



Original Article

The effects of stabilization exercises using a sling and stretching on the range of motion and cervical alignment of straight neck patients

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Abstract. [Purpose] The purpose of this study was to assess how stretching exercise training and sling exercise training for stabilization influences the cervical spine angles and cervical range of motion of straight neck patients. [Subjects and Methods] Twenty straight neck patients were selected as subjects and they were randomly divided into two groups, the stretching and sling stabilization exercise groups which 60 minutes of exercise three times a week for 6 weeks. All the subjects in each of the two respective study groups received an X-ray and had their cervical range of motion measured, both before and after the exercise. [Results] When differences in the cervical spine angle between the pre- and the post-test were checked, it was found that only the stretching exercise group showed statistically significant decreases in the craniovertebral angle and the cranial rotation angle. When differences in the range of motion between pre- and post-test were checked, the sling stabilization exercise group showed a significant change in flexion, right rotation, left lateral bending, right lateral bending, and the stretching exercise group showed a significant change in left rotation, left lateral bending, and right lateral bending. [Conclusion] These results indicate that both types of exercises are effective at improving the cervical range of motion of straight neck patients, and that the stretching exercise was more effective than the sling stabilization exercise at improving cervical spine angles.

Key words: Straight neck, Sling exercise, Stretching exercise

(This article was submitted Sep. 1, 2015, and was accepted Oct. 30, 2015)

INTRODUCTION

Owing to the development of modern technology, the use of smartphones has been increasing rapidly. According to the Pew Research Center¹⁾, smartphone users represent 56% of the entire US population, and the average amount of time spent on a smartphone per day is 5.1 hours. This increases up to 5.6 hours per day on weekends. It was reported that the average time spent on a smartphone per day has increased rapidly as the smartphone penetration rate has soared. However, poor posture while using a smartphone for continuous periods causes musculoskeletal problems²⁾.

Forward neck posture (forward head posture), a postural distortion, is regarded as a typical musculoskeletal disorder, and it is commonly seen in patients with cervical diseases³⁾. If the horizontal distance between the ear's tragus and the posterior angle of the acromion is more than 5 cm while a person is standing, the occiput and upper cervical spine lean forward excessively and the lower cervical spine and the upper vertebrae lean backward excessively. All these symptoms correspond to the features of forward head posture (forward neck posture)⁴⁾. When abnormal alignment of the vertebrae is continuously maintained due to inappropriate posture, that is, forward head posture, the vertebrae and surrounding soft tissues might be easily exposed to a sudden impact or chronic stress, and this could lead to possible changes in the blood vessels, spinal

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disease, organ dysfunction, degenerative diseases, and autonomic dysfunctions, such as headaches and chronic fatigue⁵).

The sling stabilization exercise can be used as a therapy for straight neck treatment and Kim and Kim⁶) have noted that stretching and sling exercises are effective at ameliorating cervical spine instability. The curative power of a sling stabilization exercise is found in its ability to enhance mobility, improve sensorimotor function, and increase relaxation⁷). The sling stabilization exercise is a type of treatment in which patients with neck pain can use their own body weight to resist gravity; thus, this type of exercise can be performed very safely. As the sling stabilization exercise enables patients to perform unloading exercise in a gravity-reduced environment, it has a similar effect to what would be expected from an aquatic exercise. A study was concluded to determine the effect of the co-contraction of the masticatory muscles during neck stabilization exercises on changes in the thickness of the neck flexors. That study concluded that co-contraction of the masticatory muscles during neck stabilization exercise is helpful, increasing the thickness of the longus colli muscle⁸).

A number of different types of stretching exercises can be used to treat patients with chronic neck pain, including dynamic stretching, which a patient can practice alone for prophylaxis⁹), proprioceptive neuromuscular facilitation, where the release and contraction of a muscle are repeatedly practiced, and Evjenth-Hamberg stretching, where isometric contraction and static stretching are applied to agonist and antagonist muscles using the hold-relax technique and the contract-relax technique¹⁰). Lee¹¹) investigated the effects of stretching exercises on forward head posture. In that study, the subjects were divided into three groups, a balance exercise group, a stretching exercise group, and a control group, and the respective groups performed the assigned exercises for four weeks. That study found that maximum muscle contraction was increased in the balance exercise group and the stretching exercise group. It also found that the forward head posture improved in those two groups. In addition, Park¹²) reported that the symptoms of forward head posture improved after applying static stretching and Evjenth-Hamberg stretching.

Most of the existing studies have mainly focused on comparing stretching with other types of exercises and they have concentrated only on demonstrating that stretching is effective for the treatment of forward head posture. However, very few studies have investigated the effect of training patients to use stretching and sling stabilization exercises in order to treat straight neck symptoms. Only a few studies have focused on how to treat straight neck symptoms and correct spinal alignment. Hence, this present study was conducted to compare the pre- and post-test results of the craniovertebral angle (CVA), the cranial rotation angle (CRA), and cervical range of motion (ROM), aiming to demonstrate whether or not training by stretching and sling stabilization exercises has any remedial value.

