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Review Article

Efficacy of Low-Level Laser Therapy in The Management of Neck Pain: Systematic Review

Iqra Mazhar[1], Muhammad Asif[2], Ismail Anwar Khokhar[3*]

[1]*Riphah International University, Islamabad, Pakistan*
[2]*Physiotherapy Department, Mansoora Hospital, Lahore, Pakistan*
[3*]*Elaj Medical Center, Lahore, Pakistan*

ABSTRACT

Background: Laser therapy is an effective therapeutic option that has helped patients with both acute and chronic neuropathies. Low-level laser therapy provides effective short-term pain relief and improvement in cervical range of motion in participants with neck pain. **Objective:** To explore the evidence related to the efficacy of low-level laser therapy in patients with neck pain. **Methods:** This systematic review comprised randomized controlled trials in which pain and range of motion were the outcomes investigated. The PEDro scale was then used to assess the quality of the studies involved. Studies from Google Scholar, PubMed, the HEC Digital Library, PEDro and the Cochrane Library were included in this review. Only randomized trials and English-language papers involved people over the age of 18 with neck discomfort and both genders. The population with psychiatric illnesses and traumatic traumas who were less than 18 years old included observational studies, copyright issues and paper in other languages.[26] A PRISMA flowchart was also used to demonstrate the entire process of adding and removing articles from review. **Results:** PEDro scale was used to assess the quality of studies as shown in Table I, showed that all the studies are of high quality. The following variables were collected for each study: general patient information such as mean age, mean duration, percentages of male and female in sample size, country of study, year of study publication, name of first author, sample size and outcome measure (Table II). Studies revealed that laser therapy is found to be statistically significant in treating neck pain, neck range of motion and disability when compared to placebo therapy. **Conclusion:** This study found that laser therapy decreases pain in participants with persistent neck discomfort shortly after therapy. Laser therapy is proven to be more effective than placebo therapy in relieving arm pain and improving cervical strength and flexibility in participants with severe pain and increasing the quality of life when compared to patients treated with a placebo laser therapy.

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***Corresponding Author:**
Ismail Anwar Khokhar, Elaj Medical Center, Lahore, Pakistan
Email:
ismailanwerkhokar@gmail.com

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INTRODUCTION

Neck discomfort affecting the region of the neck from the superior nuchal line to the scapular spine is a painful sensory and emotional experience that is associated with tissue damage. The neck discomfort task force has created four categories for neck pain. Grades I through III of neck discomfort are covered by the neck pain guideline. Two subtypes of grades I and II neck pain are work-related neck pain (based on a patient's description of the cause or onset of discomfort) and traumatic neck pain (whiplash or whiplash-associated illness).[1] Any portion of the body including the muscles, tendons, nerves, joints, cartilage, and ligaments, may be impacted by musculoskeletal problems (MSDs).

A sizable portion of the population is affected by musculoskeletal disorders, which include a wide spectrum of abnormalities of the muscular and skeletal systems.[2] These illnesses may develop in varying degrees of severity, either quickly (at an acute level) or gradually over time (at a chronic level). Based on the condition, acute bouts can last anywhere from one week to two months. However, severe phases occur when a disease or illness lasts a long time more than a few weeks, months, or even years.[3] With incidence rates ranging from 16.7% to 75.1% globally, neck discomfort is one of the most prevalent conditions in the adult population.[4]

Individual factors (age, genome, BMI, history of musculoskeletal pain), behavioral factors (stage of physical activity and smoking), psychological stressors (job satisfaction, depression and anxiety) and ergonomic design (heavy physical activity, faulty posture, repetitive activities) can all contribute to the etiology of this disorder.[5,6,7] There is a correlation between neck discomfort and other factors, according to several studies. Chinese laborers with neck pain performed repetitive movements, performed manual labor beyond the level of their shoulder blades and sat or stood with their necks arched. In the United States, comorbidity (including respiratory, circulatory and digestive diseases) and psychological variables were linked to neck discomfort in women. On the other side, it was believed that regular exercise and a high level of education were preventive factors.[8] People with physical disabilities, mental stress, and social alienation need a cost-effective, evidence-based rehabilitation program. The importance of comprehending the true effects of physical therapy should be reflected in the physiotherapists' knowledge of the evidence-based practice.[9]

