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The Journal of Dental Panacea

Journal homepage: https://www.jdentalpanacea.org/

Original Research Article

Role of low level laser therapy in managing post-operative inflammation following surgical removal of mandibular third molar teeth –A split mouth prospective case study

Akash Pillai[1]*, Shaji Thomas[1], Mohd. Javed[1], Akanksha Singh[2], Chitranjan Tomar[1], Jasleen Chhabra[1]

[1]Dept. of Oral and Maxillofacial Surgery, People's College of Dental Sciences and Research Center, Bhopal, Madhya Pradesh, India.
[2]Private Practitioner, Oral and Maxillofacial Surgeon and hair transplant surgeon, Mumbai Maharashtra, India.

Abstract

Background: Surgical extraction of impacted mandibular third molars often leads to pain, swelling, and functional limitations. While conventional treatments offer relief, they come with side effects. Low-level laser therapy (LLLT) has emerged as a potential non-invasive alternative.
Aim: To evaluate the role of LLLT in reducing postoperative inflammation, pain, and complications following mandibular third molar surgery.
Materials and Methods: A split-mouth prospective case-control study was conducted on 30 patients with bilateral impacted mandibular third molars. One side was treated with LLLT using a 980 nm diode laser, while the contralateral side served as control. Pain (VAS), swelling, mouth opening, masticatory load, analgesic use, bone healing, and complications were assessed at multiple intervals postoperatively.
Results: The laser group demonstrated significantly lower pain and swelling at 24 hours, 7 days, and 1 month postoperatively ($p < 0.05$) compared to the control group. There was also a marked reduction in analgesic consumption during the first 48 hours and over a 3-day period. Additionally, patients in the laser group exhibited greater mouth opening, improved masticatory function, and enhanced bone healing as observed radiographically at both 1 and 3 months. Furthermore, the incidence of postoperative complications, particularly dry socket and delayed healing, was notably lower in the laser-treated group, indicating the overall effectiveness of LLLT in improving surgical recovery outcomes
Conclusion: LLLT effectively reduces postoperative discomfort and promotes faster healing following third molar surgery.

Keywords: Low-Level Laser Therapy (LLLT), Mandibular Third Molar, Postoperative Pain, Laser in Oral Surgery, Split-Mouth Study

Received: 04-01-2025; **Accepted:** 14-03-2025; **Available Online**: 23-04-2025

1. Introduction

Third molar extraction is one of the most common procedures performed by oral and maxillofacial surgeons. Surgical removal of an impacted third molar often involves postoperative inflammation, pain and loss of jaw function. The many factors that contribute to these situations are complex, but originate from an inflammatory process that is initiated by surgical trauma.[1] About 3-5 hours following surgery, the pain reaches its maximum intensity and may last 2-3 days; and then diminishes within 7 days after surgery.[2-3] Moreover, post-operative inflammation vanishes 5-7 days after surgery.[4] usually, it is advised to use local or systemic steroid and non-steroidal anti-inflammatory therapy to reduce inflammation and relieve pain after molar surgery, but these drugs present some side effects, including gastrointestinal issues, systemic bleeding and allergic reactions.[5]

The biological effects of lasers were first investigated in 1967.[6] Laser treatment originated in 1971.[7] Since then, it has been utilized for the treatment of several ailments, including carpal tunnel syndrome, rheumatoid conditions, osteoarthritis, tendinopathy, ankle sprains, epicondylitis, lumbago, and non-healing wounds.[8] The precise molecular mechanism underlying the anti-inflammatory and analgesic effects of low-level laser treatment (LLLT) remains ambiguous.[9] It is posited that the anti-inflammatory impact of LLLT may stem from the dose-dependent suppression of IL-6, MCP-1, IL-10, and TNF-α. 10 leading to enhanced

*Corresponding author: Akash Pillai
Email: akashaditya24@gmail.com

DOI: https://10.18231/j.jdp.2025.008

phagocytic activity, increased width and quantity of lymphatic vessels, restoration of microcapillary circulation, normalization of vascular wall permeability, and reduction of edema.[10]

Low-Level Laser Therapy (LLLT) is alternatively referred to as "soft laser therapy" and bio-stimulation. Low-level laser therapy (LLLT) has been described in healthcare literature for over thirty years. Multiple research investigations have shown that low-level laser therapy (LLLT) is helpful for some specialized uses in dentistry. The LLLT method is considered superior for wound healing as it alleviates inflammation and pain in patients; however, additional research is necessary to evaluate its effectiveness in minimizing infection in post-extraction sockets. The objective of the study is to examine the efficacy of low-level laser therapy in mitigating post-operative inflammation after the surgical extraction of mandibular third molars.