SUBJECTS AND METHODS

From among people in their 20s who were suffering from straight neck syndrome, 20 patients, diagnosed with straight neck, were recruited as the study's subjects. The subjects were divided into two groups: one sling stabilization exercise group, and one stretching exercise group. All the subjects voluntarily participated in the experiment and were thoroughly briefed on the purpose of the study and the tasks to be performed. The experiment began only after the subjects fully understood the study's intention and had consented to participation. Exclusion criteria included: heart disease, a mental health condition, dementia, sensory disturbance, spinal tumor, spondylolisthesis, pelvic osteoporosis, spinal osteoporosis, lumbar herniated intervertebral disc, or any other disease that might have influenced the spine or musculoskeletal system during experiment.

For ROM, the angle of flexion, extension, rotation, and lateral bending were measured within the active range of motion, using a standard goniometer (Table 2). When the ROM was measured, the intraclass correlation coefficient (ICC) was used as an index of reliability. As the ICC (2, k) was 0.934, the reliability of the measurements was considered to be high. The measurements were taken twice, and the mean value of the two measurements was used for the analysis. The measurements were taken before the experiment began and then again after the 6-week intervention had ended.

For the CVA and CRA measurements, the subjects were positioned so as to retain their natural head posture while standing at ease with both of their arms relaxed and placed alongside their torso. To measure the cervical angle, the 7th cervical (C7) vertebra, ear tragus, and the lateral canthus of each subject were linked by straight lines on the X-ray, and then the CVA and CRA were measured. If the X-ray showed a small CVA and a large CRA, the subject was noted as having greater forward head posture.

For the sling stabilization exercise, the cervical flexion-extension exercise and cervical lateral bending exercise were performed with the aid of sling stabilization exercise equipment. To perform the cervical flexion-extension exercise, the subjects were instructed to maintain the head in a neutral position while in a supine position and to slowly extend the neck, using the strap of the sling. The cervical flexion exercise was performed with the subjects in the prone position. In this position, the strap of sling was adjusted so that it would be perpendicular to the surface of the ground in order to prevent the chin and shoulders from being lifted during the exercise. The subjects performed three sets of exercise, and the exercise was repeated 15 times within each of the sets. Between each set, the subjects rested for 30 seconds. To perform the cervical lateral bending exercise, the subjects slowly performed right and left lateral bending of the head while releasing their neck. They were instructed not to lift their shoulders. The subjects performed three sets of exercise, and the exercise was repeated 15 times within each of the sets. Between each set, the subjects rested for 30 seconds. To perform the stretching exercise, this study adopted a method in which active contractions and passive relaxations of the agonist muscles were repeated, and active contraction of antagonist muscles was added, finally. Modifying the stretching exercise used by Park¹²), the

sternocleidomastoid and upper trapezius muscles were stretched in this study. This stretching exercise was performed for six weeks, and it was practiced three times each week. To stretch the sternocleidomastoid muscle, the subjects were instructed to lie in the supine position, to let their head and neck hang over the end of a hospital bed, and to place their shoulders at the edge of a bed. The therapist was told to stand at the head of the hospital bed after fixing the subject's shoulder and chest to the table using a belt. The head and neck posture were arranged so that the subjects would easily feel the tension created by the muscle contraction. When the therapist held the subject's head, both of the subject's ears were covered by both of the therapist's palms, and the subject's sternocleidomastoid muscles were held by the therapist's fingers. While holding this posture, the therapist fully rotated the subject's head to the right and pulled the head, making it perform left lateral bending. The subject was then instructed to say 'stop' at the point just prior to pain being triggered. When that occurred, the early stage of stretching began. At this stage, the subject was directed to apply force. The subject pressed the therapist's right hand in order to signal that the therapist should apply a similar amount of force in the opposite direction. Using these balanced forces, the therapist guided the subject in performing isometric contractions. The subject performed the isometric contraction for six seconds, counting from one to six, and gradually increased the intensity of the contraction, in order to prevent the Valsalva maneuver from occurring. While the subject relaxed for two to three seconds after the contraction, the therapist moved the subject's head in the direction in which greater stretching was possible. The therapist had to move the subject's head beyond the point which the muscle did not allow further movement, and held the stretch for 15–16 seconds. Finally, the therapist asked the subject to look to the right side and to move the head in the direction where the subject could extend the head further. By resisting this type of movement, the therapist strengthened the subject's antagonist muscles. This movement was continued for six seconds and the subject was allowed to rest for 10 seconds. These movements were repeated four times, and a total of 160 seconds were assigned to the stretching exercises. For the upper trapezius, the subject was instructed to hang his head and neck over the end of a hospital bed in the supine position and the therapist used a belt to fix the subject's shoulder and chest to the bed. The therapist was required to stand at the head of the bed, to hold the back of subject's head in his right hand, and to hold up the subject's head using his wrist and arm. The subject's jaw was held by the therapist's left hand and the therapist pulled up the subject's head. In this condition, the therapist arranged the subject's cervical vertebrae to first slowly rotate fully to the right and then to engage in left lateral bending. This time, the therapist's body moved along with the subject's head. Afterwards, isometric contraction was implemented and maintained for six seconds. In order to strengthen the antagonist muscle, the therapist kept his hands in the same place and pulled the subject's jaw to the right. The therapist then asked the subject to look towards the direction in which the head was to be extended to and move the head further in that direction. By resisting these movements, the therapist strengthened the subject's antagonist muscles. The time assigned for the isometric contraction, the method used to relax the muscle, and the entire time assigned for the stretching exercise were identical to the conditions used for the sternocleidomastoid stretches.

