Effect of Low Level Laser Therapy versus Dry Needling on Myofascial Trigger Points Associated with Supraspinatus Tendinitis: Randomized Controlled Trial

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ABSTRACT

Background: Among people with shoulder pain, supraspinatus tendinitis has the highest prevalence and accounts for 36% of shoulder disorders and its recurrence is common after treatment. Myofascial trigger points (MTrPs) in the supraspinatus muscle were found in 65% of patients diagnosed with shoulder impingement. **Purpose:** To investigate the effect of low level laser therapy (LLLT) versus dry needling (DN) on shoulder pain, function, and range of motion in patients with supraspinatus tendinitis. **Materials and Methods:** Seventy-five subjects of both genders with MTrPs associated with grade 2 (according to Neer's classification) supraspinatus tendinitis participated in this study. Subjects were randomly assigned into three groups (each group consisted of twenty five subjects). Group (A) with a mean age of 40.4 (±7.76) years was LLLT group (Gallium arsenide laser at a wavelength of 810 nm and 583 Hz with maximum power output of 150 mW for 160 seconds so that the total energy density was 8 J/cm2) was applied on MTrPs, group (B) with a mean age of 42.2(±9.25) years was DN group (with depth of insertion range from 30-35mm), group (C) with a mean age of 40.84 (±7.58) years was the control group. Subjects in all groups received conventional physical therapy for 5 consecutive days. Subject data was called at baseline and after treatment regarding shoulder flexion, abduction, internal and external rotation ROM and shoulder pain and disability index (SPADI). **Results:** Subjects of the three groups showed statistical significant improvement in all the measured variables. Between groups comparison revealed a significant difference in flexion, abduction ROM, and SPADI score of groups A and B compared with that of group C ($p < 0.01$). There was no significant difference in the shoulder flexion, abduction ROM, and SPADI score between group A and B post treatment ($p > 0.05$). Also there was no significant difference in internal and external rotation between the three groups post treatment ($p > 0.05$). **Conclusion:** both low level laser therapy and dry needling are effective in treatment of patients with myofascial trigger points associated with chronic stage 2 supraspinatus tendinitis with no statistically significant differences between them. However, low level laser therapy may be considered as a treatment of choice because it is non-invasive, easy to apply in contrary of dry needling which needs learning and practice, there is no agitation of hyperirritated areas, and it may be the method of choice for patients with a fear of needles and health professionals inexperienced with the dry needling technique.

KEY WORDS: Low level laser, Supraspinatus tendinitis, Myofascial trigger points, and Dry needling.

INTRODUCTION

Supraspinatus tendonitis is a common condition with the highest prevalence (36%) of shoulder disorders that causes shoulder pain, limited ROM (mainly flexion and abduction) and muscle imbalance due to rotator cuff overload [1, 2]

MTrPs in the supraspinatus muscle were found in 65% of patients with a medical diagnosis of shoulder impingement causing pain in the lateral aspect of the shoulder that may spread distally to the lateral epicondyle and forearm. [3]

Depending on the severity of the condition, some treatments are available, including physical therapy, nonsteroidal anti-inflammatory drugs, and local injection treatments. [4,5].

After treatment, the symptoms of supraspinatus tendonitis are usually relieved. , but recurrence is common, affecting the patient's quality of life [6] and causing pathological changes such as rotator cuff calcification tendinitis with supraspinatus being the most affected (80%). [7]

The physical therapy treatment addresses associated impairments of the shoulder, scapular region, and cervicothoracic spine including DN, stretching, manual therapy, mobilization techniques, applying cold, exercise, ischemic compression of MTrPs, LLLT, and ergonomic recommendations. [8-11].

Arias-Buría et al., [12] reported that inclusion of MTrP-DN into an exercise program resulted in greater improvements on shoulder-related disability in subjects with subacromial pain syndrome. MTrP-DN cause local twitch response that interrupt motor end-plate noise, eliciting an analgesic effect. It also relax the actin-myosin bonds in the taught band [13]. DN also stimulates Aδ and C sensory fibers which send afferent signals to the dorsolateral tracts of the spinal cord and activate the supraspinal and higher centers involved in pain processing. [14]

LLLT is safe, very much endured, available, and noninvasive procedure which reduces pain and MTrP sensitivity, improving the quality of life [15]. LLLT may reduce skin resistance, enhance circulation at the MTrPs, improve oxygenation of the hypoxic cells, increase ATP formation, normalize metabolic rate of tissues with diminished energy levels, and facilitate the removal of waste products from the MTrPs area. [16]

There is strong evidence on the effect of LLLT and DN on supraspinatus tendinitis [16-18] but no study in the literature determined which modality is more effective. So, this study was conducted to examine the hypothesis that there will be no significant difference between LLLT and DN in management of supraspinatus tendinitis.