2. Materials and Methods

This study was designed as a split-mouth prospective case-control study to evaluate the role of low-level laser therapy (LLLT) in managing post-operative inflammation following the surgical removal of mandibular third molars. The study was conducted at the Department of Oral and Maxillofacial Surgery, People's College of Dental Sciences and Research Centre, Bhopal, from June 1, 2023, to May 30, 2024. Prior to participation in the study, all patients were thoroughly informed about the nature, purpose, procedure, potential risks, and benefits of the research. Written informed consent was obtained from each participant in their preferred language, ensuring complete understanding of their voluntary involvement. A total of 30 patients aged between 18 and 50 years, presenting with bilateral impacted mandibular third molars confirmed through clinical and radiographic evaluation, were included in the study. Patients with systemic diseases, mental health issues, additional maxillofacial infections, or known drug allergies, as well as those who refused to consent, were excluded.

A diode laser with a continuous wavelength of 980 nm was used. The laser was applied intraorally (on the lingual and vestibular sides) at a distance of 1 cm from the surgical site, and extraorally at the insertion point of the masseter muscle, immediately after the surgical procedure and repeated after 24 hours. One side of the mouth received laser therapy while the contralateral side served as the control. Minor oral surgical instruments were used to carry out the surgical extractions under aseptic conditions. Patients bore the cost of surgical and hospital expenses.

Clinical parameters such as pain (assessed using the VAS scale), swelling, amount of analgesics used, mouth opening, and masticatory load were evaluated post-operatively. Pain and swelling were monitored at 6, 12, and 24 hours, and at 7 and 15 days. Analgesic consumption was documented over 24 hours. Soft tissue healing was assessed at 24 hours, 7 days, 1 month, and 3 months, along with radiographic evaluations using IOPA. Data were collected using standardized forms.

The collected data were analyzed using SPSS version 29.0. Repeated measures ANOVA was applied to assess statistical differences in pain and swelling over time, while the Chi-square test was used to evaluate the use of antibiotics and incidence of complications such as dry socket between groups. A p-value less than 0.05 were considered statistically significant.

3. Result

The demographic variables including age (mean age: 27.8 ± 5.6 years in the laser group and 28.2 ± 5.3 years in the control group; $p = 0.74$), gender distribution (17 males and 13 females in both groups), and side of impaction (right: 50%, left: 50%) were comparable, ensuring that the groups were well matched for comparison.

In terms of postoperative swelling, the laser group consistently showed reduced mean swelling measurements compared to the control group at all key intervals: at 24 hours (13.2 ± 1.6 mm vs. 15.8 ± 1.9 mm; $p = 0.001$), at 7 days (9.6 ± 1.1 mm vs. 11.0 ± 1.3 mm; $p = 0.004$), and at 1 month (3.4 ± 0.6 mm vs. 4.1 ± 0.8 mm; $p = 0.018$), with the difference narrowing by 3 months ($p = 0.124$). (**Table 1**)

Pain scores measured on the Visual Analog Scale (VAS) were significantly lower in the laser group at all time points: at 6 hours (3.2 ± 0.9 vs. 5.6 ± 1.1; $p = 0.001$), 12 hours (2.9 ± 0.8 vs. 5.0 ± 1.0; $p = 0.002$), 24 hours (2.2 ± 0.7 vs. 4.4 ± 0.9; $p = 0.001$), and 7 days (0.6 ± 0.3 vs. 1.4 ± 0.5; $p = 0.006$). (**Table 2**)

