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# Effectiveness of Low-Level Laser Therapy Combined With an Exercise Program to Reduce Pain and Increase Function in Adults With Shoulder Pain: A Critically Appraised Topic

**Aimee L. Thornton, Cailee W. McCarty, and Mollie-Jean Burgess**

***Clinical Scenario:*** Shoulder pain is a common musculoskeletal condition that affects up to 25% of the general population. Shoulder pain can be caused by any number of underlying conditions including subacromial impingement syndrome, rotator-cuff tendinitis, and biceps tendinitis. Regardless of the specific pathology, pain is generally the number 1 symptom associated with shoulder injuries and can severely affect daily activities and quality of life of patients with these conditions. Two of the primary goals in the treatment of these conditions are reducing pain and increasing shoulder range of motion (ROM).[3] Conservative treatment has traditionally included a therapeutic exercise program targeted at increasing ROM, strengthening the muscles around the joint, proprioceptive training, or some combination of those activities. In addition, these exercise programs have been supplemented with other interventions including nonsteroidal anti-inflammatory drugs, corticosteroid injections, manual therapy, activity modification, and a wide array of therapeutic modalities (eg, cryotherapy, EMS, ultrasound). Recently, low-level laser therapy (LLLT) has been used as an additional modality in the conservative management of patients with shoulder pain. However, the true effectiveness of LLLT in decreasing pain and increasing function in patients with shoulder pain is unclear. ***Focused Clinical Question:*** Is low-level laser therapy combined with an exercise program more effective than an exercise program alone in the treatment of adults with shoulder pain?

***Keywords:*** therapeutic modality, shoulder injury, upper extremity treatment, shoulder rehabilitation

## Clinical Scenario

Shoulder pain is a common musculoskeletal condition that affects up to 25% of the general population.[1] Shoulder pain can be caused by any number of underlying conditions including subacromial impingement syndrome, rotator-cuff tendinitis, and biceps tendinitis.[2,3] Regardless of the specific pathology, pain is generally the number 1 symptom associated with shoulder injuries and can severely affect daily activities[4] and quality of life[5,6] of patients with these conditions. Two of the primary goals in the treatment of these conditions is reducing pain and increasing shoulder range of motion (ROM).[3] Conservative treatment has traditionally included a therapeutic exercise program targeted at increasing ROM, strengthening the muscles around the joint, proprioceptive training, or some combination of those activities.[7,8] In addition, these exercise programs have been supplemented with other interventions including nonsteroidal anti-inflammatory drugs, corticosteroid injections, manual therapy, activity modification, and a wide array of therapeutic modalities (eg, cryotherapy, EMS, ultrasound).[2,3,7] Recently, low-level laser therapy (LLLT) has been used as an additional modality in the conservative management of patients with shoulder pain.[3,9,10] However, the true effectiveness of LLLT in decreasing pain and increasing function in patients with shoulder pain is unclear.

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## Focused Clinical Question

Is low-level laser therapy combined with an exercise program more effective than an exercise program alone in the treatment of adults with shoulder pain?

## Summary of Search, "Best Evidence" Appraised, and Key Findings

- The literature was searched for studies of level 2 evidence or higher that investigated the effects of LLLT on pain and function in adults with shoulder pain.
- The literature search returned 7 possible studies related to the clinical question; 4 randomized controlled trials met the inclusion criteria and were included.

- Of the included studies, 2 demonstrated significantly greater improvement in some of the outcome measures with the addition of LLLT to an exercise program
- Of the included studies, 2 studies showed no significant difference between a group that received LLLT and a group that received a placebo treatment in conjunction with an exercise program.

