J Int Acad Phys Ther Res 2016; 7(1): 956-964
ISSN 2092-8475

www.iaptr.org
http://dx.doi.org/10.20540/JIAPTR.2016.7.1.956

Effects of Continuous Antagonistic Muscle Strengthening and Evjenth-Hamberg Stretching on the Pressure Pain Threshold of Forward Head Posture Subjects

The purpose of this study was to identify the effects of continuous muscle strengthening applied to the antagonist of the sternocleidomatoid, upper trapezius, and pectoralis major, which are the shortened muscles of forward head posture(FHP) subjects, and Evjenth-Hamberg stretching(EHS) applied to the shortened muscles on changes in pressure pain threshold(PPT). Twenty subjects were divided into the continuous antagonist strengthening(CAS) group(n=10) and the EHS group(n=10), and each group performed its respective exercise three times a week for a six week period. The results were as follows: The comparison of changes in PPT within each group before and after the treatment showed a statistically significant difference($p<.05$) according to the treatment period and a statistically significant difference according to the treatment period and method($p<.05$). While the comparison of the tests of between subjects effects between the groups did not show a statistically significant difference, the CAS group exhibited better effects. The above results suggest that the combined application of CAS and EHS generates better effects on changes in PPT than the single application of EHS. Given that stretching and muscle strengthening exercises even for the short research period of six weeks could change the PPT, continuous exercises and a correct postural habit for a longer period of time are likely to help prevent chronic pain and correct FHP

Key words: *Forward Head Posture, Antagonist Strengthening, Evjenth-Hamberg Stretching, Trigger Point*

Ja Pung Koo[a], Wan Suk Choi[b], Ju Hyun Park[c]
[a]Pohang College, Pohang, [b]International university of korea, Jinju, [c]Suwon women university, Suwon, Korea

Received : 15 November 2015
Revised : 27 December 2015
Accepted : 25 January 2016

Address for correspondence
Joo Hyun Park, PT, Ph.D
Department of Physical Therapy, Suwon Women s University, 1098, Juseok-ro, Bongdam-eup, Hwaseong-si, Gyeonggi-do, Korea
TEL: +82 31-290-8978
E-mail: park33sp@empal.com

INTRODUCTION

A correct posture means straightening the spine while maintaining the natural spinal curves of the human body. In other words, as a balanced posture that does not incline to any side(front, back, left, or right), it minimizes pressure on the body. Individuals lose this balanced body shape due to bad habits, exercises, labor, accidents, or shocks in daily life. In particular, the unhealthy lifestyles of students due to their excessive use of computers, lack of education on healthcare, lack of exercise, and improper postures while working affect changes in muscle shape and skeletal structure, which are likely to cause abnormal development in various forms. Therefore, it is of great importance to maintain correct postures in daily life(1). Because of the popularization of computers, students and workers who frequently use the computer are increasingly complaining of disorders in the musculoskeletal systems of the neck and shoulders(2-4). In particular, the maintenance of static postures such as looking at a monitor for long hours causes bad postures due to the effects of gravity(5). Among them, the most common postural change is forward head posture(FHP). FHP increases the bending moment of the neck as the head is located forward, and shortens the muscles in the back of the head and neck and leads to the relative forward protrusion of the upper cervical spine by causing compensatory bending in the upper cervical joints and the atlantooccipital articulation to fix one's eyes on the front(6). The continuous maintenance of a wrong posture causes upper crossed syndrome.

This consequently weakens deep flexors such as the rhomboids, serratus anterior, and lower trapezius and shortens the pectoralis major, pectoralis minor, upper trapezius, and levator scapular (4,7,8), thereby causing pain in the head, temporomandibular joints, cervical vertebrae, thoracic vertebrae, shoulders, and arms(9,10). A number of studies reported that therapeutic approaches that apply the strengthening of weakened muscles and the stretching of shortened muscles are necessary for postural alignments to improve FHP(11,12). Among muscle stretching methods, Evjenth-Hamberg stretching(EHS) applies the combination of isometric contraction and static stretching in the agonist and antagonist(13). Continuous antagonist strengthening(CAS) maximizes stretching effects on the agonist through the continuous application of antagonist strengthening exercises which were initially applied in EHS.

While various studies have been conducted to improve FHP, studies that examine changes in the pressure pain threshold(PPT) of the above muscles by applying EHS and CAS remain inadequate. Therefore, the purpose of this study is to learn about the effects of CAS applied to the antagonist of the sternocleidomatoid, upper trapezius, and pectoralis major, which are the shortened muscles of FHP subjects, and EHS applied to the shortened muscles on changes in PPT.

