Effects of cervical sustained natural apophyseal glide on forward head posture and respiratory function

Se-Yoon Kim, MS, PT1), Nan-Soo Kim, PhD, PT2)*, Laurentius Jongsoon Kim, PhD, PT2)

1) Mirae Health Medical Center, Republic of Korea
2) Department of Physical Therapy, College of Health and Science, Catholic University of Pusan: 9 Bugok 3-dong, Geumjung-gu, Busan 609-757, Republic of Korea

Abstract. [Purpose] To determine the effects of cervical sustained natural apophyseal glide on forward head posture and respiratory function. [Subjects and Methods] Thirty male and female adults in their 20s with forward head posture were included in the study. The subjects were divided randomly into experimental and control groups (n=15 each). Subjects in the experimental group performed cervical sustained natural apophyseal glide three times/week for four weeks while subjects in the control group did not perform the intervention. The craniovertebral angle, forced vital capacity and forced expiratory volume in the first second, as well as the % predicted value of each measurement were assessed to determine the changes in respiration functions before and after the exercise. [Results] The craniovertebral angle four weeks after the experiment was increased in the experimental group, whereas the control group showed no significant difference compared to baseline. The forced vital capacity, forced expiratory volume in the first second, and the % predicted values thereof were significantly increased in the experimental group four weeks after the experiment, but not in the control group. [Conclusion] Cervical sustained natural apophyseal glide was determined to be effective in improving neck posture and respiratory functions for patients with forward head posture.

Key words: Cervical SNAG, Forward head posture, Respiratory function

INTRODUCTION

Forward head posture is anterior positioning of the cervical spine, which is regarded as a “bad” head posture and is commonly found in patients who experience problems with the head and neck3). Particularly, forward head posture is frequently found in people sitting in front of a computer for prolonged periods. Load increases in the muscles and joints of the cervical spine as a result of forward head posture are considered a major cause of musculoskeletal disorders3). Sustained computer work affects the range of cervical flexion, especially in the upper cervical part3), and forward head posture is related to reduced proprioception3).

Respiration is a complex function that involves cooperation between the musculoskeletal and nervous systems, by which air can move in and out of the lungs according to changes in the volume of the rib cage5). The loss of respiratory functions is related to functional disorders associated with trunk posture and weakening of the respiratory muscles6). Forward head posture reduces muscle power in the neck, which is followed by a reduction in muscle power of the respiratory muscles. Thus, damage in the respiratory muscles is associated with damage of the motor control in the cervical spine. In addition, forward head posture has a negative effect on the expansion of the thorax and alveolar ventilation, thereby reducing the lung volume and vital capacity as well as weakening respirator functions7).

Joint mobilization is a method that applies traction and gliding techniques passively to the articular surface in order to maintain or recover mobility back to the normal state. These movements are applied by a physical therapist, and this is a passive technique that is performed at slow speed, allowing the patients to stop the movement by themselves.

Mulligan first proposed the use of Sustained Natural Apophyseal Glide (SNAG) mobilization, which can be applied for spinal pain treatment8). The concept of SNAG is to increase the treatment effects by having patients perform active movements while removing pain in the lesions by means of manipulative therapy. This is a new concept in the manipulative therapy field, and differs from traditional manipulative therapy by combining the active movements of the patients with additional passive movements performed with the aid of therapists8). It should be noted that while applying SNAG mobilization, the therapist needs to apply the exercise to be horizontal or perpendicular to the joint, and the movements of the patient should be performed within...
a range in which the patient does not feel any pain. At the end of the joint movement, the therapist may apply slight overpressure\textsuperscript{8}. Silveria et al.\textsuperscript{10} revealed that respiratory functions can change as a result of forward head posture and that inappropriate posture may worsen respiratory functions, particularly in patients with respiratory diseases\textsuperscript{11}. Furthermore, forward head posture can induce inappropriate posture, thereby causing compensation mechanisms to increase the respiratory functions, and Kim et al.\textsuperscript{12} moreover reported that forward head posture induced weakening of the respiratory functions.