The deep cervical extensors can physiologically govern movements of the sectors of the cervical spine, such as the deep cervical flexors. Numerous studies have shown that individuals with neck pain have irregularities in the control of the cervical flexor muscles, which has led to the development of successful scientifically proven therapeutic approaches to address these problems.[10] Numerous distinct factors may contribute to neck musculoskeletal disease. The majority of those under 30 can have neck pain. It is only surpassed by lower back and shoulder pain in terms of musculoskeletal discomfort.[11] At some point each year, over one-third of all Americans have neck soreness. A highly incapacitating neck condition affects 10–24% of people.

The cost of treatment for persistent neck pain is high.[12] The annual expense of treating neck pain is estimated to be in the hundreds of millions of dollars.[13] Researchers have shown that both the incidence of lower neck and shoulder pain and the severity of disability have significantly increased during the last 25 years. As the population ages, it is anticipated that this trend will continue. In 2015, more than 500 million individuals claimed to have had low back pain, and more than 300 million

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claimed to have experienced chronic neck pain (CNP).[14] Medication, electrotherapy, patient education, spinal manipulation, exercise and behavioral therapy are all effective ways to manage chronic neck pain. There is often minimal evidence to support such claims.[15,16] Along with exercise, spinal mobilization and manipulation seem to improve persistent neck pain. Low-level laser treatment (LLLT) was superior to placebo therapy in reducing arm pain over the short term and enhancing neck extension in individuals with radiculopathy and acute neck pain.[17]

Over 30 years have been spent searching for the use of LLLT for tissue regeneration and pain relief. However, no evidence has ever mentioned this approach as a possible future therapeutic method. Literature reveal that LLLT has anti-inflammatory properties. That aid in pain management. Cochrane review evaluated the efficacy of LLLT for treating low back pain. On the other hand, owing to a lack of information or the erroneous interpretation of conflicting results, the efficacy of LLLT therapy is reliant on the radiation's wavelength, location, duration, and dosage. Right timing and dosage are procedures rarely examined in systematic studies.[18]

The epidermis contains the slow-conducting, sparsely myelinated A and C fibers that make up the nociceptors' peripheral nerve ends. Through this intricate process, damaging inputs are converted into nerve impulses. Additionally, the shallowness of these nerve terminals makes it possible for LLLT wavelengths to flow right through them. The neurons' expanded cytoplasm (axons), which extend from the cell body to the exposed nerve terminals on the skin's surface, are found in the posterior nerve root ganglia. The first thing that LLLT impacts is the epidermal neural network, but it also has an impact on the muscles, nerves, neural trunks, and autonomic ganglia in subcutaneous tissues. A 30% neuronal blockage is produced by LLLT within 10 to 20 minutes of treatment and lasts for around 24 hours. The delivery of a laser to a peripheral nerve has cascade effects. The cerebral components of the pain network are prevented from activating because the synaptic activity of second neurons is decreased.[19] Acupuncture points are the laser-assisted locations used in acupuncture that promote activation, pain relief, and tissue regeneration. Electrically stimulating a high-energy media such as a gas, liquid, crystal, dye or semiconductor, results in laser light.

In the visible to infrared range, coherent single-wavelength beams are produced and created in both pulsed and continuous wave modes.[20] Surgical laser treatments employ strong heat to destroy excess illness, as opposed to utilizing light energy to alter cellular physiology and deliver therapeutic advantages without a visible thermal effect (cold laser).[21] A thorough examination and meta-analysis on the purpose of laser and its effects on the treatment of cervical pain were carried out by Chow RT *et al.* in 2009. Randomized controlled trials (RCTs) using a placebo or active therapy were thoroughly reviewed by the author.

