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# Effects of Neck Exercise on High-School Students' Neck–Shoulder Posture

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**Abstract** [Purpose] This study examined the effects of deep flexor muscle-strengthening exercise on the neck–shoulder posture, and the strength and endurance of the deep flexor muscles of high-school students. [Subjects] The subjects were 30 seventeen-year-old female high-school students who complained about bad posture and chronic neck–shoulder pain. They were randomly divided into an experimental group of 15 subjects, who performed a deep flexor muscle-strengthening exercise and a control group of 15 subjects, who performed a basic stretching exercise. [Methods] The experimental group of 15 subjects performed a deep flexor muscle-strengthening exercise consisting of low-load training of the cranio-cervical flexor muscle, and the control group of 15 subjects performed a basic stretching exercise consisting of seven motions. [Results] The experimental group showed statistically significant changes in head tilt angle, neck flexion angle, forward shoulder angle, and the result of the cranio-cervical flexion test after the training. In contrast, the control group showed no statistically significant changes in these measures following the training. When the results of the groups were compared, statistically significant differences were found for all items between the experimental group and the control group. [Conclusion] Strengthening cranio-cervical flexor muscles is important for the adjustment of neck posture, and maintaining their stability is required to improve neck-shoulder posture.
**Key words:** Cranio-cervical flexion training, Forward head posture, Neck exercise

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## INTRODUCTION

Posture is an essential element of normal balance[1)], and bad posture is commonplace in adolescence[2)]. Various factors trigger spasm of the shoulders and back muscles, reduce the effectiveness of biomechanical functions, and weaken soft tissues[3)]. These include forward head posture, due to popularization of computers[4)], sitting at a desk or a computer for a long time, use of desks and chairs not appropriate for the physique, a bed not conducive to good posture, lack of exercise, excessive learning activities[3)], and heavy school bags[5)].

Forward head posture is one of the most common postural alterations in patients with neck diseases[6)]. Patients with neck–shoulder diseases have more severe forward head posture than those without such diseases, and their scapular acromion protrudes[7)].

The role of the longus capitis and longus colli, deep flexor muscles of the neck, is considered important in postural adjustment and maintaining stability of the neck[8)]. They jointly cooperate to support the weight of the head while moving the head in various directions and provide stability during low-intensity static muscle endurance exercise, but not during high-intensity exercise, for which strong muscle contraction is required[9)].

High-school students are adolescents who experience a period of accelerated growth and development of skeletal and soft tissue[10)]. Posture of adolescents can be affected by both internal and external influences, which may make adolescents more susceptible to injury[5)].

This study examined the effects of deep flexor muscle-strengthening exercise on neck–shoulder posture, and the strength and endurance of the deep flexor muscles of high-school students who complained about bad posture and chronic neck–shoulder pain.

## SUBJECTS AND METHODS

### *Subjects*

The subjects were 30 seventeen-year-old female high-school students in their senior year who sat behind a desk for at least 10 hours a day, had experienced pain in the neck–shoulder region for 3 months or longer, had a neck disability index of less than 15 points, whose symptoms were not aggravated by muscle-strengthening exercise, and who did not show a second-stage pressure increase of 4 mmHg above an initial pressure of 20 mmHg for 10 seconds or longer during a cranio-cervical flexion test[11)]. This study was conducted from January 2012 to February 2012. The subjects were randomly and equally assigned to a deep flexor muscle-strengthening exercise group and a basic stretching exercise group. A sufficient explanation of the purpose of

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this study was given to all the subjects and their guardians, and written consent was obtained from all the participants in this study.

*Methods*

The experimental group was assigned to cranio-cervical flexion training, in other words, deep flexor muscle-strengthening exercise. The control group performed neck–shoulder stretching exercises. They received training under the supervision of a researcher for no longer than 30 minutes, five times per week, for a total of 8 weeks.

