J. Phys. Ther. Sci. 30: 804–808, 2018

The Journal of Physical Therapy Science

Original Article

Effect of scapular stabilization exercise on neck alignment and muscle activity in patients with forward head posture

Jeong-Il Kang, PT, PhD[1)], Hyun-Ho Choi, PT, MS[1)*], Dae-Keun Jeong, PT, PhD[1)], Hyun Choi, PT, PhD[2)], Young-Jun Moon, PT, PhD[3)], Joon-Su Park, PT, MS[1)]

[1)] *Department of Physical Therapy, Sehan University: 1113 Noksaek-ro, Samho-eup, Yeongam-gun, Jeollanam-do, Republic of Korea*
[2)] *Department of Physical Therapy, Mokpo Mirae Hospital, Republic of Korea*
[3)] *Department of Physical Therapy, Mokpo Jung-Ang Hospital, Republic of Korea*

Abstract. [Purpose] The purpose of this study was to investigate the effects of scapula movement on neck alignment and the muscles in patients with forward head posture, who has the structural changes around the neck caused from the forward head posture, when scapular stabilization exercise is applied. [Subjects and Methods] A sample of 30 patients with forward head posture were recruited and participated in an intervention for 30 minutes a day, three times per week for 4 weeks. Fifteen patients were assigned to the scapular stabilization exercise group and the remaining 15 were assigned to the neck stabilization exercise group. Before the intervention, the craniovertebral angle (CVA), cranial rotation angle (CRA), and muscle activity of the muscles around the neck were measured. Four weeks later, these 3 factors were re-measured and analyzed. [Results] Within-group changes in CVA and CRA were observed in both groups and were statistically significant. Only the CVA group had a statistically significant between-group differences. Within-group changes in muscular activity were significant differences in all groups. Between groups, the lower back trapezius and serratus anterior showed statistically significant differences. [Conclusion] Scapular stabilization brought about improvement in posture through activation of the neck muscles, the lower trapezius, and the serratus anterior. Therefore, the intervention has a positive effect on neck alignment by reducing the compensatory movements of the muscles involved in forward head posture. Structural changes are observed.
Key words: Forward head posture, Muscle activity, Scapular stabilization exercise

(This article was submitted Jan. 30, 2018, and was accepted Mar. 8, 2018)

INTRODUCTION

Forward head posture is the anterior positioning of the cervical spine occurring when the lower neck bone is bent and there is an extension of the upper neck bone and the head[1)]. This condition has increased and is exacerbated with the advancement in technology and the increasing use of computers and smartphones for extended periods of time[1, 2)]. This posture reduces the dispersion of biomechanical loading and therefore causes degeneration of the neck muscles and structural changes[3)]. In addition, compensatory actions, such as spinal curve changes, rounded shoulders, and abnormal muscle activity can be observed[4, 5)]. Specifically, the deep cervical flexors and scapular retractors are weakened, and there is increased tension and thickness of the sternocleidomastoid[6)]. Furthermore, a decline in the serratus anterior muscle is observed. Finally, the upper trapezius and lower trapezius are overly activated because of the upper rotator disability of the scapula[7)]. The abnormal responses are due to protective reaction of hyperactivity and inhibition of muscle to prevent damage to the body or reduce pain[8)]. This causes malalignment of the neck, a tilting in posture, and an imbalance of the muscles and leads to pain[9)]. To

*Corresponding author. Hyun-Ho Choi (E-mail: hot486zz@naver.com)

solve this problem, patients with forward head posture should be in body alignment. This involves muscle strengthening, specifically strengthening the deep cervical flexors[10]. In addition to strengthening, exercises targeting this group of muscles are needed[11]. Patients with forward head posture have problems around the neck, around the neck-shoulder muscles, as well as abnormal postures such as rounded shoulders[5]. In order to correct head and neck posture, it is important to improve the thoracic spine[12]. Therefore scapular stabilization exercise is used as an effective way to recover the imbalance in posture and the muscles[13, 14]. Scapular stabilization exercise is effective in the early rehabilitation and the balance of both sides of the trapezius with the movement and couple motion of the scapula. It is also effective in increasing muscle activation in the serratus anterior and lower trapezius, through decreasing the compensatory movement, which is caused by the forward head posture, and in decreasing muscle activation on the upper trapezius. Furthermore, it brings about a spinal curve change and upper crossed syndrome improvement[15]. There are many studies worldwide that have investigated forward head posture. Further research is needed to conduct quantitative studies on how exercises can solve neck alignment issues. Scapular stabilization is one such solution that can provide positive effects on forward head posture. Therefore, this research provides evidence for the effectiveness of scapular stabilization exercises in patients with forward head posture.

