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A Study on the Impact of Continuous Antagonist Strengthening and Evjenth-Hamberg Stretching on the Cervical Mobility in Forward Head Posture Subjects

This study aims to reveal the impact of continuous antagonist strengthening(CAS) and Evjenth-Hamberg stretching(EHS) on the cervical mobility in the university students with abnormal transformation of forward head posture(FHP). Our experiment was conducted 3 times a week for 6 weeks in a total of 20 individuals : continuous antagonist strengthening(CAS) group(n=10) & Evjenth-Hamberg stretching(EHS) group(n=10). In a pre and post comparison, both CAS group and EHS group appeared significantly in mSBI and SBA($p<.05$) and the two-group comparison showed a significant difference($p<.05$) : CAS group showed better effects. Thus, it is considered that the combined use with continuous antagonist strengthening(CAS) had better effects for cervical mobility than Evjenth-Hamberg stretching(EHS) alone.

Key words: *Continous Antagonist Strengthening; Evjenth-Hamberg Stretching; Forward Head Posture*

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INTRODUCTION

Correct posture refers to a posture that an individual erects spine straight maintaining human's natural lines of spine. It refers to a posture that burdens human body the least at a balanced posture without being biased back and forth or left and right(1). Such a balanced body type collapses by bad habits, exercise, labor, accident or shock in everyday lives. In particular, as incorrect living habits caused by students' excessive use of computer, lack of education on health care, lack of exercise, inappropriate learning attitude are likely to cause students' abnormal development in various shapes because it may influence their muscular form and changes in skeletal structure, maintaining a correct posture in everyday lives is very important(2). With the popularization of computer, frequent computer users such as students and office workers are complaining of abnormalities in muscles and bones around neck and shoulder more frequently(3, 4, 5). In particular, if they keep maintaining a static posture such as watching a monitor for long time, it may cause a bad posture, which is influenced by gravity(6). The most representative postural deformity is forward head posture(FHP). In FHP, head comes forward, which increases the moment of neck bending and causes compensative bending of upper neck joint and atlantooccipital articulation to fixate eyes toward the front, which leads to reduced muscles in head and rear part of neck and upper cevical is protruded relatively forward(7). Continuous incorrect posture causes Upper Crossed Syndrome, which weakens deep flexors such as rhomboids, srratus anterior, and lower trapezius, shortens pectoralis major, pectoralis minor, upper trapezius, and levator scapular(5, 8, 9), and causes pains in head, temporomandibular joint, cervical, thoracic, shoulder, and arm(10, 11). Many researchers reported that they need to take a therapeutic approach to stretch shortened muscles and strengthen weakened muscles in arranging a posture in order to improve FHP(10, 12, 13). Evjenth-Hamberg Stretching(EHS), one of the stretching methods, is a method to combine isometric contraction and static stretching in agonistic muscles and antagonistic muscles(14). Continuous antagonist strengthening(CAS) is a method to maximize the stretching effect of agonistic muscles by applying the antagonist strengthening exercise applied in EHS continuously.

Many researches have been carried out to improve the forward head posture, but we still lack of researches on the improvement of cervical mobility by using EHS and CAS. Therefore, this study aims to identify the impact of the continuous strengthening exercise applied into the antagonistic muscles in SCM muscle, upper trapezius, and pectoralis major muscle which are shortened muscles in forward head posture subjects and the EHS applied into the shortened muscles on the cervical mobility.

METHODS

Subjects

This study was carried out in 20 students whose forward head posture degree was over mild transformation in accordance with New York City Posture Evaluation Standards(8) among the male and female college students attending the colleges located at Gyeongnam region. Of those subjects, those who had pain or injury in shoulder girdle, those who had orthopedic, neurological, and dermatological diseases in spine and upper limbs, and those who did not understand this experiment and agree to participate in this experiment positively were excluded.

Methods

In this study, subjects were randomly assigned to CAS group(n=10) and EHS group(n=10) and then intervention was given 3 times a week for a total of 6 weeks. CAS group took antagonist strengthening exercise for 10s after EHS and then took a rest for 5s, which was repeated 4 times(4 sets). After 10 sets of exercise, 10-minute rest time was given, which was repeated 3 times(60 minutes in total). EHS group carried out Evjenthe-Hamberg stretching(14). A preliminary inspection was carried out before intervention and post-inspection was carried out on the 3rd and 6th week in order to measure changes.

A total of 20 subjects were randomly classified into two groups and explained exactly about how to stretch one day before the date of commencement of research on the premise that they had already understood how to stretch. As warm-up before stretching, 5-minute standing jump was carried out, and the stretching was conducted in the order of left and right SCM, upper trapezius, and pectoralis major.

