



Original Article

Effects of scapular stabilization exercise on neck posture and muscle activation in individuals with neck pain and forward head posture

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Abstract. [Purpose] The purpose of this study was to investigate the effects of scapular stabilization exercise on neck posture, muscle activity, pain, and quality of life in individuals with neck pain and forward head posture. [Subjects and Methods] Fifteen participants were recruited according to the selection criteria and were randomly allocated to the scapular stabilization group (n=8) and the control group (n=7). The scapular stabilization group underwent training for 30 minutes a day, 3 times a week for 4 weeks; the control group performed relaxation exercises for 4 weeks. [Results] After training the scapular stabilization group showed significant improvement on the craniocervical angle, upper trapezius muscle activity, serratus anterior muscle activity, Neck Disability Index scores, Visual Analog Scale scores, and World Health Organization Quality of Life Assessment-BREF scores compared to those in the control group. [Conclusion] Scapular stabilization exercise can help improve the head posture and pain in the patients with neck pain and forward head posture. Controlling the muscular activities through scapular stabilization exercise also improves the patients' quality of life.

Key words: Forward head posture, Neck pain, Scapular stabilization exercise

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INTRODUCTION

Neck pain is one of the most common musculoskeletal disorders, next to back pain. Many people seek medical centers for the treatment at least once in their lifetime¹⁾. Individuals with chronic neck pain have altered postural behaviors due to the tasks that require prolonged sitting such as computer-based work, paper work in the office, or industry-related tasks. Most of the patients with neck pain spend all day in sitting position. Continuous neck pain has the potential to change the biomechanics of the cervical spine²⁾.

Forward head posture frequently appears in the patients with neck disorders. Approximately 60% of the neck pain patients are reported to have forward head posture. Continuous forward head posture increases the load on the posterior cervical structures such as bones, ligaments, joint capsules, and muscles, and changes scapular kinematics and kinetics³⁾. Previous studies have shown that forward head posture leads to shortening of the posterior neck extensors, tightening of the anterior neck and shoulder muscles, and affects scapular position and kinematics⁴⁾. Serratus anterior and upper trapezius muscles are the primary stabilizers of the scapula that regulate the force to control scapular motion for functional activities. Properly coupled motions of these two muscles are considered necessary for correct scapular movements, including proper initiation and recruitment of the muscles⁵⁾. Abnormal scapular orientations can alter the activation of the stabilizing muscles such as

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levator scapulae and upper trapezius muscles, and also the mobilizing muscles such as rhomboids and pectoralis minor⁶).

Traditional ways to treat neck pain include deep neck flexor stabilizing exercises, manual therapy, electrical therapy, and non-surgical interventions. Helgadottir et al. revealed that changes in scapular orientation caused neck pain in the patients who performed reaching or weight-lifting tasks with their upper extremities⁷. Other studies reported that neck pain during upper extremity tasks is due to a change in the upper trapezius muscle activity and alters scapular axis in scapular orientation⁸. The strategies for dealing with neck pain can include scapular posture stabilization, upper trapezius and serratus anterior muscle activity regulation, and muscle re-education. Another possible way to improve neck pain and mechanical dysfunctions of the cervical spine is to exercise the neck and shoulder muscles. The purpose of this study was to investigate the effects of scapular stabilization exercise on neck posture, muscle activity, neck pain, and quality of life in the patients with neck pain and forward head posture.

SUBJECTS AND METHODS

The researchers recruited a total of 15 patients with neck pain. The inclusion criteria were as follows: (1) craniovertebral (CV) angle of 44 degrees or less, (2) suffered at least 3 months of neck pain, (3) no cervical or shoulder neurological movement disorder, and (4) shoulder flexion at least 130 degrees or more. This study excluded if they had a history of: (1) cervical surgery and cervical spine fracture, (2) temporomandibular surgery, (3) pathologic trauma, and (4) psychosocial problem. This study informed all participants of the purpose and procedures of this study, after which the subjects signed a consent form for participation. The local institutional review board approved the study.