METHODS

Subjects

This study was carried out in 20 students whose forward head posture degree was over mild transformation in accordance with NewYork 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 Continuous antagonist strengthening(CAS) group(n=10) and Evjenthe-Hamberg stretching(EHS) group(n=10) and then intervention was given 3 times a week for a total of 6weeks. CAS group took antagonist strengthening exercise for 10s after EHS and then took a rest for 5s, which was repeated 4times(4sets). After 10 sets of exercise, 10-minute rest time was given, which was repeated 3times(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 sternocleidomastoid, upper trapezius, and pectoralis major.

Evjenth-Hamberg Stretching

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 sternocleidomastoid muscle.

pectoralis major

Subject's posture and experimenter's location are the same as the methods applied for sternocleidomastoid 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.

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 sternocleidomastoid muscle.

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 sternocleidomastoid muscle.

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 sternocleidomastoid muscle.

Continuous Antagonist Strengthening Exercise

After carrying out Evjenthe-Hamberg stretching(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 the pressure pain threshold

The level of pressure pain in trigger points is defined as pressure pain threshold(PPT). The PPT is defined as the minimum pressure that generates pain(15) and has been measured using the pressure algometer(Meditech group, USA).

In particular, the pressure algometer is effectively used in measuring the trigger points of myofascial pain syndrome as it can quantify the accurate locations of trigger points and pressure sensitivity in muscles(14,15). found that measurements using the pressure algometer showed substantially high levels of intra-rater reliability (r=.69~.97) and inter-rater reliability (r=.71~.89) in measuring the PPT of trigger points. Turk and Ruby reported that the test-retest reliability (r=.85) and the inter-rater reliability(r=.85) of the PPT measured using the pressure algometer were very high(16).

The level of pressure pain was measured as follows: First, each patient was instructed to stay relaxed. In this condition, a pressure algometer was directly placed on the patient's trigger points to be perpendicular to the skin surface. The pressure for the measurement of pressure pain was applied at a rate of 1lb/sec. The patient was instructed to give the voice signal "Ah!" at the time when pain started, and the value on the pressure algometer at the moment was measured based on lb. After measuring three times at a one-minute interval, the average of the three measured values was obtained as a final score.

The pressure algometer used in this study consisted of a body applied to the patient's skin and a zero-point switch, and enabled measurements based on lb/㎠. The measurement of up to 60lb was possible and the gradations had an interval of 1lb.

Data Analysis

In this study, the statistics software SPSS/WIN 18.0 was used for statistical processing and the independent t-test was used to identify the general characteristics of the subjects. The repeated measure analysis of variance(ANOVA) was used to identify changes in the PPT of each group before the treatment, and three weeks and six weeks after the treatment. The statistical significance level for the processing of all data was set at α =.05.

RESULTS

General characteristics of the subjects

Twenty individuals participated in this study as FHP subjects including ten in the CAS group and ten in the EHS group. The CAS group consisted of six men and four women, and the EHS group con-

Table 1. General characteristics of the subjects

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

CASG : Continuous Antagonist Strengthening Group EHSG : Evjenthe-Hamberg Stretching Group sisted of seven men and three women. The subjects in the CAS group were, on average, 23 years old in age, 172cm in height, and 62.8kg in weight. The subjects in the EHS group were, on average, 22.8 years old in age, 174.8cm in height, and 67.7kg in weight(Table 1).

The comparison of changes in PPT after the treatment according to the treatment period

The results of comparing changes in PPT before and after the treatment in the two groups according to the treatment period were as shown in Table 2. Based on the results of multivariate tests, the comparison of changes in PPT before and after the treatment within each group showed a statistically significant difference($p<.05$)(Table8~13), and a statistically significant difference according to the treatment period and method ($p<.05$)(Table 8, 13). The comparison of the tests of between–subjects effects between the groups did not show a statically significant difference ($p<.05$)(Table 14~19).

Table 2. Variation of Rt SCM treatment period on each group (unit : lb/㎠)

Variation	pre	3weeks	6weeks
CASG	1.40±0.70	3.50±1.65	3.50±1.65
EHSG	2.70±1.83	3.60±1.65	3.40±1.43

Table 3. Variation of Lt SCM treatment period on each group (unit : lb/㎠)

Variation	pre	3weeks	6weeks
CASG	1.60±0.70	3.10±1.29	3.30±1.41
EHSG	2.10±1.73	3.00±1.33	2.70±1.42

Table 4. Variation of Rt Trapezius treatment period on each group (unit : lb/㎠)

Variation	pre	3weeks	6weeks
CASG	6.20±3.61	9.90±5.63	10.10±5.74
EHSG	5.30±2.11	7.40±3.13	7.70±2.91

Table 5. Variation of Lt Trapezius treatment period on each group (unit : lb/㎠)

Variation	pre	3weeks	6weeks
CASG	6.00±3.20	9.40±5.72	9.90±5.49
EHSG	5.00±1.94	6.80±2.15	7.10±2.13

