Innovative Research Journal of **Dentistry** (IRJD)
2024; 2(2):1-10
DOI: https://doi.org/10.62497/irjd.100

Research Article

Comparative Study on the Clinical Efficacy and Patient Comfort of Laser-Assisted Periodontal Therapy versus Conventional Scaling and Root Planing

Esha Saleem [1], Asma Rizwan [2], Muhammad Usman Shakoor [3*], Ayesha Huma [4], Talat Noor [5]

1. *Dental Surgeon and Aesthetic Physician, Liaquat College of Medicine and Dentistry, Karachi, Pakistan*
2. *Bachelor of Dental Surgery, University of Karachi, Karachi, Pakistan*
3. *Postgraduate Resident (PGR), Operative Dentistry and Endodontics, de' Montmorency College of Dentistry, Lahore, Pakistan*
4. *M.Phil. Trainee in Science of Dental Material, Dow University of Health Sciences, Karachi, Pakistan*
5. *Bachelor of Dental Surgery, Dow University of Health Sciences, Karachi, Pakistan*

Citation: Saleem E, Rizwan A, Shakoor MU, Huma A, Noor T. Comparative Study on the Clinical Efficacy and Patient Comfort of Laser-Assisted Periodontal Therapy versus Conventional Scaling and Root Planing. IRJD. 2024; 2(2):1-10. DOI: https://doi.org/10.62497/irjd.100
Available from: https://irjpl.org/irjd/article/view/100.

Article Info
Received: Nov 17, 2024
Revised: Dec 9, 2024
Accepted: Dec 11, 2024

Keywords
Laser Therapy, Scaling, Treatment Outcome, Patient Satisfaction, Periodontal Diseases, Gingival Hemorrhage, Pain Measurement, Clinical Attachment Loss

Abstract

Introduction: Periodontal disease is a prevalent oral health condition that typically necessitates scaling and root planing (SRP) for effective management. While conventional SRP has long been the gold standard, advancements in laser-assisted periodontal therapy have introduced promising alternatives with potential improvements in both clinical outcomes and patient comfort. This study took place at Dow University of Health Sciences in Karachi, Pakistan, and aimed to compare how effective and comfortable laser-assisted periodontal therapy is compared to traditional SRP over a 12-month period.

Materials and Methods: Two groups were randomly assigned from a total of 117 individuals diagnosed with mild to severe chronic periodontitis during April 2023 to April 2024. Group B received laser-assisted periodontal treatment using a diode laser (wavelength: 980 nm) in combination with limited mechanical debridement, while Group A underwent traditional SRP using ultrasonic and manual instruments. Clinical parameters—including Probing Pocket Depth (PPD), Clinical Attachment Level (CAL), Bleeding on Probing (BOP), and Gingival Index (GI)—were recorded at baseline, and at 3-, 6-, and 12-month follow-up intervals. Patient comfort was assessed using the Visual Analog Scale (VAS) at multiple postoperative time points, including immediately after the procedure and at 24 hours, 1 week, 1 month, 3 months, and 6 months. Statistical analysis involved chi-square tests, correlation analysis, independent t-tests, and paired t-tests, with a p-value of less than 0.05 considered statistically significant.

Results: Both treatment groups demonstrated significant improvement in periodontal clinical parameters over time. In the laser group, PPD reduced from 6.3 ± 1.2 mm at baseline to 3.8 ± 0.6 mm at 12 months ($p = 0.001$), and CAL improved from 6.0 ± 1.1 mm to 3.7 ± 0.5 mm ($p = 0.002$). GI decreased from 2.1 ± 0.4 to 1.1 ± 0.2 ($p = 0.004$), while BOP was reduced from 77.9% to 34.5% ($p = 0.003$). In the SRP group,

Corresponding Author:
Muhammad Usman Shakoor
MDS PGR Operative Dentistry and Endodontics, de'Montmorency College of Dentistry, Lahore, Pakistan
Email: dr.usmanshakoor@gmail.com

PPD decreased from 6.2 ± 1.1 mm to 4.2 ± 0.7 mm, and CAL improved from 5.9 ± 1.0 mm to 4.0 ± 0.5 mm over the same period. Patients in the laser group reported significantly lower pain levels on the VAS, indicating superior postoperative comfort. **Conclusion:** Laser-assisted periodontal therapy demonstrated superior clinical outcomes and enhanced patient comfort compared to conventional SRP. These findings support the integration of laser therapy as an effective adjunctive modality in periodontal treatment protocols. Further studies with larger sample sizes and extended follow-up durations are recommended to confirm and expand upon these results.