## Clinical Bottom Line

There is minimal evidence to support the use of LLLT in the treatment of adults with shoulder pain. This review has revealed that there are conflicting results in the current literature as to whether LLLT is an effective treatment for shoulder pain. Some evidence suggests that LLLT should be used in conjunction with an exercise program,[2,3] while other evidence supports the use of exercise alone.[7,8] The literature also suggests that a comprehensive rehabilitation program alone may be just as effective as one paired with LLLT. It is still unclear which treatment parameters of LLLT will produce the most favorable outcomes, as well as what long-term effects may be associated with LLLT. Some evidence indicates that treating anatomical landmarks as opposed to tender points will enhance the short-term benefit of the laser treatment. It is important to consider the populations examined in these studies when extrapolating the results to patients. There is currently no evidence that examines age or level of activity as a factor in the effectiveness of LLLT on shoulder pain. Future research is needed to determine which protocols will be most effective for different populations and multiple types of shoulder injuries, as well as what long-term effects LLLT may have on patients. Research on the effects of LLLT is still limited, and clinicians should use their best clinical judgment when determining whether to use LLLT in clinical practice.

**Strength of Recommendation**: Due to the inconsistent and conflicting results of the randomized controlled trials included, there is grade C evidence to support the use of LLLT in the treatment of adults with shoulder pain. It must be noted that only short-term effects were assessed, and it is still unclear what long-term effects LLLT may have on adults with shoulder pain.

## Search Strategy

### Terms Used to Guide Search Strategy

- **P**atient/Client group: *patients* or *people* or *subjects*
- **I**ntervention/Assessment: *low-level laser therapy* or *laser*
- **C**omparison: *control* or *placebo*
- **O**utcome: *pain* or *function*

### Sources of Evidence Searched

- Medline
- Cochrane Database
- CINAHL
- SPORTDiscus
- Additional resources obtained via review of reference lists and hand search

## Inclusion and Exclusion Criteria

### Inclusion Criteria

- Level 2 evidence or higher
- Studies that investigated the effects of LLLT on shoulder pain and function when added to an exercise program
- Studies that used a placebo laser treatment in the control group
- Limited to studies published in the past 10 years (2003–2012)

### Exclusion Criteria

- Studies that had a control group that received no intervention
- Studies that included therapeutic interventions in addition to an exercise program and/or LLLT
- Studies that did not include an exercise program for both groups

## Results of Search

Four relevant studies[2,3,7,8] were located and categorized as shown in Table 1 (based on Levels of Evidence, Centre for Evidence-Based Medicine, 2009).

## Best Evidence

The included studies (Table 2) were identified as the best evidence and selected for inclusion in this critically appraised topic (CAT). These studies were selected because they were scored with a level of evidence of 2 or higher, examined an LLLT intervention compared with a placebo intervention when added to an exercise program, outcomes included pain and some type of functional assessment, and the effects of the intervention on outcomes of pain and function were described.

**Table 1 Summary of Study Designs of Articles Retrieved**

| Level of evidence | Study design | Number located | Reference |
|---|---|---|---|
| 1b | Randomized controlled trial | 4 | Abrisham[2] |
| | | | Binjol et al[3] |
| | | | Yeldan et al[7] |
| | | | Dogan et al[8] |

