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Original Article

Effectiveness of Low-Level Laser Therapy Versus Ischemic Compression on Pressure Pain Threshold Using Algometry in Upper Trapezius Myofascial Pain Syndrome: A Randomized Controlled Trial

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ABSTRACT

Background: Upper-trapezius myofascial pain syndrome is characterized by trigger-point tenderness and reduced pressure pain threshold. Low-level laser therapy and ischemic compression are commonly used interventions, but their comparative effects remain uncertain. Objective: To compare the effects of low-level laser therapy and ischemic compression on pressure pain threshold in individuals with upper-trapezius myofascial pain syndrome. Methods: This randomized controlled trial included 40 adults allocated equally to low-level laser therapy or ischemic compression. Both interventions were administered three times weekly for four weeks. Pressure pain threshold was measured using a pressure algometer at baseline and after treatment. Within-group changes were assessed using paired-samples t tests, and changes between groups were compared using an independent-samples t test. Results: Pressure pain threshold increased from 2.15 ± 0.42 to 3.85 ± 0.55 kg/cm² in the low-level laser therapy group and from 2.20 ± 0.45 to 3.40 ± 0.60 kg/cm² in the ischemic-compression group. Mean improvements were 1.70 ± 0.48 and 1.20 ± 0.52 kg/cm², respectively. The between-group difference was 0.50 kg/cm² (95% CI: 0.18–0.82; p=0.003; Hedges' g=0.98). Conclusion: Both interventions improved pressure pain threshold, but low-level laser therapy produced a greater short-term increase in mechanical pain tolerance. Keywords: Algometry; Ischemic compression; Low-level laser therapy; Myofascial pain syndrome; Myofascial trigger points; Photobiomodulation; Pressure pain threshold; Upper trapezius.

INTRODUCTION

Myofascial pain syndrome is a common musculoskeletal disorder characterized by localized pain arising from hypersensitive myofascial trigger points within taut bands of skeletal muscle. These trigger points may produce local tenderness, referred pain, muscle stiffness, restricted movement, and heightened sensitivity to mechanical pressure. The upper trapezius is among the muscles most frequently affected because it is exposed to sustained postural loading, repetitive upper-limb activity, prolonged computer use, and occupational or ergonomic strain (1). Persistent upper-trapezius trigger points can impair cervical and shoulder function and reduce tolerance to mechanical pressure, thereby affecting daily activity and quality of life.

Pressure pain threshold represents the minimum externally applied pressure at which a sensation of pressure first becomes painful. Pressure algometry provides a quantitative and relatively objective method of assessing mechanical pain sensitivity in individuals with myofascial trigger points. It is also useful for monitoring changes following therapeutic intervention when the measurement site, participant position, pressure-application technique, and assessor instructions are standardized (2). A reduced pressure pain threshold is commonly associated with increased trigger-point sensitivity and may therefore serve as a clinically relevant outcome when evaluating interventions for upper-trapezius myofascial pain syndrome.

Conservative physiotherapy management may include stretching, manual therapy, ischemic compression, dry needling, therapeutic ultrasound, electrical modalities, and photobiomodulation. Ischemic compression involves the gradual application of sustained pressure directly over a myofascial trigger point. The technique is intended to reduce local tenderness, normalize muscle activity, improve tissue perfusion after pressure release, and decrease nociceptive input. Previous clinical studies have reported improvements in pain, disability, and pressure sensitivity after compression-based trigger-point treatment, although intervention protocols have varied in pressure intensity, duration, repetition, and combination with other therapeutic approaches (3,4).