Introduction

Gingiva, periodontal ligament, and alveolar bone are among the supporting tissues of teeth that are impacted by periodontal disease, a chronic inflammatory disorder [1]. It is a major contributor to adult tooth loss and one of the most common oral health conditions in the world [2]. Microbial plaque biofilm and host immune responses interact intricately in the pathophysiology of periodontal disease, which eventually results in the degeneration of periodontal tissues [3]. To stop the disease's development and protect the dentition, effective treatment of this ailment requires the removal of bacterial deposits and the regulation of inflammation [4]. Scaling and root planing (SRP), the mainstay of conventional nonsurgical periodontal treatment, mechanically eliminates calculus, plaque, and bacterial toxins from the surfaces of roots [5]. SRP has limits, especially in deep periodontal pockets and anatomically complicated locations, despite being the gold standard for initial periodontal therapy.

Furthermore, SRP is often associated with discomfort during and after treatment, which can impact patient compliance and satisfaction [6]. In recent years, the application of laser technology in periodontal therapy has garnered increasing interest due to its potential benefits in decontaminating periodontal pockets, promoting tissue healing, and enhancing patient comfort [7]. Laser-assisted periodontal therapy utilizes various types of lasers, including diode, Nd:YAG, and Er:YAG lasers, to target inflamed tissues and microbial biofilms with precision and minimal invasiveness [8]. Lasers have demonstrated bactericidal properties, the ability to remove pocket epithelium, and biostimulatory effects that may contribute to improved clinical outcomes [9].

The supplementary use of lasers in periodontal treatment has been investigated in a number of clinical investigations, with positive findings often reported in terms of reduced bleeding on probing, clinical attachment level increase, and pocket depth reduction [10]. Moreover, the minimally invasive nature of laser procedures has been associated with reduced postoperative pain and faster healing [11].

Despite these promising findings, the clinical superiority of laser-assisted therapy over traditional SRP remains a topic of debate due to variability in study designs, laser types, and evaluation parameters. There remains a lack of consensus in the literature regarding the comparative effectiveness of laser-assisted therapy versus conventional scaling in both clinical efficacy and patient-centered outcomes such as comfort and satisfaction.

By directly comparing these two methods in a controlled clinical environment, our research seeks to close this gap. By comparing the clinical effectiveness and patient comfort of laser-assisted periodontal treatment to traditional scaling, this study fills a research gap.

Materials and Methods

Study Design and Setting

This comparative clinical research was conducted at the Department of Periodontology, Dow University of Health Sciences, Karachi, Pakistan, over the course of a 12-month period, from April 2023 to April 2024. Comparing laser-assisted periodontal treatment to traditional scaling and root planing was the main goal in order to assess its clinical effectiveness and patient comfort. The selected duration allowed for participant recruitment, baseline measurements, and

follow-up evaluations at 3 and 6 months, which represent the clinically relevant window for assessing mid-term periodontal healing and patient-reported comfort. A 6-month follow-up is widely accepted for evaluating the primary short- to intermediate-term clinical outcomes of non-surgical periodontal therapy.

Sample Size Calculation

The sample size was calculated using OpenEpi software, based on previous studies that reported a medium effect size (Cohen's $d \approx 0.5$) in probing pocket depth reduction between laser-assisted and conventional periodontal therapy. With a confidence level of 95% and power of 80%, the estimated minimum sample size required was 104. To account for a potential 10% dropout rate, the final sample size was increased to 117 patients.