Thus, the purpose of this study was to determine the effects of the cervical SNAG mobilization proposed by Mulligan on forward head posture and various respiratory functions.

**SUBJECTS AND METHODS**

The study subjects included individuals whose craniovertebral angle was ≤49°\textsuperscript{13} in order to determine the effects of cervical SNAG manipulative therapy on forward head posture and respiratory function, and the subjects were randomly classified into an experimental group receiving cervical SNAG and a control group not receiving the intervention. The changes after the exercise were measured and compared against the baseline and between the two groups. This study conducted experiments with male and female adults in their 20s who had forward head posture. Thirty subjects who understood the purpose of this study and participated voluntarily were randomly classified into the experimental (15 subjects) and control groups (15 subjects). The exclusion criteria were as follows: subjects who had undergone operations in the spinal bones or chest, had traumatic neck injury, had acute or chronic neuromuscular pain not related to other body parts, had severe obesity (body mass index [BMI] > 40 kg/m\textsuperscript{2}), had clinical abnormalities in the rib cage or spine, had severe comorbid diseases, had diabetes or malignant tumors, and were smokers.

Subjects in the experimental group underwent cervical SNAG manipulative therapy as an intervention to treat forward head posture for flexion and extension, eight times per set, three times a week for four weeks. During the therapy, the subjects were seated on chairs with back support while a therapist was positioned behind the subject. The therapist applied a force to the spinous process in the upper side of the fixed joint with the thumb of the right hand and applied a passive gliding exercise continuously, while the left thumb was placed with the right thumb. The gliding exercise of the cervical SNAG for cervical flexion was performed by the subjects actively repeating flexion of their necks and returning back to the neutral position. In addition, cervical SNAG for extension was conducted by the subjects repeatedly performing extension of their necks and returning back to the neutral position. Here, the application of the passive gliding exercise maintained its direction in the anterosuperior direction along the line of the articular surface of the facet joint while flexing the neck and returning back to the neutral position, as well as when extending the neck and returning back to the neutral position repeatedly\textsuperscript{8}. To determine whether the subjects had forward head posture or not, the craniovertebral angle was measure while respiratory function was measured using a spirometer.

The craniovertebral angle is measured to determine the presence of forward head posture, which is assessed by the head position when observed laterally at the seventh cervical (C7) vertebra. This angle is formed by a horizontal line drawn through the spinous process of the C7 vertebra and a line joining the spinous process of the C7 vertebra with the tragus of the ear. The more anterior head position is observed, the smaller the angle is\textsuperscript{14}. For the measurement, the subjects maintained the upright posture while relaxing both their arms next to their trunk and gazed at a predetermined point according to their eye height. To measure the accurate position while taking a picture, positions of the tragus of the ear and the spinous process of the C7 vertebra were marked. Once a photo was shot laterally using a digital camera (IXUS951S; Canon, China), the craniovertebral angle was calculated using ImageJ software (Rasband, USA)\textsuperscript{15}. According to the study by Nemmers et al.\textsuperscript{13}, forward head posture is defined by a craniovertebral angle in the range of 49–59°. Thus, this study set the criterion of forward head posture as ≤49° in terms of the craniovertebral angle.

The respiratory functions of each subject were measured using a spirometer (SP-260 Pneumotacho Sensor; SCHILLER AG, Switzerland). Three measurements were taken and the mean was chosen as the test result if they showed reproducibility.

The measurements were performed while the subjects were in the upright position, and included forced vital capacity (FVC), % predicted value of forced vital capacity (FVC %pred.), forced expiratory volume in one second (FEV\textsubscript{1}), and % predicted value of the forced expiratory volume in one second (FEV\textsubscript{1} %pred.). Differences in the forward head posture and respiratory functions between the two groups before and after the experiment were analyzed using the Mann-Whitney U test, whereas the differences in forward head posture and respiratory functions before and after the treatment period within a group were analyzed using the Wilcoxon signed-rank test. The data were analyzed using PASW ver. 18.0 (SPSS Inc., USA). The significance level (α) was set to 0.05.

