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Original Research Article

Low-level laser therapy for gingival inflammation in orthodontic patients: A clinical and microbiological evaluation

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Abstract

Background: Fixed orthodontic appliances are associated with increased plaque retention and difficulty in maintaining oral hygiene, frequently resulting in gingival inflammation and hyperplasia. Low-Level Laser Therapy (LLLT) has been proposed as a non-invasive adjunctive approach due to its biostimulatory, anti-inflammatory, and antimicrobial properties.

Aims and Objective: To evaluate the clinical and microbiological effects of LLLT as an adjunct to conventional mechanical debridement in managing gingival inflammation among patients undergoing fixed orthodontic therapy.

Materials and Methods: A randomized, split-mouth clinical trial was conducted involving 30 patients undergoing fixed orthodontic treatment. Each patient's oral cavity was divided into quadrants, with one quadrant randomly assigned to receive mechanical debridement alone (control), and the contralateral quadrant receiving mechanical debridement in conjunction with LLLT (test group). The test quadrants underwent LLLT application on days 1, 3, and 5 post-debridement. Clinical parameters, including the Modified Sulcus Bleeding Index (M-SBI) and Plaque Index (PI), along with microbiological evaluation of bacterial load using colony-forming units (CFU), were recorded at baseline, 3 weeks, and 6 weeks.

Results: The LLLT group demonstrated a statistically significant reduction in M-SBI and PI scores at both 3 and 6 weeks compared to the control group ($p < 0.05$). Additionally, a marked reduction in CFU counts was observed in the test group, indicating a substantial decrease in microbial colonization.

Conclusion: LLLT, when used as an adjunct to mechanical debridement, effectively reduces gingival inflammation, plaque accumulation, and microbial load in patients undergoing fixed orthodontic treatment. These findings support its potential as a complementary therapeutic modality in orthodontic periodontal management.

Keywords: Low-level laser therapy, Gingival inflammation, Orthodontics, Mechanical debridement, Microbial load, Periodontal health.

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1. Introduction

In order to improve oral function and appearance and correct malocclusions, orthodontic therapy is essential. However, keeping the best possible oral hygiene is made extremely difficult by the presence of fixed orthodontic appliances such as bands, brackets, and archwires. These devices create a large number of plaque-retentive regions, which promotes biofilm formation and raises the risk of gingivitis and gingival hyperplasia.[1] Plaque-induced gingival inflammation is a common complication during orthodontic therapy, characterized by swelling, erythema, bleeding on probing, and histopathological changes in the gingival tissues.[2]

Plaque buildup on brackets and the resins that hold them together causes a change in the equilibrium of the normally stable resident oral flora, which exacerbates periodontal disease. This change can be seen through immunohistochemical analysis or clinical observation.[3]

Several studies showed that even patients with good oral hygiene who are treated with fixed orthodontic appliances may develop gingivitis.[4] Bacterial metabolic products were able to penetrate the epithelium and disturb its functional and structural integrity.[5]

Although mechanical debridement, including scaling and root planing, remains the gold standard for managing

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plaque-induced gingival inflammation, its effectiveness can be limited in the context of ongoing appliance-related biofilm accumulation.[6] Consequently, adjunctive therapies have been investigated to enhance periodontal outcomes during orthodontic treatment.

One such promising adjunct is Low-level laser therapy (LLLT). LLLT involves the application of low-intensity light at specific wavelengths, which promotes biostimulation at the cellular level. The therapeutic effects of LLLT include modulation of inflammatory mediators, reduction of edema, promotion of fibroblast proliferation, stimulation of collagen synthesis, and enhanced tissue healing.[7] A soft tissue laser with a wavelength of 810 nm or 910–980 nm is called a diode laser. It has some positive effects, including increasing growth factor release, promoting angiogenesis, and speeding up wound healing.[8] Without interacting with the hard tissues of the teeth, low power lasers have an efficient bactericidal effect. During irradiation, a portion of the laser energy scatters and enters periodontal pockets. In addition to the bactericidal effect, this causes stimulation of the cells in the surrounding tissues, which lowers inflammatory conditions and improves periodontal tissue attachment. It also increases cell proliferation and lymph flow and significantly reduces post-operative pain.[9]

The present study aims to evaluate the clinical and microbiological efficacy of LLLT as an adjunct to mechanical debridement in managing gingival inflammation in patients undergoing fixed orthodontic therapy. It is hypothesized that the adjunctive use of LLLT will result in a more significant reduction in gingival inflammation and microbial load compared to mechanical debridement alone.