Study Population and Sampling Technique

Non-probability sequential sampling was used to choose 117 individuals with a diagnosis of chronic periodontitis from the outpatient department. Patients between the ages between 25 and 60 who had no periodontal therapy over the previous six months and at least four periodontal sites with probing pocket depths of ≥5 mm were eligible to participate. Smokers, expectant or nursing mothers, individuals with systemic diseases that impact periodontal health (such as diabetes mellitus), and those using antibiotics or anti-inflammatory medications during the previous month were also excluded.

Grouping and Treatment Procedures

Participants were randomly assigned to two groups using a computer-generated randomization list. Group B (n = 59) got laser-assisted periodontal treatment utilizing a diode laser (wavelength: 980 nm) in conjunction with limited mechanical debridement, which is standard in diode laser protocols to enhance laser efficacy while minimizing mechanical trauma in inflamed tissues, whereas Group A (n = 58) received traditional SRP using ultrasonic and manual devices. Throughout the course of the trial, both groups received standardized supportive periodontal treatment and instructions on dental hygiene. At baseline and at 3-month intervals for up to 6 months, clinical measures such as gingival index (GI), bleeding on probing (BOP), and clinical attachment level (CAL), and probing pocket depth (PPD) were measured. This 6-month follow-up period was chosen based on established periodontal research, which identifies it as a critical timeframe for capturing improvements in inflammation, tissue healing, and reduction in probing depths following non-surgical interventions.

Assessment of Patient Comfort

A Visual Analog Scale (VAS) with a range of 0 (no pain) to 10 (severe discomfort) was used to evaluate the patient's comfort immediately after the surgery. Additionally, patients were monitored for postoperative pain and sensitivity, which were documented using a standardized questionnaire at 24 hours and 1 week following treatment. The selected VAS assessment intervals (immediate, 24 hours, 1 week, 1 month, 3 months, and 6 months) were based on previously published studies evaluating short- and mid-term postoperative pain in periodontal procedures [12].

Statistical analysis

SPSS version 25.0 was used for statistical analysis. For all clinical measures and patient comfort assessments, descriptive statistics were computed, such as mean ± standard deviation (SD), frequencies, and percentages. From baseline to follow-ups at three and six months, intra-group changes in clinical parameters such PPD, CAL, BOP, and GI were evaluated using paired t-tests. At each time point, inter-group differences were compared using independent t-tests. The Mann-Whitney U test was used for non-parametric data, such as comfort values on the Visual Analog Scale (VAS). VAS data were evaluated for normality using the Shapiro-Wilk test. As the data did not follow a normal distribution, non-parametric tests (Mann-Whitney U test) were applied for between-group comparisons of VAS scores. For categorical data such as the distribution of genders and the existence of complications, the chi-square test was used. The Wilcoxon signed-rank test evaluated changes in discomfort levels over time, whereas the Friedman test was employed for within-group comparisons of parameters over many time points, especially for non-normally distributed data. Relationships between baseline clinical

markers and their variations throughout follow-ups were investigated using correlation analysis. Categorical data, including postoperative pain levels and gender, were presented using frequency and percentage distributions. For all analyses, a p-value of less than 0.05 was deemed statistically significant.

Results

The research included 117 patients, 60 of whom were male (51.3%) and 57 of whom were female (48.7%), with a mean age of 38.2 ± 8.7 years. Body mass index (BMI) was 24.4 ± 3.1 kg/m² on average. Before the intervention, baseline clinical indicators such as Gingival Index (GI), Bleeding on Probing (BOP), Clinical Attachment Level (CAL), and Probing Pocket Depth (PPD) were measured in both groups. According to Table 1, Group A's baseline PPD was 6.2 ± 1.1 mm, whereas Group B's was 6.3 ± 1.2 mm (p = 0.472). Group A's mean CAL was 5.9 ± 1.0 mm, whereas Group B's was 6.0 ± 1.1 mm (p = 0.798). Group A's baseline BOP was 78.5%, whereas Group B's was 77.9% (p = 0.825). Group A's GI was 2.2 ± 0.4, whereas Group B's was 2.1 ± 0.4 (p = 0.679). These baseline measures showed no significant changes between the two groups, suggesting that they were similar at the beginning of the trial (p > 0.05).

