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The Effects of Dynamic Neuromuscular Stabilization Exercise on Forward Head Posture and Spine Posture

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ABSTRACT

Background/Objectives: The purpose of this study was to investigate the effect of dynamic neuromuscular stabilization exercise on the forward head posture.

Method/Statistical Analysis: After the end of the intervention, an experimental group, control group A, and control group B were compared in terms of changes with time within each group and among the groups. A repeated-measures ANOVA was performed to compare the three groups in terms of their spinal structures with time.

Findings: There was no significant difference between the three groups in relation to the general characteristics of the study subjects and the three groups were found to be homogeneous. Each group showed a statistically significant decline in the degree of forward head posture and improvements with time in thoracic kyphosis and lumbar lordosis after 6-week intervention ($p<0.05$) and no statistically significant difference was found among the groups.

Improvements/Applications: In conclusion, dynamic neuromuscular stabilization exercise is an effective training method to improve forward head posture, and this exercise will be useful for improving the forward head posture of subjects who cannot perform neck exercises directly.

Keywords: *Forward head posture, Dynamic neuromuscular stabilization exercises, McKenzie exercise, Neck stabilization exercise, Spinal structure*

Introduction

Habitual forward head posture leads to weakening of the deep neck flexor muscle, shortening of the muscles under the back of the head, increased lordosis of the craniocervical region connecting the head and neck, and continuous muscular contractions in the lower neck and shoulder muscles as relative compensatory actions, ultimately causing changes in the craniocervical region connecting the cranial bone and neck[1]. In some studies that aimed to improve forward head posture, neck stretching and neck extensor strengthening exercises were applied to subjects with forward head posture[2-3]. A small tool-assisted neck stabilization exercise[4-6] was one of the most popular intervention methods used among these studies.

Dynamic neuromuscular stabilization (DNS), which was proposed by a Czech physical therapist, is a rehabilitation approach that optimizes the movement system based on the principles of developmental kinesiology[7]. DNS exercises regulate optimal intraperitoneal pressure to provide stiffness and dynamic stabilization of the vertebrae. They also constitute the deep core and operate under the automatic and potential feed-forward regulation mechanisms[8].

The diaphragm functions primarily as a respiratory muscle, but also as a posture-controlling muscle by increasing intraperitoneal pressure before limbs begin

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to move[9]. This increased intraperitoneal pressure simultaneously activates the deep pelvic floor muscles, thereby providing stability in the lower part of the pelvis, and contracts the abdominal muscles eccentrically, thereby providing stability in the front and lateral surfaces and to the posterior direction, ultimately enhancing overall postural stability[10].

Vertebral curvature promotes a balance between flexibility and muscle strength and acts as a lever against the vertebral muscles so as to transmit force through the body and reduce damage in local areas[11]. However, abnormal vertebral curvature changes the mutual relations between the gravitational line and each vertebral area, thereby increasing stress on the muscles, ligaments, bones, and dendritic joints and changing the volume of the thoracic cage.

Kyphoscoliosis is associated with neck dysfunction[12], and vertebral mobility plays an important role in patients with neck injuries[13]. However, the mechanism required to mediate kyphoscoliosis and neck dysfunction is not well known. Proper vertebral curvature promotes the further extension of the bottom of the neck bone, enabling a more desirable chin-in posture. As the bottom of the neck bone is further extended, the upper craniocervical region takes a more neutral position[11].

Although DNS exercises are increasingly being studied through comparisons with existing lumbar stabilization methods[14] such as the abdominal pulling technique[15] and the abdominal bracing technique, there is little research comparing the effects of DNS exercises on forward head posture. This study therefore aimed to investigate the effects of DNS exercises on the vertebral structures and forward head postures of subjects with forward head posture.

Method

The subjects of this study were randomized by lot drawing and divided into three groups, each comprising 15 people. The experimental group performed a DNS exercise, control group A performed a neck stabilization exercise, and control group B performed stretching and extensor strengthening exercises for six weeks. Separate therapists were assigned to each group for the exercises. The principle investigator explained each method to each therapist and conducted sufficient training.

Volunteers in their 20s who were willing to participate in the experiment and gave their consent before the start of the experiment were included in the study, and the subjects with forward head posture were screened through a preliminary examination.

In the analyses of the vertebral structure, the alignment of the neck bone was assessed using a GPS 400 (Chinesport, Udine, Italy), and all lumbar measurements were conducted using a vertebral structure analyzer by the experienced principle investigator. After the interventions were completed, changes over time and the differences in change between the three different intervention groups were analysed.

A whole-body posture measurement system (GPS 400) was used to diagnose forward head posture. Subjects with a distance of 1 cm or more between the perpendicular induction lines of the shoulder upper arm bones and the outer ear line of the ear were selected as the study subjects[2] [Figure 1].

