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Effect of Low-Level Laser with and without Shoulder Mobilization in Treating Shoulder Impingement

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ABSTRACT

Background: Besides the traditional physical therapy interventions (infrared and strengthening exercises for scapular and shoulder muscles), recently, low-level laser (LLL) and mobilization with movement (MMM) gained more attention in the management of shoulder impingement syndrome (SIS).
Aim: To examine the effects of adding LLL to MMM in patients having SIS.
Design: A prospective double-blinded randomized trial.
Settings: Physical therapy outpatient clinic of Heliopolis University.
Participants: Forty patients complaining of unilateral shoulder impingement syndrome for not less than three months and not more than twenty-four months were included.
Methods: The patients were randomly assigned to group A (n=20, received the active LLL, MMM, and the above-mentioned traditional physical therapy interventions), and group B (n=20, received the same treatments as group A but the LLL was sham). All treatments were applied 3 times per week, for 6 successive weeks. The shoulder pain severity, (assessed via visual analog scale, VAS) and shoulder range of motion (ROM) (flexion, abduction, and internal rotation).
Results: The within-group analysis revealed a significant enhancement in all parameters relative to the baseline ($P < 0.05$).
Conclusion: LLL could magnify the gained improvements in pain and ROM when added to MMM and traditional physical therapy interventions in patients with SIS.
Keywords: Low-level laser; Mobilization with movement; Shoulder impingement syndrome.

INTRODUCTION

In middle age and older individuals, shoulder problems are considered among the most frequent cause of impairment due to musculoskeletal disorders with a reported prevalence ranging between 7% and 25% of the general population [(1)].

Pain, restricted range of motion, and functional disabilities are the primary symptoms concerned with shoulder disorders and cause limitations in the performance of the activity of daily living [(2)].

Subacromial impingement syndrome (SIS) contributes to micro traumatic changes and soft tissue injuries reported in (44%-65%) of patients attending the orthopedic clinic and needing physical therapy intervention for useful recovery [(3)].

Exercise programs, mobilization, acupuncture, heat, cold, and electrotherapy including low-level laser (LLLT) are modalities used in the management of SIS [(4)].

Low-level laser or photo biomodulation went on to become one of the most effective modalities used to decrease pain and accelerate the healing process either in acute or chronic conditions, especially in wavelength ranged low-level laser is a nonionizing, noninvasive and monochromatic beam, and its mechanism of action based on cell proliferation, protein and collagen synthesis [(5)].

Mobilization with movement (MWM) refers to a manual therapy technique in which an external force is applied manually by a physiotherapist in the pattern of sustained joint glide and active motion of the segment at the same time to correct the fault position of the patient which contribute to either bony or soft tissue lesions around the affected joint enhancing pain-free ROM regarding biomechanical or neurologic impacts [(6)].

To the authors' knowledge, there is no previous study that compares the impact of LLLT either with or without MWV techniques in patients with SIS and investigates the effect of LLLT in speeding up the healing process as well as the recovery time.

As a result, this research set out to evaluate the effic acy of laser plus MWM versus laser alone in treating SI S patients. It was hypothesized that adding low-level laser modality to mobilization with movement technique may accelerate the healing process, decrease pain, maximize functional ability, and minimize recovery time in patients with subacromial impingement syndrome.

SUBJECTS AND METHODS

Design

It is a randomized controlled trial; prospective study that was performed From May 2022 to August

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2022. Each person who took part in this study signed a consent form after being told how the study would work. The study's plan was approved by the Ethical Committee of the National Institute of Laser Enhanced Sciences at Cairo University.

Participants

From the outpatient clinic at Heliopolis University's Physical Therapy Department, forty patients of both sexes were recruited. The inclusion criteria include patients who had shoulder pain and limitation in range of motion for at least 3 months from the onset of illness and not more than 24 months and demonstrated at minimum 3 of the subsequent: (1) a positive Neer test, (2) a positive Hawkin's test, (3) painful arc test, and (4) the external rotation test (Infraspinatus testing) [7].

