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The Effectiveness of Selective Lower Trapezius Strengthening Exercises on Pain, Muscle Function, and Scapular Position in Patients with Rounded Shoulder and Chronic Neck Pain

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Objective: This study compared pain, muscle power (MP), muscle thickness (MT), and normalized position of the scapula (POS) between general physical therapy and general physical therapy with strengthening exercises of the lower trapezius in patients with rounded shoulder and chronic neck pain.

Design: Randomized controlled trial.

Methods: The participants were 30 patients of W hospital in Gangnamgu, Seoul, with rounded shoulders who were diagnosed with chronic neck pain. Rounded shoulder was defined as a distance between the surface and acromion of >1 inch in the supine position. The participants were assigned to an experimental group ($n=15$) and a control group ($n=15$). The experimental group completed four types of strengthening exercises program for 15 minutes, twice weekly, for a total of 5 weeks. Soft tissue mobilization (STM), cervical extension flexion rotation (CEFR), and physical modality were also performed in both groups.

Results: The degree of pain was assessed using the numerical rating scale (NRS), MP was measured a handheld dynamometer, MT was measured by ultrasound, and POS was measured using a tapeline. Significant between-group differences were observed in VAS, MP, MP, and POS. Significant changes were observed in the experimental group for VAS, MP, MT, and POS.

Conclusions: Based on the results of this study, it was indicated that lower trapezius strengthening exercises performed together with general physical therapy was significantly improved in pain, MP, MT, and POS in patients with rounded shoulder and chronic neck pain compared to when general physical therapy was performed alone.

Key Words: Neck pain, Scapula, Strengthtraining, Trapezius

Introduction

In contemporary society, the incidence of chronic cervical pain is increasing, with pain in the head-neck area common musculoskeletal disorders in adults [1,2]. About 67% of the total population experience neck pain at least once in their lifetime, and when it becomes chronic, it is emerging as a serious problem that affects the quality of life [3].

Recently, work-related cervical pain has been increasing, especially in workers with high computer usage [4]. Sitting for long periods makes it difficult to maintain proper body alignment due to muscle weakness in the lower back muscles, resulting in a habitually bent posture and rounded shoulder posture (RSP) [5]. Calibration of the scapula in patients with neck pain and an abnormal scapular position effectively changed the activity of the three parts of the trapezius to close to that in an unaffected

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person [6]. Hwang and Mun [7] reported that the treatment of neck pain and disability affected shoulder pain and disability. Thus, neck pain and RSP are closely related.

There are various causes of RSP, although shortening of the pectoral muscle is a major factor [8]. Treatment for this condition is an important factor in the rehabilitation of shoulder impingement and RSP, and soft tissue mobilization is proposed as a treatment for restoring the length of the pectoral muscle [9,10]. In addition, to increase muscle strength and motion affected by RSP, the lowertrapezius and serratus anterior muscles should be strengthened [11]. According to previous study, muscle imbalance in the scapulothoracic occurred when the upper fiber of trapezius muscle was shortened and lower trapezius muscles was weakened, and exercises to improve the ratio of lower trapezius muscle strength to upper fiber of trapezius muscle reduced muscle imbalance and improved scapulothoracic posture [12]. Cools et al. [12] described a method for selectively modifying weakened muscles, including the scapula, to control muscle imbalance. Mottram et al. [13] proposed an orthodontic movement of the scapula that emphasized lower trapezius muscle in patients with abnormal positional shifts of the scapula. Previous studies have suggested that decreased lower trapezius muscle strength leads to postural changes and loss of scapula control, which are related to neck pain. However, However, randomized controlled trial studies that selectively train lower trapezius for patients with RSP and chronic neck pain are lacking.

This study investigated the effects of a general physiotherapy intervention combined with exercises to strengthen the lower trapezius muscles on pain, muscle strength, muscle thickness, and scapular position in patients with RSP and chronic neck pain.

Methods

Participants

This study included 30 outpatients at W Hospital in Gangnam-gu, Seoul, Korea. The sample size was calculated by the G-Power software (version 3.0.1; Franz Faul, University of Kiel, Kiel, German). Based on the previous study, the effect size was set to 1.1, the power was set to 0.8, the alpha error was set to 0.05, and a minimum sample size of 30 people was calculated [14]. In this study, 30 participants were recruited, and each group was randomly assigned to 15 experimental group and 15 control group using a random number function in Excel program.

