

EFFECTS OF CERVICAL STABILIZATION EXERCISES WITH THORACIC SPINE EXTENSION EXERCISES ON THE CERVICAL RANGE OF MOTION OF MEN AND WOMEN WITH FORWARD HEAD POSTURE

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Abstract

This study aimed to investigate the effects of cervical stabilization exercises with thoracic spine extension exercises on the cervical range of motion (CROM) of men and women with forward head posture (FHP). The study included 15 adults with FHP. Two groups, eight men in one group and seven women in the other group, were required to perform cervical stabilization exercises with thoracic spine extension exercises. After four weeks of exercise, the changes in CROM (extension, flexion, right rotation, left rotation, right bending, and left bending) were measured again. The results showed that after four weeks of exercise, the CROM of all members significantly increased, and a significant difference was found between pre- and post-exercise ($p < 0.05$). A significant difference was found pre- and post-exercise in the two groups ($p < 0.05$). In the between-group comparison, no significant difference was observed in CROM between the men's group and the women's group ($p > 0.05$). Cervical stabilization exercises with thoracic spine extension exercises are recommended to improve the CROM of both men and women with FHP.

Keywords: cervical stabilization, forward head posture, thoracic extension.

1. Introduction

1.1 Necessity of the study

A sedentary lifestyle can cause forward head posture (FHP) [1,2], which is a poor habitual neck posture characterized by a forward translation of the cervical vertebrae greater than the upper cervical vertebrae [3]. Continuous FHP changes the kinetics and kinematics of the scapula and adds load to the posterior cervical structures (e.g., muscles, joint capsules, ligaments, and bones) [4]. FHP may keep ligaments and/or joint capsules stretched out, which puts more strain on neck structures [5]. This posture causes a variety of health problems, such as an imbalance in the scapular or neck muscles, a disruption in the activation of the spinal muscles, and changes to other parts of the spine to compensate for the distorted cervical alignment [6].

Cervical health is crucial for daily activities that involve orienting and stabilizing the head. [7, 8]. FHP ostensibly increases compressive loading in the cervical spine and results in a reduction in cervical range of motion (CROM) [9]. In people with FHP, the upper cervical spine is hyperextended, but other areas of the cervical spine are flexed, limiting extension [8]. Reduced CROM is often reported in people with neck pain [7]. Patients with cervical spine dysfunction have reduced CROM and greater head repositioning errors [10]. FHP can also restrict functional movement in the head and neck. These limitations are caused by irregular rotation and gliding movement inside the articular capsule while moving the joint. Furthermore, prolonged FHP can result in a decrease in the number of sarcomeres and a shortening of muscle fibers, which can affect muscular contraction. FHP maintains muscle tightness by shortening the craniocervical area's rear extension muscles and lengthening the front flexion muscles. These biomechanical changes may affect the muscle thickness and functional activity of the muscles in the craniocervical region. The ROM in the cervical area was found to be reduced in FHP participants, as was the craniovertebral angle (CVA) [11]. In one study, increased cervical extension ROM was found to reduce FHP and increase deep neck flexor endurance [8].

Previous studies have demonstrated that cervical stabilization exercises have a positive effect on FHP [12–15]. Thoracic stretching exercises can improve postural alignment related to FHP. Various studies have been conducted on thoracic spine extension exercises for kyphosis. These exercises can improve lumbosacral alignment and relieve low back pain. Trunk extension exercises are used to improve the strength and endurance of trunk extensor muscles [16–19]. Thoracic expansion exercises and abdominal breathing do not change sagittal shoulder posture, but they are effective in improving the cranial rotation angle (CRA) and the CVA [20]. Cervical and thoracic stretching and strengthening exercise programs can improve spinal postural alignment by decreasing FHP in subjects [21]. Neck and thoracic extensor strength exercises have a positive effect on FHP and CROM [22].

Although there have been many previous studies on CROM, there has never been a direct investigation on cervical stabilization exercises with thoracic spine extension exercises in men and women with FHP.

2. Methods

2.1 Experimental subjects

This study consisted of 15 subjects (eight men and seven women) with FHP attending Daegu University in Gyeongsan, South Korea. The average age of the subjects was 20.53 ± 1.92 years, the average height was 173.23 ± 9.79 cm, and the average weight was 68.00 ± 15.55 kg. The average body mass index of the subjects was 22.46 ± 3.43 kg/m², the average CVA was $50.01 \pm 3.54^\circ$, and the average CRA was $150.43 \pm 4.55^\circ$. All subjects read and signed the university-approved human subject consent form before taking part in the study. Daegu University's Institutional Review Board approved the study (IRB: #1040621-202007-HR-002). The inclusion criteria were (1) CVA of 53° or lower [23] and (2) CRA greater than 143° [24]. The exclusion criteria were (1) mental or cognitive problems that could affect the experiment and (2) subjects with a history of cervical surgery, injury-limiting activities, and cervical or thoracic fractures.