SUBJECTS AND METHODS

This study was conducted between November 16th, 2017 and December 30th, 2017 for six weeks. The study was approved by the Institutional Review Board of Sehan University (approval No. SH-IRB 2017-21). Thirty patients, aged 25–50 years, who had been diagnosed with forward head posture specifically with the vertical line between the acromion process and external acoustic meatus at least 5 cm were selected[4]. Patients were selected if they had not undergone surgery for lumber spondylolisthesis and an X-ray revealed no fractures in their spine. Patients with orthopedic or neurologic symptoms were excluded. Patients with headaches or nerve root injection were excluded. Patients participated in this research voluntarily and provided formal consent (Table 1). Thirty patients with forward head posture were sampled and randomly assigned into two groups. Fifteen patients were assigned to the scapular stabilization exercise group (Experiment group I) and 15 patients were assigned to the neck stabilization exercise group (Experiment group II). Each intervention was performed for 30 minutes each day, three times per week for 4 weeks. Before the intervention, craniovertebral angle (CVA) and cranial rotation angle (CRA) was measured using radiography and the muscles around the neck were measured through surface EMG. Four weeks later, these outcomes were analyzed using the same methods. Neck alignment was measured using radiography; CVA was measured with the horizontal angle between tragus and 7th prominens of the neck bones; and CRA was measured with the angle between tragus, the end of lateral of eye and 7th prominens of the neck bones[16]. Muscle activity in the neck region was measured using an 8-channel EMG MP 150 system (Biopac Systems, Inc., USA). An electrode was attached to the muscle belly of the following muscles: sternocleidomastoid, upper and lower trapezius muscle, and serratus anterior[13]. Data values are measured by the %RVC method which bases its measurement on the muscle contraction of a specific movement. This was measured when patients were sitting with their arms by their trunk. Standard movement RMS measured the average 5 seconds of muscle activation by estimating sitting posture three times for 15 minutes. Specific movement RMS was measured in a similar manner; however, patients were holding a 1 kg dumbbell. Fatigue was minimized by provided a three-minute interval break each time[8]. With scapular stabilization exercise, patients placed a gym ball or chair between the chest and abdomen, lowered both arms “thumbs up” and make the “I shape”. After this, patients reached both arms up to 45 degrees to make a ‘Y shape,’ and reached both arms horizontally to make a ‘T shape.’ Lastly, patients bent both arms to 90 degrees and horizontally to make a ‘W shape.’ Every activity was maintained for three seconds and was carried out 10 times for three sets. These were carried out until the patients felt pain. They were given gradual resistance with a thera-band[13, 17]. Neck stabilization exercise was performed in a chin-in posture using a sling. Patients preformed isometric exercises in all sides of neck. Exercises were conducted for 10 seconds, 10 times for three sets. The holding time was gradually increased[18]. The analyzing method in this study was a paired t-test for comparing within-groups changes of CVA and CRA and muscle activation was measured using SPSS 20.0. Between-group changes of CVA, CRA, and muscle activation was compared using analysis of covariance (ANCOA) and the significance level was set at α=0.05.

Table 1. Subjects’ general characteristics

Item	Experimental group I (n=15)	Experimental group II (n=15)
Age (years)	31.8 ± 7.5	33.8 ± 4.8
Height (cm)	168.2 ± 6.8	168.1 ± 9.5
Weight (kg)	61.9 ± 10.3	69.3 ± 13.2
SMM (kg)	26.2 ± 5.8	28.7 ± 6.4
BFM (kg)	14.6 ± 4.3	17.9 ± 6.1
BMI (kg/m^2)	21.8 ± 2.5	24.5 ± 3.3

Data are presented as mean ± SD.
SMM: skeletal muscle mass; BFM: body fat mass; BMI: body mass index.

RESULTS

Within-group comparison of changes in CVA revealed a statistically significant difference in every group (Table 2). Between-groups comparison of changes revealed that experiment group I had a greater statistically significant difference than did experiment group II (Table 2). Within-group comparison of changes in CRA revealed that both experiment groups I and II had statistically significant differences (Table 2). There were no statistical significance between-group differences in CRA (Table 2). Finally, within-group comparison of changes in muscle activation revealed a significant difference in every group (Table 3). Between-group comparison of changes in muscle activation, revealed that experiment group I had a greater statistically significant difference in the lower trapezius muscle and serratus anterior than did experiment group II (Table 3).