The selection criteria of the study were patients diagnosed with neck pain and with RSP, with a distance from the floor to the posterior surface of the protrusion of the apex of 2.5 cm or more [14], age 20–55 years, numeric rating scale (NRS) of 5 or greater [15], and treatment for cervical pain for at least 3 months. The exclusion criteria were: patients with shoulder joint pain, shoulder surgery, history of spinal surgery, neurological symptoms, and heart disease. The study was approved by the institutional review board of the University of Sahmyook (2-1040781-AB-N-01-2016040HR). All participants provided written informed consent.

Procedures

The 30 participants were randomly assigned to two groups: 15 people belonged to the experimental group and received lower trapezius strengthening and 15 people belonged to the control group and received general physical therapy (Figure 1). Pain, muscle strength, muscle thickness, and scapular position were measured before the intervention. Both groups received intervention twice a week, 5 weeks. The experimental group performed 45 minutes of general physical therapy and 15 minutes oflower trapezius strengthening exercises for a total of 60 minutes. The control group performed general physical therapy for 45 minutes.

Intervention

Lower trapezius strengthening exercise

Based on previous studies, we performed four types of postures in which the lower trapezius muscle was the most activated [16]. The latissimus pull-down exercise was performed by pulling the legs apart to shoulder-width, holding the bar fixed at 90° to the elbow, and pulling it downward (Figure 2). The prone V-raise flexed the shoulder by 180° in the prone position; with the thumb abducted 150°, it was raised upward toward the ceiling (Figure 3). In the prone row,