Low-level laser therapy is a non-invasive photobiomodulation intervention in which low-intensity light energy is applied to biological tissue. Its proposed effects include modulation of mitochondrial activity, adenosine triphosphate production, microcirculation, inflammatory mediator activity, peripheral nociception, and tissue repair. Clinical trials and evidence syntheses have indicated that photobiomodulation may reduce pain and improve pressure pain threshold in patients with upper-trapezius myofascial trigger points; however, reported effects have differed according to wavelength, power, energy density, treatment frequency, anatomical application, and comparator intervention (5-7). Evidence from studies using high-intensity or pulsed laser systems cannot necessarily be generalized to low-level laser therapy because these modalities differ in their physical characteristics and tissue effects (8).

Both low-level laser therapy and ischemic compression are used in physiotherapy practice for managing myofascial trigger points, but direct comparative evidence remains limited. Existing studies have often evaluated laser therapy against ultrasound, dry needling, sham treatment, or multimodal manual therapy, while other investigations have combined laser therapy with pressure-release techniques, making it difficult to determine their independent comparative effects (2,5,7,9). A direct comparison using a standardized quantitative outcome may therefore help clarify which intervention produces a greater short-term reduction in mechanical trigger-point sensitivity. Accordingly, this randomized controlled trial aimed to compare the effects of low-level laser therapy and ischemic compression on pressure pain threshold measured by algometry in individuals with upper-trapezius myofascial pain syndrome.

MATERIALS AND METHODS

A two-arm randomized controlled trial was conducted among 40 adults with upper-trapezius myofascial pain syndrome. Eligible participants were aged 18–60 years and presented with localized neck or shoulder pain, a palpable trigger point in the upper trapezius muscle, localized tenderness, and reduced pressure pain threshold. Individuals with neurological disorders, previous cervical trauma, systemic inflammatory disease, or a history of shoulder surgery were excluded. Each participant was clinically screened before enrolment to confirm eligibility. Ethical approval was obtained before initiation of the study, and written informed consent was obtained from all participants. The study procedures were conducted in accordance with established principles for research involving human participants.

Participants were randomly allocated in a 1:1 ratio to a low-level laser therapy group or an ischemic-compression group, with 20 participants assigned to each intervention. Both groups received three treatment sessions per week for four consecutive weeks, resulting in a planned total of 12 treatment sessions per participant. The identified upper-trapezius trigger point was used as the treatment and outcome-assessment site. Participants were instructed to report any discomfort or adverse response occurring during or after treatment.

Participants assigned to the low-level laser therapy group received laser application directly over the identified upper-trapezius trigger point. The laser probe was positioned over the treatment site during each session, and treatment was delivered three times weekly for four weeks. The application was restricted to the clinically identified trigger-point region to target localized mechanical sensitivity. Appropriate protective and procedural precautions associated with therapeutic laser application were observed during treatment.

Participants allocated to the ischemic-compression group received sustained manual pressure over the identified upper-trapezius trigger point. Pressure was applied gradually to the point of tolerable tenderness and maintained until a reduction in the tenderness response was perceived, after which the pressure was released in a controlled manner. The procedure was performed during each treatment session three times weekly for four weeks. Treatment was directed to the same clinically identified trigger-point region used for pressure pain threshold assessment.

Pressure pain threshold was the principal outcome and was measured using a pressure algometer. Algometry is commonly used to quantify mechanical sensitivity at myofascial trigger points and to monitor changes following treatment (2). The algometer was positioned perpendicular to the identified trigger point, and pressure was gradually increased until the participant first reported that the sensation had changed from pressure to pain. The pressure recorded at that point was documented in kg/cm^2. Measurements were obtained before commencement of the intervention and after completion of the four-week treatment period. The same anatomical trigger-point region was assessed at both measurement occasions to improve consistency.

Data were analysed using IBM SPSS Statistics version 26.0. Continuous variables were summarized as mean and standard deviation, while categorical variables were summarized as frequencies and percentages. Baseline demographic and clinical characteristics were examined to describe the comparability of the intervention groups. Within-group changes in pressure pain threshold from baseline to the end of the four-week intervention were assessed using paired-samples t tests. Differences in pressure pain threshold improvement between the low-level laser therapy and ischemic-compression groups were assessed using an independent-samples t test. All statistical tests were two-tailed, and statistical significance was established at $p<0.05$.

