Effect of Posture Correction Band on Pulmonary Function in Individuals With Neck Pain and Forward Head Posture

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Background: Individuals with forward head posture (FHP) have neck pain. To correct the FHP, a posture correction band is commonly used. However, we do not know the posture correction band influenced the pulmonary function in individuals with FHP.

Objects: This study aimed to elucidate the effects of the posture correction band on the pulmonary function in young adults with neck pain and FHP and to monitor how the pulmonary function changed over time.

Methods: Twenty subjects with chronic neck pain and forward head posture were recruited. Subjects performed pulmonary function test four times: before, immediately, and 2 hours after wearing the postural band, and immediately after undressing the postural band. Vital capacity (VC), forced vital capacity (FVC), peak expiratory flow (PEF), and forced expiratory volume at one second (FEV1) were measured. The modified Borg dyspnea scale was used to measure each subject's responses to the posture correction band. The mixed-effect linear regression was used to the effect of the posture correction band over time.

Results: There were no significant differences in VC, FVC, PEF, FEV1 values over time ($p > 0.05$), although all values slightly decreased after applying posture correction band. However, the score of the modified Borg scale significantly changed after wearing the postural bands ($p < 0.05$), indicating the subject felt discomfort with posture correction band during breathing.

Conclusion: Because the posture correction band did not change the pulmonary function over time, but it induces psychological discomforts during breathing in people with FHP. Therefore, this posture correction band can be used for FHP realignment after discussion with the subjects.

INTRODUCTION

Recently, as the time to use a smartphones or computer in a poor sitting posture increases [1], the occurrence of neck pain increases. An average of 37.2% of adults now complain of neck pain [2]. This sedentary lifestyle changes the normal body alignment, causing forward head posture and neck pain [3]. Forward head posture (FHP) defines as an increased curvature of the cervical vertebrae due to the extension of head and upper cervical vertebrae (C1-C3) and the flexion of the lower cervical vertebrae (C4-C7), resulting in the forward head and round shoulders [4]. FHP is associated with neck pain and people with FHP report more severe neck pain than people without FHP [5].

FHP is also known to affect respiratory function due to weakness and imbalance in the respiratory muscles [6,7]. As the head moves forward, the inhalation muscles such as sternocleidomastoid, scalenus, suboccipitalis are shortened, limiting the expansion of the rib cage. This restriction of rib mobility reduces the amount of air that enters the lungs [6,8,9]. Another study analyzed the relationship between the craniovertebral angle and respiratory circulatory function, and showed that the smaller the craniovertebral angle, the less carbon dioxide emission. This result indicates that the pulmonary function in people with FHP is worse than those with a neutral head posture, thus FHP treatment is required for better pulmonary function [10].

Various conservative treatments, such as muscle stretching/

strengthening exercises, electrical stimulation therapy, traction, and McKenzie's posture correction exercises are used to improve FHP and neck pain [11-13]. One of commonly used method to correct FHP is a posture correction band to align the spine, which is a kind of orthosis that can be easily obtained on the market. According to Morningstar [13], when a patient with thoracic spine pain was treated with a posture correction band, not only the lordotic curve was decreased, but FHP was also decreased. Because the posture correction band changes the position of the body's center of gravity, it maintains the spine curve correctly and corrects the forward head posture [14]. Despite the advantages of the posture correction band for FHP realignment, some research have reported that the posture correction band affects the pulmonary function by compressing the rib cage. In the study of Puckree et al. [15], the tidal volume and respiratory rate in young adults were examined before, immediately after, an hour after the postural correction band was worn, and immediately after the band was removed in the sitting and lying position. Authors found that the respiratory rate increased before and 1 hour after wearing the postural correction band while the tidal volume decreased significantly [15]. This result might be due to that the postural correction band pressed the abdomen and interfered

the normal inhalation process. As a result, negative changes in breathing were observed in the pulmonary function test conducted after wearing a posture correction band. However, to the best of our knowledge, there are no studies on the changes in pulmonary function in adults with FHP and neck pain after applying the posture correction band. Therefore, this study investigated the effect of the posture correction band on the pulmonary function and the Borg rating for breathing difficulty in people with neck pain and forward head posture.