Evjenth-Hamberg Stretching(EHS)

Sternocleidomastoid

Participants took a supine position on the hospital bed and protruded their heads and necks out of their bed with their shoulders placed at the edge of bed. Their shoulders and chests were fixated with belt. At the same time, an experiment stood in the bedhead. Their heads and necks took position so that patients could feel tension in easily shortened muscles. The therapist held subject's head with his/her hand and held subject's mastoid with his/her fingers so that subject's both ears could be placed into therapist's both palms comfortably. Maintaining this posture, the experimenter rotated subject's head completely toward right side and bent it toward left side while towing them simultaneously. Subjects were instructed to say "stop" when they felt a slight tractive sensation right before they felt pain. This point was set as initial stretching posture. In this initial stretching posture, subjects were instructed to apply a strain as if they were pressing an experimenter's right hand and isometric contraction was induced by exerting a balanced force of the same amount in the opposite direction.

The period of isometric contraction was given for 6s. During contraction, they were instructed to count one, two, three, four, five, and six slowly to prevent blood pressure from rising rapidly as Valsalva maneuver phenomenon that may appear during isometric contraction.

The subject relaxed for 2-3s after contraction, whereas the experimenter moved by hand power into more stretched direction. The experimenter had to move to the point where muscles stopped and at this point, maintained for 15-16s. Finally, to strengthen antagonist, the experimenter looked at the right side and had the subject move further in the direction that hairs sticked out. The experimenter resisted this movement and strengthened subject's antagonistic muscle. The time was given for 6s, and they were instructed to maintain their relaxed state to take a rest for 10s. It was carried out 4 times repeatedly and the stretching time was 160s in total.

Upper trapezius

Subjects were instructed to take a lying position with their heads and necks protruded out of beds. Their shoulders and chests were fixated with belts. The experimenter stood at the bedhead. He held subject's back of the head with his right hand, supported subject's head with his wrists and arms, and held subject's jaw with his left hand. Maintaining this

posture, the experimenter applied a tractive force. Maintaining this traction, the experimenter rotated subject's cervical vertebrae slowly and completely toward the right side and bent toward the left side. He moved his neck simultaneously when subject's head moved. After then, isometric contraction was induced and maintained for 6s. To strengthen antagonistic muscle, he maintained the location that he held with his hands and pulled subject's chin toward right side. After then, the experimenter had the subject look at the direction that hairs were sticking out and moved hairs further in the direction that hairs were sticking out. The experimenter resisted this movement to strengthen subject's antagonistic muscles. Time of isometric contraction, relaxing method, and overall stretching time are the same as the methods applied for SCM muscle.

Pectoralis major

Subject's posture and experimenter's location are the same as the methods applied for SCM muscle. Thoracic cage was fixated into bed using belt. Before carrying out treatment, subject's knee and hip joint were bent to stabilize waist and back and prevent forward bending of lumbar vertebrae.

Abdominal part

The experimenter used his both hands to hold subject's inner side of arm right above his elbow so that subject's both arms could be completely rotated outward and bent at shoulder joint. At this state, the experimenter bent subject's shoulder joint completely and slowly. After then, isometric contraction was induced for 6s, and to strengthen antagonistic muscles, the subject put his/her hands under arms to hold on the contrary to the hairs sticking out and bent his/her shoulder joint further in the direction of sticking out, and at this posture, the experimenter gave resistance to strengthen the subject's antagonistic muscles. Isometric contraction time, relaxing method, and overall stretching time are the same as the methods applied for SCM muscle.

Sternocostal part

The experimenter used his both hands to hold subject's elbow and lower arms. The experimenter held the subject so that the subject's arms could be bent and rotated outward completely in the location that exercises are significantly limited between subject's arm 90° bending and complete bending. In this state, the experimenter bent subject's shoulder joint completely and slowly. After then, isometric contraction was induced for 6s, and to strengthen antagonistic muscles, the subject put his/her hands under arms to hold on the contrary to the hairs sticking out and bent his/her shoulder joint further in the direction of sticking out, and at this posture, the experimenter gave resistance to strengthen subject's antagonistic muscles. Isometric contraction time, relaxing method, and overall stretching time are the same as the methods applied for SCM muscle.

Clavicular part

The experimenter used his both hands to hold subject's upper arm of elbow joint. The experimenter held the subject so that subject's arms could be bent and rotated outward completely in the state of shoulder joint 90° bending and elbow joint 90° bending. In this state, the experimenter opened subject's shoulder joint slowly and completely. After then, isometric contraction was induced for 6s, and to strengthen antagonistic muscles, the subject put his/her hands under arms to hold on the contrary to the sticking out and bent his/her shoulder joint further to the direction of sticking out, and at this position, the experimenter gave resistance to strengthen subject's antagonistic muscles. Isometric contraction time, relaxing method, and overall stretching time are the same as the methods applied for SCM muscle.