The measurements were analyzed using the statistical analysis program, SPSS 18.0. The Kolmogorov-Smirnov (K-S) test was used to verify the normality of the data. In order to analyze the way in which the straight neck symptoms varied depending on the type of treatment, the independent t-test was used. The paired t-test was used to investigate variations in the pre- and post-test measures of straight neck and spinal posture, depending on the type of treatment. A statistical significance level of $\alpha = 0.05$ was used. This study was approved by the Institutional Review Board of Namseoul University (Cheonan, Korea, NSU-140609-2).

RESULTS

This study investigated whether sling stabilization and stretching exercises could cause structural changes in the cervical spine of straight neck patients. In terms of the change in the cervical angle, there was no significant difference between the sling stabilization exercise group and the stretching exercise group. When a comparison of the pre- and post-test results was conducted, focusing on changes in CRA and CVA, the stretching exercise group was found to show a statistically significant changes while the sling stabilization exercise group did not (Table 1). In terms of ROM, there was no significant difference between the two groups. When the pre- and post-test results of the sling stabilization exercise group were compared, a significant difference was found in flexion, right rotation, left lateral bending, and right lateral bending. A significant difference was found in left rotation, left lateral bending, and right lateral bending, when the pre- and post-test results of the stretching exercise group were compared (Table 2).

DISCUSSION

People today commonly experience neck diseases because of repetitious jobs and inappropriate posture resulting from industrialization¹³⁾. Sling exercise has the major therapeutic advantage of underwater exercise, a reduction of the influence of gravity, on hard ground. It uses variable changes in axes to exercise the body¹⁴⁾. The present study found that only the stretching exercise group displayed a significant difference in terms of CVA and CRA changes when the pre- and post-test results were compared. In the stretching exercise group, CVA decreased from 71.33 ± 6.28 to 65.33 ± 5.22 degrees and CRA decreased from 150.66 ± 11.21 to 142.70 ± 10.53 degrees.

Yang et al.¹⁵⁾ conducted a study of subjects with forward head posture, who performed neck flexion and extension exer-

Table 1. Changes in CVA and CRA of the two groups (degrees)

Variable	Group	Pre-test	Post-test
CVA	Sling	73.1±6.9	69.1±5.4
	Stretching	71.3±6.2	65.3±5.2 [†]
CRA	Sling	153.0±11.2	148.7±15.9
	Stretching	150.6±11.2	142.7±10.5 [†]

Values are expressed as mean ± standard deviation; CVA: Craniovertebral angle; CRA: Craniovertebral angle; * <0.05 ; [†] $p < 0.05$: significance difference between pre- and post-exercise

Table 2. Changes in ROM of the two groups (degrees)

Variable	Group	Pre-test	Post-test
Flexion	Sling	46.5±9.8	49.6±8.4 [†]
	Stretching	50.2±4.8	52.4±6.0
Extension	Sling	37.0±11.7	41.7±8.0
	Stretching	38.4±6.5	41.0±5.7
Left Rotation	Sling	49.1±6.9	54.4±8.4
	Stretching	48.4±6.2	54.5±4.9 [†]
Right Rotation	Sling	48.5±8.4	56.3±9.2 [†]
	Stretching	51.5±3.5	54.5±6.5
Left	Sling	34.2±7.2	42.0±5.4 [†]
Lateral Bending	Stretching	34.3±4.4	38.3±4.5 [†]
Right	Sling Ex	30.1±3.3	36.6±4.7 [†]
Lateral Bending	Stretching	33.8±4.8	37.3±5.1 [†]

