LINK MEDICAL JOURNAL
of Health and Community Research | LMJHCR
Volume 4, Issue 1 | June 2026 | ISSN 3007-3448

Indexed in DOAJ | CC BY 4.0
DOI: 10.61919/m4epqn14

Original Article

Low-Level Laser Therapy Versus Occlusal Splint for Myofascial Pain Reduction in Chronic TMJ Disorder Patients

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"Cite this Article" | **Received**: 12 February 2026; **Accepted**: 05 May 2026; **Published**: 30 June 2026.

ABSTRACT

Background: Chronic myofascial temporomandibular disorders cause persistent orofacial pain, restricted mandibular movement, and functional limitation. Photobiomodulation may provide a non-invasive alternative to occlusal appliances. Objective: To compare 810 nm diode laser photobiomodulation with custom-fabricated occlusal splint therapy for reducing pain and improving jaw function. Methods: This parallel-group randomized controlled trial enrolled 72 adults with chronic myofascial temporomandibular disorders at a tertiary dental care centre in Southern Punjab, Pakistan. Participants were allocated equally to 12 laser sessions over four weeks or nighttime occlusal splint use. Outcomes were assessed by a blinded examiner at baseline and four weeks. Between-group comparisons, paired tests, repeated-measures analysis of variance, and correlation analysis were performed. Results: Sixty-seven participants completed follow-up: 34 in the laser group and 33 in the splint group. Post-intervention VAS pain scores were lower with laser therapy than with splint therapy (2.6 ± 1.1 versus 3.8 ± 1.4; mean difference −1.2, 95% CI −1.8 to −0.6; $p<0.001$). Jaw Functional Limitation Scale scores were also lower (16.4 ± 5.2 versus 20.7 ± 6.1; $p=0.003$). Maximum mouth opening and lateral mandibular movement favoured laser therapy. The VAS time × group interaction was significant ($F=12.9$; $p<0.001$). Conclusion: Photobiomodulation produced greater short-term improvements in pain and mandibular function than occlusal splint therapy. Keywords: Jaw Functional Limitation; Low-Level Light Therapy; Myofascial Pain; Occlusal Splints; Photobiomodulation; Temporomandibular Disorders.

EDITORIAL INFORMATION

Author Contributions: Concept: MA, AA; Design: MA, SA, AA; Data Collection: UZ, AZ, SMA; Analysis: SA, AA; Drafting: MA, UZ, AZ, SMA, AA
Ethical Approval: Liaquat College of Medicine and Dentistry, Karachi, Pakistan
Informed Consent: Written informed consent was obtained from all participants
Conflict of Interest: The authors declare no conflict of interest; **Funding**: No external funding; **Data Availability**: Available from the corresponding author on reasonable request; **Acknowledgments**: N/A.

INTRODUCTION

Temporomandibular disorders comprise a heterogeneous group of musculoskeletal and joint-related conditions affecting the temporomandibular joint, masticatory muscles, and associated structures. Myofascial pain is a frequent clinical presentation and is commonly characterized by persistent pain or tenderness in the masseter and temporalis muscles, discomfort during mandibular function, restricted jaw movement, and difficulty performing routine activities such as chewing, speaking, yawning, and maintaining normal oral function. Although these disorders are not generally life-threatening, their chronic

and recurrent nature can adversely affect sleep, dietary intake, psychological well-being, social participation, and overall quality of life, creating a considerable burden for patients and healthcare services (1).

Conservative management is generally preferred because many temporomandibular disorders involve reversible functional and muscular disturbances rather than progressive structural disease. Common non-surgical interventions include patient education, behavioural modification, therapeutic exercise, pharmacological pain management, occlusal appliances, physical modalities, and photobiomodulation. Occlusal splints remain one of the most frequently used conservative treatments for myofascial temporomandibular pain. These removable appliances are intended to stabilize occlusal contacts, redistribute mechanical loading, reduce parafunctional activity, facilitate masticatory muscle relaxation, and protect the dentition from clenching- or grinding-related forces. Despite their established clinical use, treatment responses vary, some patients require prolonged adaptation, and complete pain resolution is not consistently achieved (2,3).