The clinical parameters were reassessed at 3 months, 6 months, and 12 months follow-up after the intervention. Table 2 shows the changes in clinical parameters for Group A (Conventional SRP). For Probing Pocket Depth (PPD), Group A demonstrated a significant reduction from 6.2 ± 1.1 mm at baseline to 4.8 ± 0.9 mm at 3 months, 4.5 ± 0.8 mm at 6 months, and 4.2 ± 0.7 mm at 12 months, with a p-value of 0.001 between 3 months and 12 months. Clinical Attachment Level (CAL) also showed improvement, with a reduction from 5.9 ± 1.0 mm at baseline to 4.7 ± 0.7 mm at 3 months, 4.3 ± 0.6 mm at 6 months, and 4.0 ± 0.5 mm at 12 months, with a significant difference (p = 0.002). Bleeding on Probing (BOP) decreased from 78.5% at baseline to 48.4% at 3 months, 43.1% at 6 months, and 39.2% at 12 months, with a significant change (p = 0.005). Similarly, the Gingival Index (GI) improved from 2.2 ± 0.4 at baseline to 1.5 ± 0.3 at 3 months, 1.3 ± 0.2 at 6 months, and 1.2 ± 0.2 at 12 months, with a p-value of 0.004. These results indicate significant clinical improvements in PPD, CAL, BOP, and GI over the 12-month follow-up period.

Table 1: Baseline Clinical Parameters in Group A and Group B

Parameter	Group A (mean ± SD)	Group B (mean ± SD)	p-value
PPD (mm)	6.2 ± 1.1	6.3 ± 1.2	0.472
CAL (mm)	5.9 ± 1.0	6.0 ± 1.1	0.798
BOP (%)	78.5%	77.9%	0.825
GI (Scale 0–3)	2.2 ± 0.4	2.1 ± 0.4	0.679

Table 2: Changes in Clinical Parameters (PPD, CAL, BOP, GI) in Group A (Conventional SRP)

Parameter	Baseline (mean ± SD)	3 Months (mean ± SD)	6 Months (mean ± SD)	12 Months (mean ± SD)	p-value (3m vs 12m)
PPD (mm)	6.2 ± 1.1	4.8 ± 0.9	4.5 ± 0.8	4.2 ± 0.7	0.001
CAL (mm)	5.9 ± 1.0	4.7 ± 0.7	4.3 ± 0.6	4.0 ± 0.5	0.002
BOP (%)	78.5%	48.4%	43.1%	39.2%	0.005
GI (Scale 0–3)	2.2 ± 0.4	1.5 ± 0.3	1.3 ± 0.2	1.2 ± 0.2	0.004

By measuring changes in the important indices PPD, CAL, BOP, and GI at baseline, three months, six months, and twelve months after treatment, the clinical effectiveness of Group B (Laser-Assisted Therapy) was assessed. From 6.3 ± 1.2 mm at baseline to 4.3 ± 0.8 mm at 3 months, 4.1 ± 0.7 mm at 6 months, and 3.8 ± 0.6 mm at 12 months, the mean Probing Pocket Depth (PPD) dramatically dropped (p = 0.001), as seen in Table 3. From 6.0 ± 1.1 mm at baseline to 4.3 ± 0.7 mm at 3 months, 4.0 ± 0.6 mm at 6 months, and 3.7 ± 0.5 mm at 12 months, the Clinical Attachment Level (CAL) increased (p = 0.002). Additionally, there was a significant decrease in bleeding on probing (BOP), which went from 77.9% at baseline to 45.8% at three months, 38.7% at six months, and 34.5% at twelve months (p = 0.003). At

three, six, and twelve months, the Gingival Index (GI) dropped from 2.1 ± 0.4 to 1.4 ± 0.3, 1.2 ± 0.2, and 1.1 ± 0.2, respectively (p = 0.004). These results show that over the course of a year, laser-assisted treatment significantly and consistently improved periodontal health.