2.2 Experimental procedure

The preparatory experiment began before the formal experiment. The study lasted from September to November 2020. Two groups, eight men in one group and seven women in the other group, were required to perform cervical stabilization exercises with thoracic spine extension exercises. Their CROM (extension, flexion, right rotation, left rotation, right bending, and left bending) were measured before the first exercise. After four weeks of exercise, their CROM was measured again.

2.3 Experimental assessment

2.3.1 Measurement of FHP

To measure the FHP, the CVA and CRA were measured based on previous studies [24, 25], with the seventh cervical vertebra, tragus, and lateral canthus connected in a straight line [26]. The CVA and CRA were determined using digital lateral-view photographs of the subjects standing in normal standing postures [23]. The CVA increased in the sitting posture compared to the standing posture, and the standing posture was considered a more sensitive posture for evaluating the FHP [27]. The angle formed by the seventh cervical vertebra (C7), the horizontal line, and the tragus of the ear (C7-tragus-horizontal angle) defined the CVA. Lower values denoted greater FHP [5]. Palpation revealed the spinous process of C7 [5]. Calculation was performed using an angle measurement software program (Angulus; DPP, Beijing, China). A mobile camera (Huawei Nova 5i Pro; Huawei Technologies, Co. Ltd., Shenzhen, China) was placed 1.5 m away at the height of the acromion of each participant [26].

2.3.2 Measurement of CROM

Before beginning treatment, the subjects' cervical extension, flexion, rotation, and lateral flexion were measured using movement angle analysis equipment (4DMT Software, Relive, Korea). The signal was sent to the 4D-MT ROM software by the equipment, which was specially designed to measure CROM. All CROM assessments began with a natural head posture and were explained with demonstration. The average value was recorded after the subjects completed each exercise three times [28].

2.4 Experimental intervention

2.4.1 Cervical stabilization exercises

Cervical stabilization exercises comprised two stages: (i) 1–2 weeks in the first stage and (ii) 3–4 weeks in the second stage (Table 1) [29].

Table 1. Cervical stabilization exercises

First stage	Second stage
Ligament nuchae stretching	Deep neck flexor strengthening (supine position)
Upper trapezius stretching	Deep neck flexor strengthening (sitting position)
Levator scapular stretching	Nodding exercise
Scalene stretching	Pectoralis major stretching
Deep neck flexor strengthening (supine position)	Scapular upward rotation
Deep neck flexor strengthening (sitting position)	(neck flexor) Forward, posterior sagittal rotation in sitting
Nodding exercise	(neck flexor) Forward, posterior sagittal rotation in quadruped

2.4.2 Thoracic spine extension exercises

The thoracic spine extension exercises were taken from previous studies [30]. Each exercise was performed 15 times as a group and repeated for the two groups (Table 2) three times a week for four weeks.

Table 2. Thoracic spine extension exercises

Thoracic spine extension exercise	Exercises
1 program	Put the foam roller on the limited spine segment, bend the knee to lie down, put both hands on the chest, gently lift a little from the floor, and slowly roll the foam roller up and down in segmentation.

2 program	To protect the knee, lay a mat on the ground, bend the knee, get the Swiss ball, put hands on the ball, and walk forward. The upper body is tilted forward to debilitate the upper spine, which is maintained at the end point for 10 s.
3 program	With both arms supported, lift the upper body up repeatedly as in the existing demotion position. The patients maintained the demeaning position for 7 s.

2.4 Statistical analysis

To determine normality, the Kolmogorov-Smirnov test was used. For the two groups, the paired t-test was used to compare the difference within the group before and after the intervention, and the independent t-test was used to determine the difference between the two groups. SPSS was used for statistical analysis (version 20.0 for Windows; IBM Corp., Armonk, NY, USA). The level of statistical significance was set at = 0.05. The effect size was calculated using Cohen's D, with 0.2 representing a small effect size, 0.5 representing a medium effect size, and 0.8 representing a large effect size.

3. Results

3.1 Comparison of CROM between pre- and post-exercise among all subjects

According to the statistics from the paired t-test, after the exercises, extension, flexion, right rotation, and left rotation were significantly different among all the subjects ($p < 0.05$) (Table 3).

Table 3. Comparison of CROM between pre- and post-exercise among all subjects

N = 15 (Unit: degree)

	Pre	Post	t	P	Effect size
Extension	62.18±12.64 ^a	71.47±9.99	-5.715	.000*	-0.82
Flexion	36.23±9.02	44.16±8.50	-5.977	.000*	-0.90
Right rotation	66.90±8.11	77.28±6.47	-6.073	.000*	-1.41
Left rotation	67.00±7.32	74.74±6.76	-6.084	.000*	-1.10
Right bending	32.89±7.76	37.37±6.73	-3.77	.003*	-0.62
Left bending	30.87±8.80	38.79±8.20	-4.32	.001*	-0.93

^amean±standard deviation

* $p < .05$.

3.2 Comparison of CROM between men and women

According to the statistics from the paired t-test, after the exercises, extension, flexion, right rotation, and left rotation were significantly different between men and women ($p < 0.05$) (Table 4).

