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Original Article

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

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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

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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 neck[1)]. 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 disorders[2)]. Sustained computer work affects the range of cervical flexion, especially in the upper cervical part[3)], and forward head posture is related to reduced proprioception[4)].

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 cage[5)]. The loss of respiratory functions is related to functional disorders associated with trunk posture and weakening of the respiratory muscles[6)]. 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 functions[7)].

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 treatment[8)]. 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 therapists[9)]. 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

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a range in which the patient does not feel any pain. At the end of the joint movement, the therapist may apply slight overpressure[8].

Silveria et al.[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[11]. Furthermore, forward head posture can induce inappropriate posture, thereby causing compensation mechanisms to increase the respiratory functions, and Kim et al.[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°[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^2), had clinical abnormalities in the rib cage or spine, had severe comorbid diseases, had diabetes or malignant tumors, and who 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[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[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)[15]. According to the study by Nemmers et al.[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_1), and % predicted value of the forced expiratory volume in one second ($FEV_{1\%}$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_1, and $FEV_{1\%}$pred., were 22.07 years, 167.93 cm, 65.20 kg, 22.94 kg/m^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^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_1/FVC.

The craniovertebral angle of the subjects in the ex-

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 (°)	Experimental	45.74±3.16	52.32±2.68	*
	Control	46.26±2.23	47.41±2.53	
FVC (L)	Experimental	3.54±0.75	3.75±0.65	*
	Control	3.91±0.62	3.94±0.83	
FVC %pred.	Experimental	84.07±9.15	89.67±9.38	*
	Control	88.47±7.86	89.53±10.68	
FEV_1 (L)	Experimental	3.27±0.75	3.49±0.64	*
	Control	3.68±0.72	3.83±0.79	
$FEV_{1\%}$pred.	Experimental	90.20±10.92	96.60±9.36	*
	Control	97.07±6.83	100.67±10.08	

CVA: craniovertebral angle, SD: standard deviation, FVC: forced vital capacity, FEV_1: forced expiratory volume at one second, %pred.: percent predicted value, *$p < 0.05$

perimental 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., FEV_1 and $FEV_{1\%}$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).

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 capabilities[15, 16]. In addition, changes in the posture have been known to affect the length of the respiratory muscles during the breathing rest[17]. Kim et al.[12] measured the craniovertebral angle of healthy adults in their 20s and studied 15 subjects with forward head posture (experimental group) and 15 healthy adults (control group) by measuring and comparing their respiratory functions. The experiment result showed that the mean FVC %pred. of the subjects in the experimental group was 81.95%, while that of the control group was 93.54%. Moreover, the mean $FEV_{1\%}$pred. of the subjects in the experimental group was 90.20%, 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 Oh[18], 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.

Kim[19] 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 interventions[20]. 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. Hwangbo[21] 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.

In conclusion, cervical SNAG mobilization, which has been previously shown to reduce neck pain and increase the

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.

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