**RESULTS**

This study was approved by the Bioethics Committee of the Catholic University of Pusan (CUPIRB-2013-015). The average age, height, weight, BMI, craniovertebral angle, FVC, FVC %pred., FEV\textsubscript{1}, and FEV\textsubscript{1} %pred., were 22.07 years, 167.93 cm, 65.20 kg, 22.94 kg/m\textsuperscript{2}, 45.74°, 3.54 L, 84.07%, 3.27 L, and 90.20%, respectively, in the experimental group. In the control group, the corresponding values were 21.47 years, 170.13 cm, 62.33 kg, 21.54 kg/m\textsuperscript{2}, 46.26°, 3.91 L, 88.47%, 3.68 L, and 97.07%, respectively. There were no significant differences in the general characteristics and variables between the two groups before the experiment. The analysis results of the respiratory functions showed that the subjects in both groups had normal FVC and FEV\textsubscript{1}/FVC.

The craniovertebral angle of the subjects in the ex-
postural improvements in the neck postures after the treatments were compared. The results showed that joint mobilization had the most significant effect on postural improvements in the neck. In the present study, there was no significant difference in the craniovertebral angle between the two groups before the intervention, whereas the experimental group showed significant improvements after four weeks of intervention. On the other hand, no significant changes were observed in the control group after the four-week period. Hence, these results suggest that cervical SNAG mobilization is effective in improving forward head posture.

Kim19) divided subjects with forward head posture into an experimental group, for which the McKenzie intervention was applied, and a control group. No significant differences in respiration functions were observed between the groups before the intervention, whereas significant improvements were noted in the subjects in the experimental group after four weeks of intervention. Furthermore, another previous study aimed to determine the effect of thoracic spine posture correction using chiropractic manipulations, and divided the subjects into a thoracic spine correction group using manual therapy and a thoracic spine correction group using an impulse gun, after which the differences in vital capacity were compared before and after the interventions. The results revealed that the subjects in both groups showed significantly increased vital capacity after the interventions20). In our study, the experimental group demonstrated significantly improved respiration functions after the intervention, whereas no significant differences were observed in the control group compared to at baseline. Accordingly, after the four-week intervention, statistically significant differences in the respiration functions were found between the experimental and control groups. Hwangbo21) conducted experiments with 45 chronic neck pain patients who had thoracic kyphosis and divided the subjects into thoracic joint mobilization plus self-stretching exercise groups. All three groups showed significantly improved joint range of motion and respirator
c

Table 1. Comparison of the CVA and respiratory functions between the experimental (n=15) and control groups (n=15)

| Group      | Pre test (Mean ± SD) | Post test (Mean ± SD) |
|------------|----------------------|-----------------------|
|            |                      |                       |
| CVA (°)    | 45.74±3.16           | 52.32±2.68 *          |
| Experimental | 46.26±2.23          | 47.41±2.53           |
| Control    | 3.54±0.75            | 3.75±0.65 *          |
| FVC (L)    | 3.91±0.62            | 3.94±0.83           |
| Experimental | 84.07±9.15          | 89.67±9.38 *         |
| Control    | 88.47±7.86           | 89.53±10.68          |
| FVC %pred. | 3.27±0.75            | 3.49±0.64 *          |
| Experimental | 3.68±0.72            | 3.83±0.79           |
| Control    | 90.20±10.92          | 96.60±9.36 *         |
| FEV1 (L)   | 97.07±6.83           | 100.67±10.08         |
| Experimental | 3.75±0.65            | 3.94±0.83           |
| Control    | 88.47±7.86           | 89.53±10.68          |
| FEV1%pred. | 84.07±9.15           | 89.67±9.38 *         |
| Experimental | 88.47±7.86          | 89.53±10.68          |
| Control    | 90.20±10.92          | 96.60±9.36 *         |

CVA: craniovertebral angle, SD: standard deviation, FVC: forced vital capacity, FEV1: forced expiratory volume at one second, %pred.: percent predicted value, *p < 0.05

