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Treatment of Myofascial Trigger Points of the Infraspinatus is Effective in Relieving Shoulder Pain and Improving Shoulder Functions

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Objective: This study aimed to investigate the effects of ischemic compression treatment (ICT) or low-level laser therapy (LLLT) applied to the trigger points of the infraspinatus muscle on shoulder pain and function in patients with shoulder pain.

Design: A randomized clinical trial

Methods: Thirty patients with shoulder pain were randomly allocated into the ICT group (n = 15) or LLLT groups (n = 15). ICT was performed on three myofascial trigger points (MTrPs) of the infraspinatus muscle twice a week for 4 weeks (eight sessions), with 5 minutes of treatment per trigger point. LLLT was performed similarly. Shoulder pain was assessed using the visual analogue scale (VAS) and pain pressure threshold (PPT), and shoulder function was assessed using the Korean Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire, rotator cuff strength, and range of motion (ROM) of shoulder flexion and abduction.

Results: Significant changes in VAS score and PPT were found after the intervention in both groups ($p < 0.05$). Significant changes were observed in the Korean DASH score, rotator cuff strength, and ROM of shoulder flexion ($p < 0.05$) but not in the ROM of shoulder abduction ($p < 0.05$). There were no significant differences between the two groups.

Conclusions: This study showed that both ICT and LLLT applied on the MTrPs of the infraspinatus muscle were effective for relieving shoulder pain and improving shoulder functions in patients with shoulder pain.

Key Words: Shoulder pain, Rotator cuff, Trigger points, Low-level light therapy

Background

As one of the muscles of the rotator cuff, the main function of the infraspinatus muscle is to externally rotate the glenohumoral joint and provide stability [1]. This muscle is easily influenced by movement involving the hands. Previous studies reported that the infraspinatus muscle shows higher muscle activity than other shoulder muscles during manual work [2]. A similar studies reported that excessive use of the hand increases pressure within a muscle in the shoulders, leading to clear changes in infraspinatus muscle activity [3, 4]. In addition, computer work that requires concentration also affects the infraspinatus muscle [5].

Infraspinatus tendon injury is common and, when coupled with subscapularis tendon injury, it may disturb the balance of anteroposterior strength of the shoulder joint [6]. An imbalance of strength alters the position of the humeral head [7, 8] and may induce secondary articular injuries, such as articular cartilage degeneration, rotator cuff tear, and injury of the long

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head of biceps [9]. Although these studies were unable to confirm the exact mechanism, they found an correlation between the infraspinatus muscle and shoulder pain.

Muscle pain seems to be related to myofascial trigger points (MTrPs) [10]. MTrPs refer to a taut band formed in a stiff muscle that induces myofascial pain, and are known to be a common cause of musculoskeletal pain [11]. The exact pathophysiology of MTrPs is as yet unclear, but the possibility of local metabolic disturbance caused by abnormal electrical activity known as endplate noise, altered muscle activities, and blood circulation disturbance has been proposed [12].

Various treatments are applied for MTrPs, as the exact etiology and healing mechanism are currently unknown [13]. Of these, ischemic compression is the most common treatment for MTrPs. This treatment decrease pain and radiating pain, improves limited range of motion (ROM), and facilitates recovery of muscle functions [14].

In addition, recent studies have applied low-level laser therapy (LLLT) to MTrPs [15]. LLLT, such as He-Ne laser and infrared laser, do not injure tissues and are utilized to treat pain of various causes.

Although relevant studies are still lacking, treatment of MTrPs is expected to be helpful for patients with shoulder pain [16-18]. In particular, treatment of MTrPs of the infraspinatus muscle is expected to have clinical efficacy for shoulder pain. Previous studies reported that MTrPs frequently occur in the infraspinatus and upper trapezius and that the infraspinatus is particularly associated with myofascial pain related to the shoulder joint [19, 20]. Another study reported that removing MTrPs in the shoulder could facilitate recovery of shoulder function and relieve pain [21].

However, most previous studies treated MTrPs of muscles related to shoulder pain instead of applying treatment based on an accurate diagnosis, so may have unintentionally affected irrelevant MTrPs [10]. Further, studies comparing ischemic compression and LLLT, which are effective on MTrPs, are also scarce.

Therefore, in this study, the effect on shoulder pain and function was investigated by applying a treatment that specifically targets the MTrP of the infraspinatus muscle without maximally affecting the MTrP of other muscles.