Cranio-cervical flexion training was conducted as low-load training of the cranio-cervical flexor muscle[12]. Relaxation of the superficial flexor muscles, sternocleidomastoid muscle, and scalenus anterior muscle was maintained while the cranio-cervical flexion was performed to strengthen the deep flexor muscles of the upper neck, the longus capitis and longus colli muscles. A pressure sensor filled with air was placed behind the neck near the occipital region, and the flattening of cervical lordosis was confirmed using visual feedback from the sensor's dial. An air-filled bag was placed behind the neck and inflated until the sensor displayed 20 mmHg. When the subject checked the dial and pressed the bag slowly, the researcher palpated the sternocleidomastoid muscle and the scalenus anterior muscle with her fingers so that contraction did not occur. At this point, the occipital region should be in contact with the ground. The pressure was incrementally increased by contraction gently and slowly, by 2 mmHg each time until a value of 30 mmHg was reached. The contraction was maintained for 10 seconds, and this was repeated 10 times, with a break of 3 to 5 seconds between contractions[13].

The basic stretching exercise consisted of seven motions[14]. At the start, the motion was performed for about 10 seconds, and the time was extended by 2 to 3 seconds every two to three days until it reached a value of 25 seconds. The neck and the shoulder were lightly tapped with both hands at the beginning and end of the stretching.

A description of the instructions given to the subjects is provided below.

1. Clasp the hands and stretch them straight upwards (with the subject looking at the hands).

2. Place both hands on the shoulders and push out the chest (with the head thrown backwards).

3. Look straight ahead and slowly turn the head horizontally and stop when the maximum value is reached (right and left).

4. Throw back the head, and turn it until it has reached the fully stretched point (right and left).

5. Lower the head, and turn it until it has reached the maximal point (right and left).

6. Place one hand over the shoulder and grasp the elbow of the turned hand, with the other hand over the head and slowly pull it inward until it has reached the full stretched point (right and left).

7. Straighten the upper part of the body, and slowly raise both arms up with the hands clasped.

A photographer at the Department of Diagnostic Radiology photographed the neck–shoulder posture from the front and from the side using diagnostic X-ray equipment. Four lead markers were attached to the center of the forehead, the tragus of the ear, the spinous process of the 7th cervical vertebra (C7), and the end of the scapula acromion. The head's tilt angle was measured on the X-ray images, as the angle between the line connecting the forehead and the tragus of the ear and the Y-axis at the tragus. The neck's flexion angle was measured as the angle between the line connecting the tragus of the ear and C7 and the Y-axis at C7. The forward shoulder angle was measured as the angle between the line connecting C7 and the end of the acromion and the Y-axis at C7[7, 15, 16]. Subjects stood normally to achieve a natural head–shoulder position. The subjects performed cervical flexion and extension in a large arc and gradually reduced the size of the arc thereby allowing the head to fall into the most comfortable position. The subject was directed to look at his or her eyes in a mirror, which was placed to the front, to discourage changes in posture (Fig. 1)[17].


**Fig. 1.** X-ray comparison of pre- and post-intervention

The cranio-cervical flexion test was conducted to test the strength and the endurance of the deep muscles of the neck[18]. The Subjects lay on the floor, face up, and an air-bag fitted with a pressure sensor was placed beneath the neck near the occipital region. Air was then pumped into the bag to produce an initial pressure of 20 mmHg. The dial was checked, and the head's nodding movement was slowly and smoothly adjusted. The researcher palpated the sternocleidomastoid muscle and the scalenus anterior muscle to ensure that they did not contract. The strength and the endurance of the deep flexor muscles were tested in five increments of 2 mmHg until the pressure reached the maximum level of 30 mmHg. Contractions were performed 10 times for 10 seconds each time, then the next stage was performed. The level of the pressure achieved by the subject was measured.

The results were analyzed using SPSS 18.0, and the mean and the standard deviation were calculated. The nonparametric Wilcoxon signed rank test was used to determine changes in the neck–shoulder posture and in the strength and the endurance of the muscles. The nonparametric Mann-Whitney test was employed to examine differences between the groups. Statistical significance was accepted for values of $p<0.05$.