RESULTS

A total of 40 participants completed the study and were included in the reported analysis, with 20 participants in the low-level laser therapy group and 20 in the ischemic-compression group. The mean age was 34.6 ± 8.2 years in the low-level laser therapy group and 35.1 ± 7.9 years in the ischemic-compression group. Women constituted 55.0% and 60.0% of the two groups, respectively. Mean symptom duration was 6.2 ± 2.1 months in the low-level laser therapy group and 6.5 ± 2.4 months in the ischemic-compression group. The groups had comparable baseline age, sex distribution, symptom duration, and pressure pain threshold, with no statistically significant differences between them.

Table 1. Baseline Demographic and Clinical Characteristics of Participants by Intervention Group

Characteristic	Low-Level Laser Therapy (n=20)	Ischemic Compression (n=20)	Mean Difference or Test Statistic	p-value
Age, years	34.6 ± 8.2	35.1 ± 7.9	−0.50	0.845
Male sex, n (%)	9 (45.0)	8 (40.0)	χ^2=0.102	0.749
Female sex, n (%)	11 (55.0)	12 (60.0)	—	—
Symptom duration, months	6.2 ± 2.1	6.5 ± 2.4	−0.30	0.676

Characteristic	Low-Level Laser Therapy (n=20)	Ischemic Compression (n=20)	Mean Difference or Test Statistic	p-value
Pressure pain threshold, kg/cm²	2.15 ± 0.42	2.20 ± 0.45	−0.05	0.718

Data are presented as mean ± standard deviation unless otherwise indicated. Mean differences were calculated as low-level laser therapy minus ischemic compression. Continuous variables were compared using independent-samples t tests, and sex distribution was compared using the chi-square test. χ^2, chi-square statistic.

At baseline, mean pressure pain threshold was 2.15 ± 0.42 kg/cm² in the low-level laser therapy group and 2.20 ± 0.45 kg/cm² in the ischemic-compression group. The baseline mean difference was −0.05 kg/cm² (95% confidence interval: −0.33 to 0.23; p=0.718), indicating no evidence of an initial difference in mechanical pain sensitivity between the groups.

Following four weeks of treatment, pressure pain threshold increased to 3.85 ± 0.55 kg/cm² in the low-level laser therapy group and 3.40 ± 0.60 kg/cm² in the ischemic-compression group. The low-level laser therapy group demonstrated a mean within-group increase of 1.70 ± 0.48 kg/cm² (95% confidence interval: 1.48 to 1.92; t=15.839; p<0.001). The ischemic-compression group demonstrated a mean increase of 1.20 ± 0.52 kg/cm² (95% confidence interval: 0.96 to 1.44; t=10.320; p<0.001).

Table 2. Changes in Pressure Pain Threshold Following Four Weeks of Treatment

Intervention Group	Baseline PPT, kg/cm²	Four-Week PPT, kg/cm²	Within-Group Change, kg/cm²	95% CI for Change	t Statistic	p-value
Low-level laser therapy (n=20)	2.15 ± 0.42	3.85 ± 0.55	1.70 ± 0.48	1.48 to 1.92	15.839	<0.001
Ischemic compression (n=20)	2.20 ± 0.45	3.40 ± 0.60	1.20 ± 0.52	0.96 to 1.44	10.320	<0.001

Data are presented as mean ± standard deviation. Within-group changes were assessed using paired-samples t tests. CI, confidence interval; PPT, pressure pain threshold.

The improvement in pressure pain threshold was greater in the low-level laser therapy group than in the ischemic-compression group. The unadjusted between-group difference in mean change was 0.50 kg/cm² (95% confidence interval: 0.18 to 0.82). This difference was statistically significant (t=3.160; p=0.003). The standardized between-group difference was large, with a Hedges' g of 0.98, indicating that the magnitude of pressure pain threshold improvement favoured low-level laser therapy.