**Table 2 Characteristics of Included Studies**

| | Yeldan et al[7] | Abrisham et al[2] | Dogan et al[8] | Binjol et al[3] |
|---|---|---|---|---|
| Study design | Randomized controlled trial | Randomized controlled trial | Randomized controlled trial | Randomized controlled trial |
| Participants | 67 participants with a diagnosis of subacromial impingement syndrome (made by referring physician). Duration of symptoms not reported.<br>34 participants (55.32 ± 8.73 y) in the intervention group and 33 (55.00 ± 8.75 y) in the control group.<br>Participants were randomly assigned to groups using Microsoft Excel RANDO() function.<br>Exclusion criteria: (1) presence of direct trauma to the shoulder; (2) patients with frozen shoulder, acromioclavicular arthritis, or clinical rotator-cuff tears; (3) presence of underlying neurologic, inflammatory rheumatic diseases such as cervical spondylosis with referring pain to the shoulder; (4) physical therapy was given 6 mo prior to the study; (5) patients who had received intra-articular or subacromial steroids in the 3 mo prior to treatment.<br>No restrictions on medications reported.<br>7 control group participants dropped out (surgery, scheduling problems, personal circumstances that prevented weekly visits).<br>60 participants (34 intervention, 26 control) completed treatment without any adverse effects. | 80 participants with a diagnosis of subacromial impingement syndrome (rotator cuff and biceps tendonitis) on clinical presentation and physical exam. Duration of symptoms not reported.<br>40 participants (52.2 ± 5.7 y) in the intervention group and 40 (51.2 ± 6.7 y) in the control group.<br>Participants were randomly assigned to groups using sealed envelopes.<br>Exclusion criteria: (1) significant trauma or systemic inflammatory conditions such as rheumatoid arthritis or polymyalgia, (2) neurological or structural abnormality affecting the shoulder, (3) postoperative and perioperative shoulder pain, (4) pregnancy or breastfeeding, (5) anticoagulation therapy, (6) diabetes mellitus, (7) cardiac-type chest pain, (8) cigarette smoking, (9) shoulder infection, (10) shoulder trauma, (11) contraindications to laser therapy.<br>Participants were not permitted to take analgesics or NSAIDs during the study period.<br>All 80 participants completed treatment without any adverse effects. | 52 participants with a diagnosis of subacromial impingement syndrome on physical and neurological exam. Duration of symptoms not reported.<br>30 participants (53.7 ± 12.6 y) in the intervention group and 22 (53.45 ± 9.64 y) in the control group.<br>Participants were randomly assigned to groups through a numbered-envelope system.<br>Exclusion criteria: (1) presence of acute trauma, (2) acromioclavicular arthritis, (3) glenohumeral arthritis, (4) rotator-cuff tears, (5) neurologic or inflammatory disease, (6) referring pain due to neck pathologies, (7) history of physical therapy, surgery, or subacromial or intra-articular injection within 6 mo.<br>No restrictions on medications reported.<br>All 52 participants completed the therapy program without any adverse effects. | 40 participants with shoulder pain in the last 3 mo and a VAS greater than 3.<br>20 participants (63.8 ± 9.77 y) in the intervention group and 20 (57.25 ± 10.21 y) in the control group.<br>Participants were randomly assigned to groups by random selection of cards from a bag by a blinded physician.<br>Exclusion criteria: (1) diagnosis of inflammatory arthritis, polymyalgia rheumatic, or cervical spondylosis; (2) history of shoulder dislocation or fracture; (3) previous deltoid surgery; (4) neurological problems; (5) osteoarthritis; (6) rotator-cuff repair; (7) local or systemic steroid therapy; (8) physiotherapy within the last 6 mo.<br>Participants were instructed to stop NSAID treatment 1 wk prior to laser treatment and were not permitted to take NSAIDs during the study period.<br>All 40 participants completed the therapy program without any adverse effects. |