Moreover, we aim to propose an efficient treatment method for the shoulder by comparing the effects of ischemic compression treatment (ICT) and LLLT.

Method

Study design

A pretest-posttest two group design was used including patients who visited a hospital in Seoul between July 31, 2017 and August 26, 2017. This study registered in Clinical Research information Service (CRIS) with clinical trial registry number KCT0004576. This study was conducted after receiving approval from the Bioethics Committee of Sahmyook University (2-1040781-AB-N-01-2017063HR).

Participants

The inclusion criteria were patients 20–50 years of age who had non-traumatic shoulder pain for at least six months, had a Korea version of the Disability of the Arm, Shoulder and Hand (K-DASH) score of 15 or higher, had trigger points in the infraspinatus muscle, and had both shoulder pain and reduced range of motion (ROM) [22, 23].

The exclusion criteria were history of shoulder surgery or severe shoulder trauma, referred pain in the shoulder due to a heart disease, mental disease, radiculopathy, or neuropathy [23].

Sample size

The sample size required for the purpose of this study was calculated using the G*Power program(3.1.9.2, University of Kiel, Germany). Significance level was set at 0.05 and power 0.8. The mean treatment effect size of 1.06 on cervical spine ROM was applied to our study with reference to the study by Ravichandran et al. (2016). Considering a 10% dropout rate, 34 participants were recruited [24].

Randomization

Assignment of randomized was simple randomization method. Of the 34 participants, two persons were excluded according to the inclusion criteria of subject, and two persons were excluded due to personal circumstances (moved and absence). The physical therapist involved in this study allocated randomly eligible 30 participants into the ICT group and LLLT group using on excel program. Randomized patients received ICT and LLLT respectively during the study period according to the intervention they were allocated. Patients were blinded to treatment allocation.

Study procedure

The participants were divided into an ICT group and LLLT group, and the interventions were conducted twice a week for 4 weeks and 15 minutes per session from July 31, 2017 to August 26, 2017.

The subjects who participated in the experiment were assessed prior to the study visual analogue scale (VAS), pressure-pain threshold (PPT), and K-DASH scores. A physical therapist with at least five years of clinical experience who thoroughly understood the overall study procedure and had experience ischemic compression treatment in the past administered the ischemic compression treatment and LLLT.

Interventions

Ischemic compression treatment (ICT)

Trigger points were identified using the palpation technique. Startling, involuntary muscle contraction due to tenderness, and radiating pain when the therapist applied pressure with the thumb were considered positive responses.

With the participant prone position, the therapist first lightly pressed on the trigger points of the infraspinatus muscle. Then, the pressure was increased to a level eliciting endurable pain and maintained for 30 seconds followed by a 30-second rest. The treatment was applied for five repetitions lasting five minutes for each of the trigger points 1, 2, and 3 of the infraspinatus, for a total of 15 minutes (Figure 1) [22].

Low Level Laser treatment (LLLT)

The low-level laser (STL-101, Stratek, Korea) used in this study was a diode laser with a 650 nm wavelength and 50 mW power. With the participant lying comfortably on the stomach, the low-level laser was applied for five minutes to each of the trigger points 1, 2, and 3 of the infraspinatus, for a total of 15 minutes. The diameter of the laser was adjusted to 0.5 cm [25].

Outcome measure

Shoulder pain was measured using VAS and PPT. Shoulder functions were measured based on ROM, K-DASH, and rotator cuff strength.

Pain

Pain was assessed using VAS and PPT. PPT was measured with an algometer (12-1440, Fabrication enterprises, USA). With the participant seated comfortably, the examiner identified the participant's trigger point in the infraspinatus muscle and applied pressure with the algometer perpendicular to the skin surface until the participant made an "Ah" sound. Three measurements were taken and the mean was used for analysis [26]. Interrater reliability is intraclass correlation coefficient (ICC)=0.79−0.90 [27].

Function

Active ROM of the shoulder joint was measured using a goniometer (12-1028HR, HiRes, USA). In the

Figure 1. Infraspinatus trigger point

present study, shoulder movements frequently used in daily living (shoulder flexion, abduction), as opposed to the functional movements of the infraspinatus muscle, were measured. Flexion and abduction were measured with the participant in a standing position. Three measurements were taken and the mean was used for analysis. Intertester reliability is r=0.98, ICC =0.99 [27].

The K-DASH was used to assess the ability to perform activities. The K-DASH questionnaire consists of 38 items, with 30 items related to the disability/symptom, four items related to work, and four items related to sport/art activities. In the present study, only the disability/symptom scale was used. Reliability The Cronbach's alpha of is 0.89 [28].