Continuous Antagonist Strengthening Exercise

After carrying out EHS like the above methods, antagonist strengthening exercise was carried out for neck extensor, lower trapezius, and deltoid posterior. Antagonist strengthening exercise was carried out in the same way as the Evjenthe-Hamberg stretching's final method. Cervical extensor and deltoid muscle posterior strengthening exercise were carried out in a prone position, and lower trapezius strengthening exercise was carried out in a sitting posture. In the strengthening exercise time, strengthening exercise was carried out for 10s and then rest time was given for 5s, which was one(1) set: this set was carried out 4 times repeatedly. During one session, a patient carried out 10 sets. After 10 sets, rest time was given for 10 minutes, which was repeated 3 times: 60 minutes in total.

Measurement of Posture

This study used SonoSens(friendly Sensors AG, Germany) that was used to analyze spinal movement by joint segment in real time as noninvasive method and analyzed the changes in spinal back and forth

and left and right movement and structure among subjects.

First, 8 electrodes were attached to each spinal segment and initially zero adjustment was carried out for 30s. And then fixing pelvis, the experimenter measured the maximum range of motion in the trunk bending and pulling back, right and left lateral bending, and right and left rotation for analysis. To analyze the movement of each spinal segment, electrodes were attached to cervical no. 3, thoracic no. 2, thoracic no 12, and right and left side of posterior superior iliac spine(PSIS) at intervals of 3cm.

After then, in each spinal segment(cervical) of sagittal plane, mSBI(median Sagital Bending Index) indicating the changes in back and forth movement of spinal segment(cervical) and SBA(Sagittal Bending Amplitude) indicating the changes in magnitude of each movement, i.e range of motion were measured. mSBI and SBA indicate % extended from the initial length value around the spine with electrodes attached. The obtained data was analyzed with SonoSens Analyzer 3.3.

Data Analysis

This study used SPSS/WIN 18.0 statistical program for statistical processing, independent sampling t-test to identify the general characteristics of research subjects, and repeated measures of one-way ANOVA to identify the changes in posture depending on treatment period of 3 weeks after and before treatment and 6 weeks after and before treatment in each group. The significance level of all data processing was set as α=.05.

RESULTS

General Characteristics of Research Subjects

The total number of forward head posture subjects who participated in this study was 20: 10 in continuous antagonist strengthening exercise group and 10 in EHS group. Of them, there were 6 and 7 males, respectively, and 4 and 3 females, respectively. Their mean age was 23 years old and 22.8 years old, respectively; their height 172cm and 174.8cm, respectively; and their mean weight 62.8kg and 67.7kg, respectively(Table 1).

Table 1. General characteristics of the subjects

	CASG	EHSG	t	p
Gender	Male(n=6)	Male(n=7)	0.447	0.660
Age(years)	Female(n=4)	Female(n=3)	0.269	0.791
Height(cm)	23.0±2.0	22.8±1.1	-1.054	0.306
Weight(kg)	172±5.6	174.8±6.3	-1.671	0.112
	62.8±7.8	67.7±4.9		

CASG : Continuous Antagonist Strengthening Group
EHSG : Evjenthe-Hamberg Stretching Group

Comparison of Changes in Posture before and after Treatment Duration

The comparison of mSBI and SBA before and after treatment is shown in 〈Table 2〉 and 〈Table 3〉.

In Mauchly's sphericity test, mSBI and SBA were statistically significant(p〉.05)(Table 4)(Table 5). To look at the result of multivariate test, in the comparison of mSBI and SBA before and after treatment,

Table 2. Variation of mSBI treatment period on each group (unit : %)

Variation	pre	3weeks	6weeks
CASG	6.33±3.63	-1.59±3.53	-4.68±2.80
EHSG	6.82±1.92	4.07±2.49	2.25±2.86

Table 3. Variation of SBA treatment period on each group (unit : %)

Variation	pre	3weeks	6weeks
CASG	10.63±2.67	16.07±2.74	19.81±1.66
EHSG	11.15±1.38	13.71±1.52	15.00±1.74

Table 4. Mauchly's test of mSBI

Within subject effect	Mauchly's W	Chi-square	df	P
Treatment period	.869	2.393	2	.302

* p〈.05

Table 5. Mauchly's test of SBA

Within subject effect	Mauchly's W	Chi-square	df	P
Treatment period	.791	3.978	2	.137

* p〈.05

both CASG and EHSG showed a statistically significant difference in treatment period ($p<.05$)(Table 6)(Table 7) and also showed a statistically significant difference in treatment period and treatment method($p<.05$). As a result of testing the effect size of mSBI and SBA between groups depending on treatment period, both groups showed a statistically significant difference($p<.05$)(Table 8)(Table 9).