2. Materials and Methods

2.1. Study design and participants

This study employed a split-mouth randomized clinical trial design to minimize inter-individual variability, allowing each participant to serve as their own control. The trial was conducted in the Department of Periodontics following ethical approval from the institutional review board.

A total of 30 participants undergoing comprehensive fixed orthodontic treatment were selected through random sampling. The inclusion criteria comprised patients aged between 18 and 30 years, in good general health, and with no systemic conditions that could compromise periodontal health. Exclusion criteria included smokers, individuals with systemic illnesses, pregnant or lactating women, and patients who had received antibiotics or periodontal treatment within the past three months.

Each participant's oral cavity was divided into four quadrants, which were randomly assigned to one of two groups:

1. Test group (LLLT Group): Quadrants received full-mouth mechanical debridement in combination with Low-level laser therapy (LLLT) on days 1, 3, and 5 post-debridement.
2. Control group: Quadrants were subjected only to mechanical debridement, with no adjunctive laser therapy.

This split-mouth design enabled intra-patient comparison between treatment modalities, thereby controlling for confounding factors such as age, oral hygiene practices, systemic health, and plaque susceptibility.

2.2. Intervention

2.2.1. Test group (LLLT group)

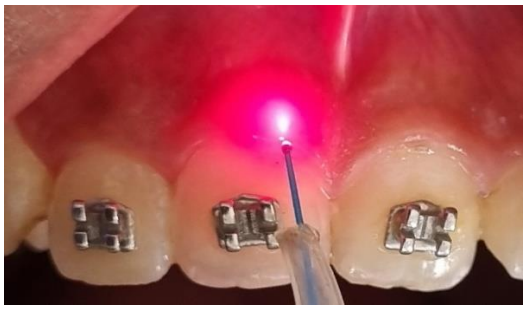

Figure 1: *Application of diode laser in the gingival sulcus*

1. Laser parameters: LLLT was performed using a diode laser (wavelength: 810 nm) with a power output of 100 mW and an energy density of 4 J/cm².
2. Application protocol: Laser irradiation was applied to each designated quadrant for 20 seconds per tooth, focusing on the gingival margins. Treatments were administered on Day 1, Day 3, and Day 5 following mechanical debridement to align with key phases of gingival healing and inflammation resolution.

2.2.2. Control group

1. The control quadrants were subjected only to mechanical debridement using ultrasonic scalers, with no laser application.

All participants received standardized oral hygiene instructions at baseline and during follow-up visits. They were advised to maintain their usual oral hygiene regimen throughout the duration of the study.

2.3. Outcome measures

Three primary clinical and microbiological outcome measures were evaluated in this study to assess the impact of Low-Level Laser Therapy (LLLT) on gingival inflammation in patients undergoing fixed orthodontic treatment.

2.3.1. Modified sulcus bleeding index (M-SBI)

The Modified sulcus bleeding index (M-SBI) was employed to assess the degree of gingival inflammation based on the

bleeding response elicited upon gentle probing of the gingival sulcus. The scores ranged from 0 to 3, as follows:

M-SBI Scoring	Description
0	No bleeding
1	Point bleeding
2	Line bleeding
3	Profuse bleeding

This index provides a sensitive measure of inflammatory status and vascular response within the gingival tissues.

2.3.2. Plaque index (PI)

The Plaque index (PI) was used to quantify the amount of dental plaque accumulation on tooth surfaces, based on visual and tactile inspection. The scoring criteria were as follows:

PI Score	Criteria
0	No plaque
1	A thin film of plaque detectable only with a probe
2	Moderate plaque visible to the naked eye
3	Abundant plaque covering more than one-third of the tooth surface

This index served as an indirect indicator of the patient's oral hygiene status and the biofilm burden contributing to gingival inflammation.