*(continued)*

**Table 2 *(continued)***

| | Yeldan et al[7] | Abrisham et al[2] | Dogan et al[8] | Binjol et al[3] |
|---|---|---|---|---|
| Intervention investigated | All participants completed a 3-wk (10 sessions) exercise program in conjunction with either the laser or placebo laser treatment.<br>Laser treatment group received treatment with a GaAs diode laser (wavelength 904 nm, maximum peak power 27, 50, or 27×4 W) to a maximum of 5 tender points over the superior and anterior periarticular parts of the glenohumeral joint (~15 $cm^2$).<br>Laser was applied for 90 s at each location (~8 min total treatment time) with a frequency of 2000 Hz.<br>Placebo group received the same treatment protocol, but no laser was emitted from the transducer.<br>Both groups received the laser or placebo treatment before the exercise protocol.<br>Exercise program consisted of a 15- to 30-min progressive ROM, strengthening, and stretching protocol. Protocol was performed 2 times a day under supervision at the clinic or at home. After exercise, cold pack was applied for 15 min.<br>Participants and outcome assessor were blinded to treatment group. Only the treating physiotherapist knew what treatment group each subject was assigned to. | All participants completed a 2-wk (10 sessions) exercise program in conjunction with either the laser or placebo laser treatment.<br>Laser treatment group received treatment with infrared laser radiation (wavelength 890 nm, pulsed) to 3 points on the shoulder (coracoid, glenohumeral joint, rotator-cuff tendon).<br>Laser was applied for 2 min at each site (6 min total treatment time) with an energy density of 2–4 J/$cm^2$.<br>Placebo group received the same treatment protocol, but no laser was emitted from the transducer.<br>Both groups received the laser or placebo treatment after the exercise protocol.<br>Exercise protocol consisted of strengthening, stretching, and mobilization exercises. Protocol was performed in the clinic and at home. Each subject attended 10 sessions in the clinic over the 2-wk period.<br>Participants and outcomes assessor were blinded to treatment group. One physiotherapist administered treatment to all participants. | All participants completed a 3-wk (14 sessions) exercise program in conjunction with either laser or placebo laser treatment.<br>Laser treatment group received treatment with GaAlAs infrared laser (wavelength 850 nm, power output 100 mV, continuous wave) over a maximum of 5–6 tender points.<br>Laser was applied for 1 min at each site (~5–6 min total treatment time) with an energy density of 5 J/$cm^2$<br>Placebo group received the same treatment protocol, but no laser was emitted from the transducer.<br>Both groups received the laser or placebo treatment prior to the exercise protocol.<br>All participants had cold-pack therapy applied for 10 min prior to laser or placebo treatment<br>Exercise program included ROM, stretching, and progressive resistive exercises. Each exercise was performed once a day with 10–15 repetitions, 5 times a week, for 14 sessions<br>Participants and outcomes assessor were blinded to treatment group. One physiotherapist administered treatment to all participants. | All participants completed a 2-wk (10 sessions) exercise program in conjunction with either laser or placebo laser treatment.<br>Laser treatment group received treatment with a GaAs diode laser (wavelength 904 nm, maximum peak power 27, 50, or 27×4) to 5 anatomical landmarks (greater and lesser tubercle, bicipital groove, anterior and posterior aspects of the capsule)<br>Laser was applied for 1 min at each site (5 min total treatment time) with an energy density of 2.98 J/$cm^2$ and frequency of 2000 Hz.<br>Placebo group received the same treatment protocol, but no laser was emitted from the transducer.<br>Both groups received the laser treatment prior to the exercise protocol.<br>Supervised exercise program lasted 15 min and consisted of ROM exercises (Codman, shoulder wheels, and finger stair components).<br>Participants and outcomes assessor were blinded to treatment group. One physiotherapist administered treatment to all participants. |
| Outcome measures | Strength (flexion, abduction, external rotation, internal rotation, extension), ROM (flexion, abduction, external rotation, internal rotation, extension), VAS (active, at rest, and at night), Constant Scoring System (pain, ROM, ADL, power, ROM, total), SDQ, and DASH. | Active and passive ROM (flexion, abduction, external rotation) and VAS. | ROM (flexion, abduction, adduction, internal and external rotation, extension), VAS, SPADI (functional subscore, pain subscore, total), and self-administered shoulder-specific questionnaire. | Active and passive ROM (flexion, abduction, extension, internal and external rotation, adduction), palpation sensitivity (at the 5 treatment points), algometric sensitivity (at the 5 treatment points), and VAS. |