Materials and methods

***Participants*:** Seventy-five subjects **(GPower 301 http:www.psycho.uni-duesseldorf.de)** with MTrPs associated with chronic stage 2 supraspinatus tendinitis were involved in this study. Subjects were randomly assigned into three groups; each group consisted of 25 subjects. Group (A) was the LLLT group, group (B) was the DN group, and group (C) was the control group. All subjects were assessed for ROM (flexion, abduction, internal, and external rotation) and SPADI at baseline and after treatment.

***Randomization*:**

Sealed envelope method was used in which involved subjects were given randomly generated treatment programs within sealed opaque envelopes. Once the subject has consented to participate in the trial an envelope is opened and the subject is then offered the allocated treatment program. [19]

Ethical approval:

This study was approved by the Research Ethical Committee of physical therapy college, Cairo University. No:P.T,REC/012/002949

***Inclusion* criteria:**

The ages ranged from 30 to 66 years. Referred by the orthopedic physician and diagnosed with chronic stage 2 supraspinatus tendinitis by physical examination, and MRI [20]. They were suffering from pain and restricted range of motion of shoulder joint (mainly flexion and abduction beyond 90^0) for at least 3 months [21]. They had at least two out of five of: (1) painful arc syndrome, (2) Codman's test, (3) Hawkins–Kennedy test, (4) Neer's sign, and (5) supraspinatus test [22]**.** They had at least one active MTrP in supraspinatus muscle typically in the mid-region of the supraspinous fossa characterized by pain in the lateral aspect of the shoulder that may spread distally to the lateral epicondyle and forearm. [3]

***Exclusion* criteria :**

Past history of diagnosis of shoulder girdle fracture, systemic or neurological diseases, patients who had intra-articular injection, and pain onset of less than 3 months. [8]

***Evaluation* :**

1) **Shoulder Pain and Disability Index (SPADI):**

The Shoulder Pain and Disability Index (SPADI) is a self-administered questionnaire that consists of two dimensions, one for pain and the other for functional activities. The pain dimension consists of five questions regarding the severity of an individual's pain. Functional activities are assessed with eight questions designed to measure the degree of difficulty an individual has with various activities of daily living that require upper-extremity use. The SPADI takes 5 to 10 minutes for a patient to complete and is the only reliable and valid region-specific measure for the shoulder.

Scoring instructions:

To answer the questions, patients place a mark on a 10cm visual analogue scale for each question. Verbal anchors for the pain dimension are 'no pain at all' and 'worst pain imaginable', and those for the functional activities are 'no difficulty' and 'so difficult it required help'. The scores from both dimensions are averaged to derive a total score.

Interpretation of scores

- Total pain score: (/ 50 x 100) = %
- (Note: If a person does not answer all questions divide by the total possible score, eg. if 1 question missed divide by 40)
- Total disability score: (/ 80 x 100) = %
- (Note: If a person does not answer all questions divide by the total possible score, eg. if 1 question missed divide by 70)
- Total Spadi score: (/ 130 x 100) = %
- (Note: If a person does not answer all questions divide by the total possible score, eg. if 1 question missed divide by 120)
- The means of the two subscales are averaged to produce a total score ranging from 0 (best) to 100 (worst).
- Minimum Detectable Change (90% confidence) = 13 points [23]

2) **Universal goniometer:** (made in Egypt) to measure shoulder joint ROM (abduction, flexion, external rotation, and internal rotation). (Table 1) [24]