Table 6. Variation of Rt Pectoralis major treatment period on each group (unit : lb/㎠)

Variation	pre	3weeks	6weeks
CASG	7.50±5.04	10.70±5.77	10.60±5.68
EHSG	6.00±3.86	6.80±3.74	6.80±3.62

Table 7. Variation of Lt Pectoralis major treatment period on each group (unit : lb/㎠)

Variation	pre	3weeks	6weeks
CASG	6.80±3.80	11.00±5.00	10.90±5.11
EHSG	5.80±3.62	6.30±3.64	6.80±3.16

Table 8. Multivariate tests on Rt SCM

		Value	F	hypothesis df	error df	p
threshold	Pillai's Trace	.683	18.337	2.000	17.000	.000*
threshold * group	Pillai's Trace	.320	3.991	2.000	17.000	.038*

* $p<.05$

Table 9. Multivariate tests on Lt SCM

		Value	F	hypothesis df	error df	p
threshold	Pillais Trace	.680	18.101	2.000	17.000	.000*
threshold * group	Pillais Trace	.210	2.261	2.000	17.000	.135

* p<.05

Table 10. Multivariate tests on Rt Trapezius

		Value	F	hypothesis df	error df	p
threshold	Pillais Trace	.657	16.278	2.000	17.000	.000*
threshold * group	Pillais Trace	.103	.980	2.000	17.000	.396

* p<.05

Table 11. Multivariate tests on Lt Trapezius

		Value	F	hypothesis df	error df	p
threshold	Pillais Trace	.689	18.818	2.000	17.000	.000*
threshold * group	Pillais Trace	.162	1.640	2.000	17.000	.223

* p<.05

Table 12. Multivariate tests on Rt Pectoralis major

		Value	F	hypothesis df	error df	p
threshold	Pillais Trace	.431	6.440	2.000	17.000	.008*
threshold * group	Pillais Trace	.206	2.209	2.000	17.000	.140

* p<.05

Table 13. Multivariate tests on Lt Pectoralis major

		Value	F	hypothesis df	error df	p
threshold	Pillais Trace	.684	18.380	2.000	17.000	.000*
threshold * group	Pillais Trace	.514	8.983	2.000	17.000	.002*

* p<.05

Table 14. Teat of between-subject effects on Rt SCM

	Type Ⅲ SS	df	MS	F	p
Group	2.817	1	2.817	.457	.507
Error	110.833	18	6.157		

* p<.05

Table 15. Teat of between-subject effects on Lt SCM

	Type Ⅲ SS	df	MS	F	p
Group	.067	1	.067	.017	.898
Error	70.533	18	3.919		

* p<.05

Table 16. Teat of between-subject effects on Rt Trapezius

	Type Ⅲ SS	df	MS	F	p
Group	56.067	1	56.067	1.220	.284
Error	827.333	18	45.963		

* p<.05

Table 17. Teat of between-subject effects on Lt Trapezius

	Type Ⅲ SS	df	MS	F	p
Group	68.267	1	68.267	1.765	.201
Error	696.333	18	38.685		

* p<.05

Table 18. Teat of between-subject effects on Rt Pectoralis major

	Type Ⅲ SS	df	MS	F	p
Group	141.067	1	141.067	2.273	.149
Error	1117.333	18	62.074		

* p<.05

Table 19. Teat of between-subject effects on Lt Pectoralis major

	Type Ⅲ SS	df	MS	F	p
Group	160.067	1	160.067	3.429	.081
Error	840.333	18	46.685		

* p<.05

DISCUSSION

FHP refers to the posture in which the center-line of the head is placed forward compared to the center-line of the shoulders(17). FHP causes the shortening of the levator scapular, sternocleido-mastoid, scalene, upper trapezius, and pectoralis major and minor, and the weakening of the lower cervical vertebrae, lower cervical and thoracic erector spinae, middle and lower trapezius, and rhomboid(18,19). As improvements in FHP are the key to reducing these problems, clinicians aim at corrective exercises regarding this abnormal alignment in the head region(12,20). In this regard, this study intended to examine changes in the PPT of the respective muscles through EHS and CAS.

Stephanie et al. improved the FHP and round shoulders of swimmers through the combined exercises of stretching and muscular strength exercises using a ball and foam roller for eight weeks(21). Choi reported that the application of stretching and muscle strengthening exercises in the cervical and chestal regions of 16 subjects for 10 weeks resulted in the effects of improving FHP(22). In addition, Lee reported that the application of stretching exercises in 14 subjects for four weeks resulted in the effects of improving FHP(7). Moreover, Truk and Rudy conducted a study aimed at identifying the effects of stretching the pectoralis major of subjects with various FHPs and round shoulders on their scapular postures while they were relaxed. In this study, the A group that had moderate levels of FHPs and round shoulders and the B group that had minor levels of FHPs and round shoulders were instructed to perform stretching exercises. On the other hand, the C group that had minor levels of FHPs and round shoulders did not perform any exercise(16). While the comparison of the A group and the C group in postural changes showed a statistically significant difference ($p<.05$), the comparison of the B group and the C group did not exhibit a statistically significant difference ($p=.13$).