Table 3. Between-Group Comparison of Improvement in Pressure Pain Threshold

Outcome	Low-Level Laser Therapy (n=20)	Ischemic Compression (n=20)	Between-Group Mean Difference	95% CI	t Statistic	p-value	Hedges' g
Change in PPT, kg/cm²	1.70 ± 0.48	1.20 ± 0.52	0.50	0.18 to 0.82	3.160	0.003	0.98

Data are presented as mean ± standard deviation. The between-group mean difference was calculated as low-level laser therapy minus ischemic compression and assessed using an independent-samples t test with 38 degrees of freedom. Hedges' g represents the standardized mean difference corrected for small-sample bias. CI, confidence interval; PPT, pressure pain threshold.

Overall, both interventions were associated with statistically significant increases in pressure pain threshold over the four-week treatment period. However, low-level laser therapy produced an additional mean improvement of 0.50 kg/cm² compared with ischemic compression. The confidence interval excluded zero, and the standardized effect estimate indicated a large between-group difference in favour of low-level laser therapy.

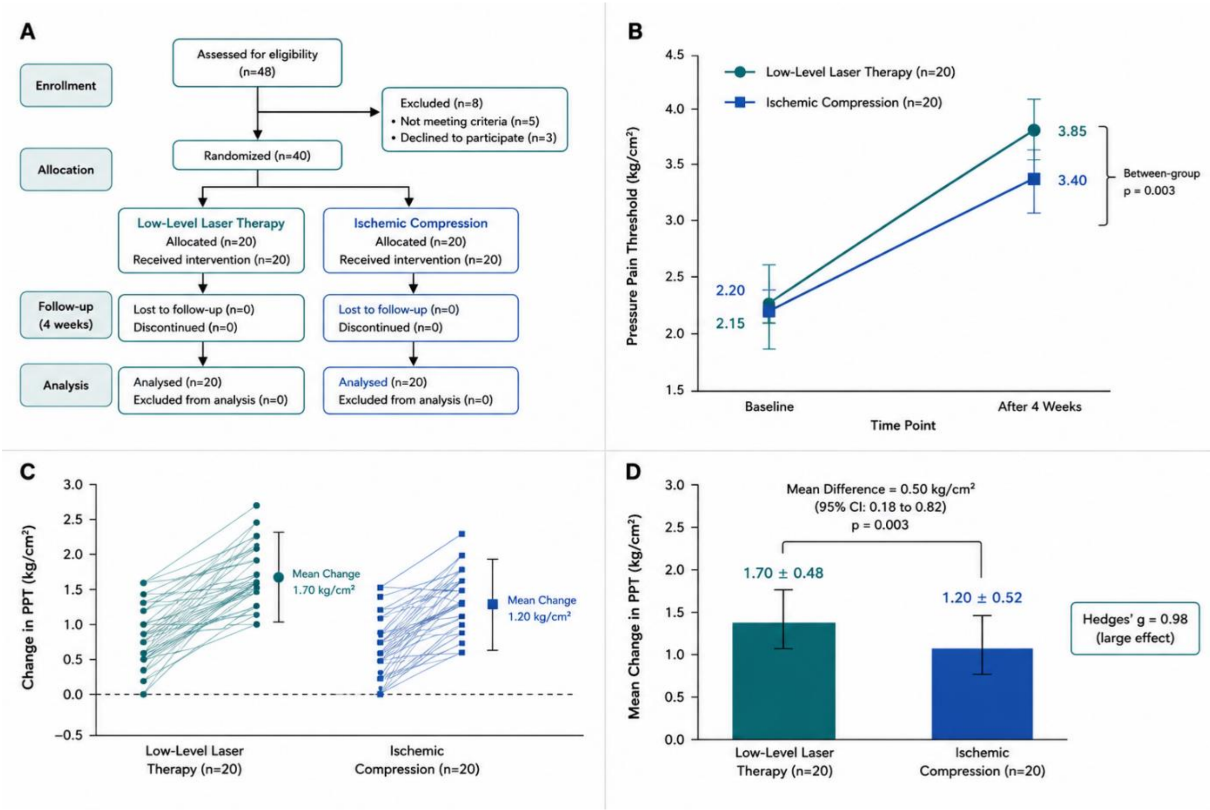

Figure 1 presents the participant flow and comparative effects of low-level laser therapy and ischemic compression on pressure pain threshold in upper-trapezius myofascial pain syndrome. Of 48 individuals assessed for eligibility, 8 were excluded, leaving 40 participants who were randomized equally between low-level laser therapy and ischemic compression, with all 20 participants in each group completing treatment and being included in the analysis. Mean pressure pain threshold increased from 2.15 ± 0.42 to 3.85 ± 0.55 kg/cm² in the low-level laser therapy group and from 2.20 ± 0.45 to 3.40 ± 0.60 kg/cm² in the ischemic-compression group after four weeks. The corresponding mean changes were 1.70 ± 0.48 and 1.20 ± 0.52 kg/cm², respectively. The between-group mean difference in change was 0.50 kg/cm² (95% CI: 0.18–0.82; p=0.003), with a large standardized effect in favour of low-level laser therapy (Hedges' g=0.98).

DISCUSSION

The present randomized controlled trial compared low-level laser therapy with ischemic compression for improving pressure pain threshold in individuals with upper-trapezius myofascial pain syndrome. Both interventions produced significant short-term improvements after four weeks; however, the increase was greater following low-level laser therapy. The low-level laser therapy group demonstrated a mean improvement of 