Table 1. Goniometry for shoulder joint

Movement	Position	Axis location	Stationary arm	Movement arm
Abduction	Patient is supine with palm facing upwards and wrist in supination with arm by the patient's side	Inferior lateral coracoid process	Parallel with the trunk	In line with the mid line of the humerus
Flexion	Patient is supine with knees flexed. Palm facing medially and thumb is up with arm by the patient's side	Middle of humeral head laterally	Parallel with the trunk	In line with the mid line of the humerus
Internal and External rotation	Patient is supine with the shoulder abducted to 90 degrees and the length of the humerus on the test side is supported on the plinth. Forearm is in neutral position	Olecranon process of the ulna	Perpendicular to the floor (vertical)	in line with the ulnar side of the forearm from the axis point to the ulnar styloid process

***Interventions*:**

(A) Low Level Laser Therapy:

Subjects in sitting position, supraspinatus, upper trapezius, infraspinatus, and deltoid muscles were palpated for MTrPs [3]. Gallium arsenide laser at a wavelength of 810 nm and 583 Hz with maximum power output of 150 mW for 160 seconds so that the total energy density was 8 J/cm2 was applied to all MTrPs in each muscle. The laser device was positioned so that the patient could not see it, and both the patient and the therapist wore protective eyewear. For 5 consecutive days. [16]

(B) Dry needling:

Subjects in sitting position, supraspinatus, upper trapezius, infraspinatus, and deltoid muscles were palpated for MTrPs [3]. The muscles having MTrPs were inserted by DN. The depth of needle insertion was dependent on the muscle and ranged from 10-15 mm for infraspinatus or deltoid and 30-35mm for the supraspinatus. After the first local twitch response was obtained, the needle was moved up and down (vertical motions) 3-5mm with no rotations until no more twitch responses were elicited. The duration of MTrPs-DN was 5-10 minutes in each session. For 5 consecutive days. [14]

(C) Conventional physical therapy treatment:

It was classified as warm-up, work-out (1st-3rd phase) and cool-down.

Subjects will begin physical therapy with warm-up including stationary cycling (15 min) and standing stretching for 5 min. Stationary cycling was performed at 60% VO_{2max}.

1st workout phase involved prone horizontal abduction at 90°-100° with external rotation, prone extension with external rotation, prone horizontal abduction at 90° elbow flexion with external rotation, forward flexion, abduction, and shrug on floor at an intensity of less than 13 (somewhat difficult) on the rating of perceived exertion (RPE) scale. This stage focused on the pain reduction, the tolerance of weight bearing and the ROM improvement.

Following this, all subjects performed the 2nd work-out phase, which included internal rotation scaption, external rotation scaption, military press, internal horizontal abduction, external horizontal abduction, triceps extension, biceps curl and shoulder rowing.

Finally, the 3rd phase included horizontal abduction, straight arm press, internal rotation, external rotation and press-ups. Both phases focused on the tolerance of full weight bearing, on the passive ROM improvement and on the neuromuscular control.

The cool down after the rehabilitation program consisted of two therapeutic modalities. First, all subjects performed the static and dynamic stretching on mattress for about 20 min. Then they were managed by icing (10 min). [25]

DATA ANALYSIS

ANOVA test were conducted for comparison of age between groups. Chi-squared test was used for comparison of sex distribution between the three groups. Normal distribution of data was checked using the Shapiro-Wilk test for all variables. Levene's test for homogeneity of variances was conducted to test the homogeneity between groups. Mixed MANOVA was performed to compare within and between groups effects on shoulder ROM and SPADI. Post-hoc tests using the Bonferroni correction were carried out for subsequent multiple comparison. The level of significance for all statistical tests was set at $p < 0.05$. All statistical analysis was conducted through the statistical package for social studies (SPSS) version 25 for windows (IBM SPSS, Chicago, IL, USA).

RESULTS

- *Subject characteristics*:

Table (1) showed the subject characteristics of the group A, B and C. There was no significant difference between groups in age and sex distribution between groups ($p > 0.05$).

Table 1. Basic characteristics of participants.