The author of this research came to the conclusion that LLLT induced moderate-to-severe side effects but offered temporary pain alleviation for those with neck discomfort.[22] Dundar U *et al.* (2007) examined the effectiveness of gallium arsenide aluminum laser therapy for the treatment of cervical myofascial pain syndrome in a double-blinded experiment (MPS). In all, 64 MPS patients participated in the experiment. Two sets of individuals were randomly chosen from the crowd. Three trigger sites in Group 1 (n=32) had twice-daily, two-minute treatments with a Ga-As-Al laser for a total of 15 days over three weeks. The treatment strategy for group 2 (n=32) was the same as that for group 1,

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with the difference that the laser device was turned off between administrations. Extremely substantial improvements from the baseline were seen for all outcome measures in both groups ($p>0.05$). Between the two groups, there were no significant differences ($p>0.05$).[23] Chow RT *et al*. examined the effectiveness of laser in treating chronic neck pain in an RCT conducted in 2006. Over seven weeks, 90 subjects underwent 14 sessions with either an active laser or a dummy laser. Change on visual analog scale (VAS) for pain was the main efficacy metric.

Low-level laser therapy (LLLT) significantly lessened neck pain in study participants who had chronic pain.[24] Gur A. carried out this (2007) using 904 nm gallium arsenide LLLT for the treatment of chronic myofascial pain in the cervical region. This RCT included 60 MPS subjects in total. Two groups of randomly selected patients have created: group I (30 patients received laser therapy) and group II (30 patients received non-laser therapy). The degree of pain relief is within the patient's control. There were observable changes between placebo and active groups ($p<0.001$) for laser groups (63 vs 19%). The study suggested that when used sparingly, LLLT may aid in healing and pain relief.

As a result of the therapy, the patient's functional ability and quality of life have increased.[25] This study was designed to evaluate the effects of low-level laser therapy for the treatment of neck pain. METHODS Studies from Google Scholar, PubMed, the HEC Digital Library, PEDro and the Cochrane Library were included in this systematic review. The MESH phrases "efficacy, effectiveness, neck pain, low cervical discomfort, low-level laser therapy, and photobiomodulation (PBM)" were used to identify all papers whose titles and abstracts were included in the research. The research used wildcards and Boolean operators. Only RCTs and English-language papers included people over the age of 18 with neck discomfort and both genders. The population with psychiatric illnesses and traumatic traumas who were less than 18 years old included observational studies, copyright issues and paper in other languages.[26] Using the Boolean procedures, a systematic keyword search was carried out to locate studies that were appropriate for the assessment (AND, OR). A PRISMA flowchart was also used to demonstrate the entire process of adding and removing articles from this review. Choosing the methodology for selecting studies, the reasons for rejecting them at each stage, the number of studies eliminated, and finally the studies that satisfy the criteria for inclusion in this study are all necessary steps in this process.

Quality assessment: Before gathering, retrieving and synthesizing the data, it is crucial to evaluate the internal validity and reliability of the selected research. The quality of a research project may be evaluated using a variety of techniques. About 29 RCTs were used, and that was taken into account; as a result, that is how it should also be investigated. Some of the tools used to evaluate RCTs included the PEDro, the Critical Appraisal Skills Programme (CASP), and the Down and Black Scale.