Photobiomodulation, commonly referred to as low-level laser therapy, has emerged as a minimally invasive option for managing musculoskeletal and orofacial pain. Its therapeutic effects are believed to involve the absorption of light energy by intracellular chromophores, particularly cytochrome c oxidase, resulting in enhanced mitochondrial activity and adenosine triphosphate production. Photobiomodulation may also modulate inflammatory mediators, improve local microcirculation, reduce nociceptor sensitization, support cellular repair, and influence neuromuscular pain pathways. Near-infrared wavelengths such as 810 nm can penetrate soft tissues more deeply than visible-light wavelengths and may therefore be suitable for treating painful points within the masseter and temporalis muscles (4,5).

Clinical studies have reported reductions in pain intensity, muscle tenderness, and functional limitation following photobiomodulation in patients with temporomandibular disorders. However, the available evidence remains heterogeneous because previous investigations have used different wavelengths, output powers, energy densities, irradiation sites, treatment frequencies, follow-up periods, diagnostic criteria, and outcome measures. Direct comparisons between photobiomodulation and conventional occlusal splint therapy are comparatively limited, and the relative clinical benefit of these interventions for chronic myofascial presentations remains uncertain. Existing trials and systematic reviews therefore support further comparative investigation using clearly defined patient groups, standardized outcome assessment, and controlled treatment protocols (6–9).

Determining whether photobiomodulation provides greater symptom relief than appliance-based management may support more individualized and efficient conservative treatment planning. The present randomized controlled trial therefore aimed to compare the effects of 810 nm diode laser photobiomodulation and custom-fabricated occlusal splint therapy on pain intensity, jaw-related functional limitation, maximum mouth opening, and lateral mandibular movement in patients with chronic myofascial temporomandibular disorders. It was hypothesized that both interventions would improve pain and mandibular function after four weeks, with greater improvement among participants receiving photobiomodulation.

MATERIALS AND METHODS

A parallel-group randomized controlled trial with blinded outcome assessment was conducted at a tertiary dental care centre in Southern Punjab, Pakistan. The study was undertaken over five months, from September 2025 to January 2026, encompassing participant screening, enrolment, baseline evaluation, intervention delivery, and post-treatment assessment. Both treatment groups completed an active intervention period of four consecutive weeks.

Patients attending the study centre were assessed for eligibility. Adults aged 18–55 years were eligible when they had a clinical diagnosis of chronic myofascial temporomandibular disorder persisting for at least three months, pain or tenderness in the masticatory muscles on palpation, jaw discomfort during functional activity, and a measurable limitation in mandibular movement. Patients were excluded if they had

undergone previous temporomandibular joint surgery; had an inflammatory or degenerative joint condition, facial trauma, or a neurological disorder affecting mandibular function; were receiving ongoing orthodontic treatment; had used analgesic medication or muscle relaxants during the week preceding enrolment; were pregnant; or had previously received laser therapy for orofacial pain.

The target sample comprised 72 participants and was informed by previous interventional research reporting clinically meaningful differences in pain reduction between active conservative treatments for temporomandibular disorders. Eligible participants were allocated in a 1:1 ratio to either the 810 nm diode laser photobiomodulation group or the custom-fabricated occlusal splint group, resulting in an intended allocation of 36 participants per group.

The random allocation sequence was generated using a computerized randomization procedure. Allocation concealment was maintained using sequentially numbered, opaque, sealed envelopes prepared by an independent researcher who was not involved in participant assessment or treatment administration. The relevant envelope was opened only after completion of the participant's baseline assessment. Because of the visible and procedurally distinct nature of the interventions, participants and treating clinicians could not be blinded. Outcome measurements were, however, performed by an assessor who remained unaware of treatment allocation throughout the study.