DISCUSSION

Movements of the thorax can be controlled by coordinated movements among the spine, ribs, and surrounding joints. Forward head posture can increase kyphosis, and excessive kyphosis of the thoracic spine due to forward head posture can reduce the mobility of the thorax, thereby having a negative effect on the respiration capabilities15, 16). In addition, changes in the posture have been known to affect the length of the respiratory muscles during the breathing rest17). Kim et al.12) measured the craniovertebral angle of healthy adults in their 20s and studied 15 subjects with forward head posture correction through manipulative therapy, and respiratory functions after the interventions. The above study results are consistent with those of the present study, in which postural correction through manipulative therapy was found to be an effective method for recovering and improving respiratory functions.

In conclusion, cervical SNAG mobilization, which has been previously shown to reduce neck pain and increase the experimental group increased significantly after four weeks of intervention (p<0.05). In the control group, there was no significant difference in the craniovertebral angle before and after the four-week experiment (p>0.05) (Table 1).

Moreover, the respiratory functions in the experimental group before and after the intervention were compared, and the result showed that the FVC, FVC %pred., FEV1 and FEV1%pred. increased significantly after four weeks of intervention (p<0.05). However, there were no significant differences in the control group (p>0.05) (Table 1).

The experiment result showed that the mean FVC %pred. of the subjects in the experimental group was 93.54%, while that of the control group was 99.62%, indicating that the respiration functions in the experimental group were significantly lower than those of the control group.

In a study by Oh18), the subjects were divided into a joint mobilization group, for which cervical SNAG mobilization was applied; a neuro-feedback group; and a control group, and changes in the neck postures after the treatments were compared. The results showed that joint mobilization had the most significant effect on postural improvements in the neck. In the present study, there was no significant difference in the craniovertebral angle between the two groups before the intervention, whereas the experimental group showed significant improvements after four weeks of intervention. On the other hand, no significant changes were observed in the control group after the four-week period. Hence, these results suggest that cervical SNAG mobilization is effective in improving forward head posture.

Kim19) divided subjects with forward head posture into an experimental group, for which the McKenzie intervention was applied, and a control group. No significant differences in respiration functions were observed between the groups before the intervention, whereas significant improvements were noted in the subjects in the experimental group after four weeks of intervention. Furthermore, another previous study aimed to determine the effect of thoracic spine posture correction using chiropractic manipulations, and divided the subjects into a thoracic spine correction group using manual therapy and a thoracic spine correction group using an impulse gun, after which the differences in vital capacity were compared before and after the interventions. The results revealed that the subjects in both groups showed significantly increased vital capacity after the interventions20). In our study, the experimental group demonstrated significantly improved respiration functions after the intervention, whereas no significant differences were observed in the control group compared to at baseline. Accordingly, after the four-week intervention, statistically significant differences in the respiration functions were found between the experimental and control groups. Hwangbo21) conducted experiments with 45 chronic neck pain patients who had thoracic kyphosis and divided the subjects into thoracic joint mobilization, self-stretching exercise, and thoracic joint mobilization plus self-stretching exercise groups. All three groups showed significantly improved joint range of motion and respiratory functions after the interventions. The above study results are consistent with those of the present study, in which postural correction through manipulative therapy was found to be an effective method for recovering and improving respiratory functions.
joint range of motion, can also help recover the posture of persons with forward head posture and improve their respiratory functions.

As a limitation of this study, the experiments were conducted only on young adults in their 20s, and the effects of this treatment on people of various ages were not examined. Furthermore, our study also did not verify how long the effects are maintained after the intervention. Therefore, it will be necessary to conduct a study on the effects of cervical SNAG mobilization on forward head posture and respiratory functions in subjects of various ages and to determine how long the effects continue after the intervention in the future.

ACKNOWLEDGEMENT

This paper was supported by RESEARCH FUND offered from Catholic University of Pusan.