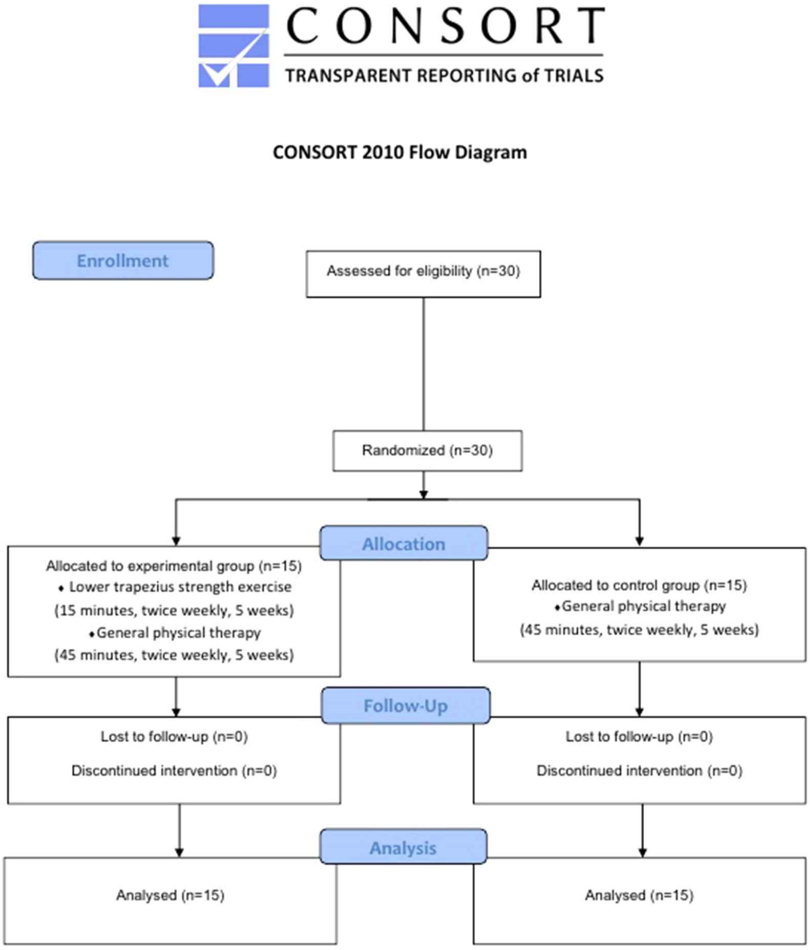

Figure 1. CONSORT Flow chart

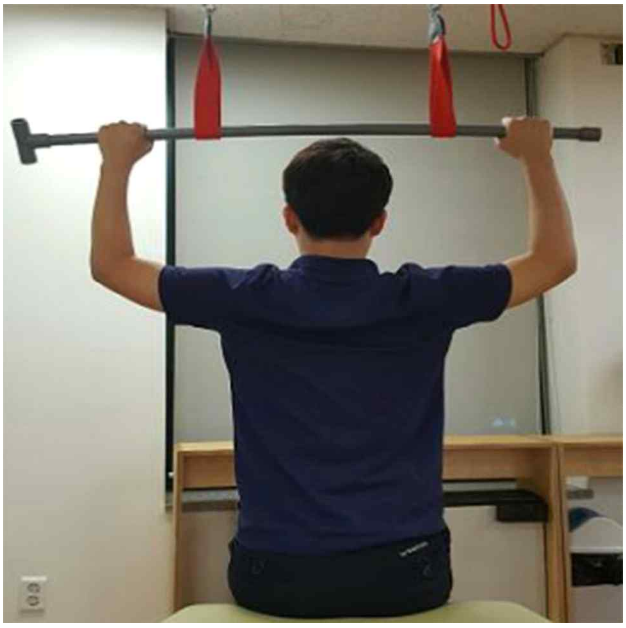

Figure 2. Latissimus pull down

Figure 3. Prone V-raise

Figure 4. Prone row

Figure 5. Modified prone cobra

the subject was placed in a neutral position with his shoulders in a prone position, flexed 90° on both elbows, and placed beside the torso. The patient then lifted the elbow as far as possible upward toward the sky (Figure 4). The modified prone cobra was performed on the therapeutic couch, with the arms are next to each other. The thumb was moved upward to start the exercise (Figure 5). The chest was raised 10 cm from the floor by tightening the scapula back and bottom. The position was held for 10 seconds before rest.

In the first week, three sets of 10 repetitions of bare-handed exercises were performed. In the second week, three sets of 10 repetitions of each exercise were performed using a yellow Thera-Band. In the third week, three sets of 15 repetitions were performed using the yellow and red Thera-Bands according to participants strength level. In the 4th and 5th weeks, the participants performed three to five sets of 15 repetitions using the yellow and red Thera-Bands according to their physical strength. The band color was set to the extent of feeling fatigue by pulling the band with the same motion using 12-15 of the rating scales of perceived exertion 20-point scale [17]. Break intervals of 30 seconds to 1 minute for each set.

General physical therapy

1) Pectoralis minor soft tissue mobilization

Soft tissue mobilization was performed perpendicular to the pectoralis minor muscles with the therapist's fingers. The therapist performed the exercises for 3 min with sufficient force [5,14].

2) Cervical extension flexion rotation

The cervical extension flexion rotation exercise is a method of improving the performance of the cervical flexor and extensor muscles in the posture of a four-posture device. The patient was kept in the posture for 10 s without pain and the exercise was repeated 10 times. The exercise was stopped if pain was felt [10,18].

3) Interference current therapy

Interference current therapy was applied to the site of pain for 15 minutes.

Outcome measure

1) Numerical rating scale (NRS)

A 10-point NRS was used to assess the neck pain level of the participants.The NRS has excellent reliability (ICC = 0.95) and is a pain scale widely used in clinical practice [19].

2) Measurement of the muscle power of lower trapezius

The muscle power was measured using an electronic handheld dynamometer (MicroFET2, HogganScientific, USA). The participants were flexed at 45°in the hip, 90°in the knee, flexed and abducted in the shoulder at 160°, as measured using a goniometer. The elbow was completely flat and the muscular system was in contact with the distal forearm and proximal wrist. After pressing for 3 s, the participants were instructed to contrast the muscles as much as possible for 10 seconds and then relax [20]. The average of three measurements was used.

Reliability values (ICCs) for measuring muscle power ranged from 0.85 to 0.96 [21].

3) Measurement of muscle thickness of lower trapezius

B-mode ultrasonography (MYSONO U5, Samsung Medicine, Korea) was used to measure the thickness of the lower trapezius muscle at the 8th thoracic vertebra. The participants placed their arms next to their body with their palms facing upwards in a prone position, and placed a pillow on their abdomen to reduce lordosis of the lumbar spine [22]. Then the probe was placed horizontally in the middle of the spinous process and moved 2 cm transversely to measure the lower trapezius [22,23]. Three measurements were performed to obtain an average value [23]. ICCs for intra-rater reliability for trapezius thickness measurements ranged from 0.990 to 0.999 [24].

4) Measurement of the position of scapula

The position of the scapula was measured from the 8th thoracic spinous process to the scapular inferior angle. The patient was instructed to stand and the tape was attached. The scapula inferior angle and the eighth thoracic vertebra were marked with a pen and the distance between the two marks was measured using a tapeline [25]. Gibson et al. [25] reported that the intratester reliability of this method ranged from good to high (ICCs = 0.81 − 0.95).