Finally, rotator cuff strength was measured using a portable dynamometer (EH101, TNI Commerce, China). With the participant sitting down, hand grip strength was measured three times in 90º abduction and 90º external rotation and the mean was used for analysis (Figure 2) [29]. The correlation between grip strength and shoulder lateral rotation strength ranged between r=0.91 and r=0.72 [29].

Analysis

All work and statistical analyses in the present study were performed using SPSS ver. 21.0 (IBM, Washington, USA). The kolmogorov-Smirnov test was performed for the study population to test for normality assumption and all variables were normally distributed. Intergroup differences were analyzed with independent t-tests. Differences after treatment were analyzed with paired t-tests. For withdrawn participants, intention to treat (ITT) was measured using the last observation carried forward (LOCF) method, where the values observed immediately prior to withdrawal were used as the final values. Statistical significance was set at 0.05 for all data.

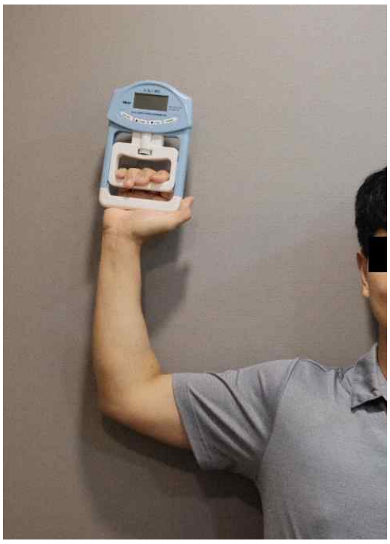

Figure 2. Rotator cuff strength measurement

Results

General characteristics and homogeneity testing

Both the ICT and LLLT groups were found to be homogeneous in terms of general characteristics. A total of 30 individuals participated in this study, with 15 in the ICT group and 15 in the LLLT group. The mean age was 36.49 years in the ICT group and 32.60 years in the LLLT group, with no significant differences between the two groups. The mean height was 166.26 cm in the ICT group and 168.00 cm in the LLLT group and the mean body weight was 63.06 kg in the ICT group and 65.47 kg in the LLLT group, showing no significant differences in height or body weight between the two groups (Table 1).

Changes in pain in the ICT and LLLT groups

Pain was measured using the VAS and PPT. In the ICT group, VAS significantly decreased by 2.73 from 5.53 before treatment to 2.8 after treatment ($p<0.05$), while PPT significantly increased by 0.31 kg from 3.84 kg before treatment to 4.15 kg after treatment ($p<0.05$). In the LLLT group, VAS significantly decreased by 2.20 from 5.67 before treatment to 3.47 after treatment ($p<0.05$), while PPT significantly increased by 0.25 kg from 3.89 before treatment to 4.14 kg after treatment ($p<0.05$). There were statistically no significant differences in pain after treatment between the two groups (Table 2).

Changes in shoulder pain in the ICT and LLLT groups

Shoulder function was assessed based on shoulder ROM, K-DASH, and rotator cuff strength. In the ICT group, shoulder flexion significantly increased by 2.27°

Table 1. Participants' general characteristics (n=30)

Parameter	ICT (n =15)	LLLT (n =15)	*p*
Gender (male/female)	5/10	7/8	
Age (years)	36.49 (9.66)	32.60 (6.33)	0.213
Height (cm)	166.26 (8.11)	168.00 (5.35)	0.496
Body weight (kg)	63.06 (11.74)	65.47 (9.23)	0.539
K-DASH (score)	31.41(8.56)	33.00 (10.645)	0.66

The values are presented mean (SD)
ICT: ischemic compression treatment, LLLT: Low level laser treatment, K-DASH: Korea version of the Disability of the Arm, Shoulder and Hand

Table 2. Changes in shoulder pain and function after ischemic compression therapy and low level laser therapy (n=30)