MATERIALS AND METHODS

1. Subjects

Total twenty young university students with FHP and neck pain for more than 6 months were recruited for this study (Table 1). Inclusion criteria were who 1) had a craniovertebral angle less than 50° , 2) had some neck pain and disability, greater than 5 as measured by Korean version of the Neck Disability Index (NDI). Exclusion criteria were who 1) had a history of spinal or chest surgery 2) had a history of smoking, 3) had an acute or chronic neuromusculoskeletal pain, 4) had severe obesity (body mass index > 40), diabetes, or malignant tumors, or 5) had clinical abnormalities or severe comorbidities of the

Table 1. Descriptive characteristics of the participants

Variable	Male (n = 10)	Female (n = 10)	Total (N = 20)
Age (y)	23.6 $\pm$ 2.3	22.4 $\pm$ 0.9	23.0 $\pm$ 1.8
Height (cm)	178.8 $\pm$ 6.9	161.7 $\pm$ 3.6	170.2 $\pm$ 10.2
Weight (kg)	83.5 $\pm$ 12.9	69.3 $\pm$ 5.6	71.4 $\pm$ 16.1
Body mass index (kg/m ²)	25.9 $\pm$ 3.3	22.7 $\pm$ 3.2	24.3 $\pm$ 3.6
CVA ($^\circ$)	46.1 $\pm$ 1.4	46.1 $\pm$ 1.9	46.1 $\pm$ 1.7

Values are presented as mean $\pm$ standard deviation.

Figure 1. (A) Craniovertebral angle, (B) Pony Fx, and (C) posture correction band.

thoracic spine (nervous system, neuromuscular, cardiovascular disease, psychosis and musculoskeletal diseases) [16]. This study was approved by the Institution of Review Board of Jeonju University (approval No. jjIRB-2018-0505).

2. Measurements

1) Cranio-vertebral angle

To evaluate FHP, cranio-vertebral angle was measured using image J version 1.47 program (National Institutes of Health, Bethesda, MD, USA). Cranio-vertebral angle referred to the angle between the horizontal line passing through the 7th cervical spine and the oblique line connecting the 7th cervical spine and the tragus [17] (Figure 1A). Three photos were taken using NIH image J and calculated each cranio-vertebral angle. When the angle was less than 50°, the subjects were considered as FHP and were recruited for the study [18].

2) Pulmonary function test

A pulmonary function test (Pony Fx; COSMED, Rome, Italy) was used to measure the inspiration and expiration functions such as forced expiratory volume in one second (FEV1), peak expiratory flow (PEF), vital capacity (VC), and forced vital capacity (FVC) (Figure 1B). Pony Fx device composed of spirometer, main body, and a paper mouthpiece. A paper mouthpiece inserted to the end of the spirometer, then the spirometer connected to the main body to send the information of each subject's pulmonary function. Although there is no direct validity or reliability study related to the Pony Fx, this device has been used in various studies to compare the pulmonary function before and after breathing exercise in burn patients [19] and to know the correlation between trunk flexion angle and lung capacity in a sitting position [20].

3) Modified Borg dyspnea scale

Each participants' subjective discomfort in breathing was used as the modified Borg dyspnea scale that measured respiratory distress [21] (Table 2). The subjects were asked about the degree of discomfort in breathing four times: before, immediately, and 2 hours after wearing the posture correction band, and immediately after taking off the posture correction band. To minimize the measurement errors between examiners, the modified Borg dyspnea scale was performed by the same examiner. The test-retest reliability for the modified Borg dyspnea scale was good (intraclass correlation coefficient [ICC]

= 0.83) [22].

4) Neck pain

The Korean version of the NDI questionnaire was used to measure the degree of neck pain and disability in subjects with FHP. This questionnaire contains ten questions related to neck pain and its influences during daily livings such as self-management, lifting, work status, headache, etc. The participants select one of the five answer for each question and the total score is 50. When the score is high, the level of disability is severe [23]. The test-retest reliability of the NDI is excellent (ICC = 0.90) [24].

5) Posture correction band

Postural correction band (Hansome, manchester, UK) used to support neck and trunk from the 7th cervical to the 7th thoracic vertebrae (Figure 1C). The straight main support bar was positioned in the midline of the trunk. The straps that run through both shoulders, lower ribs, and waist were connected to the support bar so that the upper part of the back was stretched. Due to the anthropometry for each subject was different, two different sizes (S and M) of the postural correction bands were used.