1.70 ± 0.48 kg/cm², compared with 1.20 ± 0.52 kg/cm² in the ischemic-compression group. The resulting between-group difference was 0.50 kg/cm², with a 95% confidence interval of 0.18–0.82 kg/cm² and a large standardized effect estimate of Hedges' g=0.98. These findings indicated that, under the treatment conditions used in this study, low-level laser therapy produced a greater reduction in mechanical trigger-point sensitivity than ischemic compression.

The improvement following low-level laser therapy was consistent with evidence indicating that photobiomodulation may reduce pain sensitivity in upper-trapezius myofascial pain syndrome. A systematic review and meta-analysis by Alayat et al. reported beneficial effects of photobiomodulation on pain-related outcomes in patients with upper-trapezius trigger points, although the included trials varied considerably in wavelength, energy dosage, treatment frequency, and comparator intervention (5). Mammen similarly reported favourable effects of low-level laser therapy in the management of active trapezius trigger points when compared with therapeutic ultrasound (6). Iqbal et al. also found improvements following laser treatment in patients with upper-trapezius myofascial trigger points, supporting the direction of the present findings (7). Differences in treatment magnitude across studies may reflect variability in laser parameters, participant characteristics, trigger-point classification, treatment duration, and outcome-assessment procedures.

The findings were also broadly consistent with Ahmed et al., who reported improvement in upper-trapezius trigger-point pain following laser-based treatment in patients with mechanical neck pain (10). However, their intervention incorporated post-isometric relaxation, making it difficult to isolate the independent effect of laser therapy. Similarly, Alayat et al. evaluated pulsed Nd:YAG laser combined with progressive pressure release and reported beneficial effects in cervical myofascial pain syndrome (4). Because pulsed Nd:YAG and high-intensity laser systems differ from low-level laser therapy in output characteristics and tissue penetration, evidence from these modalities should be interpreted as supportive rather than directly equivalent. Taleb et al. and Ebtesam et al. reported favourable outcomes with high-intensity laser in upper-trapezius myofascial pain, but these interventions cannot be considered interchangeable with low-level photobiomodulation (8,11).