	ICT (n=15)				LLLT (n=15)			
	Pre	Post	Change	ES [CI]	Pre	Post	Change	ES [CI]
Pain								
VAS	5.53 (1.06)	2.80 (0.94)	2.73 (1.27)*	2.54 [2.0～3.44]	5.53 (0.92)	3.33 (0.72)	2.20 (1.14)*	2.66 [1.56～2.83]
PPT	3.84 (0.57)	4.17 (0.47)	0.30 (0.41)*	0.63 [−0.53～−0.07]	3.89 (0.61)	4.14 (0.75)	0.25 (0.29)*	0.36 [−0.900~−3.32]
Function								
Shoulder ROM								
flexion	168.33 (3.37)	170.60 (4.11)	2.26 (3.69)*	0.60 [−4.311～−0.22]	167.80 (3.27)	169.93 (4.39)	2.13 (3.18)*	0.55 [−0.37～−2.59]
abduction	163.13 (5.46)	164.73 (4.78)	1.60 (3.22)*	0.31 [−3.38～0.18]	164.00 (4.76)	165.07 (2.68)	1.07 (3.97)*	0.27 [−3.266～1.13]
K-DASH	31.41 (8.56)	22.54 (7.55)	8.86 (5.93)*	1.09 [5.57～12.15]	33.01 (10.64)	26.72 (9.84)	6.29 (2.78)*	0.61 [7.82～8.75]
Strength	27.05 (5.97)	28.24 (5.87)	1.18 (1.64)*	0.20 [−2.09～−0.27]	29.27 (4.39)	30.65 (4.91)	1.38 (0.75)*	0.29 [−2.43～−0.34]

The values are presented mean (SD)
ICT: ischemic compression treatment, LLLT: Low level laser treatment, ES: effect size(cohen's d, CI: confidence interval, VAS: visual analog scale, PPT: pain pressure threshold, ROM: Range of motion, K-DASH: Korea version of the Disability of the Arm, Shoulder and Hand
* $p < 0.05$

from 168.33˚ before treatment to 170.60˚ after treatment ($p < 0.05$), and shoulder abduction increased by 1.60˚ from 163.13˚ before treatment to 164.73˚ after treatment, though statistically insignificant. The K-DASH score significantly decreased by 8.87 from 31.41 before treatment to 22.54 after treatment ($p < 0.05$), and rotator cuff strength significantly increased by 1.17 kg from 27.07 kg before treatment to 28.24 kg after treatment ($p < 0.05$).

In the LLLT group, shoulder flexion significantly increased by 1.53˚ from 167.80˚ before treatment to 169.93˚ after treatment ($p < 0.05$), and shoulder abduction increased by 1.07˚ from 164.00˚ before treatment to 165.07˚ after treatment, though statistically insignificant.

The K-DASH score significantly decreased by 6.29 from 33.01 before treatment to 26.72 after treatment ($p < 0.05$), and rotator cuff strength significantly increased by 1.37 kg from 29.28 kg before treatment to 30.65 kg after treatment ($p < 0.05$). There were no statistically significant differences in shoulder functions after treatment between the two groups (Table 2).

Discussion

Although there are only a few reliable tests for shoulder pain, it is determined in association with the subacromial bursa, rotator cuff tendon, and tendon of the long head of biceps muscle, which are the anatomical structures of the subacromial space [30-32]. This assumption does not take into account the fact that muscle tissue may induce pain in the shoulder area [33].

A recent study on the referral of muscle pain is based on the fact that the synaptic connection of central dorsal horn neurons may be altered as a result of nociceptive input. Dorsal horn neurons have an effective and ineffective synaptic connection including afferent neurons. An effective synapse accepts information regarding trigger points and forms an existing receptive field. Local pain is moderated through this pathway. An ineffective synapse fires an insufficient potential to induce a response in the dorsal horn neuron. However, when an ineffective synapse is placed in a pathological environment, neurons stimulated by nociceptive input create a new receptive field and it is converted into an effective synapse, a process known as central sensitization. When a new receptive field emerges, non-nociceptive input in a location other than the existing location of pain can be felt as pain [34].

Trigger points of the rotator cuff may provoke local referral pain deep in the shoulder joints. As a result, shoulder pain caused by trigger points may be misunderstood as subarcomial buritis or tendinitis, and consequent inflammation-related treatment may diminish the efficacy of treatment [22]. Therefore, direct treatment of MTrPs of the infraspinatus muscle can be an alternative for shoulder pain.

The ICT applied in this study reduced VAS by 49.36% and improved PPT by 8.07%. LLLT reduced VAS for shoulder pain by 38.80% and improved PPT by 6.42%. These results suggest that both treatments alleviate shoulder pain.