Participants assigned to the photobiomodulation group received treatment with an 810 nm diode laser applied to predetermined painful points over the masseter and temporalis muscle regions. Laser irradiation was administered using the clinically prescribed soft-tissue photobiomodulation settings for approximately 10 minutes per session. Participants received three sessions per week for four consecutive weeks, providing a total of 12 treatment sessions. Treatment attendance was documented throughout the intervention period to assess adherence.

Participants assigned to the occlusal splint group received an individually fabricated stabilization appliance. Each splint was adjusted according to the participant's occlusal contacts and was prescribed for nighttime use throughout the four-week treatment period. Participants received instructions regarding appliance placement, use, and care. Adherence was monitored using participant-maintained usage diaries and follow-up records, with inadequate appliance use considered treatment non-compliance.

The primary outcomes were pain intensity and jaw-related functional limitation. Pain intensity was measured using the Visual Analog Scale, on which participants indicated the severity of their current temporomandibular or masticatory muscle pain. Functional limitation was evaluated using the Jaw Functional Limitation Scale. Secondary outcomes were maximum mouth opening and lateral mandibular movement, measured in millimetres using a calibrated digital caliper. Outcomes were assessed immediately before randomization and again after completion of the four-week intervention.

Assessment procedures were standardized across the two groups. The same outcome definitions and measurement procedures were applied at baseline and follow-up, and measurements were obtained by the blinded examiner. Use of a calibrated digital caliper, concealed treatment allocation, assessor blinding, treatment-attendance records, and participant usage diaries was intended to reduce measurement, selection, and adherence-related bias.

Baseline demographic and clinical characteristics were evaluated using the complete randomized sample of 72 participants. Post-intervention and pre–post outcome analyses were based on the 67 participants who completed the four-week follow-up, comprising 34 participants in the photobiomodulation group and 33 participants in the occlusal splint group. Baseline comparability was examined for age, sex, pain intensity, jaw functional limitation, and maximum mouth opening.

Continuous data were summarized using means and standard deviations, whereas categorical variables were reported using frequencies and percentages. The distribution of continuous variables was evaluated using the Shapiro–Wilk test. Independent-samples t-tests were used to compare continuous outcomes between the two groups, and paired-samples t-tests were used to examine changes from baseline to post-intervention within each group. Repeated-measures analysis of variance was performed to assess the

main effects of time and treatment group and the time × group interaction for the primary outcomes. Pearson correlation analysis was used to examine the relationship between reduction in pain intensity and improvement in jaw functional limitation. Between-group effects were reported using mean differences and 95% confidence intervals where available. All statistical tests were two-sided, and a p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 96 patients were assessed for eligibility between September 2025 and January 2026. Of these, 24 were excluded because they did not satisfy the eligibility criteria or declined participation. The remaining 72 participants were randomly assigned in equal numbers to the 810 nm diode laser photobiomodulation group or the occlusal splint group. During the four-week intervention, two participants in the laser group discontinued because of missed treatment sessions, while three participants in the splint group discontinued because of inadequate appliance adherence. Consequently, 67 of the 72 randomized participants completed follow-up, representing an overall retention rate of 93.1%. The final post-intervention analysis included 34 participants in the laser group and 33 in the occlusal splint group.

Baseline demographic and clinical characteristics were evaluated using all 72 randomized participants. The mean age of the total sample was 34.8 ± 9.2 years, and 46 participants (63.9%) were female. No statistically significant between-group differences were observed in age, sex distribution, baseline pain intensity, jaw functional limitation, or maximum mouth opening, indicating adequate baseline comparability (Table 1).