The PEDro instrument which has 11 distinct components, is being used to assess the study. For this investigation, RCTs with final grades of 5 or above were considered. Studies are rated as being of moderate to high quality (PEDro score$\geq$5) or moderate to poor quality (PEDro score $\leq$5). It is crucial to stress that only high or moderate-quality RCTs may be included in this evaluation owing to criteria on the PEDro scale. For instance, blinding is a crucial component of RCTs and entails the therapist, patient, and assessor all being blinded and earning one point each.[27]

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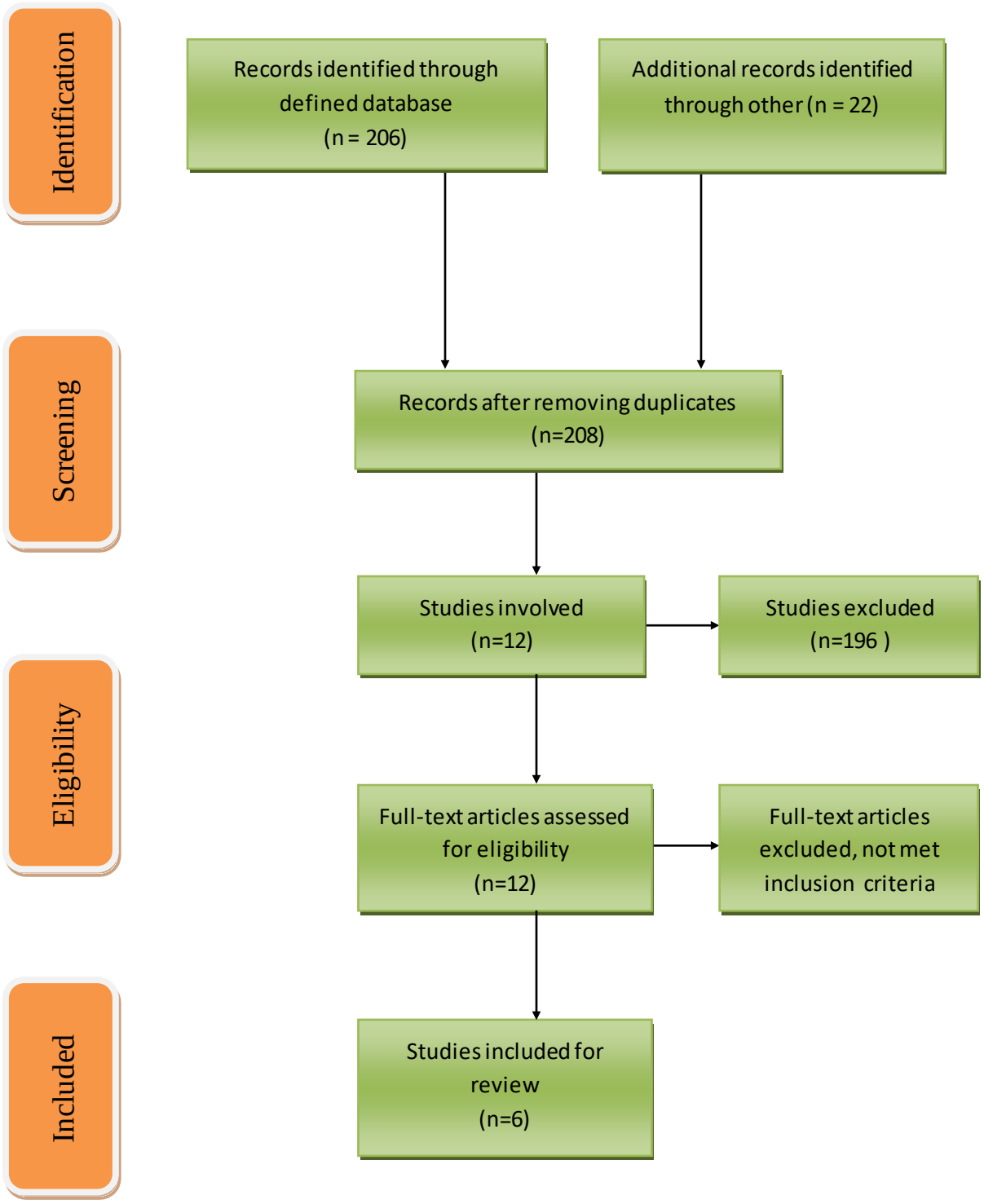