Statistical analysis

All statistical analyses were performed using SPSS (version 19.0, SPSS Inc., USA). The mean and standard deviations were calculated. Shapiro-Wilk tests were used to confirm the normality of the participants' general characteristics and variables. Independent t-tests and chi-square tests were used to test the homogeneity between groups. The changes in dependent variables before and after training were analyzed using paired t-tests. Independent t-tests were used to compare the effects between the groups. Statistical significance was set at $p < 0.05$.

Results

The measurements data for30participants were analyzed. The demographic characteristics of the participants are presented in Table 1.

The NRS of experimental group showed significant improvement, from 6.73 points to 2.45 points ($p < 0.01$). The control group showed a significant improvement from 6.93 points to 3.73 points ($p < 0.01$). In addition,

Table 1. General subject characteristics (N = 30)

	Experimental group (n=15)	Control group(n=15)	X^2/t(p)
Sex (male/female)	8/7	7/8	0.133 (0.715)
Age (year)	37.00 (9.54)	28.13 (10.23)	−0.341 (0.756)
Height (cm)	168.53 (8.69)	169.53 (8.94)	−0.311 (0.758)
Weight (kg)	64.73 (11.77)	65.80 (11.03)	−0.256 (0.800)
BMI	22.74 (2.96)	22.78 (2.50)	−0.037 (0.971)

Values are presented as number or mean (standard deviation).
BMI: body mass index, NRS = numeric rating scale.

there was a statistically significant improvement in the comparison between the two groups ($p<0.01$)(Table 2).

The muscle power of the lower trapezius muscle significantly increased from 2.05 kg to 2.92 kg ($p<0.01$). The control group also showed a mean difference of 0.03 kg, but there was no statistically significant change. There was a statistically significant difference between the two groups in the mean difference in muscle power($p<0.01$)(Table 3).

The lower trapezius muscle thickness improved significantly in the experimental group from 2.1 mm to 2.2 mm ($p<0.05$). In the control group, an improvement in muscle thickness was observed, howeverthe difference in the mean was not significant(Table 3).

The experimental group showed a significant improvement in position of scapular from 10.13 cm to 9.49 cm ($p<0.01$). The control group showed a significant improvement from 10.33 cm to 10.15 cm ($p<0.05$). In the mean comparison between the two group showed a more significant improvement ($p<0.05$) (Table 4).

Table 2. Comparisons of pain (N=30)

	Experimental group (n=15)	Control group (n=15)	t(p)
NRS (score)			
Pre-test	6.73 (0.88)	6.93 (0.80)	
Post-test	2.47 (0.83)	3.73 (1.10)	
Change	4.26 (0.96)	3.20 (0.83)	3.450 (0.002)††
t(p)	17.193 (0.001)**	13.169 (0.001)**	

Values are presented as mean (standard deviation).
NRS: numeric rating scale.
Between the group (†p<0.05, ††p<0.01), With in the group(*p<0.05, **p<0.01)

Table 3. Comparisons of muscle power and thickness (N=30)

	Experimental group (n=15)	Control group (n=15)	t(p)
Muscle power (kg)			
Pre-test	2.05 (1.07)	2.27 (1.31)	
Post-test	2.92 (1.12)	2.30 (1.35)	
Change	0.87 (0.45)	0.03 (0.18)	6.72 (0.001)††
t(p)	−7.542 (0.001)**	−0.717 (0.485)	
Muscle thickness (mm)			
Pre-test	2.10 (0.40)	2.00 (0.40)	
Post-test	2.20 (0.50)	2.10 (0.40)	
Change	0.1 (0.1)	0.1 (0.0)	2.197 (0.036)†
t(p)	−3.371 (0.005)**	−1.581 (0.136)	

Values are presented as mean (standard deviation).
Between the group (†p<0.05, ††p<0.01), With in the group(*p<0.05, **p<0.01)

Table 4. Comparisons of scapular position (N=30)

	Experimental group (n=15)	Control group (n=15)	t(p)
Position of scapular (cm)			
Pre-test	10.13 (1.26)	10.33 (1.81)	
Post-test	9.49 (0.94)	10.15 (1.85)	
Change	0.64 (0.36)	0.18 (0.25)	3.513 (0.002)††
t(p)	4.663 (0.001)**	2.806 (0.014)*	

Values are presented as mean (standard deviation).
Between the group (†p<0.05, ††p<0.01), With in the group (*p<0.05, **p<0.01)