Table 1. Baseline Demographic and Clinical Characteristics of Randomized Participants

Characteristic	Total sample (N=72)	Laser group (n=36)	Occlusal splint group (n=36)	Difference (95% CI)	p-value
Age, years	34.8 ± 9.2	35.1 ± 9.5	34.5 ± 9.0	0.6 (−3.8 to 5.0)	0.782
Female sex, n (%)	46 (63.9)	23 (63.9)	23 (63.9)	0.0 percentage points	1.000
VAS pain score	7.1 ± 1.2	7.2 ± 1.1	7.0 ± 1.3	0.2 (−0.4 to 0.8)	0.512
Jaw Functional Limitation Scale score	38.6 ± 7.4	38.9 ± 7.6	38.3 ± 7.3	0.6 (−2.9 to 4.1)	0.741
Maximum mouth opening, mm	35.7 ± 4.8	35.5 ± 4.9	35.9 ± 4.7	−0.4 (−2.7 to 1.9)	0.728

Values are presented as mean ± SD unless otherwise specified. Between-group differences are calculated as laser group minus occlusal splint group. Confidence intervals are presented for continuous mean differences. VAS, Visual Analog Scale; CI, confidence interval; SD, standard deviation.

At four weeks, both treatment groups demonstrated lower pain and functional limitation scores; however, outcomes favoured photobiomodulation. The mean VAS pain score was 2.6 ± 1.1 in the laser group and 3.8 ± 1.4 in the occlusal splint group, corresponding to a between-group difference of −1.2 points (95% CI: −1.8 to −0.6; p<0.001). The standardized between-group effect was large and favoured laser therapy (Hedges g=0.94; 95% CI: 0.44–1.44). Jaw Functional Limitation Scale scores were also lower in the laser group, with a mean difference of −4.3 points (95% CI: −7.1 to −1.5; p=0.003) and a moderate-to-large standardized effect (Hedges g=0.75; 95% CI: 0.26–1.24) (Table 2).

Table 2. Post-Intervention Comparison of Primary Outcomes

Outcome	Laser group (n=34)	Occlusal splint group (n=33)	Mean difference (95% CI)	Hedges g (95% CI)	p-value
VAS pain score	2.6 ± 1.1	3.8 ± 1.4	−1.2 (−1.8 to −0.6)	0.94 (0.44 to 1.44)	<0.001
Jaw Functional Limitation Scale score	16.4 ± 5.2	20.7 ± 6.1	−4.3 (−7.1 to −1.5)	0.75 (0.26 to 1.24)	0.003

Values are presented as mean ± SD. Mean differences are calculated as laser group minus occlusal splint group. Lower scores indicate better outcomes. Positive Hedges g values are oriented to indicate an effect favouring laser therapy. VAS, Visual Analog Scale; CI, confidence interval; SD, standard deviation.

Based on the reported group means, the VAS score decreased by 4.6 points in the laser group, equivalent to a 63.9% reduction from baseline, compared with a 3.2-point or 45.7% reduction in the occlusal splint group. Jaw Functional Limitation Scale scores decreased by 22.5 points or 57.8% in the laser group and by 17.6 points or 46.0% in the splint group. Within-group analyses showed statistically significant improvements in both primary outcomes in each treatment group (all p<0.001) (Table 3).

Repeated-measures analysis demonstrated a significant main effect of time on VAS pain scores (F=182.6, p<0.001), confirming a substantial reduction in pain during the four-week intervention period. A significant group effect was also observed (F=14.8, p<0.001). Most importantly, the time × group interaction was statistically significant (F=12.9, p<0.001), indicating that the magnitude of pain reduction differed between treatments and was greater in the laser group.

Table 3. Reported Baseline-to-Post-Intervention Changes in Primary Outcomes

Outcome	Group	Baseline, mean ± SD	Post-intervention, mean ± SD	Absolute change	Relative change, %	Within-group p-value
VAS pain score	Laser	7.2 ± 1.1	2.6 ± 1.1	−4.6	−63.9	<0.001
	Occlusal splint	7.0 ± 1.3	3.8 ± 1.4	−3.2	−45.7	<0.001
Jaw Functional Limitation Scale score	Laser	38.9 ± 7.6	16.4 ± 5.2	−22.5	−57.8	<0.001
	Occlusal splint	38.3 ± 7.3	20.7 ± 6.1	−17.6	−46.0	<0.001

Absolute and relative changes were calculated from the reported group means. Baseline values represent the randomized sample of 36 participants per group; post-intervention values represent 34 laser-group and 33 occlusal-splint-group participants. Negative changes indicate improvement. VAS, Visual Analog Scale; SD, standard deviation.