Correspondingly, analgesic consumption was also significantly lower in the laser group: in the first 24 hours (1.4 ± 0.6 doses vs. 3.0 ± 0.8 doses; $p = 0.001$), between 24–48 hours (0.7 ± 0.3 vs. 2.1 ± 0.6; $p = 0.001$), and the total over 3 days (3.2 ± 0.9 vs. 6.6 ± 1.2; $p = 0.001$). (**Table 3**)

Functional recovery was better in the laser group, with greater mouth opening on day 7 (35.8 ± 1.9 mm vs. 32.0 ± 2.2 mm; $p = 0.001$) (**Table 4**). Reduced masticatory load scores on day 7 (2.0 ± 0.9 vs. 4.5 ± 1.1; $p = 0.001$) and day 15 (0.9 ± 0.4 vs. 2.3 ± 0.7; $p = 0.001$). (**Figure 1**)

Radiographic assessment of bone healing showed significantly better outcomes in the laser group at 1 month ($p = 0.019$) and 3 months ($p = 0.011$), indicating faster and more efficient bone regeneration. (**Table 5**)

Postoperative complications were also fewer in the laser group. The incidence of dry socket was significantly lower (1 case [3.3%] in the laser group vs. 5 cases [16.7%] in the control group; $p = 0.037$). Overall, any postoperative complication occurred in only 2 patients (6.6%) in the laser group compared to 9 patients (30.0%) in the control group (*p* = 0.018). (**Figure 2**)

These results strongly suggest that the use of LLLT postoperatively can substantially improve patient outcomes by reducing pain, swelling, medication intake, and complications while promoting better healing and functional recovery.

Table 1: Comparison of postoperative swelling between laser group and control group at different time interval (n=30)

Time interval	Laser group Mean ± SD (mm)	Control group Mean ± SD (mm)	F-value	p-value
24 Hours	13.2 ± 1.6	15.8 ± 1.9	18.4	0.001*
7 days	9.6 ± 1.1	11.0 ± 1.3	12.9	0.004*
1 month	3.4 ± 0.6	4.1 ± 0.8	6.2	0.018*
3 months	0.5 ± 0.2	0.7 ± 0.3	2.3	0.124

*statistically significant

Table 2: Comparison of postoperative pain (VAS Scale) between laser group and control group at different time interval (n=30)

Time Point	Laser Group (Mean ± SD)	Control Group (Mean ± SD)	F-value	*p*-value
6 Hours	3.2 ± 0.9	5.6 ± 1.1	19.1	0.001*
12 Hours	2.9 ± 0.8	5.0 ± 1.0	16.8	0.002*
24 Hours	2.2 ± 0.7	4.4 ± 0.9	18.3	0.001*
7 Days	0.6 ± 0.3	1.4 ± 0.5	9.4	0.006*

*statistically significant

Table 3: Comparison of analgesic use between laser group and control group at different time interval (n=30)

Time Interval	Laser Group (Mean ± SD)	Control Group (Mean ± SD)	*t*-value	*p*-value
0–24 Hours	1.4 ± 0.6	3.0 ± 0.8	6.3	0.001*
24–48 Hours	0.7 ± 0.3	2.1 ± 0.6	7.5	0.001*
Total Dose (3 Days)	3.2 ± 0.9	6.6 ± 1.2	8.1	0.001*

*statistically significant

Table 4: Comparison of mouth opening (mm) between laser group and control group at different time interval

Time Point	Laser Group (Mean ± SD)	Control Group (Mean ± SD)	*t*-value	*p*-value
Pre-op	38.1 ± 2.0	38.1 ± 2.0	—	—
7 Days Post-op	35.8 ± 1.9	32.0 ± 2.2	3.81	0.001*

*statistically significant

Table 5: Comparison of radiographic evaluation (bone healing score) between laser group and control group at different time interval

Time Point	Group	Score 0	Score 1	Score 2	Score 3	χ^2-value	*p*-value
24 Hours	Laser	28	2	0	0	—	—
	Control	29	1	0	0	—	—
7 Days	Laser	20	8	2	0	2.12	0.125
	Control	23	6	1	0		
1 Month	Laser	2	6	13	9	9.86	0.019*
	Control	4	10	11	5		
3 Months	Laser	0	1	6	23	11.02	0.011*
	Control	0	2	11	17		