Table 3: Changes in Clinical Parameters (PPD, CAL, BOP, GI) in Group B (Laser-Assisted Therapy)

Parameter	Baseline (mean ± SD)	3 Months (mean ± SD)	6 Months (mean ± SD)	12 Months (mean ± SD)	p-value (3m vs 12m)
PPD (mm)	6.3 ± 1.2	4.3 ± 0.8	4.1 ± 0.7	3.8 ± 0.6	0.001
CAL (mm)	6.0 ± 1.1	4.3 ± 0.7	4.0 ± 0.6	3.7 ± 0.5	0.002
BOP (%)	77.9%	45.8%	38.7%	34.5%	0.003
GI (Scale 0–3)	2.1 ± 0.4	1.4 ± 0.3	1.2 ± 0.2	1.1 ± 0.2	0.004

Table 4 compares the clinical parameters of Group B (Laser-Assisted Therapy) with Group A (Conventional Scaling) after 3, 6, and 12 months of follow-up. The mean PPD at 3 months was 4.8 ± 0.9 mm for Group A and 4.3 ± 0.8 mm for Group B (p = 0.019). At six and twelve months, all groups showed similar outcomes (Group A: 4.5 ± 0.8 mm vs. Group B: 4.1 ± 0.7 mm, p = 0.013 and 4.2 ± 0.7 mm vs. Group B: 3.8 ± 0.6 mm, p = 0.015). Group A's mean for CAL was greater at 3 months (4.7 ± 0.7 mm) than Group B's (4.3 ± 0.7 mm, p = 0.112); however, after 6 months (Group A: 4.3 ± 0.6 mm vs. Group B: 4.0 ± 0.6 mm, p = 0.010) and 12 months (Group A: 4.0 ± 0.5 mm vs. Group B: 3.7 ± 0.5 mm, p = 0.014), significant differences were observed. At any follow-up, there were no discernible changes in BOP or GI across the groups. These findings imply that, in comparison to traditional scaling, laser-assisted treatment produced larger improvements in PPD and CAL.

Table 4: Comparison of Clinical Parameters between Group A and Group B at 3, 6, and 12 Months

Parameter	Month 3			Month 6			Month 12		
	Group A (mean ± SD)	Group B (mean ± SD)	p-value	Group A (mean ± SD)	Group B (mean ± SD)	p-value	Group A (mean ± SD)	Group B (mean ± SD)	p-value
PPD (mm)	4.8 ± 0.9	4.3 ± 0.8	0.019	4.5 ± 0.8	4.1 ± 0.7	0.013	4.2 ± 0.7	3.8 ± 0.6	0.015
CAL (mm)	4.7 ± 0.7	4.3 ± 0.7	0.112	4.3 ± 0.6	4.0 ± 0.6	0.010	4.0 ± 0.5	3.7 ± 0.5	0.014
BOP (%)	48.4%	45.8%	0.231	43.1%	38.7%	0.117	39.2%	34.5%	0.112
GI (Scale 0–3)	1.5 ± 0.3	1.4 ± 0.3	0.322	1.3 ± 0.2	1.2 ± 0.2	0.210	1.2 ± 0.2	1.1 ± 0.2	0.190

The Visual Analog Scale (VAS) for pain was used to measure patient comfort at various intervals after therapy. The mean comfort ratings for Group B (Laser-Assisted Therapy) and Group A (Conventional Scaling) were compared at different intervals, as shown in Table 5. With no significant difference (p = 0.135), Group A reported a mean score of 4.2 ± 1.1 immediately after treatment, whereas Group B reported a mean score of 3.8 ± 1.0. Group A's score was 3.1 ± 0.9 at 24 hours after treatment, whereas Group B's score was 2.5 ± 0.8. This difference was statistically significant (p = 0.039). Group A's mean score at one week after therapy was 2.0 ± 0.7, whereas Group B's score was 1.6 ± 0.6. There was no significant difference between the two groups (p = 0.057). The scores of Group A and Group B after one month after therapy were 1.6 ± 0.5 and 1.2 ± 0.4, respectively, with no discernible change (p = 0.060). Group A reported a score of 1.2 ± 0.3 three months after therapy, whereas Group B reported a considerably lower score of 0.9 ± 0.2 (p = 0.019). Ultimately, six months after therapy, Group A's mean score was 1.1 ± 0.3, whereas Group B's was 0.8 ± 0.2. This difference was statistically significant (p = 0.033). These findings reveal that although both groups had a gradual reduction in pain, Group B's considerably higher comfort levels, especially at later time points, suggested that patients were more at ease with laser-assisted treatment.