Statistics from the independent t-test showed that after the exercises, no significant difference was found in the different values of extension, flexion, right rotation, and left rotation between the two groups ($p > 0.05$) (Table 4).

Table 4. Comparison of CROM between men and women

N = 15 (Unit: degree)

		Pre	Post	<i>p</i>	Effect size	DV	Between group <i>p</i>
Extension	Men	62.87±14.40 ^a	68.04±11.11	.026*	-0.40	5.17±5.20	.847
	Women	61.63±5.18	67.34±7.75	.032*	-0.87	5.71±5.45	
Flexion	Men	35.16±10.86	40.75±6.54	.032*	-0.62	5.58±5.91	.730
	Women	34.08±7.08	38.71±8.44	.028*	-0.59	4.63±4.26	
Right rotation	Men	61.30±7.06	68.26±8.55	.005*	-0.87	6.97±4.93	.838
	Women	62.55±5.83	70.12±9.29	.018*	-0.98	7.57±6.18	
Left rotation	Men	64.13±6.32	68.35±5.43	.000*	-0.72	4.22±1.92	.606
	Women	63.17±6.45	66.73±5.76	.016*	-0.58	3.56±2.83	
Right bending	Men	35.01±11.35	39.70±10.48	.003*	-0.43	4.70±2.97	.234
	Women	30.56±5.78	33.79±5.91	.004*	-0.55	2.95±1.93	
Left bending	Men	33.88±9.70	38.50±9.55	.009*	-0.48	4.62±3.67	.802
	Momen	28.42±5.44	33.46±4.19	.001*	-1.04	5.03±2.23	

^amean±standard deviation

DV: different value

* *p* < .05.

4. Discussion

Affecting head posture, FHP is becoming increasingly common in day-to-day life. Therefore, this study aimed to explore the effects of exercises on CROM.

The CROM results of the present study found statistically significant differences in each group before and after the intervention. Stretching exercises were used in the cervical stabilization exercises in this study. Cervical stabilization exercises involve neck muscle stretching. A previous study showed that stretching exercises relative to neck flexors and extensors could improve ROM and FHP [31]. Stretching exercises have been found to increase CROM [32]. They contribute to muscle length normalization by extending the shortened muscle, and muscle length normalization can improve ROM [32].

Many studies have reported that cervical stabilization exercises may affect an increasing range of motion, muscular endurance, and muscle strength. These exercises are commonly used for preventing functional and structural problems, improving neck stability, and in rehabilitation and physical therapy [28]. The subjects also performed the thoracic spine extension exercise 2 program with both arms supported, upper body lifted, and head extended. The spine extension exercise 3 program includes scapular elevation and upward rotation exercises. Changes in the alignment of either the cervical spine or the scapulae can influence the biomechanics of the other by altering cervicospinal muscle tension. The cervical spine and scapulae like through the two cervicospinal

muscles: the levator scapulae and the upper trapezius. Modification of the shoulder girdle alignment or scapular can reduce mechanical stress on the cervical spine, as shown in studies and in the clinical field [33].

In the between-group comparison, no significant difference was observed in CROM between the men's group and the women's group. However, men showed a greater CROM than women in all three planes except for the right rotation. Regarding the effect of sex on CROM, no significant difference was found in the 20s age group, as the youngest age group in most populations shows the greatest mobility [34]. Males' muscle changes during puberty are dominated by rising levels of testosterone and IGF-1, resulting in increased muscle mass and strength. The combination of higher deformation forces and higher bending moments caused by longitudinal growth results in a periosteal apposition-dominated bone growth pattern. As a result, muscle growth is more parallel in nature in men, and the peak values of the cortical area and the muscle cross-sectional area tend to coincide within half a year. The greater total bone area corresponds to the greater muscle cross-sectional area found in young men compared to young women. There are obvious gender differences in the correlation of the muscle area with the bone area in young adulthood. The muscle area mostly explains the variation in bone dimensions in men [35]. Men have a lower cervical lordosis and a smaller upper cervical lordosis than women, and they do more daily activities (e.g., males spend more time than females on moderate and vigorous physical activities) [34].

This study also has limitations. The leisure sports activities of the subjects could have affected the experimental results. The study population included only students, not professional groups. Moreover, the experimental period was short. When the cervical spine is active, there may be compensatory activities in the shoulder, thoracic spine, lumbar spine, and other positions. This compensation may cause the obtained value to be larger than the real result. In addition, the age group was not sufficiently comprehensive. In the future, we hope to control for other variables more effectively and increase the experimental population and time.

5. Conclusion

This study aimed to investigate the effects of cervical stabilization exercises with thoracic spine extension exercises on the CROM of men and women with FHP. The results showed a significant difference between the two groups before and after four weeks of exercise. No significant difference was observed between the two groups. Therefore, cervical stabilization exercises with thoracic spine extension exercises are recommended to improve the CROM of both men and women with FHP.

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