This study involved a pretest-posttest control group design. This study assigned the 15 participants to the experimental group (n=8) and the control group (n=7), based on the demographic characteristics of the subjects. Subjects in the experimental group performed scapular stabilization exercise for 30 minutes per session, 3 days a week for 4 weeks while the control group conducted relaxation exercises for the same period. The scapular stabilization exercise was composed of five stages: (1) in supine position, the patient was instructed to take a deep breath to relax the body while holding his shoulders and neck in a comfortable posture; (2) the patient bent his knees and placed his feet flat on the floor, and held the posture without any neck movement. Then the patient raised his dominant arm to 90° shoulder flexion with full elbow extension and scapular protraction. This posture was held for 10 seconds before returning to the starting position⁹. Three laps of 10 repetitions with one-minute break in between were performed; (3) in quadruped position, the patient lifted up his arms alternatively with shoulder abduction and 120° flexion. This posture was held for 10 seconds before returning to the starting position. Three laps of 10 repetitions with 30-second break in between were performed; (4) in sitting position with 90° knee flexion on a stool or bed without back support, the patient held a pair of dumbbells (2 kg) in each hand and laterally lifted them up while maintaining the height of scapulae below 80°. This scapular position was held for 10 seconds before returning to the starting position¹⁰. Three laps of 10 repetitions with 30-second break in between were performed; (5) in sitting position, a mirror was placed in front of the patient. The patient was instructed to check and correct his posture by himself. To evaluate the effects of scapular stabilization exercise, this study used the following outcome measures: CV angle, surface electromyography, Visual Analogue Scale (VAS), Neck disability index (NDI), and World Health Organization Quality of Life Assessment-BREF (WHOQOL-BREF).

This study used SPSS for Windows version 17.0 (SPSS Inc., Chicago, IL, USA) for data analysis. A paired t-test was used to compare pre and post-treatment results of each group. An independent t-test was used to determine the changes in the experimental group compared to the control (reported as the mean±standard deviation). The statistical significance level was set at $p < 0.05$.

RESULTS

The researchers recruited a total of 15 patients with neck pain (11 men, four women, aged 36±9.9 years). [Table 1](#) lists the common characteristics of all study participants. The experimental group showed a significant decrease in upper trapezius muscle activity and an increase in serratus anterior muscle activity ($p < 0.05$). Upper trapezius muscle activity significantly decreased from 40.6 to 29.0, and serratus anterior muscle activity significantly increased from 28.5 to 37.4 in the experimental group after training. The activity of these two muscles in the experimental group significantly improved after training compared to the control group ([Table 2](#)). The CV angle increased significantly in the experimental group (from 38.7 to 49.3) after training compared to the control group (from 40.7 to 41.0) ($p < 0.05$). VAS score significantly decreased in the experimental group (from 6.3 to 3.1) after training compared to the control group (5.1 to 4.4) ($p < 0.05$). The NDI score showed a significant improvement in the experimental group compared to the control group. The mean pre-test score was 14.4 in the scapular stabilization exercise group and 10.9 in the control group. The mean post-test score of each group was 7.9 and 10.7, respectively. The WHOQOL scores showed a significant improvement after training in the experimental group compared to the control group. The mean pre-test score was 84.1 in the scapular stabilization exercise group and 89.3 (10.4) in the control group. The mean post-test scores were 96.1 and 89.7, respectively ([Table 3](#)).

Table 1. Common and clinical characteristics of all participants (N=15)

Variables	Experimental group (n=8)	Control group (n=7)
Gender (male/female)	5/3	6/1
Age (yrs)	35.5±8.8 ^a	35.7±9.8
Height (cm)	167.5±7.0	171.1±5.0
Weight (kg)	69.5±14.7	74.1±11.6
CV angle (°)	38.8±2.5	40.7±2.8
VAS	6.3±1.7	5.1±1.5
NDI	14.4±8.1	10.9±3.2
WHOQOL-BREF	84.1±9.4	89.3±10.4
Upper trapezius (%MVC)	40.6±10.5	36.1±10.8
Lower trapezius (%MVC)	44.4±17.0	36.6±10.8
Serratus anterior (%MVC)	28.9±8.04	29.8±8.8

^a mean±SD

CV angle: Craniovertebral angle; VAS: Visual analog scale; NDI: Neck disability index; WHOQOL-BREF: World Health Organization quality of life assessment-Brief; MVC: maximal voluntary contraction

Table 2. Muscle activation during loading-based flexion task (N=15)

Muscle	Experimental group (n=8)		Control group (n=7)	
	Pre-test	Post-test	Pre-test	Post-test
Upper trapezius (%MVC)	40.6±10.5 ^a	29.0±7.5*	36.1±10.8	37.5±3.4
Lower trapezius (%MVC)	44.4±17.0	47.2±19.4	36.6±13.1	27.4±12.0
Serratus Anterior (%MVC)	28.5±7.6	37.4±8.1*	29.8±8.8	26.5±7.0