## RESULTS

The experimental group showed statistically signifi-

**Table 1.** Comparison of outcome measures within and between groups at pre- and post-intervention (Mean±SD)

| | Group | Experimental group | Control group |
|---|---|---|---|
| HTA* | Pre-test | 54.29±5.14 | 54.33±3.48 |
| | Post-test* | 51.69±4.70 | 54.55±3.36 |
| NFA* | Pre-test | 36.50±4.59 | 34.77±6.38 |
| | Post-test* | 27.52±4.84 | 34.22±5.87 |
| FSA* | Pre-test | 33.17±11.80 | 33.65±10.29 |
| | Post-test* | 20.95±4.29 | 33.00±9.57 |
| CCFT* | Pre-test | 2.37±0.12 | 2.39±0.23 |
| | Post-test* | 7.78±0.57 | 2.40±0.28 |

*$p<0.05$. HTA = head tilt angle, NFA = neck flexion angle, FSA = forward shoulder angle, CCFT = craniocervical flexion test

cant changes in head tilt angle, neck flexion angle, forward shoulder angle, and the results of the cranio-cervical flexion test after the training ($p<0.05$). In contrast, the control group showed no statistically significant changes in these parameters following the training ($p>0.05$) (Table 1). When the results of the two groups were compared, statistically significant differences were found for in all items between the experimental group and the control group ($p<0.05$) (Table 1).

## DISCUSSION

The human head weighs 3.5 to 4.5 kg, and muscles in the neck and shoulder areas support the head[19]. Bad posture over a long period triggers dynamic stress and pain in the neck and shoulders, leading to an abnormal imbalance in muscle strength and flexibility[20] and chronic or idiopathic headache[21]. Correct posture habits and posture training are necessary for high-school students who lead a sedentary life for more than 10 hours a day, in order to prevent postural pain syndrome and functional disorders[20].

Petty et al. noted that weakened deep flexor muscles and consequentially decreased adjustment ability activated the superficial muscles, sternocleidomastoid muscle and scalenus anterior muscle, and triggered excessive movement of the chin and the head resulting in excessive extension of the upper neck bone and shortening of the posterior muscles of the neck bone, reducing the stability of the neck[22].

Conley et al. reported that deep muscles of cervical vertebrae maintain cervical lordosis and play an essential role in adjusting the movement of spinal segments. Much research has focused on the correlation between the stability of the cervical spine and the deep flexor muscles[23].

Heo JG observed that impairment of the deep flexor muscle in patients with chronic neck pain weakened the strength of static muscles and severely weakened the endurance of the muscles. He added that for rehabilitation of patients with neck pain, the primary objective should be to improve the endurance of the neck muscles so that they can withstand low-intensity load for a long time[24].

In the present study, female high-school students performed neck deep flexor muscle-strengthening exercise for 8 weeks, and their neck–shoulder posture (head tilt angle, neck flexion angle, and forward shoulder angle) significantly improved ($p<0.05$). Our results for the head tilt angle and the neck flexion angle are slightly different than those of Szeto et al.[7], whose subjects were employees with and without neck–shoulder discomfort. The contadictory results possibly arise from differences in the age range of the subjects and the measurement methods.

We found a significant improvement in the strength and the endurance of the deep flexor muscles in the present study ($p<0.05$). This finding is almost consistent with that of Chiu et al.[25] who performed the cranio-cervical flexion test on subjects with and without neck pain. They reported that the pressure level of those with neck pain was significantly lower than of those without symptoms. Our results suggest that strengthening deep flexor is muscles important for the adjustment of neck posture, and maintaining their stability is required to improve neck-shoulder posture.

We are living in a world where interest in health and the body is ever increasing. The need for posture education and exercise should be emphasized to adolescents who adopt incorrect sitting positions while spending long periods of time studying, and indulge in additional unhealthy behaviors that can trigger postural alteration. This study confirmed that selective neck exercise improved high-school students' posture and significantly enhanced the strength and endurance of their deep flexor muscles.

The limitations of this study were the small number of participants in the study, the inclusion of female students only, and the lack of information on their levels of activity, all of which make it difficult to generalize the results. Future research should include a greater number of subjects and make gender comparisons.

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### REFERENCES

1) Shumway-Cook A, Wollacoot MH: Motor Control: Translating Research into Clinical Practice, Philadelphia: Lippincott Williams & Wilkins, 2006.
2) Cho CY: Survey of faulty postures and associated factors among Chinese