3. Experiment Method

The experiment began with a sufficient explanation of entire experimental process to the subjects and they signed the consent form. Subjects worn the posture correction band for 2 hours in sitting position, and they performed interests, such as reading books, doing assignments, or operating smartphone while staying in the same position as possible. Pulmonary function test was conducted before, immediately, and 2 hours

Table 2. Modified Borg dyspnea scale

Marks	Dyspnea grade
10	Maximal
9	Very, very severe (almost maximal)
8	
7	Very severe
6	
5	Severe
4	
3	Moderate
2	Slight
1	Very slight
0.5	Very, very slight (just noticeable)
0	Nothing at all

after wearing the posture correction band, and lastly immediately after removing the posture correction band. The subjects learned how perform the pulmonary function test and had a short familiarization period. After taking several cycles of normal breaths, they inhaled and exhaled as much as possible three times according to the instruction, such that, “inhale as deep as you can, and exhale for 6 seconds.” [16]. The best breathing performance was used for the statistical analysis (Figure 2).

4. Statistical Analysis

All statistical analysis was performed using R team. Kolmogorov-Smirnov test was used to test the normality of the variables obtained from pulmonary function test (FEV1, PEF, VC, FVC), and the modified Borg dyspnea scale. To know the effects of the posture correction band on pulmonary function and perceived exertion during breathing, the mixed-effect linear regression was used. We treated time (before, immedi-

ately after, 2 hours, and immediately takeoff) as a categorical variable and set each subject as random intercept. Bonferroni test was used to check the difference over time. The statistical significance level was set as $\alpha = 0.05$.

RESULTS

1. Changes in Pulmonary Function with the Posture Correction Band Over Time

There was no significant difference in the FEV1, FVC, PEF, and VC values of subjects with forward head posture before, immediately, and 2 hours after wearing the posture correction band, and immediately after taking off the posture correction band ($p > 0.05$) (Table 3).

2. Changes in the Modified Borg Scale after Posture Correction Band Over Time

There was a significant difference in the evaluation of respi-

Figure 2. Pulmonary function test (A) without postural correction band and (B) with postural correction band.

Table 3. Changes in FEV1, FVC, PEF, and VC after wearing posture correction band over time (N = 20)

Variables	Pre-postural band	Immediate	2 h later	Post-postural band	F	p-value
FEV1	93.33 ± 7.73	88.56 ± 6.77	89.83 ± 7.06	90.72 ± 8.19	1.11	0.35
FVC	80.29 ± 1.61	76.06 ± 2.24	77 ± 2.24	77.41 ± 2.28	1.31	0.28
PEF	90.18 ± 4.53	87.11 ± 6.32	87.61 ± 6.32	87.18 ± 6.41	0.10	0.96
VC	75.88 ± 1.95	74.06 ± 2.72	75.28 ± 2.72	74.41 ± 2.76	0.18	0.91

Values are presented as mean ± standard deviation. FEV1, forced expiratory volume in one second; PEF, peak expiratory flow; VC, vital capacity; FVC, forced vital capacity. Immediate and 2 h later: immediately and 2 hours after the posture correction band respectively.

ratory function before and after the posture correction band was worn (Figure 3). As a result of the Bonferroni post-test, the degree of discomfort immediately after the posture correction band was significantly higher than before the band ($p < 0.05$), but this discomfort immediately disappeared when the subjects took the band off.

DISCUSSION

The purpose of this study was to determine the effect of a posture correction band on breathing in the subjects with neck pain and forward head posture. There was a decrease in FEV1 immediately after wearing the posture correction band, but it did not reach a statistically significant level. Other variables of pulmonary function were not different over time ($p > 0.05$). On contrary, the scores of Borg scale of perceived exertion dramatically increased with the posture corrective band, but it decreased immediately after taking the posture corrective band off ($p < 0.05$).