Pain greater than 5 on the visual analog scale (VAS) [8]. The participants' age ranged from 40 to 55 years. Subjects were excluded if there were frozen shoulders, arthritis of the shoulders, shoulder instability, pregnant women, patients with pacemakers, previous shoulder surgery, history of dislocation/subluxation of the shoulder, fracture of shoulder girdle, traumatic or congenital anomalies shoulder conditions, internal metallic fixation of shoulder, malignancy or radiotherapy of the shoulder, previous corticosteroid injection, rheumatoid arthritis, gout, lupus, full-thickness tears of the rotator cuff, cervical radiculopathy, patients with neurogenic or systemic diseases, shock wave therapy and physiotherapy for the shoulder within the last three months.

Randomization

A third party randomly allocated 40 patients to one of two therapy groups using sealed envelopes. The letters inside the envelopes explained which group each patient would be placed in. No one informed the patients of which group they would be placed in.

Interventions

The twenty patients in the first treatment group (11 males and 9 females) were treated by low-level laser 808 nm with power destiny 1.43w/cm2 and power output 2.5mw and mobilization with movement, while the other twenty patients in the second treatment group (13 males and 7 females) were treated by mobilization with movement technique and sham laser for the affected shoulder girdle. All patients were treated for 18 sessions (3 sessions /week) every alternating day for six weeks. Both groups received infrared radiation therapy, scapular muscle exercises and shoulder strengthening exercises 3 times/ week.

Infrared Radiation

The infrared was received as a source of superficial heat for preparation before conventional physical therapy exercises.

Scapular Muscle Exercises

The exercises were performed using (1-1.5 Kg) weight, 3 sets of 10 repetitions with 60 seconds rest period between each set

Rotator Cuff muscle Strengthening Exercises

The shoulder scaption exercise was performed while the shoulder in scaption elevation movement using an elastic band through an angle less than 60 degrees (three sets of ten repetitions each with a sixty-second resting period among each set) based on the work of **Kamal *et al.*** [9].

Low-Level Laser Therapy

The patient was in a sitting position with the affected shoulder in full adduction, flexion elbow, and supinated forearm with a hand supported on the patient's lab. The transducer's head was held at a right angle to the skin and no pressure was applied at tender points (maximum 5 points along the anterior and superior surface of shoulder joint covering approximately 15 cm^2). Each session consisted of the application of three 3-Joule pulses to a maximum of five painful points identified during clinical evaluation. (Pain with palpation). Every session consisted of 90 seconds of laser application [10].

Mobilization with Movement Technique

Mobilization with Movement Techniques was applied by the therapist using a mulligan belt to increase shoulder flexion, abduction, and internal rotation. The patient was instructed to inform the therapist in case of pain during application. Each technique was applied 6 repetition/3 sets.

Outcome measures

1- Shoulder Joint Pain Severity

A visual analog scale was utilized to assess shoulder pain severity. Patients were asked to rate the pain when they were at rest (R), during activity (A) that occurs when the patient lifts his/her arm or reaches his arm backward, and at night (N) when the patient sleeps on the affected side. The location of the pain is at the shoulder, near the top of the arm, or down the outside of the arm [11]. Pain is represented by a VAS from 0 (no pain) to 10 (very painful) on a 10-cm scale [10].

2- Shoulder Joint Mobility

Baseline 12-1027 Absolute Axis 360 Degree Digital goniometer (Fabrication Enterprises, Inc. PO Box 1500, White Plains, New York 10602 USA) was used to assess shoulder ROM (flexion, abduction, and internal rotation). The digital goniometer replaced the use of manual measurement as it reduces the assessment time.

The goniometer can accurately and quickly measure all angles or ranges of motion. It has a range of 0 to 360 and is accurate to +/- 1. The validity also reliability of the electro-goniometer for measuring shoulder joint movement was tested and well documented [12,13,14].

Ethical approval:

This study was conducted in the Department of Medical Applications of Laser at the National Institute of Laser Enhanced Sciences at Cairo University and was authorized by the Institutional Review Board and the Local Committee of Ethics. Written consent for being informed was collected from all participants before their involvement in this study.