A study that applied manual therapy, passive muscle stretching, and cold compresses while stretching to trigger points in the shoulder muscles significantly improved VAS and K-DASH scores and decreased the number of active trigger points [22]. A study applying LLLT to the trigger point of the masseter and temporalis reported that it was effective in reducing jaw joint pain [35]. Although the type of treatment used and muscle involved differed between our study and previous studies, one similarity is that the studies aimed to identify pain by treating trigger points.

Although the exact mechanism underlying the pain-reducing effects observed in this study is yet unclear, it can be understood through various hypotheses. A recent study reported that pain mechanism is related to glial cells. Microglia and astrocytes have been reported to be activated by peripheral pathological changes, including inflammation [36]. Data on whether trigger points generally impact glial cells are scarce. However, because pain receptors activate glial cells, pain receptors in trigger points may have an impact on glial cells [37]. During an ICT, compression induces a momentary ischemic state in the trigger points and once the compression is removed, reactive hyperemia occurs, in which increased blood flow to the muscle fibers facilitates circulation [38]. LLLT controls microcirculation and increases oxygen supply to the trigger points, thereby normalizing the metabolic rate of tissues [39]. The enhanced blood circulation as a result of these treatments is speculated to impact the pain receptors in the trigger points by reducing inflammation in the body and thus affecting glial cells.

In the present study, we assessed shoulder ROM (flexion, abduction), K-DASH, and rotator cuff strength to evaluate shoulder function. ICT increased the range of shoulder flexion by 1.34% and shoulder abduction by 0.98%, decreased K-DASH score by 28.23%, and improved rotator cuff strength by 4.39%. LLLT increased the range of shoulder flexion by 1.26% and shoulder abduction by 0.65%, decreased K-DASH score by 19.05%, and improved rotator cuff strength by 4.71%. These results show that all shoulder functions, with the exception of range of abduction, were improved. However, both ICT and LLLT seem to have clinical effects on the range of shoulder abduction, though the effect sizes are small, at 0.31 for ICT and 0.27 for LLLT.

Prior studies applied sham compression and ICT on trigger points of the supraspinatus, infraspinatus, deltoid, and biceps brachii muscles, which led to significant improvements in shoulder pain and dysfunction index (SPADI) [21]. A study of the application of LLLT to trigger points around the neck in patients with chronic neck pain reported significant changes in the Neck Pain and Disability Scale (NPAD) and McGill Pain Questionnaire (MPQ) for therapeutic effect[40]. The present study also confirmed improvements in shoulder functions after MTrP treatment, but our study differs in that shoulder function was assessed after treatment of MTrPs in a single muscle.

Subacromial pain reduces voluntary activity of the infraspinatus muscle and external rotation of the shoulder joint. Inhibition of the infraspinatus muscle by subacromial pain may lead to abnormal glenohumeral joint motion and translation [41]. As a result, normal muscle activation patterns may be affected, which may result in muscle weakening and motor disabilities [42] as well as reduced ROM. A another studies reported that passive stretching and dry needling to reduce MTrPs led to normalized motor activation pattern within 20–30 minutes [43].

In the present study, treatment of MTrPs of the infraspinatus muscle is believed to have improved external rotation and normalized shoulder joint movement. In the long term, normal motor activation patterns appeared, which seems to have increased rotator cuff strength. However, these speculations are based on previous findings, so additional studies are needed to establish a theoretical mechanism.

Because there were no differences between the two groups in our study, we compared their effect sizes as well. ICT had greater effect sizes than those of LLLT, with the exception of effect sizes for VAS and rotator cuff strength. This suggests that both treatments were helpful for mitigating pain and improving shoulder function in patients with shoulder pain. Therefore, selective treatment of MTrPs of the infraspinatus muscle is effective, and ICT and LLLT could be clinically effective when used appropriately according to patient characteristics.

This study has a few limitations. First, the sample size was not sufficient to generalize the study findings. Second, the infraspinatus muscle is not the only muscle that can provoke shoulder pain and limit shoulder functions. Third, we examined the ROM of shoulder movements that are frequently used in daily life (flexion, abduction), so we could not determine external rotation, the major function of the infraspinatus muscle. Finally, due to a lack of a control group, we could not examine changes in the variables over time. Subsequent studies should address these limitations for further comparisons.

Conclusion

This study showed that ICT and LLLT were both effective on MTrPs of the infraspinatus muscle in patients with shoulder pain but could not discriminate which of the two treatments is more effective. With more diverse studies on the trigger points related to shoulder pain in the future, these treatments could be proposed as effective clinical treatments for patients with shoulder pain.

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None.

Conflict of interests

The authors declare that they have no competing interests

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