^a mean±SD

MVC: maximal voluntary contraction

*p<0.05

Table 3. Clinical measures before and after stabilization exercises in all subjects (N=15)

Muscle	Experimental group (n=8)		Control group (n=7)	
	Pre-test	Post-test	Pre-test	Post-test
CV angle (°)	38.8±2.5 ^a	49.3±4.9***	40.7±2.8	41.0±2.8
VAS	6.3±1.7	3.1±1.1**	5.1±1.5	4.4±0.5
NDI	14.4±8.1	7.9±3.1*	10.9±3.2	10.7±3.0
WHOQOL-BREF	84.1±9.4	96.1±5.4**	89.2±10.4	89.7±10.6

^a mean±SD

CV angle: Craniovertebral angle; VAS: Visual analog scale; NDI: Neck disability index; WHOQOL-BREF: World Health Organization quality of life assessment-Brief

* p<0.05; ** p<0.01; *** p<0.001

DISCUSSION

Previous studies have reported that weakened muscles cause disruptions in normal movement patterns and motor control, and that these muscles are replaced by other muscles to perform similar movements^{5, 8)}. Movement pattern correction is an important part of muscle-recruiting strategies in rehabilitation. Recovering the normal activation of the serratus anterior and trapezius muscles is essential for neck and shoulder disorder rehabilitation. A study by Wegner et al. reported that patients with forward head posture showed more anterior-tilted shoulder joints, lesser serratus anterior muscle activity, and greater scapular internal rotation during shoulder flexion compared to normal subjects¹¹⁾. Thigpen et al. reported that patients with forward head posture had a significantly decreased activity in the serratus anterior muscle when performing overhead shoulder flexion tasks. The authors suggested that the change in the serratus anterior muscle activity is one of the reasons for biomechanical changes in the scapula⁵⁾. Holtermann et al. showed that the decreased activity of the upper trapezius muscle

and the increased activity of the serratus anterior muscle through motor control leads to functional changes associated with head posture¹²). Proper firing patterns and recruitment of muscles require coupling of the serratus anterior muscle with the upper, middle, and lower trapezius muscles, consequently resulting in “force couples,” which are considered necessary for normal scapular orientation^{4, 11}).

Previous studies have shown that the main goal was to inhibit the over activity of muscle (i.e., upper trapezius) and to facilitate the muscle with weak activity (i.e., lower trapezius and serratus anterior) for postural control. Previous research studied artificially increased upper trapezius muscle activity and found that it increased the forward head angle. The main goal of the study was to inhibit over-activation of the muscle (i.e., upper trapezius) and to facilitate the weak muscles (i.e., lower trapezius and serratus anterior) for postural control¹¹). Therefore, the serratus anterior and upper trapezius muscles are more controlled in the forward head posture after training in this study, and resulting scapular or thoracoscapular position are changed from normal to the forward head posture. The training in this study resulted in the most controlled use of the serratus anterior and upper trapezius muscles, and brought the scapular and thoracoscapular positions closer to normal from forward head posture.

This study used VAS, NDI, and WHOQOL-BREF to estimate the recovery of pain, activity limitations according to disability, and quality of life. Neck pain with forward head posture is associated with many different conditions such as excessive workload, postural disorders, psychological state, poor postures, and structural disorders²). Therefore, this makes neck pain with forward head posture a more common disease than other musculoskeletal or neuromuscular disorders. Correlation between pain and its severity was found in neck pain patients with forward head posture. Chronic neck pain affects active participations in daily activities and influences emotional control, and may lead to depression associated with frustration and anger. Pain can also deteriorate the quality of life, which is considered an important indicator of health care¹³).

The exercise program used in this study was 4 weeks long, which is a relatively short amount of time, and therefore, the results of this study could not determine the long-term effects of the exercise. Another limitation of this study is the small sample size; making it difficult to generalize the effects of scapular stabilizing exercise. In addition, the subjects with neck pain experienced fatigue easily and were not able to concentrate for a long time; we did provide the subjects with a break after performing loaded flexion task for EMG analysis. Despite these limitations, the effects of scapular stabilizing exercise on different degrees of forward head posture and muscular activity in patients with neck pain can be studied during various scapular movements. Further studies with various exercise protocols are essential for neck pain patients with forward head posture.

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