DISCUSSION

Patients with forward head posture have rounded shoulders or poor back posture, resulting from a compensatory movement. Therefore, the scapular stabilization exercise is applied to patients in a clinic with the goal of stabilizing the scapula, not just the neck area[2, 13, 14]. After prescribing scapular stabilization exercises to the 16 patients with forward head posture three times per week for 8 weeks, Yoon and Lee[14] have stated that scapular stabilization exercise can have positive effects on CVA, CRA, and muscle activation. Scapular stabilization exercise changes the patterns of muscle imbalances caused by upper crossed syndromes. In this study CVA and CRA have statistically significant differences in each group before and after the intervention. However, in the between-groups comparison only CVA had significant differences. These differences were greater in experiment group I than experiment group II. This is because scapular stabilization exercise, which leads to the improvement of the general improvement of the upper body rather than the sling exercise movement limited to the neck stabilization is considered to be the result of improvement of the round shoulder and backbone in upper crossed syndrome. Furthermore, scapular stabilization exercise is effective in minimizing impingement syndrome, which results from changes in the shoulder girdle[19] and proves to be effective in improving posture. Wegner et al.[20] have stated that positive changes were observed in 38 patients with neck problems because of technology overuse, specifically using the computer, up on prescribing scapular stabilization exercises for them. Kim et al.[9] have stated that correction exercises for regions around the neck and scapula of patients with forward head posture help improve the recovery of positional distortion and muscle

Table 2. Comparisons of changes between groups on CVA and CRA

Item	Group	Pre-test (M ± SD)	Post-test (M ± SD)	
CVA (◦)	Experimental group I	49.5 ± 3.8	53.9 ± 3.4***	*
	Experimental group II	50.9 ± 3.7	52.9 ± 4.1*	
CRA (◦)	Experimental group I	147.5 ± 3.7	144.4 ± 4.9**	
	Experimental group II	147.4 ± 4.6	144.2 ± 4.4***	

*p<0.05, **p<0.01, ***p<0.001.
Data are presented as mean ± SD, paired t-test, analysis of covariance.
CVA: Cranio Vertebal Angle; CRA: Cranial Rotation Angle.

Table 3. Comparisons of changes between groups on muscle activity

Item	Group	Pre-test (M ± SD)	Post-test (M ± SD)	
SCM (%)	Experimental group I	38.9 ± 10.2	36.1 ± 10.1***	
	Experimental group II	39.6 ± 12.2	35.3 ± 10.3***	
UTM (%)	Experimental group I	46.9 ± 5.5	43.9 ± 6.1***	
	Experimental group II	47.3 ± 6.1	43.1 ± 7.4***	
LTM (%)	Experimental group I	32.8 ± 7.5	36.8 ± 9.1**	*
	Experimental group II	33.8 ± 9.4	34.2 ± 9.7*	
SAM (%)	Experimental group I	13.5 ± 3.1	19.5 ± 2.7***	*
	Experimental group II	13.2 ± 3.2	17.2 ± 4.1***	

*p<0.05, **p<0.01. ***p<0.001.
Data are presented as mean ± SD, paired t-test, analysis of covariance.
SCM: Sterno Cleidomastoid Muscle; UTM: Upper Trapezius Muscle; LTM: Lower Trapezius Muscle; SAM: Serratus Anterior Muscle.

stiffness. In this study the activation of the sternocleidomastoid, upper trapezius muscle, lower trapezius muscle, and serratus anterior revealed significant differences in every group before and after the intervention. However, in the between-groups comparison there were significant differences only in the lower trapezius muscle and serratus anterior. This reduced the compensatory movement on the muscles that resulted from abnormal posture by increasing activities of the lower trapezius muscle and serratus anterior and effectively improved the muscles around the neck by stabilization of scapula. Furthermore, as activation of the lower trapezius muscle increases a tilt in the scapula occurs and reduces the upper rotation angle through scapula alignment[2]. As activation of the serratus anterior increases it decreases the activation of the upper trapezius muscle and it is effective in raising of the scapula and stretching of the neck. Overall there is a positive effect on the improvement of the abnormal postures such as an opposite rotating movement[1]. Therefore, scapular stabilization exercise can be considered an effective method to improve abnormal posture in patients who is forward head posture results in structural distortion of the neck and compensatory movement of the muscles as it solves the problems associated with the neck, back, and scapula.

The limitations of this study are that we cannot control for the daily lives of the patient's and period was short. This means there may be other variables in this study that we cannot account for such as patient's taking other pills or being involved in other interventions. In addition, this study was conducted in one medical institution only and it is difficult to generalize these findings to all patients with a forward head posture. However, scapular stabilization exercise can be considered a more effective intervention method for patients with forward head posture in neck alignment, change in muscle activity and many advanced research studies. Prospective research on this intervention with adjustment of study period and exercise method will be needed in the future.