In the results of this study, the difference in the effects of improvement between the EHS group and the CAS group may be differences in the effects of applying stretching in the agonist and the time for applying muscle strengthening exercises in the antagonist. While it may be a priority to treat abnormal postural alignments, the results of this study also suggest the importance of preventing the development of these symptoms into chronic diseases in the early stages by applying the stretching of the upper trunk and muscle strengthening exercises for the agonist and antagonist in normal individuals who do not show subjective symptoms due to FHP. In addition, given that this study could change the PPT through stretching and muscle strengthening exercises despite the short research period of six weeks, individuals who steadily exercise and maintain a correct postural habit for a longer period of time are likely to have better effects in preventing chronic pain and correcting FHP.

REFERENCES

1. Lee CY. Postural patterns of daily life of male high school students by positional distortion. Korea National University of Education A Masters degree 2004.
2. Faugli HP. Medical exercise therapy, coursenote, Norway, 1996.
3. Johnson GM. The correlation between surface measurement of head and neck posture and the anatomic position of the upper cervical vertebrae, Spine, 1998:23(8):921-927.
4. Mekhora K, liston CB, Nanthavanij S. The effect of ergonomic intervention on discomfort in computer users with tension neck syndrome, Int J Ind Ergo, 2000:26(3):367-379.
5. Erik D. Strategies to address forward head postures Part 1:Sacrificing compleity for stability, Massage Magazine 2006.
6. Cailliet R. Soft tissue pain and disability 3rd ed, Philadelhia 1996.
7. Lee DH. The effects of Balance Exercise and Stretching Exercise on Forward Head Posture. aegu University A doctors degree 2011.
8. Myers RS. Saunders Manual of Physical Therapy Practice, Philadelphia, W.B., Saunders Co., 1995.
9. Janda V. Muscles and motor control in cervicogenic disorders:assessment and management. In: Grant R, editor. Physical therapy of the cervical and thoracic spine. New York: Churchill Livingstone, 1994: 195-216.
10. Leon C, Craig L, Graeme C, Laurie H, Patrick CP. Muscle energy Techniques : Advanced soft tissue techniques, 3rd ed, Elsevier Health Sciences, 1996.
11. Kendall FP, McCreary EK, Provance PG, Rodger MM, Romani WA. Muscles testing and function with posture and pain, 5th ed, Lippincott, Williams & Winkins, 2005.
12. Wright E, Domenech M, Fisher J. Usefulness of posture training for patients with temporomandibular disorders, J American Den Asso, 2000:131(2):202-210
13. Evjenth O, Hamberg J. Muscle stretching in manual therapy: A clinical manual, Sweden, Alfta rehab, 1994.
14. Roddey TS, Olson SL, Grant, SE. The effect of pectoralis muscle stretching on the resting position of the scapula in persons with varying degrees of forward head/rounded shoulder posture, J Manual and Manipulative therapy, 2002: 10(3):124-128.

15. Fischer AA. Pressure threshold meter: Its use for quantification of tender spots. Arch. Phys. Med. Rehabil., 1986:67:836-838.
16. Turk DC, Rudy TE. Assessment of cignitive factors in chronic pain. J Consulting and Clinical Psycho, 1986:54:760-768.
17. Caneiro JP, OSullivan P, Burnett A, Barach A, ONeil D, Tveit O, Olafsdottir K. The influence of different sitting postures on head/neck posture and muscle activity. Manual Therapy, 2010:15(1): 54-60.
18. Giallonardo LM. Posture Saunders manual of physical therapy practive, Myers R S(ed), Philadelphia, WB, Saunders Co, 1995:1087-1104.
19. Jull G, falla D, Hodges P. Cervical flexor muscle retraining; physiological mechanisms of efficacy, Paper presented at 2nd international conference on movement dysfunction, Edingburgh scotland, 2005.
20. Darling D, Kraus S, Glasheen-Wray M, Relationship of head posture and rest position of mandible, J Prosthe Den, 1984: 52(1):111-115.
21. Stephanie SL, Charles AT, Jason PM, William EP, Darin P, The effects of an exercise intervention on forward head and rounded shoulder postures in elite simmers, Br J Spor Med, 2010:44:376-381.
22. Choi YJ. Effectiveness of an Cervical and Thoracic Stretching and Strengthening Exercise to Improve Forward Head Posture. Korea University Masters degree 2007.