Table 6. Multivariate tests on mSBI

		Value	F	Hypothesis df	Error df	p
mSBI	Pillai's trace	.959	197.649	2.000	17.000	.000*
mSBI * group	Pillai's trace	.824	39.746	2.000	17.000	.000*

* $p<.05$

Table 7. Multivariate tests on SBA

		Value	F	Hypothesis df	Error df	p
SBA	Pillai's trace	.951	165.128	2.000	17.000	.000*
SBA * group	Pillai's trace	.746	24.989	2.000	17.000	.000*

* $p<.05$

Table 8. Test of between-subject effects on mSBI

	Type III SS	df	MS	F	p
Group	272.214	1	272.214	11.606	.003*
Error	422.189	18	23.455		

* $p<.05$

Table 9. Test of between-subject effects on SBA

	Type III SS	df	MS	F	p
Group	73.704	1	73.704	7.439	.014*
Error	31.742	18	1.763		

* $p<.05$

DISCUSSION

FHP refers to the posture that the central line of head comes forward more than the central line of shoulder(15). This FHP may shorten levator scapulae, SCM muscle, scalene muscle, upper trapezius, pectoralis major and minor and weaken lower cervical and thoracic erector spinae, medium and lower trapezius muscle, and rhomboid(16, 17). The improvement of forward head posture is a key to reducing these problems. This is why clinicians are targeting exercise of correction for this abnormal arrangement of head(13, 18). Accordingly, this study aimed to identify the effect of EHS and CAS exercise on the cervical mobility in FHP subjects.

Cheon et al.(19) reported that in comparative study of active movable range of Evjenthe- Hamberg stretching and static stretching in hip joint, two groups showed increased active movable range before and after experiment and in between-group comparison, Evjenthe-Hamberg stretching group showed more significant movable range than static stretching group($p<.05$). Lee(20) reported that compared to the static stretching whose movable range of joint increased by 8°, Evjenthe-Hamberg stretching increased by 12°. In addition, Swank et al.(21) reported that the group with stretching performed after resistance movement showed significantly increased movable range of joint compared to the group without stretching. Handel et al.(22) announced that in 8-week isometric exercise combined with static stretching in hamstring muscles, the movable range of knee joint increased by 6°. Like this, in the group applied with isometric exercise showed increased mobility rather than the group applied with static stretching and the group applied with antagonist strengthening also showed increased mobility. In this study, we used SonoSense(Friendly Sensors AG, Germany), a spinal structure analysis system that is used to analyze the changes in spinal structure when subjects performed various functional activities in order to measure the spinal movement in quantifiable numbers. Baum et al.(23) used this system to analyze the trends in spinal changes with the passage of time without spatial restrictions or posture changes to the spinal structure in lumber pain patients during their daily lives and verified its reliability.

According to these research findings, mSBI, an indicator that represents back and forth spinal movement in sagittal plane showed a significant difference in both CAS and EHS($p<.05$). If mSBI orients toward +, it means that cervical is bent forward, whereas if mSBI orients toward −, it means that cervical is bent backward. And the normal range is designated as −3∼−10%. In addition, SBA is an indicator that represents the amplitude of back and forth movement. As SBA increased significantly in two groups($p<.05$), it means that the movement increased.

In the comparison of cervical mobility(mSBI and SBA) observed through spinal structure analysis system, CAS group showed a significant effect on the increase of cervical mobility than EHS group, which supported the previous research findings. From this study, it is found that the difference in the improvement effect between CAS group and EHS group is the difference between the effect of stretching in agonist and the time of antagonist strengthening exercise. Treatment is a priority if posture arrangement is not normal, but given the findings in this study, early stage prevention is important so that ordinary people who do not show subjective symptoms due to forward head posture cannot develop into chronic diseases through upper part of trunk stretching and agonist and antagonist strengthening exercise. In the same manner that cervical mobility was possible through stretching and muscle strengthening exercise in this short 6-week period, steady exercise and posture habits for longer time is considered to be helpful for lowering the cervical mobility and preventing chronic pain.

CONCLUSION

This study classified 20 forward head posture subjects into 10 in CAS group and 10 in EHS group to identify the improvement effect of cervical mobility through 6-week continuous antagonist strengthening and Evjenthe-Hamberg stretching exercise and obtained the following results. In the pre and post-comparison, both CAS group and EHS group showed significant improvement effect of cervical mobility ($p<.05$) and showed significant difference between two groups($p<.05$) and CAS group showed better effects. Given these findings, the combined use with continuous antagonist strengthening exercise is considered to have better improvement effects in cervical mobility than Evjenthe-Hamberg stretching alone.

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