*statistically significant, **Score 0**: No bone fill, **Score 1**: Initial trabeculation, **Score 2**: Moderate bone fill, **Score 3**: Complete trabeculation

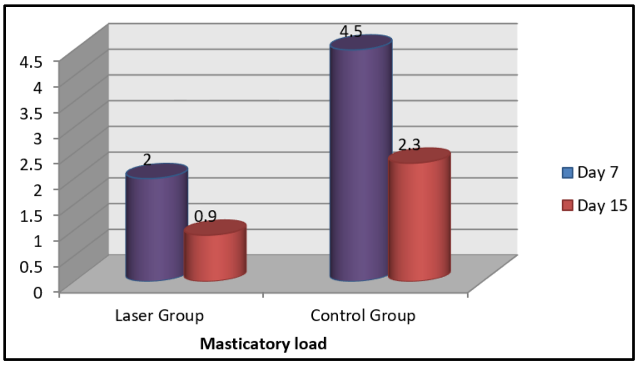

Figure 1: Comparison of masticatory load between laser group and control group at different time interval.

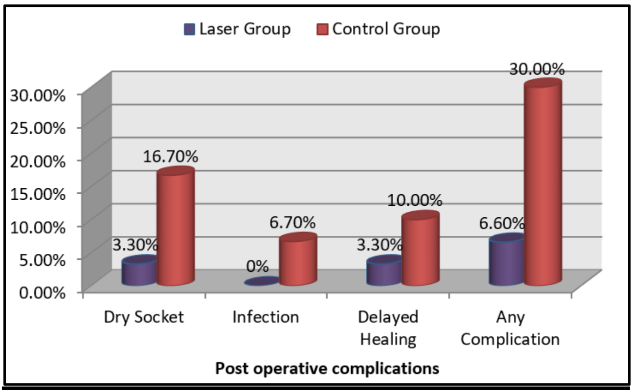

Figure 2: Comparison of postoperative complications between laser group and control group

4. Discussion

The present study aimed to evaluate the effectiveness of low-level laser therapy (LLLT) in managing postoperative outcomes following the surgical removal of mandibular third molars. A thorough analysis was conducted by comparing various clinical parameters between the laser-treated group and the control group to determine the therapeutic benefits of LLLT. The demographic characteristics of the study participants were well balanced between the laser and control groups, ensuring comparability and minimizing confounding factors.

The study showed that low-level laser therapy (LLLT) significantly reduced postoperative swelling compared to the control group, particularly during the early healing phase. Swelling was notably lower in the laser group at 24 hours (13.2 mm vs. 15.8 mm; $p = 0.001$), 7 days (9.6 mm vs. 11.0 mm; $p = 0.004$), and 1 month (3.4 mm vs. 4.1 mm; $p = 0.018$). By 3 months, the difference was no longer significant ($p = 0.124$), highlighting LLLT's effectiveness in reducing early postoperative inflammation. These findings are consistent with the results reported by Marković et al[4] who found that LLLT, in combination with dexamethasone, significantly reduced postoperative edema after mandibular third molar surgery. Similarly, Thorat et al.[11] demonstrated that diode lasers with a wavelength of 980 nm were effective in reducing postoperative swelling when applied immediately after third molar removal. The mechanism is likely related to the anti-inflammatory effects of LLLT, which reduce vascular permeability and stimulate lymphatic drainage, leading to decreased tissue fluid accumulation. Ansari N et al.[12] also reported that swelling was consistently lower in the laser group compared to the non-laser group at all assessed time points, with statistically significant differences ($p < 0.05$) observed at each interval except on the 7th day. The reduction in swelling with LLLT is likely due to its ability to decrease inflammatory mediators like IL-1β and TNF-α, reduce vascular permeability, and enhance lymphatic drainage. It also boosts cellular energy (ATP), promoting faster tissue repair and reducing fluid accumulation at the surgical site.