Discussion

This study investigated the results of a 5weeks intervention in 30 patients with chronic round neck pain and RSP who were randomized to either a control group that received generalized physical therapy only or an experimental group was additionally received strengthening exercises of the lower trapezius. Pain, muscle strength, muscle thickness, and scapular position were measured and compared. The pain and scapular position significantly decreased after the intervention in both groups, with asignificant improvement in the experimental group compared to the control group ($p<0.05$). The muscle power and thickness of the lower trapezius increased significantly after the intervention only in the experimental group, with no significant difference between the control groups. Petersen and Wyatt [26] measured the lower fiber of trapezius muscle strength in individuals with unilateral neck pain and compared muscle strength of the contralateral trapezius, and the ipsilateral muscle strength was reported to be significantly lower by an average of 3.9 N. However, no study has assessed intervention methods to improve muscle power of the lower fiber of trapezius muscle in patients with RSP and neck pain. The present study performed four strengthening exercises; namely, latissimus pull-down, prone raise, modified prone cobra and prone row. Arlotta et al. [16] performed a comparative analysis of the posture of the lower trapezius according to the exercise method. According to these results, we performed the most effective lower limb muscle-strengthening exercises. Both experimental and control groups performed soft tissue mobilization of the pectoral minor muscles and rangeofmotion exercises of the neck. We concluded that the addition of the lower trapezius strengthening exercise to general physical therapy more effectively reduced pain and increased physical function. The results of the present study showed a significant difference in pain level between the experimental and control groups attributed to the lower trapezius strengthening exercises.

We also observed significant differences between the two groups. Ferrari and Monticone [27] investigated the effects of a combined rehabilitation program on pain and dysfunction by applying a chronic rehabilitation program in dental hygienists with chronic pain and upper extremity disease. They reported improved pain and neck disorder indices. The results of present study showed that the therapeutic exercise program was effective for reduced pain and increasing range of motion in patients with chronic cervical pain and that strengthening exercises of the lower trapezius muscles was more effective for pain by stabilizing the scapulothoracic muscles. The selective strengthening exercise of the lower trapezius showed significant improvement in muscle strength and thickness compared to that in the control group. Petersen and Wyatt [26] reported that the trapezius muscle strength on the side with neck pain was weaker than on the other side. thus, demonstrating muscle weakness of the lower trapezius muscles in patients with cervical pain. Muscle strengthening exercises increase muscle size or nervous system activation. Muscle hypertrophy increases myofibrils and increases muscle strength due to increased total protein and myosin filaments [28]. The results showed significantly increased lower trapezius strength and thickness, supporting previous study findings. Although the upper and middle trapezius muscles were excluded in this study, further studies are needed to perform comparative analyses of the upper, middle, and lower trapezius muscles. Studies are also needed to compare and analyze the postures that are most effective for muscle function in various strengthening exercises using rehabilitation ultrasound. In this study, the scapular position significantly decreased after the intervention in the experimental group ($p<0.01$). The control group showed a statistically significant decrease ($p<0.05$), and the comparison of the average difference between the two groups showed that the experimental group significantly improved ($p<0.01$). An et al. [29] reportedon effectiveness of scapular stabilization exercises on scapula location in patients with upper extremity lymphoma. They observed significant improvements in scapula and pectoralis major indexes but not the distance between the thoracic spine 8 and the scapular inferior angle before and after the exercise. The results of this study showed that weakness of leg muscles and shoulder joint adduction due to adhesion of the lower thoracic occurred because these muscles were not specifically strengthened. However, the positioning of the scapula has not been confirmed by measuring asymmetry on only one side. Additional studies are needed to investigate scapular asymmetry by measuring the lower trapezius on the affected side. This study performed strength training through selective resistance exercises based on previous studies, which added soft tissue mobilization of the pectoralis minor to improve the scapular position. The limitations of this study included the enrollment only of patients who visited a specialized hospital in Gangnam-gu, Seoul. There was also a limit to the generalization of the number of participants. Follow-up studies should investigate the effect of various strengthening exercises on cervical pain, muscular strength, muscle thickness, scapular position, and radiographic image in patients with RSP.

Conclusion

The results of this study showed that strengthening exercises of the lower trapezius in addition to general physical therapy significantly improved the pain, muscle strength, muscle thickness, and scapular position in patients with chronic neck pain and rounded shoulders. Therefore, it is considered that it is necessary to perform the lower trapezius strengthening exercise together with general physical therapy for chronic neck pain patients with round shoulders rather than applying only general physical therapy.

Conflict of Interest

The authors declare that they have no competing financial interests or personal relationships that could influence the work reported in this paper.

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