The greater improvement associated with low-level laser therapy may be explained by photobiomodulatory effects on cellular metabolism and nociceptive processing. Absorbed light energy may influence mitochondrial activity, adenosine triphosphate production, microcirculation, inflammatory signalling, and peripheral nerve excitability. These effects may reduce local sensitization and increase the amount of mechanical pressure tolerated before pain is perceived (5). Nevertheless, the biological response to laser therapy is dose dependent, and the absence of detailed wavelength, power, irradiance, energy-density, and exposure-time information limits precise mechanistic interpretation of the present results.

Ischemic compression also produced a substantial increase in pressure pain threshold. The finding agreed with previous evidence showing that sustained trigger-point compression may reduce localized tenderness and improve mechanical pain tolerance (2,3). Ischemic compression may temporarily alter local tissue perfusion, reduce excessive muscle activity, influence mechanoreceptor input, and decrease peripheral nociceptive signalling. Rezaei et al. reported improvements following combined laser and compression therapy in patients with upper-trapezius trigger points, while Anwar et al. found that ischemic compression used with neuromuscular re-education improved clinical outcomes in patients with neck pain (2,3). The independent contribution of compression in multimodal protocols remains difficult to determine, but the present study supported its use as an active intervention rather than an inert comparator.

The between-group difference was statistically significant and the standardized effect estimate was large. However, statistical superiority should not automatically be interpreted as established clinical superiority. The study did not identify a prespecified minimal clinically important difference for pressure pain threshold, and it did not measure pain intensity, disability, cervical mobility, functional performance, quality of life, medication use, or patient satisfaction. Therefore, the observed 0.50 kg/cm^2 advantage indicated a greater short-term change in mechanical pain tolerance but did not establish that low-level laser therapy produced broader functional recovery or superior patient-perceived benefit.

The study had several strengths. It directly compared two commonly used physiotherapy interventions, used equal group sizes and treatment frequency, and assessed treatment response through quantitative pressure algometry. Reporting the between-group mean difference, confidence interval, and standardized effect estimate also provided greater interpretability than relying solely on separate within-group significance tests.

Several limitations should be considered. The sample was small, and the study setting and recruitment period were not described, limiting assessment of external validity. Details of random-sequence generation, allocation concealment, and assessor blinding were unavailable, creating possible risks of selection and measurement bias. The laser parameters and ischemic-compression dosage were not sufficiently detailed to permit exact replication. Only immediate post-intervention outcomes were assessed, and no longer-term follow-up was performed. Pressure pain threshold was the only reported outcome, while adherence, protocol deviations, concomitant treatment, adverse events, and missing-data procedures were not described. The analysis was based on participants reported as having completed the study, and an intention-to-treat approach was not documented. These limitations restrict the certainty and generalizability of the findings.

The results nevertheless suggested that both interventions may be useful for reducing short-term mechanical sensitivity associated with upper-trapezius myofascial trigger points. Low-level laser therapy produced the larger improvement in pressure pain threshold, whereas ischemic compression also yielded a meaningful within-group change and may remain relevant where laser equipment is unavailable or manual treatment is preferred. Larger trials with reproducible intervention parameters, concealed allocation, blinded outcome assessment, patient-reported and functional outcomes, adverse-event monitoring, and longer follow-up are needed to determine the durability and clinical importance of the comparative effect.

CONCLUSION

Both low-level laser therapy and ischemic compression increased pressure pain threshold after four weeks of treatment in individuals with upper-trapezius myofascial pain syndrome. Low-level laser therapy produced a greater short-term improvement, with an additional mean increase of 0.50 kg/cm^2 compared with ischemic compression. These findings support low-level laser therapy as a potentially more effective option for reducing mechanical trigger-point sensitivity under the conditions evaluated, although the clinical importance and long-term durability of the difference require confirmation in larger and more rigorously reported trials.

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