*(continued)*

**Table 2 *(continued)***

| | Yeldan et al[7] | Abrisham et al[2] | Dogan et al[8] | Binjol et al[3] |
|---|---|---|---|---|
| Main findings | No significant differences existed between groups at baseline.<br>No significant differences existed between groups after the intervention for any outcome measures.<br>Both the intervention group and the control group showed significant improvements in all ROMs, VAS, DASH, Constant, and SDQ scores from baseline after the intervention.<br>No significant improvements in strength were reported for the intervention group or control group.<br>Effect sizes were small for most outcome measures. Medium effect sizes were found for the ADL and ROM subscores of the Constant Scoring System, internal rotation and extension strength and abduction, internal rotation, external rotation, and extension ROM. | No significant differences existed between groups at baseline.<br>Intervention group showed significantly greater improvements in all active and passive ROM measurements than the control group after the intervention.<br>Intervention group showed significantly greater reduction in pain on the VAS than control group after the intervention.<br>Both the intervention group and the control group showed significant improvements in pain and ROM from baseline after the intervention.<br>Large effect sizes were found for all outcome measures except active external rotation ROM, which had a medium effect size. | No significant differences existed between groups at baseline.<br>No significant differences existed between groups after the intervention for any outcome measures.<br>Both the intervention group and the control group showed significant improvements in ROM (flexion, abduction, adduction extension), pain severity, and SPADI scores after the intervention.<br>The control group also improved in internal-rotation ROM.<br>Medium effect sizes were found for VAS, external-rotation ROM, and all SPADI scores. | No significant differences existed between groups at baseline.<br>Intervention group showed significantly greater improvements in passive extension ROM and palpation sensitivity than the control group after the intervention.<br>Both the intervention and control group showed significant improvement from baseline on all other outcome measures. |
| Level of evidence | 1b | 1b | 1b | 1b |
| Validity score | PEDro 9/10 | PEDro 9/10 | PEDro 9/10 | PEDro 8/10 |
| Conclusion | There is no significant difference between LLLT and placebo LLLT when added to a exercise program for patients with subacromial impingement syndrome.<br>Future research should focus on treatment over anatomical sites instead of tender points and longer treatment durations. | LLLT combined with an exercise program is more effective than an exercise program alone in relieving pain and improving shoulder ROM in patients with subacromial syndrome.<br>Future research should focus on larger sample sizes, long-term treatment outcomes, and comparisons with other conservative interventions. | There is no significant difference between LLLT and placebo LLLT when added to a exercise program for patients with subacromial impingement syndrome.<br>Future research should focus on larger sample sizes and longer follow-up durations. | LLLT combined with an exercise program is more effective than an exercise program alone in decreasing palpation sensitivity and improving passive extension ROM. Otherwise, there is no significant difference between LLLT and placebo LLLT when added to a exercise program for patients with shoulder pain.<br>Future research should focus on determining what treatment parameters produce the best outcomes. |

Abbreviations: NSAIDs, nonsteroidal anti-inflammatory drugs; VAS, visual analog scale; ROM, range of motion; ADL, activities of daily living; SDQ, Shoulder Disability Questionnaire; DASH, Disability of the Arm, Shoulder, and Hand; SPADI, Shoulder Pain and Disability Index; LLLT, low-level laser therapy.

## Implications for Practice, Education, and Future Research

Based on this appraisal, one[2] of the 4 studies reported a significant reduction in pain and increase in function with the addition of LLLT to an exercise program for patients with shoulder pain. One[3] of the studies noted differences in a few outcome measures but overall insignificant improvements in the intervention group, while two[7,8] of the studies found no significant improvement with the addition of LLLT to an exercise program. All 4 studies displayed positive outcomes from baseline after an exercise program whether LLLT was added or not, and no subjects from any study reported negative outcomes.[2,3,7,8] The additive effects of an LLLT application to an exercise program that includes ROM, resistive exercises, proprioceptive training, and/or manual therapy to reduce pain and increase function in adults with shoulder pain is uncertain. The treatment parameters of the laser therapy in each study differed, so it is possible that with the proper parameters LLLT could enhance recovery.

The 2 studies[2,3] that demonstrated significantly greater improvements in outcome measures when LLLT was added to the exercise program focused the treatment on specific predetermined anatomic landmarks. In addition, Abrisham et al[2] applied the LLLT after the exercise protocol, while all other studies used the LLLT before exercise. Other factors that may contribute to the effectiveness of LLLT include the addition of a home exercise program, the type of laser used (eg, GaAlAs, GaAs), the parameters of the laser selected, and the duration of treatment at each site. However, the contribution of these specific factors could not be determined based on this appraisal.