Funding

This paper was supported by the Sehan University Research Fund in 2018.

Conflict of interest

None.

REFERENCES

1) Park HK, Han KJ: Effects of upper trapezius pain and head position on scapular upward rotator activities during shoulder abduction on the scapular plane. Kor J Neuromusc Rehabil, 2017, 7: 14–20.
2) Lee JH, Cynn HS, Yoon TL, et al.: The effect of scapular posterior tilt exercise, pectoralis minor stretching, and shoulder brace on scapular alignment and muscles activity in subjects with round-shoulder posture. J Electromyogr Kinesiol, 2015, 25: 107–114. [Medline] [CrossRef]
3) Tan LA, Straus DC, Traynelis VC: Cervical interfacet spacers and maintenance of cervical lordosis. J Neurosurg Spine, 2015, 22: 466–469. [Medline] [CrossRef]
4) Kang JI, Jeong DK, Choi H: Correlation between pulmonary functions and respiratory muscle activity in patients with forward head posture. J Phys Ther Sci, 2018, 30: 132–135. [Medline] [CrossRef]
5) Singla D, Veqar Z: Association between forward head, rounded shoulders, and increased thoracic kyphosis: a review of the literature. J Chiropr Med, 2017, 16: 220–229. [Medline] [CrossRef]
6) Cho WH, Lee WY, Choi HK: An investigation on the biomechanical effects of turtle neck syndrome through EMG analysis. Jonrnal KSPE. 2008, 11: 195–196.
7) Weon JH, Oh JS, Cynn HS, et al.: Influence of forward head posture on scapular upward rotators during isometric shoulder flexion. J Bodyw Mov Ther, 2010, 14: 367–374. [Medline] [CrossRef]
8) Kim CH, Sim JH: Comparison of the effects of cervical mobilization technique, neuromuscular release, and cervical traction on cervical alignment and muscle activity in people with forward head posture. Kor J Neuromusc Rehabil, 2016, 6: 9–18.
9) Kim SD, Hong SH, Kim JH, et al.: The effects of neck scapula corrective exercise on Sc tatic posture balance and muscle stiffness. J KSSLS, 2017, 68: 601–610.
10) Lynch SS, Thigpen CA, Mihalik JP, et al.: The effects of an exercise intervention on forward head and rounded shoulder postures in elite swimmers. Br J Sports Med, 2010, 44: 376–381. [Medline] [CrossRef]
11) Sterling M, Jull G, Wright A: Cervical mobilisation: concurrent effects on pain, sympathetic nervous system activity and motor activity. Man Ther, 2001, 6: 72–81. [Medline] [CrossRef]
12) Caneiro JP, O'Sullivan P, Burnett A, et al.: The influence of different sitting postures on head/neck posture and muscle activity. Man Ther, 2010, 15: 54–60. [Medline] [CrossRef]
13) Ha SM, Kwon OY, Cynn HS, et al.: Comparison of electromyographic activity of the lower trapezius and serratus anterior muscle in different arm-lifting scapular posterior tilt exercises. Phys Ther Sport, 2012, 13: 227–232. [Medline] [CrossRef]
14) Yoon HK, Lee H: Effect of push up plus on sling and stable surface on muscle activity and lung function in adults with forward head posture. J JKAIS, 2017, 18: 624–631.
15) De Mey K, Danneels L, Cagnie B, et al.: Kinetic chain influences on upper and lower trapezius muscle activation during eight variations of a scapular retraction exercise in overhead athletes. J Sci Med Sport, 2013, 16: 65–70. [Medline] [CrossRef]
16) Ruivo RM, Carita AI, Pezarat-Correia P: The effects of training and detraining after an 8 month resistance and stretching training program on forward head and protracted shoulder postures in adolescents: randomised controlled study. Man Ther, 2016, 21: 76–82. [Medline] [CrossRef]
17) Kisner C, Colby LA, Borstad J: Therapeutic exercise: foundations and techniques. FA Davis, 2017, pp 513–515.
18) Chung SH, Her JG, Ko T, et al.: Effects of exercise on deep cervical flexors in patients with chronic neck pain. J Phys Ther Sci, 2012, 24: 629–632. [CrossRef]

19) Turgut E, Duzgun I, Baltaci G: Effects of scapular stabilization exercise training on scapular kinematics, disability, and pain in subacromial impingement: a randomized controlled trial. Arch Phys Med Rehabil, 2017, 98: 1915–1923.e3. [Medline] [CrossRef]
20) Wegner S, Jull G, O'Leary S, et al.: The effect of a scapular postural correction strategy on trapezius activity in patients with neck pain. Man Ther, 2010, 15: 562–566. [Medline] [CrossRef]