	Group A	**Group B**	**Group C**	**p-value**
Age, mean ± (SD), years	40.4 ± 7.76	42.2 ± 9.25	40.84 ± 7.58	0.72
Sex, n (%)				
Females	10 (40%)	12 (48%)	11 (44%)	0.85
Males	15 (60%)	13 (52%)	14 (56%)	

SD, standard deviation; p-value, level of significance

Effect of treatment on shoulder ROM and SPADI

Mixed MANOVA revealed that there was a significant interaction of treatment and time ($F = 3.46$, $p = 0.001$). There was a significant main effect of time ($F = 311.27$, $p = 0.001$). There was no significant main effect of treatment ($F = 1.31$, $p = 0.2$). Table 2-3 showed descriptive statistics of shoulder ROM and SPADI and the significant level of comparison between groups as well as significant level of comparison between pre and poste treatment in each group.

Within group comparison

Within-group comparison revealed a significant increase in shoulder flexion, abduction, internal and external rotation and significant decrease in pain, disability and total SPADI in the three groups post treatment compared with that pre treatment ($p < 0.001$).

Between group comparison

Between group comparison pre treatment revealed a nonsignificant difference in all parameters ($p > 0.05$). There was a significant increase in flexion and abduction ROM of the group A compared with that of group C ($p < 0.001$) and a significant increase in flexion and abduction ROM of the group B compared with that of group C ($p < 0.01$). There was no significant difference in the shoulder flexion and abduction ROM between group A and B post treatment ($p > 0.05$). There was no significant difference in

internal and external rotation between the three groups post treatment ($p > 0.05$). There was a significant decrease in pain, disability and total SPADI of the group A compared with that of group C ($p < 0.001$) and a significant decrease in pain, disability and total SPADI of the group B compared with that of group C ($p < 0.001$) post treatment. There was no significant difference in pain, disability and total SPADI between group A and B post treatment ($p > 0.05$).

Table 2. ***Mean shoulder flexion, abduction, internal and external rotation ROM pre and post treatment of group A, B and C:***

	Group A	**Group B**	**Group C**	**p-value**		
	mean ± SD	**mean ± SD**	**mean ± SD**	**A vs B**	**A vs C**	**B vs C**
ROM (degrees)						
Flexion						
Pre treatment	118.36 ± 20.8	117.6 ± 21.98	119.6 ± 18.54	1	1	1
Poste treatment	166.8 ± 9.12	163.96 ± 10.7	152.76 ± 12.88	1	0.001	0.002
	p = 0.001	***p = 0.001***	***p = 0.001***			
Abduction						
Pre treatment	133.16 ± 17.83	135.24 ± 17.24	136.2 ± 14.41	1	1	1
Poste treatment	173.36 ± 5.21	171.44 ± 6.27	166.12 ± 7.71	0.89	0.001	0.01
	p = 0.001	***p = 0.001***	***p = 0.001***			
Internal rotation						
Pre treatment	76.52 ± 8.49	77.88 ± 10.6	77.4 ± 9.05	1	1	1
Poste treatment	88.2 ± 4.53	87.6 ± 5.22	86.6 ± 5.14	1	0.77	1
	p = 0.001	***p = 0.001***	***p = 0.001***			
External rotation						
Pre treatment	66.16 ± 7.91	65.28 ± 7.73	67.36 ± 6.51	1	1	0.97
Poste treatment	88 ± 3.81	86.4 ± 5.86	85.88 ± 4.85	0.76	0.39	1
	p = 0.001	***p = 0.001***	***p = 0.001***			

SD, Standard deviation; p-value, Level of significance

Table 3. ***Mean pain, disability and total SPADI pre and post treatment of group A, B and C:***

	Group A	**Group B**	**Group C**	**p-value**		
	mean ± SD	**mean ± SD**	**mean ± SD**	**A vs B**	**A vs C**	**B vs C**
Pain						
Pre treatment	67.12 ± 13.67	70.96 ± 14.8	66.28 ± 13.32	1	1	0.71
Poste treatment	20.32 ± 7.66	22.88 ± 5.92	37.9 ± 6.24	0.53	0.001	0.001
	p = 0.001	***p = 0.001***	***p = 0.001***			
Disability						
Pre treatment	43.15 ± 10.09	44.62 ± 8.92	43.94 ± 9.29	1	1	1
Poste treatment	9.15 ± 4.36	10.77 ± 4.6	20 ± 5.14	0.68	0.001	0.001
	p = 0.001	***p = 0.001***	***p = 0.001***			
Total SPADI						
Pre treatment	55.61 ± 18.77	53.26 ± 17.06	52.3 ± 16	1	1	1
Poste treatment	12.15 ± 5.77	14.28 ± 5.21	28.88 ± 6.05	0.57	0.001	0.001
	p = 0.001	***p = 0.001***	***p = 0.001***			

SD, Standard deviation; p-value, Level of significance

DISCUSSION

This study investigated the effect of LLLT versus DN on shoulder pain, disability, and range of motion (flexion, abduction, internal, and external rotation) in chronic stage 2 supraspinatus tendinitis after one week (5 consecutive days) of applying the assigned program. Records were assessed at baseline and after treatment using SPADI and Universal Goniometer.