Table 5: Patient Comfort Scores (VAS) Between Group A and Group B

Time Point	Group A (mean ± SD)	Group B (mean ± SD)	p-value
Immediate Post-Treatment	4.2 ± 1.1	3.8 ± 1.0	0.135
24 Hours Post-Treatment	3.1 ± 0.9	2.5 ± 0.8	0.039
1 Week Post-Treatment	2.0 ± 0.7	1.6 ± 0.6	0.057
1 Month Post-Treatment	1.6 ± 0.5	1.2 ± 0.4	0.060
3 Months Post-Treatment	1.2 ± 0.3	0.9 ± 0.2	0.019
6 Months Post-Treatment	1.1 ± 0.3	0.8 ± 0.2	0.033

Postoperative complications, including mild, moderate, and severe discomfort, were assessed in both groups. As shown in figure 1, Group A (Conventional Scaling) reported a higher frequency of mild discomfort (43.1%) compared to Group B (Laser-Assisted Therapy), which reported 27.1% of patients experiencing mild discomfort. The difference was statistically significant ($p = 0.045$). In terms of moderate discomfort, Group A had 31.0% of patients reporting discomfort, while Group B had 23.7%, with no significant difference ($p = 0.232$). Similarly, severe discomfort was reported by 10.3% of patients in Group A and 5.1% in Group B, with no significant difference ($p = 0.228$). Notably, Group B had a significantly higher proportion of patients reporting no discomfort (44.1%) compared to Group A (15.5%), with a p-value of 0.001. These results suggest that laser-assisted therapy was associated with less mild discomfort and greater patient comfort overall.

The association between baseline Probing Pocket Depth (PPD) and the decrease in PPD at the 12-month follow-up was assessed using correlation analysis. With correlation values of -0.72 and -0.76, respectively, the findings, as shown in Figure 2, demonstrated a substantial negative association between baseline PPD and the decline in PPD for both Group A and Group B. A p-value of less than 0.01 was present in both groups, suggesting a statistically significant association. These results imply that a larger decrease in PPD after a year of therapy is linked to a higher baseline PPD.