Figure 1: Measurement of the forward head posture using GPS400

A vertebral structural analyzer (Formetric 4D, DIERS International GmbH, Schlangenbad, Germany) was used to evaluate the structure of the backbone. This is a non-invasive diagnostic instrument for evaluating the alignment of the vertebrae. It is a safe product commonly used in clinics to measure halogen irradiated on the body using a computer. In this study, the light irradiated on the body by a halogen lamp was measured for five seconds, and the structures of the pelvis, back bone, and vertebrae were analyzed [Figure 2].

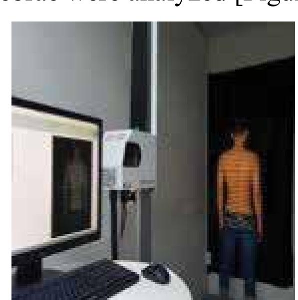

Figure 2: Measurement of the spine alignment using Formetric 4D

The DNS exercise was performed while the subject's hip joints were maintained at 90° of flexion in the supine position. A pressure biofeedback device (Stabilizer, Chattanooga Group, Inc., Hixson, TN) was placed on the waist of the subject, and while the pressure was maintained at 60 mmHg according to the pressure gauge, the anterior, lateral, and posterior parts of the abdomen were extended to increase the pressure further by 10 mmHg at the time of inhalation. This was achieved while inhaling through the nose and exhaling through the mouth[16] [Figure 3].

Figure 3: Dynamic neuromuscular stabilization exercise

The neck stabilization exercise was performed by increasing pressure by 2 mmHg up to 20−30 mmHg, as measured by the pressure biofeedback device. The exercise was carried out for 10 seconds by holding muscle strength in the static position for each reference value, followed by a three-second rest period. This process was repeated 10 times. Then, the pressure was increased by 2 mmHg and the same process was repeated, which was continued until the pressure reached 30 mmHg[17][Table 1], [Figure 4].

Figure 4: Neck stabilization exercise

Table 1: Neck stabilization exercise protocol

Exercise Intensity	Time	
20~22 mmHg	10 second*10 repetition	3 set repetition
20~24 mmHg	10 second*10 repetition	
20~26 mmHg	10 second*10 repetition	
20~28 mmHg	10 second*10 repetition	
20~30 mmHg	10 second*10 repetition	

The McKenzie neck stretching exercise consists of seven movements, but in this study, only five movements were performed. The head pull-back in the sitting position and chin-in in the supine position were excluded[18].

The neck extensor strengthening exercise was performed while the subject was displaced from the treatment bed up to the mammillary line in the prone position with his/her legs and pelvis fixed. While both hands grasped the shoulder on the opposite side, both the head and the upper body were lifted to the same level as the treatment bed and held for 10 seconds, followed by a three-second rest. This process, which was defined as one set, was repeated 10 times[19].

The collected data in this study were analyzed using SPSS 21.0 for Windows, and the statistical significance level (α) was set to 0.05. The general characteristics of the subjects were calculated using descriptive statistics, and a one-way ANOVA was conducted to determine the level of homogeneity among the groups. A repeated ANOVA was performed to compare the changes in forward head posture and vertebral structure between the three groups over time, while a one-way ANOVA was performed to compare the inter-group differences in forward head posture and vertebral structure between three weeks and six weeks after the interventions. The least significant difference method was used for the post hoc test.

Result and Discussion

1. **General characteristics of the subjects:** There was no significant difference between the three groups in terms of the general characteristics of the subjects, and the three groups were determined to be homogeneous.

2. **Change in forward head posture:** Table 2 shows the changes in the subjects' forward head postures after the six-week exercise program. The extent of the forward head posture was significantly reduced ($p<0.05$) after the exercise program, and no interaction effect was found between the training period and the group ($p>0.05$). Furthermore, there was no significant difference in the mean values between the three groups ($p>0.05$).

Table 2: Changes of distance in forward head posture at before, after 3-week and 6-week of three groups

	Before	3-week	6-week	Time (F)	Group (F)	Time* Group (F)
EG	2.91 ± 1.19	2.20 ± 0.74	1.65 ± 0.73	55.784*	0.088	1.503
CoA	2.84 ± 0.93	2.46 ± 0.77	1.68 ± 0.50			
CoB	3.03 ± 1.03	2.27 ± 0.68	1.36 ± 0.68			
F	0.121	0.508	1.145			
p	0.887	0.605	0.328			

unit: cm, *: $p<0.05$, EG: Experimental group, CoA: Control A group, CoB: Control B group

3.1 Comparison of the changes in kyphoscoliosis: Table 3 shows the changes in kyphoscoliosis in each group after the six-week exercise program. The extent of the kyphoscoliosis improved significantly ($p<0.05$) after the exercise program, and no interaction effect was found between the training period and the group ($p>0.05$). There was also no significant difference in the mean values between the three groups ($p>0.05$).

