels, still indicates significant pain, suggesting that biostimulation alone does not achieve the same level of pain reduction as treatments involving lasers. A p-value of .000* at this time point again confirms the significant impact of the treatments, particularly those involving lasers, in reducing post-operative pain.

Discussion

The present study evaluated the clinical effectiveness of using a 970 nm diode laser as an adjunct to open flap debridement (OFD), in conjunction with photo-biomodulation (PBM), in treating chronic periodontitis. The hypothesis was that diode laser therapy, due to its antimicrobial and biostimulatory effects, could enhance periodontal healing and improve clinical outcomes when combined with conventional surgical therapy.[9] The results of this study demonstrated a statistically significant improvement in clinical parameters such as probing pocket depth (PPD) reduction, clinical attachment level (CAL) gain, and reduced bleeding on probing (BOP) in the test group (OFD + 970 nm diode laser + PBM) compared to the control group (OFD alone). These findings support the adjunctive use of diode lasers in enhancing the clinical efficacy of periodontal therapy.[7] The improved outcomes in the test group may be attributed to several beneficial properties of diode lasers. The 970 nm wavelength offers optimal absorption by water and haemoglobin, enabling effective decontamination of the periodontal pocket and granulation tissue removal, which are essential for better healing. In addition, photo-biostimulation with the same wavelength likely contributed to improved tissue repair and reduced

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postoperative inflammation, owing to enhanced mitochondrial activity, increased ATP production, and modulation of inflammatory mediators.[10]

Conclusion

The most significant and striking improvements were found in the groups that integrated laser treatment. Whether employed as a standalone therapy or in tandem with biostimulation, these approaches yielded impressive results, showcasing the transformative power of innovative pain relief techniques. This remarkable enhancement underscores the profound impact of these cutting-edge therapeutic technologies, illuminating their role in vastly improving patient experiences and achieving notable pain reduction outcomes. However, it is important to recognize the limitations of the present study. The sample size was relatively small, and the follow-up period was limited to a few months. Long-term studies are required to determine the sustainability of clinical improvements. Additionally, patient-related factors such as oral hygiene compliance and systemic health may have influenced the healing outcomes and should be considered when interpreting the results.

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