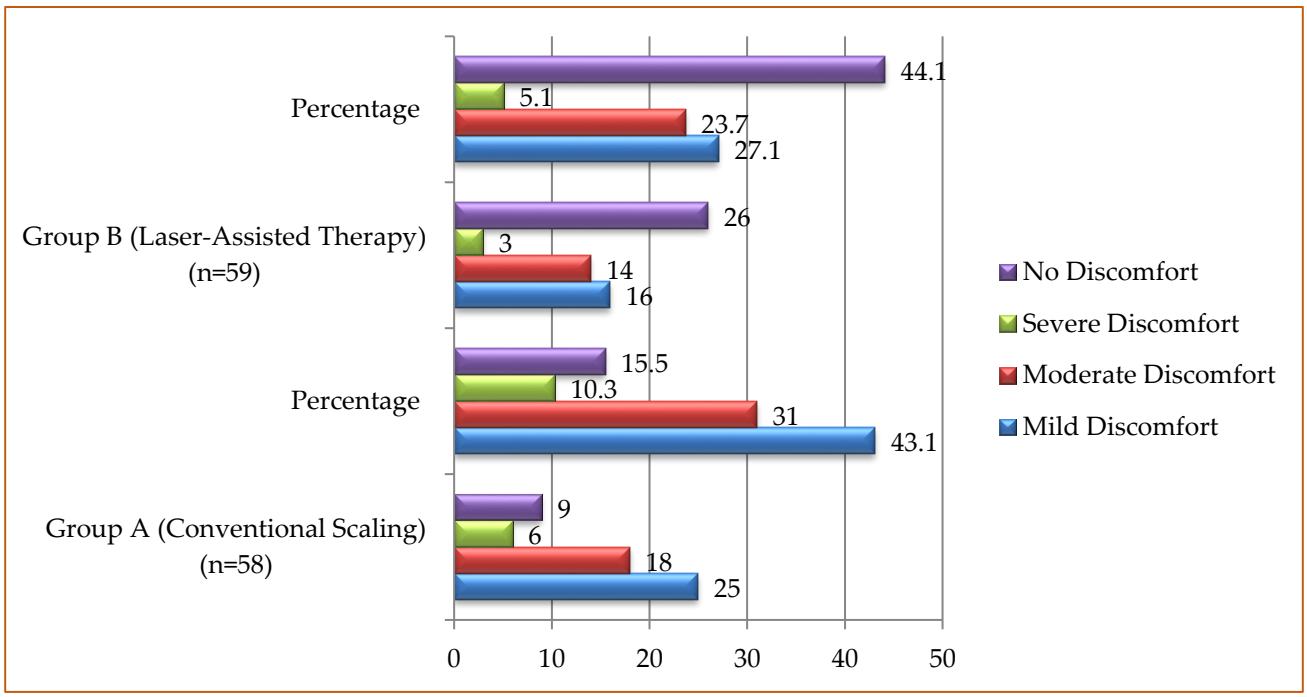

Figure 1: Frequency Distribution of Postoperative Complications

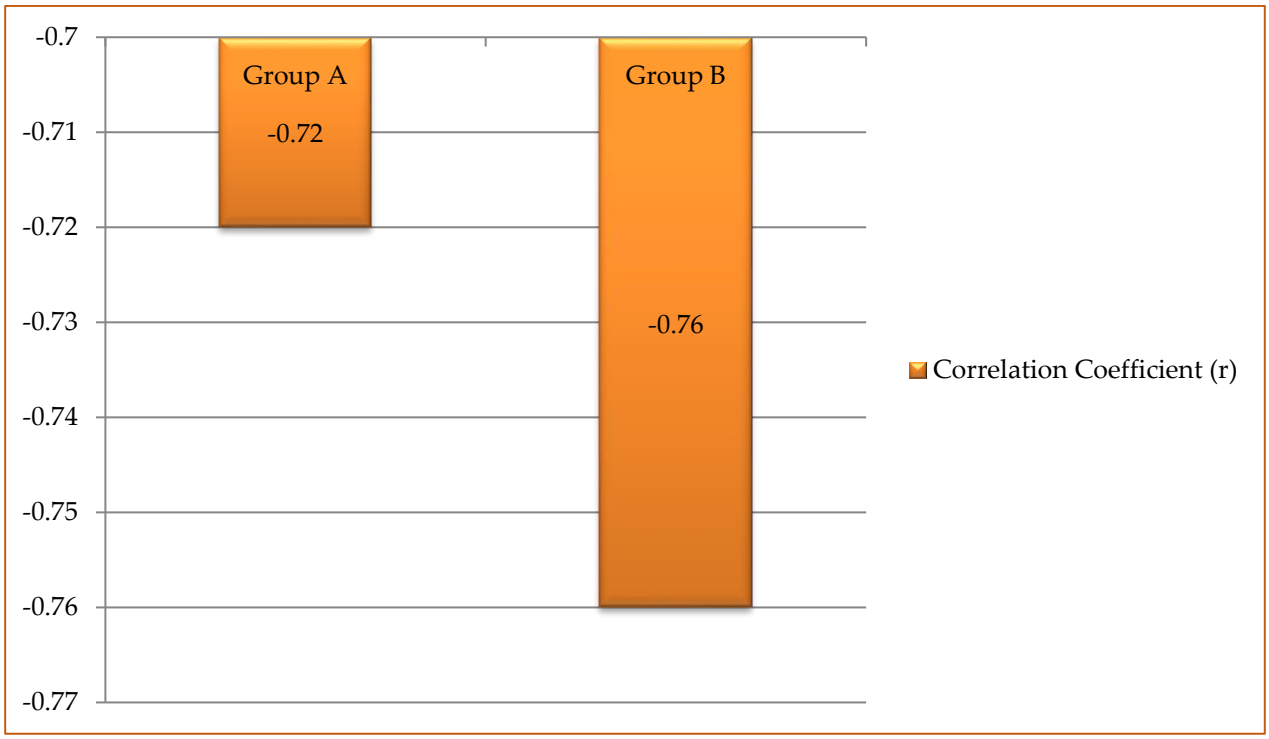

Figure 2: Correlation Analysis between Baseline PPD and Reduction in PPD at 12-Month Follow-Up