2.3.3. Colony-forming units (CFU)

Microbiological evaluation was performed by quantifying Colony-forming units (CFUs) from subgingival plaque samples. Using sterile Gracey curettes, plaque samples were collected from the gingival sulcus of designated teeth and cultured under anaerobic conditions on blood agar plates. Incubation was carried out at 37°C for 48 hours, after which the bacterial colonies were manually counted to estimate microbial load within the periodontal environment.

2.3.4. Evaluation timeline

All outcome parameters (M-SBI, PI, and CFU) were assessed at three time points during the study period to evaluate both short-term and sustained effects of the intervention:

Timeline	Evaluation Parameters	Test Group Intervention	Control Group Intervention
Day 1	M-SBI, PI, CFU	Mechanical debridement + LLLT	Mechanical debridement only
Day 21	M-SBI, PI, CFU	LLLT (administered on Days 1, 3, 5)	None
Day 42	M-SBI, PI, CFU	None	None

This structured timeline allowed for the observation of immediate, intermediate, and sustained effects of LLLT as an adjunct to mechanical debridement on gingival inflammation and microbial colonization.

3. Results

The clinical (Modified Sulcus Bleeding Index and Plaque Index) and microbiological (Colony-Forming Units) parameters were assessed on Day 1 (baseline), Day 21, and Day 42 to evaluate the efficacy of Low-Level Laser Therapy (LLLT) as an adjunct to mechanical debridement. The findings demonstrate a superior reduction in gingival inflammation, plaque accumulation, and microbial load in the LLLT group compared to the control group receiving mechanical debridement alone.

3.1. Modified sulcus bleeding index (M-SBI)

At baseline (Day 1), both the LLLT and control quadrants exhibited comparable M-SBI scores of 2.8, indicating a high level of gingival inflammation. By Day 21, the LLLT-treated quadrants demonstrated a substantial reduction in inflammation, with M-SBI scores dropping to 1.5, while the control quadrants showed only a moderate decline to 2.3. At the final evaluation on Day 42, the LLLT group exhibited an M-SBI score of 0.8, compared to 1.8 in the control group, signifying significantly greater resolution of gingival inflammation in the test group.

Table 1: Comparison of Modified sulcus bleeding index (M-SBI) Scores between LLLT and control groups at different time points

Time Point	LLLT Group	Control Group
Day 1	2.8	2.8
Day 21	1.5	2.3
Day 42	0.8	1.8

3.2. Plaque index (PI)

At baseline, both groups recorded a mean PI score of 2.5, indicative of moderate to severe plaque accumulation. By Day 3, the LLLT group showed a more marked improvement, with PI scores decreasing to 1.4, whereas the control group only improved to 2.0. By Day 5, the LLLT group had a further reduction to 0.7, while the control group achieved a PI score of 1.5.

Table 2: Comparison of Plaque index (PI) scores between LLLT and control groups at different time points

Time Point	LLLT Group	Control Group
Day 1	2.5	2.5
Day 3	1.4	2.0
Day 5	0.7	1.5

3.3. Colony-forming units (CFU)

At baseline (Day 1), the bacterial load was comparable in both groups, with CFU counts averaging 4×10^5. By Day 21,

the test group (LLLT) showed a marked reduction to 2×10^5, while the control group exhibited a milder decrease to 3×10^5. At Day 42, the LLLT group demonstrated a substantial reduction in microbial load to 0.5×10^5, compared to 2×10^5 in the control group.

Table 3: Comparison of Colony-forming units (CFU) between LLLT and control groups at different time points

Time Point	LLLT Group (CFU)	Control Group (CFU)
Day 1	4×10^5	4×10^5
Day 21	2×10^5	3×10^5
Day 42	0.5×10^5	2×10^5

Interpretation: The significantly greater microbial reduction in the LLLT group supports the antimicrobial potential of laser therapy as an adjunctive modality in periodontal management during orthodontic treatment.

These findings suggest that low-level laser therapy, when used as an adjunct to mechanical debridement, significantly enhances the management of gingival inflammation in patients undergoing fixed orthodontic therapy.