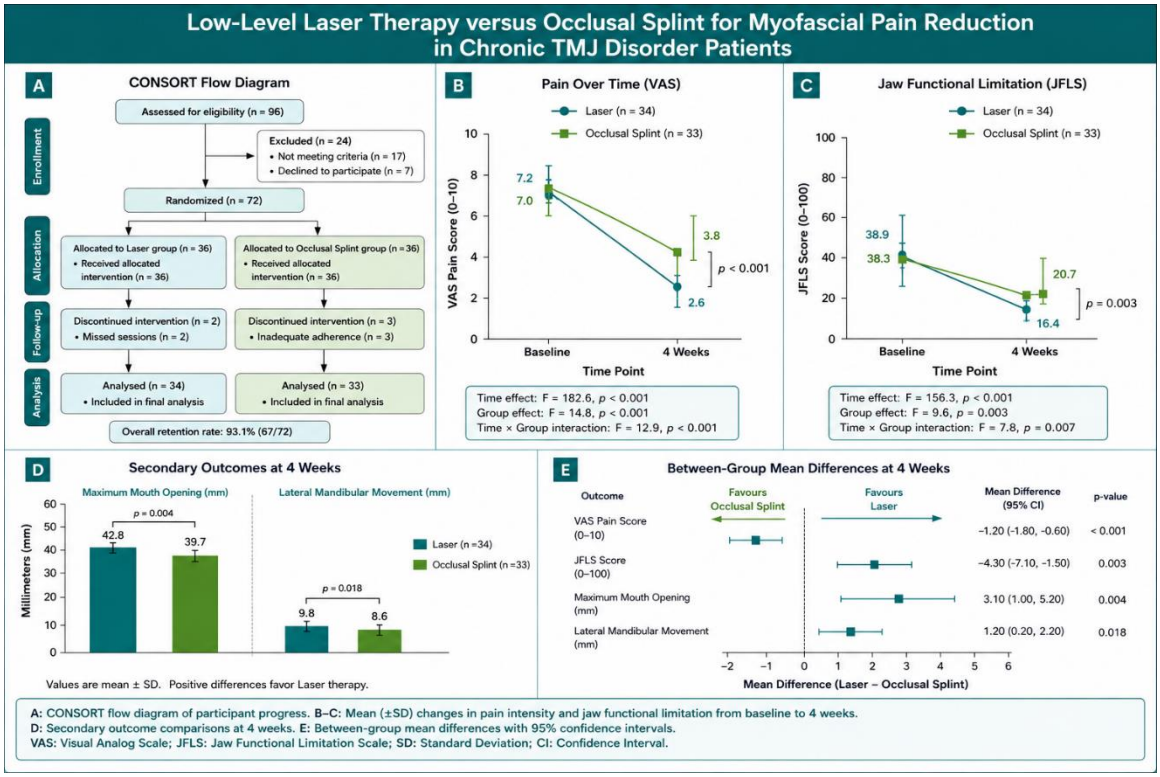

Figure 1 is multipanel figure that summarizes participant flow and treatment outcomes, showing that 67 of 72 randomized patients completed the study and that both interventions improved pain and jaw function after four weeks. However, low-level laser therapy produced greater reductions in VAS pain and jaw functional limitation scores, along with superior maximum mouth opening and lateral mandibular movement compared with occlusal splint therapy.