Values are expressed as mean ± standard deviation; * <0.05 ; [†] $p < 0.05$: significance difference between pre- and post-exercise

cises, stretching exercises, and neck stabilization exercises using sling exercise equipment. That study compared the pre- and post-test results of threshold measuring pressure pain, CVA, and CRA. No significant difference was found in threshold pressure pain, while significant differences were found in the CVA and CRA values of the Rapid Upper Limb Assessment (RULA). In another study, 25 subjects were divided into two groups, a sling stabilization exercise group and a control group, and they were instructed to conduct the assigned exercise for four weeks. CVA, CRA, muscle activity, and cervical alignments were measured after the completion of the exercise. When the pre- and post-test results of CVA and CRA were compared, the sling stabilization exercise group displayed significant differences were both CVA and CRA, while a significant difference was found in the CVA value of the control group, which only performed the stretching exercise¹⁶⁾.

As shown in this study, the stretching exercise returned the shortened muscle to normality, and the abnormal cervical range of motion caused by the shortened muscle also returned to normality. Thus, the stretching exercise was found to be effective at normalizing abnormal forward head posture. The sling stabilization exercise was also found to have exerted a positive influence. In the sling stabilization exercise group, the subjects were able to exercise with no influence of gravity, within their own cervical ROM, under the therapist's control, using the sling equipment. The weakened muscle was mobilized and the imbalanced muscles were balanced again. Thus, the normalization of abnormal forward head posture is possible using the sling stabilization exercise. However, a statistically significant result was not found for this group. This can be attributed to the fact that the subjects' living habits could not be thoroughly controlled and the therapist's contribution to the sling stabilization exercise group was less than the interference in the stretching exercise group. Therefore, the patient's weakened muscle could not be fully used, which could result in the lack of a significant difference in the findings.

In terms of ROM changes, the measurement of cervical ROM, is regarded as the standard test by which a patient with a disorder such as straight neck syndrome is assessed, because it enables investigators to focus on the factors of pain and functional movement. ROM is also frequently used as a yardstick to judge whether actual remedial value has occurred. In many studies, ROM has been proven to have a significant correlation with cervical disorders¹⁷⁾. Chun et al.¹⁸⁾ reported that the older patients who had performed stretching exercises were found to have increased their cervical range of motion. The neck pain group that had been treated by both the ROM technique (joint mobilization) and the physical therapy technique, displayed better results, thereby demonstrating that flexion, extension, left lateral bending, right lateral bending, left rotation, and right rotation were all improved in comparison to the other neck pain group, which had only been treated using the physi-

cal therapy technique¹⁹). A study, in which the head-neck flexion exercise was performed using sling equipment, reported that the ROM for flexion and extension was significantly improved²⁰.

In the present study the sling stabilization exercise group showed a significant difference in the flexion, right rotation, left lateral bending, and right lateral bending results, and the stretching exercise group showed a significant difference in the left rotation, left lateral bending, and right lateral bending results. It seems that the muscular asymmetry, caused by the straight neck symptom, was returned to the symmetric state by the sling stabilization exercise. Hence, the normal alignment of the cervical spine was realized by the exercise conducted by the sling stabilization exercise group and this led to the improvement in ROM. Moreover, the stretching exercise used in the stretching exercise group contributed to the normalization of muscle length by extending the shortened muscle, and this normalization of muscle length led to the improvement in ROM.

The results of this study coincide with the findings presented in many previous studies; thus, it is possible to infer that the stretching exercise and the sling stabilization exercise exert a positive influence on ROM. The reason why not all of the ROM variables in this present study showed improvements that were as significant as the improvements found in other studies, is attributed to the fact that the exercise methods used in this present study were different from those used in other studies; moreover, in this present study, the individual subjects' daily living habits could not be thoroughly controlled.

This study found that the sling stabilization exercise group showed significant improvement in the ROM, while the stretching exercise group showed a significant improvement in cervical alignment and ROM. All parts of the human body are intimately connected to one another, and imbalance causes abnormal body phenomena to appear when a problem breaks out even in a single part of human body. Because muscles in the human body control musculoskeletal posture, they play a fundamental role in movement. Thus, the work load on human muscles is always heavy. Due to this peculiar nature of muscles, they are vulnerable to irregular posture, unsafe movements, over-use, and unusual usage. Therefore, structural damage and functional disorders are apt to occur frequently in the muscles of the human body²¹). One study revealed that pains around the neck might develop into a more serious disease because of the psychological stress they cause²²).

In relation to cervical spine alignment and ROM, this study's findings suggest that future studies should try to identify the way in which different types of therapies could be used to treat straight neck patients, in addition to current treatment approaches. Future studies should also examine how psychological treatment could be given along with various types of existing treatment, to help ensure better patient outcomes.

ACKNOWLEDGEMENT

Funding for this paper was provided by Namseoul University.

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