Statistical analysis

The age of the groups was compared using an unpaired t-test. Gender distributions were compared between groups using the chi-squared test. The Shapiro-Wilk test was used to ensure that the data followed a normal distribution. To examine whether or not there was homogeneity in the variances among groups, Levene's test was carried out.

The impact of therapy on VAS as well as shoulder ROM was evaluated using Mixed-MANOVA. Post hoc tests with Bonferroni adjustments were performed for further multiple comparisons. Mann–Whitney U test was utilized for comparison of muscle strength among groups and the Wilcoxon signed-rank test was carried out for comparison between pre as well as post-treatment in every group.

All statistical tests were performed at the $p < 0.05$ level of significance. The Windows version of the SPSS statistical software (version 25) was utilized for all analyses (IBM SPSS, Chicago, IL, USA).

RESULTS

- *Subject characteristics*:

Subject characteristics for both groups were presented in **Table 1**.

The distribution of ages and sexes was similar across all groups with no substantial difference ($p > 0.05$).

Table 1. Comparison of subject characteristics between both groups:

	Group A	Group B	p-value
	Mean ± SD	Mean ± SD	
Age (years)	48.15 ± 5.38	47.5 ± 5.68	0.71
Sex			
Females	9 (45%)	10 (50%)	0.75
Males	11 (55%)	10 (50%)	

SD = standard deviation; p-value = probability value

<u>Effect of treatment VAS and shoulder ROM:</u>

The interaction effect of treatment and time was significant, as shown by the mixed ANOVA ($F = 9.8$, $p = 0.001$). The treatment had a substantial main impact ($F = 6.27$, $p = 0.001$). There was a substantial main impact time ($F = 1519.07$, $p = 0.001$).

Within group comparison

Following treatment, VAS scores declined significantly ($p > 0.001$) while comparing the two groups' respective baseline conditions. In group A, the VAS decreased by 84.25 % and 40.5 % respectively while in group B it was 75.17 % and 20.1 % respectively.

post-treatment, both groups' shoulder ROM substantially improved their baseline value ($p > 0.001$). Group A exhibited a 96.49, 118.09, and 109.92% improvement in flexion, abduction, as well as medial rotation.

Between-group comparison

There was no substantial difference between groups pre-treatment ($p > 0.05$). The VAS scores of those in Group A decreased significantly after treatment in comparison with those in Group B ($p < 0.01$). Post-treatment, group A had significantly improved ROM in shoulder flexion in comparison with group B ($p < 0.01$). Post-treatment, there was no statistically substantial difference in shoulder abduction as well as medial rotation ROM among the two groups ($p > 0.05$). (**Table 2**).

Table 2. Mean VAS and shoulder ROM pre and post-treatment of both groups:

	Pre-treatment Mean ±SD	Post-treatment Mean ±SD	MD	% of change	p-value
VAS					
Group A	7.3 ± 1.17	1.15 ± 0.48	6.15	84.25	0.001
Group B	7.45 ± 1.19	1.85 ± 0.68	5.6	75.17	0.001
MD	-0.15	-0.7			
p-value	***p = 0.69***	***p = 0.001***			
ROM (degrees)					
Flexion					
Group A	89.7 ± 11.51	176.25 ± 3.58	-86.55	96.49	0.001
Group B	88.2 ± 10.01	171.9 ± 6.81	-83.7	94.90	0.001
MD	1.5	4.35			
p-value	***p = 0.66***	***p = 0.01***			
Abduction					
Group A	77.95 ± 7.22	170 ± 4.58	-92.05	118.09	0.001
Group B	78.3 ± 8.42	167 ± 8.94	-88.7	113.28	0.001
MD	-0.35	3			
p-value	***p = 0.88***	***p = 0.19***			
Internal rotation					
Group A	39.3 ± 5.33	82.5 ± 4.44	-43.2	109.92	0.001
Group B	40.8 ± 5.15	80.5 ± 5.35	-39.7	97.30	0.001
MD	-1.5	2			
p-value	***p = 0.37***	***p = 0.21***			

SD = Standard deviation; MD =Mean difference; p value = Probability value

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DISCUSSION

According to the results of the research, LLL could magnify the gained improvements in pain and ROM when added to MMM and traditional physical therapy interventions in patients with SIS.