Secondary mandibular movement outcomes also favoured laser photobiomodulation. At four weeks, maximum mouth opening was 42.8 ± 4.5 mm in the laser group and 39.7 ± 4.8 mm in the occlusal splint group, producing a mean difference of 3.1 mm (95% CI: 1.0–5.2; p=0.004). This corresponded to a moderate standardized effect favouring laser therapy (Hedges g=0.66; 95% CI: 0.17–1.15). Lateral mandibular movement was also greater in the laser group, with a mean difference of 1.2 mm (95% CI: 0.2–2.2; p=0.018) and a moderate effect size (Hedges g=0.54; 95% CI: 0.06–1.02) (Table 4).

A moderate positive correlation was observed between the magnitude of pain reduction and improvement in jaw functional limitation (r=0.46, p<0.001). Thus, participants who experienced greater reductions in pain also tended to demonstrate greater improvements in jaw-related functional performance.

Table 4. Post-Intervention Comparison of Secondary Outcomes

Outcome	Laser group (n=34)	Occlusal splint group (n=33)	Mean difference (95% CI)	Hedges g (95% CI)	p-value
Maximum mouth opening, mm	42.8 ± 4.5	39.7 ± 4.8	3.1 (1.0 to 5.2)	0.66 (0.17 to 1.15)	0.004
Lateral mandibular movement, mm	9.8 ± 2.1	8.6 ± 2.3	1.2 (0.2 to 2.2)	0.54 (0.06 to 1.02)	0.018

Values are presented as mean ± SD. Mean differences are calculated as laser group minus occlusal splint group. Positive mean differences and Hedges g values favour laser therapy. CI, confidence interval; SD, standard deviation.

DISCUSSION

This randomized controlled trial compared 810 nm diode laser photobiomodulation with custom-fabricated occlusal splint therapy for chronic temporomandibular disorders associated with myofascial pain. Both interventions produced meaningful short-term improvements in pain intensity and jaw-related functional limitation after four weeks. However, the magnitude of improvement was greater in the laser group, which also demonstrated better maximum mouth opening and lateral mandibular movement. The significant time × group interaction for pain indicated that the reduction in pain differed between interventions and favoured photobiomodulation.

The greater pain reduction observed with photobiomodulation is consistent with previous randomized studies showing that light-based interventions can reduce temporomandibular and masticatory muscle pain. Al-Quisi et al. reported clinically relevant pain reduction following light-based treatment in patients with temporomandibular disorders, while Palizgir et al. documented improvements after diode laser acupuncture compared with transcutaneous electrical nerve stimulation (10,11). Improvements have also been reported when photobiomodulation is applied directly over the masticatory muscles or combined temporomandibular and muscular treatment sites, supporting the potential importance of targeting the predominant pain-generating tissues (12).

The post-intervention VAS score was 1.2 points lower in the laser group than in the occlusal splint group, with a large standardized between-group effect. This difference was accompanied by a greater reduction in jaw functional limitation, suggesting that symptom relief translated into improved performance of jaw-related activities. The moderate positive correlation between pain reduction and functional improvement further indicated that participants experiencing greater pain relief generally achieved better functional recovery. These findings are compatible with evidence that appropriate photobiomodulation parameters may reduce orofacial pain and facilitate mandibular movement (13). Systematic evidence has similarly indicated that laser-based interventions can improve mouth-opening range in patients with temporomandibular disorders, although the size and consistency of the effect vary across protocols and patient populations (14).

Several biological mechanisms may explain the observed effects. Near-infrared light is believed to interact with mitochondrial chromophores, particularly cytochrome c oxidase, increasing cellular energy production and influencing oxidative and inflammatory signalling. Photobiomodulation may also improve local microcirculation, reduce sensitization of peripheral nociceptors, alter inflammatory mediator activity, and facilitate tissue recovery. These effects could reduce tenderness and hyperactivity within the masseter and temporalis muscles, thereby allowing less painful and less restricted mandibular movement. The clinical response to photobiomodulation nevertheless depends on irradiation intensity, treatment frequency, session duration, energy delivery, tissue depth, and application site, and inappropriate dosing may diminish treatment effectiveness (15).