Figure 1: PRISMA Diagram for Inclusion of Studies

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Table I: Quality Assessment by PEDro Tool

PEDro Score	Waseem et al.[33] (2020)	Alayat MS et al.[27] (2017)	Maloney R[34] (2014)	Hsieh R-L[18] (2014)	Mario F et al. (2010)[29]	Konstantinovic LM[4] (2010)
Eligibility criteria	Y	N	Y	Y	Y	Y
Random allocation	Y	Y	Y	Y	Y	Y
Concealed allocation	Y	N	Y	Y	Y	Y
Baseline similarity	Y	Y	Y	Y	Y	Y
Measure of one key outcome measure	Y	Y	Y	Y	Y	Y
Subject blinding	Y	Y	Y	Y	Y	Y
Therapist blinding	N	N	N	N	Y	Y
Assessor blinding	Y	N	Y	Y	Y	Y
Statistical comparison between groups	Y	Y	Y	Y	Y	Y
Intention to treat analysis	Y	Y	Y	N	Y	Y
Measure of variability for one key outcome	Y	Y	Y	N	N	N
Total Score	9	7	8	7	9	9

RESULTS

The PEDro scale was used to assess the quality of studies as shown in Table I, showed that all the studies are of high quality. A quality rating of 5 or higher was assigned to every study, indicating that they all are of moderate to high level. Despite the small number of studies included in this review, the ones that were chosen all demonstrated strong internal validity, indicating that they could offer reliable and useful data, which is more important. The following variables were collected for each study: general patient information such as mean age, mean duration, percentages of male and female in sample size, country of study, year of study publication, name of first author, sample size and outcome measure (Table II). Studies revealed that laser therapy is found to be statistically significant in treating neck pain, cervical range of motion and disability when compared to placebo therapy.

DISCUSSION

The highest sample size (n=86) was found in Maloney R. (2014)'s study, which included the most participants (343 total). the variety of sexual orientations among the 343 study participants. It may be very difficult for the researcher to generalize the results from this

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study due to the limited sample size. Other elements like age, height, weight and gender distribution are taken into account while establishing the external validity of study. Waseem I et al. (2020) investigated 12 males and 50 females, in contrast to Hsieh R-L et al. (2014) who studied 22 men and 38 women. Waseem et al. (2020) conducted RCTs to examine whether low-level laser therapy may be used with conventional physical therapy for patients with upper trapezius trigger points to enhance clinical and functional complaints and cervical range of motion. The Physiotherapy, Sports, Spine, and Rehabilitation Center in Faisalabad, Pakistan.

The patients were randomized into one of two groups, with Group 1 (n=31) receiving CPT and low-level laser therapy. Group 2 (n=31) received CPT as the sole kind of therapy around the same period. The numeric pain rating scale (NPRS) was used to measure pain levels at baseline, throughout the second- and fourth-week follow-ups, and to evaluate a cervical range of motion. A within-group examination of the LLLT + CPT Group (Group=1) and the CPT Group (Group=2) from day 1 to week 4 showed an average reduction in pain levels (p 0.05).

In research conducted within each group, all mean cervical ROMs, particularly lateral flexion ROM, showed statistically significant improvements in both groups (p 0.05). The difference in the NPRS scores between Groups 1 and 2 at week four was examined using an independent sample t-test with a p-value of 0.05. However, cervical ROMs between Groups 1 and 2 did not change at week four according to independent sample t-test results (p = 0.05).[33] Alayat MS et al. (2017) conducted an RCT to evaluate the effects of a multivalve-locked system laser on pain and function in chronic neck pain. There are 75 patients with CNP (average age 46.28–5.89, weight 83.78–5.65 kg, height 1.72–4.96 m, and length of hospital stay 5.98–1.44 months). They were arbitrarily split into three groups. Group I received MLS laser treatment, Group II received LLLT, and Group III received placebo therapy together with exercises. All three groups received exercises. The neck pain and functioning were assessed using the neck disability index (NDI) and VAS, respectively. In all treatment groups after therapy, VAS and NDI dramatically reduced. The LLLT plus exercise group had a D VAS of 6.68 and a D NDI of 39.84 after six weeks of therapy, while the P.L. + EX group had a D VAS of 4.84 and a D NDI of 37.88. (36.68). Exercises and MLS laser therapy increased functional activity while lowering pain after six months of treatment.