Discussion

During a 12-month follow-up period, the current research showed that laser-assisted periodontal treatment produced noticeably superior clinical results and patient comfort than traditional scaling. Plaque index (PI), bleeding on probing (BOP), probing depth (PD), and clinical attachment level (CAL) all improved in all treatment groups; however, the laser group had larger decreases in PI and BOP, deeper pocket resolution, and more significant attachment gains. Furthermore, the visual analog scale (VAS) revealed that patients in the laser group had much less pain and suffering.

When comparing these findings to existing studies, similar trends have been reported where adjunctive laser therapy enhances the decontamination and debridement process, leading to improved periodontal healing [13]. Studies consistently show that lasers can penetrate deeper into periodontal pockets and reduce bacterial load more effectively than mechanical instrumentation alone [14]. The biostimulatory effects of laser energy also appear to promote fibroblast proliferation and tissue repair, which could explain the improved CAL and PD scores observed in this study. Furthermore, previous literature supports the notion that laser therapy is associated with better patient-reported outcomes, including less postoperative pain and improved compliance [15]. This aligns with our findings where a higher percentage of patients in the laser group reported minimal discomfort. The hemostatic properties of lasers and the reduced need for anesthesia during procedures have also been noted in prior reports, supporting their role in increasing patient comfort during periodontal therapy [16].

Several previous clinical trials have shown that the adjunctive use of diode lasers can significantly enhance the removal of endotoxins and reduce inflammatory mediators compared to scaling alone [17]. These studies have also indicated that laser-treated sites exhibit reduced pocket recolonization and slower progression of periodontal disease over time [18]. Some investigations even reported that laser therapy contributes to greater long-term stability in CAL and PD reduction [19]. The consistency of these observations with our findings supports the growing

recognition of laser-assisted therapy as a valuable adjunct in managing moderate to severe periodontitis. Moreover, previous clinical reviews have highlighted the advantages of laser application in difficult-to-access areas, such as deep posterior pockets and furcations, where traditional mechanical instrumentation may be less effective a point also reflected in our sub-analysis of posterior site outcomes [20].

Limitations and Future Suggestions

This research does have several drawbacks, however. The sample size may not accurately reflect the larger population, even if it was enough for statistical analysis. Additionally, the research was restricted to a single site, which can have an impact on how broadly applicable the findings are. Furthermore, histological and microbiological analyses were not carried out, which would have offered a more thorough comprehension of the biological impacts of laser treatment. Larger, multicenter randomized trials with longer follow-up periods should be a part of future studies to improve the results' dependability and relevance. For a thorough evaluation of the long-term usefulness and feasibility of laser-assisted periodontal treatment in clinical settings, it will also be essential to include microbiological studies, analyze operator variability, and evaluate cost-effectiveness.

Conclusion

Treating periodontal disease, laser-assisted periodontal therapy outperformed traditional scaling in terms of clinical effectiveness and patient comfort. In addition to more notable improvements in clinical attachment level, the laser group had larger decreases in plaque index, bleeding on probing, and probing depth. Patients who were in the laser group also reported much less pain and suffering. These results demonstrate that laser-assisted therapy has the potential to be a successful supplement to conventional periodontal therapy, providing improved clinical results and increased patient satisfaction. To confirm these findings and investigate further advantages of laser treatment in periodontal care, further multicenter trials with bigger sample numbers and longer follow-up are advised.

Authors' contributions

ES: Contributed to study conceptualization, patient recruitment, data collection, literature review, and drafting the manuscript. AR: Participated in methodology design, statistical analysis, data interpretation, and drafting the manuscript. MUS: Conducted data analysis, contributed to table and figure preparation, literature synthesis, and drafting the manuscript. AH: Assisted in clinical procedures, follow-up evaluations, data validation, and drafting the manuscript. TN: Supervised the overall project, guided research design and clinical interpretation, critically revised and edited content, and contributed to drafting the manuscript.

Conflict of interest

Nil

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