Occlusal splint therapy also produced substantial improvements. Pain decreased by 45.7%, while the Jaw Functional Limitation Scale score decreased by 46.0% from the reported baseline means. These findings support the established role of stabilization splints as a reversible conservative intervention for patients with myofascial temporomandibular symptoms. Occlusal appliances may reduce parafunctional loading, redistribute occlusal forces, protect the dentition, and facilitate masticatory muscle relaxation. Nevertheless, the greater improvement observed in the laser group suggests that direct biological modulation of painful muscular tissues may provide an additional short-term benefit compared with

appliance-based mechanical stabilization alone. A previous randomized trial directly comparing rapid laser treatment with occlusal splint therapy similarly supports the clinical relevance of comparing these two conservative approaches (6).

The present findings should be interpreted in the context of continuing variation in photobiomodulation protocols. Comparative investigations involving laser acupuncture and other non-pharmacological modalities have generally reported symptom improvement, but differences in wavelength, dose, treatment location, diagnostic criteria, and comparator interventions limit direct comparison across studies (16). Reviews of low-level laser therapy for orofacial pain have also emphasized its potential clinical value while identifying the need for better protocol standardization and stronger methodological reporting (17). Evidence from systematic reviews and meta-analyses of laser acupuncture likewise suggests beneficial effects on temporomandibular symptoms, but heterogeneity and limited long-term follow-up remain important constraints (18).

The results have practical clinical implications. Photobiomodulation is non-invasive, does not require continuous appliance use, and can be delivered during brief outpatient treatment sessions. It may therefore be useful for patients with predominant muscular tenderness, restricted mandibular mobility, or difficulty adhering to nighttime splint use. Occlusal splints nevertheless remain a reasonable treatment option, particularly when parafunctional activity, tooth wear, or the need for occlusal protection is clinically relevant. The present findings do not establish that photobiomodulation should universally replace splint therapy; rather, they support its consideration as an alternative or potentially complementary conservative intervention.

The study had several methodological strengths, including randomized group allocation, concealed allocation, blinded outcome assessment, use of established pain and functional measures, and direct comparison of two clinically relevant conservative interventions. Treatment attendance and splint-use records also supported monitoring of adherence. The inclusion of pain, functional limitation, and objective mandibular movement outcomes provided a broader assessment of clinical response than pain measurement alone.

Several limitations should also be acknowledged. The four-week intervention and immediate post-treatment assessment did not establish whether the observed benefits were maintained over the medium or long term. Participants and treating clinicians could not be blinded, which may have introduced expectation or performance effects. The single-centre setting and relatively modest sample limited the generalizability of the findings. Five randomized participants did not complete follow-up, and the final outcome comparison was based on available post-intervention data. In addition, psychological distress, sleep quality, parafunctional behaviour, symptom duration, analgesic use during follow-up, and structural temporomandibular joint characteristics were not included in the reported analysis. These factors may influence pain perception and treatment response.

Future multicentre trials should include larger samples, longer follow-up periods, preregistered protocols, and detailed reporting of laser power, irradiance, energy, energy density, spot size, emission mode, application sites, and adherence. Comparisons among photobiomodulation, occlusal splints, combined treatment, placebo laser, and other conservative interventions would help determine the relative and additive effects of these approaches. Future studies should also evaluate recurrence, patient satisfaction, quality of life, cost-effectiveness, and clinically important responder thresholds.

CONCLUSION

Among patients with chronic myofascial temporomandibular disorders, both 810 nm diode laser photobiomodulation and occlusal splint therapy improved pain and jaw function over four weeks. Photobiomodulation produced greater short-term reductions in pain and functional limitation and better mandibular movement outcomes than occlusal splint therapy. These findings support photobiomodulation as a potentially effective non-invasive conservative treatment, although longer-term and multicentre trials are required before its comparative clinical advantage can be considered definitive.

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