Our research findings were supported by **Abrisham *et al.*** [15] who investigated the additive 2-week interventional effects of LLL with exercise therapy (shoulder stretching, strengthening, and mobilization exercises) in comparison with exercise therapy on 80 patients with subacromial syndrome. Statistically substantial increases in shoulder range of motion were observed in both groups (passive and active flexion and abduction) and visual analog scale (VAS) of pain in favor of the LLL group.

These results can be explained that LLT can modify inflammation-related pain by lowering values of biochemical indicators/markers, neutrophil cell influx, oxidative stress/damage, histological abnormalities, as well as edema size. Altering nerve conduction and excitement in peripheral nerves as well as stimulating the release of endogenous endorphins have been proposed as additional reasons for how LLLT relieves pain [16].

High-intensity laser therapy was more effective than ultrasound therapy in reducing discomfort and improving function, ROM, and force-generating capacity as a measure of muscular strength, in 70 patients with subacromial impingement syndrome over 2 weeks [16].

In agreement with LLLT therapy, this study was supported by **Musha *et al.*** [17] who demonstrated a significant enhancement in VAS, shoulder ROM (abduction, flexion, and internal rotation), and serum prostaglandin E2 after treating women with shoulder periarthritis.

In addition, other studies showed that LLLT produced a statistically substantial improvement in VAS, shoulder function, and ROM [18,19].

Recent studies showed that adding Laser Therapy either manual therapy or conventional therapy had a substantially improving impact on shoulder pain and ROM [20,21].

In partial contrary to the findings of this study, **Bal *et al.*** [22] showed improvement in night pain in favor of the group that received LLL and a home-based exercise program versus the group with a home-based exercise program only, while SPADI RESULTS (pain domain, disability domain, and total score) did not demonstrate a substantial difference between groups.

On the other hand, **Yeldan *et al.*** [10] **Dogan *et al.*** [23] failed to document the superiority of real LLL over placebo LLL in improving VAS, DASH, range of motions of shoulder joints, and muscle strength in impingement-syndrome patients.

Regarding mobilization with movement

Previous studies reported that adding MWM to supervised exercises when treating SIS patients showed a high percentage of improvement in VAS, the pain of Neer and Hawkins-Kennedy tests, and active ROM (flexion and scaption) [24,25, 26,27,28].

In addition, the comparison between the results of assessing active pain-free shoulder ROM (abduction and flexion) in response to treatment of SIS with MMM / kinesiotaping technique versus exercise showed that the improvement was higher in patients treated with MMM / kinesiotaping technique [29].

The results of mobilization with movements can be explained through its effect on the realignment of collagen, dissolution of adhesions, and enhanced fiber glide. Also, Increased synovial fluid flow and blood flow to the arteries that supply nerves around affected tendinous tissues had circulatory effects in response to mobilization techniques. This would also help to alleviate the condition of potential ischemia [30,31].

On the contrary, **Lirio Romero *et al.*** **[32]** and **Guimares *et al.*** **[33]** reported that in individuals with SIS, abduction ROM, discomfort, and function (as defined by DASH) were not improved by MWM compared to sham intervention or traditional physiotherapy.

Limitations

Although the current study provides objective data, such as statistically significant changes, it does have certain drawbacks. The study's short time frame is its main drawback. So, longitudinal studies are essential to examine the response of the shoulder ROM, pain, shoulder muscle strength, HGS, and DASH to LLL in a large sample of SIS patients. Further research is required to assess the response of shoulder ROM, pain, shoulder muscle strength, HGS, and DASH to LLL versus MMM SIS patients. More studies are needed to compare the response of the shoulder ROM, pain, shoulder muscle strength, HGS, and DASH to LLL in different age classes of SIS patients. Furthermore, additional research is required to assess the response of shoulder ROM, pain, shoulder muscle strength, HGS, and DASH to LLL in patients who complain of SIS > 24 months.

CONCLUSION

The study demonstrated that Adding LLL to MMM and traditional physical therapy interventions increases the gained improvements in HGS, shoulder functionality, pain, also shoulder ROM in patients with SIS.

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