Exercise alone or with LLLT is less beneficial than exercise combined with MLS laser therapy for treating CNP.[27] A double-blind, randomized, placebo-controlled trial was conducted by Hsieh R-L et al. to determine the short-term preventative effectiveness of 890-nanometer light therapy for CNP (2014). Participants in the research ranged in age from 32 to 80. There were 38 ladies and 22 guys participating in this experiment. At Taipei's Shin Kong Wu Ho-Su Memorial Hospital, the investigation was carried out (SKWHS). Pain, disability, functional performance impairments, physical disability and health-related quality of life (QOL) were the metrics employed in this study.

Everyone taking part in the experiment to see how the treatment is delivered was clothedless and lying flat on a standard bed.[30] The light device was used by each respondent. The Anodyne machine in the intervention group was only run by electricity. After the experiment, the placebo group had six sessions of hot pack therapy lasting 40 minutes each over two weeks. The Fear-Avoidance Beliefs Questionnaire revealed that the treatment group had substantially reduced levels of fear-avoidance attitudes toward work (P=0.007) and physical activity (P=0.040)

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compared to baseline testing (FABQ). According to the Oswestry Disability Questionnaire (ODQ), the therapeutic community was effective in reducing a disability's severity (P=0.021). The 2-week follow-up tests for the endurance measurement revealed no statistically significant variations across the sites in comparison to the baseline level.[31] Maloney R. et al. conducted an RCT to assess the efficacy of laser therapy at 635 nm for the management of acute shoulder pain and cervical discomfort (2014). 83 persons who were older than 18 were included in the study.

The Rehabilitation Erchonia Corporation in the US conducted this investigation. Pain served as the main outcome indicator in this study. The other employs a therapeutic low-level laser procedure known as C-ROM. The VAS was employed in the study to categorize the severity of the pain, with O denoting "no pain" and 100 denoting "worst suffering imaginable." Using a linear range of motion, a universal inclinometer was utilized to measure the patient's mobility in the neck and shoulder area (ROM). Participants were assessed before, immediately after, 24 and two days following the surgery. A specific patient success criterion was defined as a 30% reduction in the VAS Degree of Pain rating throughout the different measurement periods.

The difference between the percentage of test and sham patients who cleared the cutoff was 53.5 percent, with 28 test subjects (65.1%) and 11.6% of placebo participants satisfying each of the individual success criteria. Patients in the test group saw a -29.02 decrease in the immediate post-procedure degree of pain rating ($p<0.001$) as opposed to a 4.91 decrease when compared to control patients ($p>0.05$). On the right and left sides of the neck as well as the right and left sides of the shoulder, the test group's linear range of motion dramatically increased. the creation and assessment of the therapeutic value of LLLT at 635 nm for the management of chronic neck and shoulder pain.[32] Low-level laser treatment for acute neck discomfort with radiculopathy was the subject of a double-blind, placebo-controlled, randomized research by Konstantinovic LM et al (2010). The investigation included 60 volunteers, whose ages vary from 20 to 65. This research was conducted at the Rehabilitation Clinic at the Medical School of the University of Belgrade. The primary outcome measure in this study was the pain score, which was measured using a visual analog scale (VAS). Secondary outcomes included neck mobility, NDI score and QOL.