adolescents. J Manipulative Physiol Ther, 2008, 31: 224–229. [Medline] [CrossRef]
3) Park SA, Lee KI, Kim KY: Daily living habits and knowledge of good posture among the middle school students. J Sport Leis Stud, 2008, 33: 603–614.
4) Mekhora K, Liston CB, Nanthavanij S: The effect of ergonomic intervention on discomfort in computer users with tension neck syndrome. Int J Ind Ergon, 2000, 26: 367–379. [CrossRef]
5) Chansirinukor W, Wilson D, Grimmer K, et al.: Effects of backpacks on students: measurement of cervical and shoulder posture. Aust J Physiother, 2001, 47: 110–116. [Medline]
6) Hickey ER, Romndeau MJ, Corrente JR, et al.: Reliability of the cervical range of motion device and plumb line techniques in measuring resting head posture (RHP). J Manual Manip Ther, 2000, 8: 10–17. [CrossRef]
7) Szeto GP, Straker L, Raine S: A field comparison of neck and shoulder postures in symptomatic and asymptomatic office workers. Appl Ergon, 2002, 33: 75–84. [Medline] [CrossRef]
8) Boyd-Clark LC, Briggs CA, Galea MP: Muscle spindle distribution, morphology, and density in longus colli and multifidus muscles of the cervical spine. Spine, 2002, 27: 694–701. [Medline] [CrossRef]
9) Falla DL, Jull G, Hodges PW: Patients with neck pain demonstrate reduced electromyographic activity of the deep cervical flexor muscles during performance of the craniocervical flexion test. Spine, 2004, 29: 2108–2114. [Medline] [CrossRef]
10) Parfitt AM: The two faces of growth: benefits and risks to bone integrity. Osteoporos Int, 1994, 4: 382–398. [Medline] [CrossRef]
11) Jull GA, Falla D, Vicenzino B, et al.: The effect of therapeutic exercise on activation of the deep cervical flexor muscles in people with chronic neck pain. Man Ther, 2009, 14: 696–701. [Medline] [CrossRef]
12) Jull G, Kristjansson E, Dall'alba P: Impairment in the cervical flexor: a comparison of whiplash and insidious onset neck pain patients. Man Ther, 2004, 9: 89–94. [Medline] [CrossRef]
13) Jull G, Sterling M, Falla D, et al.: Whiplash, Headache and Neck Pain: Research based directions for physical therapies. Edinburgh: Churchill Livingstone, 2008.
14) Kim JK, Lee SJ: Effect of stretching exercise as work-related musculoskeletal pain of neck and shoulder. J Kor Alliance Health Phys Edu, 2004, 43: 655–662.
15) Yoo WG, Kim MH, Yi CH: Intra-rater and inter-rater reliability of various forward head posture measurements. Phys Ther Kor, 2005, 12: 41–47.
16) Yoo WG, Yi CH, Kim MH: Effects of a proximity-sensing feedback chair in head, shoulder, and trunk postures when working at a visual display terminal. J Occup Rehabil, 2006, 16: 631–637. [Medline] [CrossRef]
17) Watson DH, Trott PH: Cervical headache: an investigation of natural head posture and upper cervical flexor muscle performance. Cephalalgia, 1993, 13: 272–284. [Medline] [CrossRef]
18) Jull GA, O'Leary S, Falla D: Clinical assessment of the deep cervical flexor muscle: the craniocervical flexion test. J Manipulative Physiol Ther, 2008, 31: 525–533. [Medline] [CrossRef]
19) Kim SY, Lee HJ: Literature review on the association between a cervical dysfunction and the change of neuromuscular control activity. J Kor Acad Orthop Manu Ther, 2006, 12: 57–67.
20) Kim MI, Jung DC: A research for solving problems over common spinal caries and chronic posture. Kor Sports Res, 2004, 15: 1411–1422.
21) Chae YW, Lee HM: The effect of craniocervical exercise on tension-type headache. J Kor Soc Phys Ther, 2009, 21: 9–16.
22) Petty NJ, Moore AP: Neuromusculoskeletal Examination and Assessment. Edinburgh: Churchill Livingstone, New York: 2001.
23) Conley MS, Meyer RA, Bloomberg JJ, et al.: Noninvasive analysis of human neck muscle function. Spine, 1995, 20: 2505–2512. [Medline] [CrossRef]
24) Heo JG: The impact of static strength and static endurance of the neck deep flexor on chronic neck pain. Kor Sport Res, 2005, 16: 215–226.
25) Chiu TT, Law EY, Chiu TH: Performance of the craniocervical flexion test in subjects with and without chronic neck pain. J Orthop Sports Phys Ther, 2005, 35: 567–571. [Medline]