The results obtained from this study clearly demonstrated that both LLLT and DN groups showed significant difference in shoulder pain, disability, flexion, and abduction ROM compared with control group. However there was no significant difference in internal and external rotation between the three groups.

The results of LLLT in this study can be supported by **Zafar et al., [26]** who stated that LLLT with exercise improve shoulder flexion, abduction, internal, and external rotation ROM and decrease pain and disability. They based their results on the work of **Chung et al., [27]** who reported that LLLT increase nerve conductivity and produce vasodilatation at the area of application. LLLT may reduce skin resistance, enhance circulation at the MTrPs, improve oxygenation of the hypoxic cells, increase ATP formation, normalize metabolic rate of tissues with diminished energy levels, and facilitate the removal of waste products from the MTrPs area. [16]

Investigations carried out by **Yamany et al., [28]** revealed that the application of LLLT and exercise on MTrPs in shoulder pain was more efficient than placebo laser with exercise, since there was a decrease in pain and increase in shoulder ROM. They proposed their results to the analgesic effect of LLLT that allows other therapeutic procedures to be more comfortable and facilitates shoulder relaxation, which helps in range of motion recovery.

Eslamian et al., [22] in his work in management of rotator cuff tendinitis reported that laser light generally decreases mitochondrial membrane potential and blocks axonal flow in dorsal root ganglion neurons, altering sensory input to the CNS, decreasing pain perception.

The results of DN in this study can be supported by **De Meulemeester et al., [29]** and **Maher et al., [30]** who reported changes in muscle characteristics after DN by observing significant improvement in elasticity and stiffness as eliciting local twitch response by DN may interrupt motor endplate noise and relax actin-myosin filaments in tight muscle fibers. DN also disrupts the contraction knots, stretches cytoskeletal structures, and reduces the overlap between actin and myosin filaments.

This also agrees with **Koppenhaver et al., [31]** who reported that shoulder ROM improved after DN in symptomatic shoulder with subacromial pain syndrome. This came along with the work of each of **Calvo-Lobo et al., [32]** suggesting a mechanical hypoalgesic effect of MTrPs-DN and **Jalilipanah et al., [33]** reporting that DN is more effective in improving flexion & abduction ROM than muscle energy technique in patients suffering shoulder impingement syndrome and active MTrPs of infraspinatus.

Mamta et al., [14] concluded that insertion of the needle into MTrP produces a local twitch response. By eliciting a local twitch response there is an influence of spontaneous electrical activity (SEA), reducing acetylcholine stores, leading to lesser SEA. DN also stimulates Aδ sensory afferent fibers and C fibers which send afferent signals to the dorsolateral tracts of the spinal cord and activate the supraspinal and higher centres involved in pain processing. [34]

The present study also showed statistically significant decrease in shoulder pain and disability as well as a significant increase in shoulder ROM in both LLLT and DN groups but there was

no statistically significant difference between both groups. However, LLLT may be considered as a treatment of choice. This result was supported by **Burger [35], Uemoto et al., [36], Rautenbach [37],** and **agung [38]** who explained that LLLT is non-invasive, easy to apply in contrary to DN which needs experience, there is no agitation of hyperirritated areas, and it may be the method of choice for patients with fear of needles and health professionals inexperienced with the DN technique.

CONCLUSION

Based on the findings of the current study we can conclude that both LLLT and DN are effective in treatment of patients with chronic stage 2 supraspinatus tendinitis. However, LLLT may be considered as a treatment of choice because it is non-invasive, easy to apply in contrary of DN which needs learning and practice, there is no agitation of hyperirritated areas, and it may be the method of choice for patients with fear of needles and health professionals inexperienced with the DN technique.

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