Measurements were made during the three-week therapeutic session. In a study that offered an intervention, participants were randomized to one of two treatments: Group A received operational effectiveness LLLT whereas Group B received local sham LLLT. An organization called Enraf Nonius produced the laser units. The two types of LLLT devices were active and placebo devices. The patients were unaware of the open facilities. Five times each week for 15 sessions, patients received therapy. Instructions were given to each participant on what they could and couldn't do (low aerobic activity). The same therapist, who was not aware of the equipment's condition, delivered both treatments.

VAS was used to gauge the level of discomfort in the arm or neck area (VAS-arm). The VAS was a horizontal scale of 100 mm that measured pain on a scale of 0 to 100, with 100 denoting the worst possible suffering and 0 representing no pain.[33] Experienced professionals evaluated the participants' clinically while keeping their knowledge of the type of therapy a secret. When neck discomfort was taken out of the equation, statistics showed that Group A performed significantly better than Group B. The VAS's neck and arm movements have a sizable effect.

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Table II: Characteristics of Studies Included

Authors	Participants	Outcome measure assessing scales	Intervention used	Outcome Measure	Results
Waseem et al. (2020)	62 patients M=12 F=50 Age:18-52 years	NPRS and C-ROM by goniometry	Group-1: LLLT + CPT Group-2: CPT	Pain C-ROM	Group-1: pain reduction and statistically significant improvement in C-ROM in day 1 to week 4
Alayat MS et al. (2017)	75 patients Age>18 years	VAS and NDI	Group-1: MLS+Exercise Group-2: LLLT+Exercise Group-3: placebo + Exercise	Pain Disability	Significant reduction in pain and disability in all groups. MLS plus exercise exhibited a significantly large reduction in VAS and NDI scores after 6 weeks
Maloney R (2014)	86 patients Age>18 years	VAS	Active/test group: LLLT Sham group: placebo therapy	Pain Quality of life C-ROM	Significant improvement in LLLT group
Hsieh R-L (2014)	60 patients M=22 F=38 Age:32-80 years	VAS, NDI, inclinometer and goniometer	Group-1 LLLT Group-2 placebo therapy + exercises	Pain Functional outcome Quality of life C-ROM	Statistically significant improvement in all baselines
Konstantinovic LM et al. (2010)	60 patients Group A age: 41±8.63 M=43.33%	NDI, VAS and SF-12	Group A : active laser to 30 patients Group B: placebo laser to 30 patients	Pain, Disability, Mobility, Quality of life	Statistically significant improvement in arm pain and neck extension
Mario F et al. (2010)	820 patients M= 172 F= 648 Age>16 years	VAS	Group-1: LLLT Group-2: placebo	Pain C-ROM	Significant difference in LLLT group

The effect sizes are, respectively, 0.98 and 1.02. Doctors concluded that LLLT is a relatively low-risk intervention in comparison to the others after observing LLLT's adverse effects in this investigation. Participants in the study reported experiencing nausea and elevated blood pressure as side effects.34 The outcomes of LLLT are contrasted favorably to those of other commonly used therapies, especially pharmacological techniques, which

have little proof and a high rate of adverse effects. But further research is required. Our findings demonstrate the advantages of LLLT for pain, cervical range of motion, improved function, and impairment. LLLT may be used in conjunction with acupuncture, as well as strengthening, stretching, and soft tissue relaxation activities. In this research, the statistical impact of LLLT on outcomes such as pain and range of motion was examined.

CONCLUSION

This research discovered that soon after treatment, LLLT helps individuals with chronic neck pain feel less pain. When compared to patients treated with a placebo LLLT technique, LLLT is more effective than placebo therapy in reducing arm pain, enhancing cervical strength and flexibility in patients with severe neck pain, and improving quality of life. The procedure seems to be almost painless, has a minimal risk of adverse effects, and is relatively simple to use.

DECLARATIONS

Consent to participate: Written consent had been taken from patients. All methods were performed following the relevant guidelines and regulations.
Availability of data and materials: Data will be available on request. The corresponding author will submit all dataset files.
Competing interests: None
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Authors' contributions: All authors read and approved the final manuscript

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