4. Discussion

Because orthodontic components make it more difficult to maintain proper oral hygiene, orthodontic therapy constitutes a major invasion of the oral environment. This may raise the risk of gingivitis and periodontitis by promoting the buildup of dental plaque on brackets and permitting the coaggregation of harmful microbes. Notably, any orthodontist finds these kinds of situations quite difficult. Sometimes severe bleeding and gingival hyperplasia make the brackets inaccessible, which makes orthodontic therapy more difficult. Additionally, if gingivitis persists, the condition could worsen and lead to periodontitis.

Because of CAL and bone resorption, the orthodontist will be forced to cease orthodontic therapy. This suggests that early treatment of gingivitis is necessary to prevent the development of periodontitis.[10]

Targeting the etiological factors—primarily tooth plaque, which contains the majority of the bacteria—is the best way to manage gingivitis. As a result, there will be fewer indications of inflammation, which will greatly enhance gingival health. Thus, the goal of the current study was to evaluate how diode lasers affected the reduction of gingival inflammation in individuals undergoing orthodontic treatment.

All patients underwent periodontal screening to assess the level of gingivitis and inflammation both before and after periodontal intervention. The four quadrants of each patient were randomly allocated to receive either supra and subgingival debridement with diode laser or debridement only.

In the context of gingival healing, the timing of LLLT application is crucial for maximizing its biological effects. In this study, LLLT was applied on the 1st, 3rd, and 5th days post-debridement, based on the rationale that these time points correspond to critical phases of wound healing:

1. Day 1 targets the acute inflammatory phase, during which LLLT modulates pro-inflammatory cytokines and reduces oxidative stress.
2. Day 3 coincides with the proliferative phase, where fibroblasts and endothelial cells are actively involved in tissue repair. LLLT at this stage enhances fibroblast activity, angiogenesis, and extracellular matrix formation.
3. Day 5 represents the early maturation phase, where collagen remodeling begins, and tissue stability increases. LLLT application supports tissue organization and consolidation.[11]

This timing strategy is supported by clinical studies demonstrating that multiple LLLT sessions during early healing periods yield superior anti-inflammatory and regenerative outcomes compared to single or delayed applications. The split-mouth design used in this study further strengthens the methodological reliability by minimizing inter-individual variability

The findings of this study corroborate the hypothesis that Low-level laser therapy (LLLT), when used as an adjunct to mechanical debridement, significantly reduces gingival inflammation and bacterial load in patients undergoing fixed orthodontic treatment. These results could be justifies by the substantial effect of diode laser on the repair of the persistent inflammatory lesions in the sulcular epithelium (micro-ulcerations), which cause gingival bleeding, may support these findings. This was consistent with prior research that demonstrated that lasers preserve tissue coherence. Additionally, it can penetrate deeper layers and subgingival tissues through overlying tissue, allowing for therapeutic penetration.[12]

Additionally, there were fewer bacteria in the laser group than in the control group. Its effective bactericidal action against harmful microorganisms may be the cause of this. These findings concurred with those of Sasaki et al., who demonstrated that the use of a diode laser decreased P. gingivalis vitality.[13] It has been noted that low-level laser irradiation exerts analgesic, biostimulatory, and anti-inflammatory effects. A stronger circulation or stimulation right after laser therapy, which increases the blood flow brought on by low-level laser irradiation, can help to explain the anti-inflammatory effect and edema reduction. This is the result of improved and restored homeostasis in the tissue metabolism, not a heat effect.[14]

Despite various outcomes, there were few limitations of the studies. The small sample size of the study cannot generalize the results obtained. Instead, a large sample size

should be assessed. Although protocols were standardized, differences in technique during mechanical debridement may have introduced variability. The six-week duration may not reflect the long-term stability and recurrence of gingival inflammation or microbial regrowth. Long term followup may lead to better predictions.[15]

5. Conclusion

Within the limitations of this study, it can be concluded that Low-level laser therapy (LLLT) serves as an effective adjunct to mechanical debridement in managing gingival inflammation in patients undergoing fixed orthodontic treatment. The adjunctive application of LLLT resulted in greater reductions in clinical inflammation and microbial load compared to mechanical debridement alone. These findings underscore the potential of LLLT as a valuable tool in enhancing periodontal outcomes during orthodontic therapy.