Our primary finding is pulmonary function does change with and without the posture corrective band. According to previous studies, the tidal volume significantly changed before and 1 hour after wearing a back-waist corset in normal adults [15]. In addition, Lanza et al. [25] reported that there was a correlation between chest wall mobility and respiratory parameters (FVC, FEV1, etc.) in normal adults so that the respiratory parameters decreased as the chest wall mobility decreased. The posture correction band used in this study was thought to influence breathing due to restriction of chest wall expansion and mobility, but it was not. Because the posture correction band we used was not personalized, thus the posture correction band could not be tightened as strong as a back-waist corset. Therefore, we concluded that the posture correction band did not significantly affect the chest wall expansion and mobility, and thus did not significantly change pulmonary function. Our results are in line with the results of previous studies by Kim

Figure 3. The modified Borg dyspnea scale. * $p < 0.05$.

and Lee [26], reporting that FEV1 and FVC were not different regardless of applying the 8-shape shoulder brace for 10 minutes in elderly females with FHP. In this study, the posture correction band was applied for 2 hours, which was much longer than the time applied by Kim and Lee [26], but no change in pulmonary function was observed before and after the band. Taken together, we can suggest that the short-term posture correction band does not affect the pulmonary function of those with FHP.

In this study, young adults with FHP showed relatively lower pulmonary function than young adults without FHP. This result is the same as the results of previous studies by Kim et al. [27]. The authors compared the pulmonary function in normal adults to that in adults with FHP, and they found that adults with FHP showed the decreased pulmonary function than normal adults. Because we did not directly measure the pulmonary function in people without FHP, we indirectly assumed that the low pulmonary function of the participants in this study was thought to be a result of the forward head posture. Another possibility of lower respiratory variables in this study is

our testing position for pulmonary function test. According to Lee and Han [20], the optimal exhalation posture is 15 degrees of forward trunk flexion. Since we instructed to our subjects to exhale with 90 degree of forward trunk flexion, air might not be fully exhausted from the airway system.

Contrary to the physiological change measured by the objective pulmonary function test, the scores of modified Borg scale were significantly different before and after the posture correction band. Before wearing the posture correction band, the modified Borg scale was 0, and the subjects reported that they comfortably breathed. However, immediately after wearing the posture correction band, their discomfort level for breathing decreased to “moderate” level, and this discomfort lasted for 2 hours. This uncomfortable breathing disappeared instantly as soon as they took the posture correction band off. These results indicate that subjective evaluation of modified Borg scale is more sensitive to detect the changes in breathing than objective and physiological evaluation of pulmonary function tests.

There are some limitations in this study. First, due to limited number of subjects and age group, it is difficult to generalize to other population. Second, since the experiment was short-term (wearing posture correction band for 2 hours), we could not observe the change in pulmonary function for a long period of time. Finally, although our subjects had familiarization time for the pulmonary function test before actual experiment, there were still some subjects who were not fully adapted to this test. A long-term study on the effect of wearing a posture correction band on FHP and pulmonary function is necessary in the future. In addition, studies with various postures such as standing posture and lying with the posture correction band are necessary to find out whether different postures lead to different changes in pulmonary function. The clinical significance of this study is that the posture correction band does not restrain the movement of the rib cage and the pulmonary function in people with neck pain and FHP. However, the posture correction band can psychologically affect breathing, such as feeling uncomfortable [28], sufficient discussion is required when applying a posture correction band to people with poor pulmonary function. Also, as previous studies have shown that breathing exercise such as McKinsey’s exercise, suboccipital release followed by cranio-cervical flexion exercise, and backward walking exercise have improved the pulmonary function in patient with FHP [29–31], not only a posture correction band

but also breathing exercise are necessary in the long term.

CONCLUSIONS

This study investigated the effect of the posture correction band on the breathing of young adults with neck pain and forward head posture. There was no significant difference in the pulmonary function test when wearing the posture correction band for two hours, but the perceived exertion of borg scale increased. Because the posture correction band induces psychological discomforts only during breathing in people with FHP, this posture correction band can be used for FHP realignment after discussion with the patient. However, a following study on the effect of the posture correction band for a long time on lung function should be needed for more safe use of this band.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

AUTHOR CONTRIBUTIONS

Conceptualization: SK, JK. Data curation: JK. Formal analysis: SK, JK, YJ. Investigation: JK. Methodology: SK, JK, YJ. Project administration: SK, JK. Resources: SK, YJ. Supervision: SK, YJ. Validation: SK, JK. Visualization: SK, JK. Writing – original draft: SK, JK, YJ. Writing – review & editing: SK, JK, YJ.

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