The study showed that low-level laser therapy (LLLT) significantly reduced postoperative pain at all evaluated time intervals. Pain scores were consistently lower in the laser group at 6 hours (3.2 vs. 5.6; $p = 0.001$), 12 hours (2.9 vs. 5.0; $p = 0.002$), 24 hours (2.2 vs. 4.4; $p = 0.001$), and 7 days (0.6 vs. 1.4; $p = 0.006$), confirming LLLT's effectiveness in early pain control. These results align with studies by Marković et al.[4], Ansari N et al.[12] and Kreisler et al.[5], which also demonstrated a reduction in postoperative pain with the use of LLLT in third molar surgeries. The analgesic effect of LLLT can be attributed to its photobiomodulatory action, which reduces the release of pro-inflammatory mediators such as prostaglandins and cytokines (e.g., IL-1β, TNF-α), thereby decreasing nerve sensitivity. Additionally, LLLT enhances mitochondrial activity and ATP production in damaged cells, promoting faster tissue repair and reducing nociceptor activation. Improved local microcirculation also facilitates the removal of inflammatory byproducts, contributing further to pain relief during the acute healing phase.

The study showed that patients treated with LLLT required significantly fewer analgesics postoperatively. These findings are in agreement with a study by Marković et al,[4] who found that LLLT effectively reduced the need for postoperative analgesics in patients undergoing third molar surgery. Similarly, Kreisler et al.[5] reported a significant decrease in pain medication use in patients treated with LLLT following endodontic surgery. LLLT reduces pain perception by modulating inflammatory cytokines and stimulating ATP production, which accelerates healing and reduces the need for analgesics.

In the present study, mouth opening was significantly better in the laser group compared to the control group on the

7th postoperative day (p = 0.001). This suggests that LLLT effectively reduced postoperative trismus. Similar findings were reported by Thorat et al[11] & Ansari N et al.[12] who found improved mouth opening in patients treated with a 980 nm diode laser following third molar surgery. LLLT decreases muscle inflammation and edema, improves blood flow, and reduces tissue stiffness—leading to faster recovery of mouth opening.

The study showed a significant reduction in masticatory load in the laser group compared to the control group postoperatively. This indicates that patients treated with low-level laser therapy (LLLT) experienced less difficulty in chewing and faster functional recovery. These findings are supported by Thorat et al.[11], who also observed improved masticatory function in patients receiving LLLT after third molar extraction.

Radiographic assessment revealed that bone healing was significantly better in the laser group compared to the control group at 1 month (p = 0.019) and 3 months (p = 0.011) postoperatively. At 3 months, 76.7% of patients in the laser group showed complete bone fill (Score 3) versus 56.7% in the control group. These findings align with the study by Albertini et al.[10], which showed that LLLT enhanced bone regeneration and tissue repair by promoting cellular proliferation and collagen synthesis. LLLT stimulates osteoblastic activity, increases collagen deposition, and enhances microcirculation—leading to faster and more complete bone healing.

Postoperative complications were significantly lower in the laser group compared to the control group. The incidence of dry socket was reduced from 16.7% in the control group to 3.3% in the laser group (p = 0.037), and overall complications were significantly fewer (6.6% vs. 30.0%; p = 0.018). These results are consistent with,[5] who reported a lower incidence of postoperative complications with the use of LLLT in oral surgeries. LLLT enhances wound healing, reduces inflammation, and improves local circulation, which helps prevents complications like dry socket and delayed healing.

5. Conclusion

Low-level laser therapy (LLLT) significantly improves postoperative outcomes following mandibular third molar surgery by reducing pain, swelling, and analgesic use, while promoting better mouth opening, bone healing, and functional recovery. It also lowers the incidence of complications, making it a beneficial adjunct in oral surgical practice.

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6. Source of Funding

None.

7. Conflict of Interest

None.

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Cite this article: Pillai A, Thomas S, Javed M, Singh A, Tomar C, Chhabra J. Role of low level laser therapy in managing post-operative inflammation following surgical removal of mandibular third molar teeth –A split mouth Prospective case study. *J Dent Panacea*. 2025;7(1):25-29.