Table 3: Changes of thoracic kyphosis at before, after 3-week and 6-week of three groups

	Before	3-week	6-week	Time (F)	Group (F)	Time*Group (F)
EG	40.93 ± 11.35	41.87 ± 10.01	42.53 ± 7.80	6.130*	0.236	0.023
CoA	40.46 ± 8.64	42.23 ± 7.29	43.31 ± 6.07			
CoB	40.77 ± 7.52	42.54 ± 6.57	43.92 ± 5.87			
F	0.009	0.024	0.151			
p	0.991	0.977	0.860			

unit: ˚(angle), *: $p<0.05$

3.2 Comparison of the changes in lumbar lordosis: Table 4 shows the changes in lumbar lordosis in each group after the six-week exercise program. The extent of the lumbar lordosis was significantly improved ($p<0.05$) after the exercise program, and no interaction effect was found between the training period and the group ($p>0.05$). There was also no significant difference in the mean values between the three groups ($p>0.05$).

Table 4: Changes of lumbar lordosis at before, after 3-week and 6-week of three groups

	Before	3-week	6-week	Time (F)	Group (F)	Time*Group (F)
EG	31.33 ± 12.15	33.47 ± 9.72	35.27 ± 8.22	5.493*	0.154	0.084
CoA	30.77 ± 9.50	32.38 ± 7.50	34.62 ± 7.50			
CoB	32.29 ± 7.08	34.86 ± 9.17	35.57 ± 6.31			
F	0.082	0.262	0.058			
p	0.921	0.771	0.943			

unit: ˚(angle), *: $p<0.05$

Discussion

In this study, 45 subjects with forward head posture were divided into three groups: the DNS group, the neck stabilization group, and the neck stretching and extensor strengthening group. The subjects in each group performed the respective exercises for six weeks. The effects of these exercises on vertebral posture and forward head posture were subsequently investigated.

Previous study[20] reported that the application of a stretching exercise induced postural changes in patients with moderate-to-mild forward head posture. Previous study[21] described improvements in forward head posture and the range of motion of the neck joints after applying a neck extensor strengthening exercise to forward head subjects for four weeks. Consistent with these findings, this study also found that, after a six-week exercise program, the subjects with forward head posture experienced postural changes. Moreover, a significant improvement in posture was observed in all three groups without a significant inter-group difference. In other words, although the DNS exercise did not directly mediate the movement of the neck or shoulder area, it seemed to be able to influence the structure of the neck bone by increasing intraperitoneal pressure through diaphragm-assisted breathing, thus stabilizing the trunk. Eventually, the stability of the vertebrae was enhanced through the integrated spinal stabilizing system, which activates not only the deep neck flexor muscles, the erector spinae, the upper and lower backbones, and the lumbar erector, but also the diaphragm, pelvic floor muscles, and abdominal muscles[8-9]. The experimental group performed a DNS exercise, which is an important component of the integrated spinal stabilization system. For this group, the rate of core muscle activity increased and endurance also improved.

Previous studies have reported that kyphoscoliosis is associated with forward head posture[12,22], and forward head posture is improved by the application of manual therapy. According to a previous study[23], flat lumbar posture is related to forward head posture, while other study[24] reported that neuromuscular retraining effectively improved forward head posture and kyphoscoliosis. In this study, kyphoscoliosis and lumbar lordosis were also improved after six weeks of exercise.

The results of this study indicated that forward head posture and vertebral structure are related to each other, and diaphragm-mediated breathing exercises applied to subjects with forward head posture who are unable to perform direct neck exercises can produce results similar to those obtained from direct neck exercises. Follow-up studies are recommended to examine whether DNS exercises have lasting effects.

Conclusion

In this study, three groups of people were classified to show the forward head posture to see the effect of DNS exercise on the forward head posture. The DNS exercise, neck stabilization exercise, neck stretching and extensor reinforcement exercise were carried out for six weeks, respectively, to measure a change in the forward head posture and spine structure, and the following conclusions were obtained. Forward head posture and vertebral structure were improved in the DNS exercise group. This finding demonstrated that this intervention method can be used in subjects who find it difficult to perform exercises relating directly to the neck and shoulder areas. This exercise affects the structure of the neck bone by increasing intraperitoneal pressure through diaphragm-mediated breathing and thus stabilizing the trunk. Therefore, it is expected that DNS exercise will be used as a exercise to improve the forward head posture, along with neck stabilization and neck stretching and extensor reinforcement exercise, which are commonly used in clinicians.

Ethical Clearance: Not required

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Conflict of Interest: Nil

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