6. Source of Funding

None.

7. Conflict of Interest

None.

References

1. Albandar JM. Epidemiology and risk factors of periodontal diseases. *Dent Clin North Am*. 2005;49(3):517–32.
2. Almeida-Lopes L, Rigau J, Zângaro RA, Guidugli-Neto J, Jaeger MM. Comparison of the low level laser therapy effects on cultured human gingival fibroblasts proliferation using different irradiance and same fluence. *Lasers Surg Med*. 2001;29(2):179–84.
3. Mártha K, Mezei T, Jánosi K. A histological analysis of gingival condition associated with orthodontic treatment. *Rom J Morphol Embryol*. 2013;54(3 Suppl):823–7Baxter GD, McDonough SM, Keating JL. Low-level laser therapy: Current clinical practice and scientific evidence. *Phys Ther Rev.* 2017;22(2):120–32.
4. Arneberg P, Ogaard B, Scheie AA, Rölla G. Selection of Streptococcus mutans and lactobacilli in an intra-oral human caries model. *J Dent Res*. 1984;63(10):1197–200.
5. Dale BA. Periodontal epithelium: a newly recognized role in health and disease. *Periodontol 2000*. 2002;30:70–8.
6. Rohith GN, Patel N, Jha R, Vachhani R, Verlianey N, Sant A. Comparative evaluation of ozonized water versus normal saline irrigation with mechanical debridement in chronic periodontitis patients – A clinical study. *J Oral Biol Craniofac Res*. 2025 Mar 31;15(3):594–9..
7. Baxter GD, Bell AJ, Allen JM, Ravey J. Low Level Laser Therapy: Current Clinical Practice in Northern Ireland. *Physiotherapy*. 1991 Mar 10;77(3):171–8.
8. Zare D, Haerian A, Molla R, Vaziri F. Evaluation of the Effects of Diode (980 Nm) Laser on Gingival Inflammation after Nonsurgical Periodontal Therapy. *J Lasers Med Sci*. 2014 Winter;5(1):27–31.
9. Yilmaz S, Kuru B, Kuru L, Noyan U, Argun D, Kadir T, et al. Effect of gallium arsenide diode laser on human periodontal disease: a microbiological and clinical study. *Lasers Surg Med*. 2002;30(1):60–6.
10. Beckwith FR, Ackerman RJ Jr, Cobb CM, Tira DE. An evaluation of factors affecting duration of orthodontic treatment. *Am J Orthod Dentofacial Orthop*. 1999 Apr;115(4):439–47.
11. Youssef M, Ashkar S, Hamade E, Gutknecht N, Lampert F, Mir M, et al. The effect of low-level laser therapy during orthodontic movement: a preliminary study. *Lasers Med Sci*. 2008 Jan;23(1):27–33.
12. Kreisler M, Christoffers AB, Willershausen B, d'Hoedt B. Effect of low-level GaAlAs laser irradiation on the proliferation rate of human periodontal ligament fibroblasts: an in vitro study. *J Clin Periodontol*. 2003;30(4):353–8.
13. Sasaki Y, Hayashi J, Fujimura T, Iwamura Y, Yamamoto G, Nishida E, et al. New Irradiation Method with Indocyanine Green-Loaded Nanospheres for Inactivating Periodontal Pathogens. *Int J Mol Sci*. 2017;18(1):154.
14. Qadri T, Miranda L, Tunér J, Gustafsson A. The short-term effects of low-level lasers as adjunct therapy in the treatment of periodontal inflammation. *J Clin Periodontol*. 2005;32(7):714–9.
15. Enwemeka CS, Parker JC, Dowdy DS, Harkness EE, Sanford LE, Woodruff LD, et al. The efficacy of low-power lasers in tissue repair and pain control: a meta-analysis study. *Photomed Laser Surg*. 2004;22(4):323–9.

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