REFERENCES

1) Good M, Stiller C, Zauszniewski JA, et al.: Sensation and distress of pain scales: reliability, validity, and sensitivity. J Nurs Meas, 2001, 9: 219–238. [Medline]
2) 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]
3) Park SY, Yoo WG: Effects of the sustained computer work on upper cervical flexion motion. J Phys Ther Sci, 2014, 26: 441–442. [Medline] [CrossRef]
4) Lee MY, Lee HY, Yong MS: Characteristics of cervical position sense in subjects with forward head posture. J Phys Ther Sci, 2014, 26: 1741–1743. [Medline] [CrossRef]
5) Kapreli E, Vourazanis E, Strimpakos N: Neck pain causes respiratory dysfunction. Med Hypotheses, 2008, 70: 1009–1013. [Medline] [CrossRef]
6) Teixeira-Salmela LF, Parreira VF, Britto RR, et al.: Respiratory pressures and thoracoabdominal motion in community-dwelling chronic stroke survivors. Arch Phys Med Rehabil, 2005, 86: 1974–1978. [Medline] [CrossRef]
7) Pires MG, Di Francesco RC, Grumach AS, et al.: Evaluation of inspiratory pressure in children with enlarged tonsils and adenoids. Braz J Otorhinolaryngol, 2005, 71: 598–601. [Medline]
8) Mulligan BR: Manual therapy. “Nags,”“Snags,””MWMS” etc. 4th ed. Wellington: Plane View Services, 1999.
9) Konstantinou K, Foster N, Rushton A, et al.: The use and reported effects of mobilization with movement techniques in low back pain management; a cross-sectional descriptive survey of physiotherapists in Britain. Man Ther, 2002, 7: 206–214. [Medline] [CrossRef]
10) Silva M, Mello FC, Guimarães FS, et al.: Postural alterations and pulmonary function of mouth-breathing children. Braz J Otorhinolaryngol, 2010, 76: 683–686. [Medline] [CrossRef]
11) Dimitriadis Z, Kapreli E, Strimpakos N, et al.: Respiratory weakness in patients with chronic neck pain. Man Ther, 2013, 18: 248–253. [Medline] [CrossRef]
12) Kim SY, Kim NS, Jung JH, et al.: Effect of forward head posture on respiratory function in young adults. J Korean Soc Phys Ther, 2013, 25: 311–315.
13) Nemmers TM, Miller JW, Hartman MD: Variability of the forward head posture in healthy community-dwelling older women. J Geriatr Phys Ther, 2009, 32: 10–14. [Medline] [CrossRef]
14) Raine S, Twomey LT: Head and shoulder posture variations in 160 asymptomatic women and men. Arch Phys Med Rehabil, 1997, 78: 1215–1223. [Medline] [CrossRef]
15) Quek J, Pua YH, Clark RA, et al.: Effects of thoracic kyphosis and forward head posture on cervical range of motion in older adults. Man Ther, 2013, 18: 65–71. [Medline] [CrossRef]
16) Shim JH, Oh DW, Lee GW: The effects of thoracic flexibility exercise on vital capacity and chest expansion in patients with idiopathic scoliosis. Phys Ther Korea, 2002, 9: 145–156.
17) Mori RL, Bergman AE, Holmes MJ, et al.: Role of the medial medullary reticular formation in relaying vestibular signals to the diaphragm and abdominal muscles. Brain Res, 2001, 902: 82–91. [Medline] [CrossRef]
18) Oh HJ: The effect of joint mobilization on forward head posture and brain concentration, a doctor’s thesis for Daeug University, 2011.
19) Kim SY: The effects of McKenzie exercise on forward head posture and respiratory function. Master’s Thesis for Catholic University of Pusan, 2014.
20) Kim YJ: A study on the effect of chiropractic thoracic spine manipulation on lung capacity. Master’s thesis for Haneo University, 2014.
21) Hwangbo PN: The effects of thoracic joint mobilization and self stretching exercises on the pulmonary function of patients with chronic neck pain. Master’s thesis for Daeug University, 2014.