The 2 studies[7,8] that used LLLT over targeted tender points rather than anatomical landmarks reported no significant differences between LLLT and a placebo treatment. While reporting no significant improvements with the addition of LLLT, Yeldan et al[7] observed medium effect sizes for the activities of daily living and ROM subscales of the Constant Scoring System, internal rotation and extension strength, and all ROMs assessed. These findings indicate that with a larger sample size significant improvements in these outcome measures may have been observed. Dogan et al[8] found medium effect sizes for visual analog scale and Shoulder Pain and Disability Index scores, as well as external-rotation ROM. One possible explanation for these findings is that participants in the intervention group may have perceived their disability as improving more than participants in the placebo group, even though objective outcomes showed no significant improvements. In addition, with a larger sample size significant differences might have been observed.

Clinicians who are considering LLLT as a treatment for patients with shoulder pain must be cognizant of a few factors. The participants in these studies were older than the traditional athletic population, and no information on their activity level or continued participation in work and activities of daily living was reported. It is possible that age and activity level play a significant role in the recovery of shoulder injuries. In addition, it is important to consider the individual goals of each patient when developing a treatment plan. Treatment plans should reflect short-term and long-term goals by focusing on which factors are most important to each patient (ie, pain, perceived function, objective measures).

Focusing LLLT on anatomical sites may be more effective than treating tender points. One possible explanation for this is that tender points reported by the patient may reflect referred pain or general soreness in the surrounding tissues rather than the actual injured site that is the underlying cause of the pain. Based on this appraisal, treatment that is applied for 2 minutes at each site may produce more favorable outcomes than shorter treatment durations. However, clinicians must also use caution and follow recommended treatment guidelines when choosing treatment parameters to avoid harm to their patients. It is also important to keep in mind that the studies examined used a variety of treatment parameters including differing wavelengths, energy densities, and number of treatment points. While treatment recommendations exist (ie, the World Association for Laser Therapy), clinicians must consider what parameters may be best suited to each patient's specific case.

Our clinical recommendation for the management of adults with shoulder pain is that treatment should include a supervised exercise program. Although each study used exercise programs that differed in the specific exercises prescribed, the results from the studies included in this CAT suggest that an exercise program that incorporates ROM and strengthening[2] may be more beneficial than a program focusing on ROM exercises alone.[3] It is still unclear if the addition of LLLT to the rehabilitation protocol is associated with more favorable outcomes. However, if clinicians choose to include LLLT in a patient's treatment plan, they should consider the LLLT recommendations set forth by The World Association for Laser Therapy (www.walt.nu) when selecting treatment parameters (eg, wavelength, energy density, number and location of treatment points).

While all 4 studies included in this appraisal assessed shoulder pain, 3 of the investigations specifically examined patients with subacromial impingement syndrome. Although the aim of this CAT was to focus on the effects of LLLT on the impairment of shoulder pain, future research should examine whether the effectiveness of LLLT depends on the type of shoulder condition being treated. Future research should also focus on interventions implemented in larger sample groups, include longer treatment durations, and assess long-term treatment outcomes.[7,8] Larger samples will allow researchers to more accurately determine whether the treatment protocol of the LLLT intervention is indeed effective as a treatment option of shoulder conditions across a wide spectrum of individuals. By observing longer treatment durations and long-term outcomes, clinicians may gain a better understanding of what treatment parameters and protocols will maximally enhance patient outcomes. Future studies

should also focus on determining whether treatment of specific anatomical sites or treatment of tender points produces more favorable results.[3] In addition, the efficacy of LLLT treatment compared with other conservative interventions should be examined.[2,8] This CAT should be reviewed in 2 years or when additional best evidence becomes available to determine whether additional information has been published that may change the clinical bottom line for the research question posed in this review.

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