



Original Article

Comparison of muscular fatigue and tone of neck according to craniocervical flexion exercise and suboccipital relaxation in cervicogenic headache patients

DAE JUNG YANG, PhD, PT¹⁾, DA HAENG KANG, MS, PT²⁾*

¹⁾ Department of Physical Therapy, Sehan University, Republic of Korea

²⁾ Department of Physical Therapy, Dongshin University: 185 Geonjae-ro, Naju, Jeollanam-do, Republic of Korea

Abstract. [Purpose] This study was conducted to compare and analyze influence of craniocervical flexion and suboccipitalis relaxation in cervicogenic headache patients of their cervical muscular fatigue, tone, and headache intensity. [Subjects and Methods] 30 patients with cervicogenic headache were selected and 10 subjects per group were randomly assigned to control group, craniocervical flexion exercise group, and suboccipitalis relaxation group. Intervention for each group was provided 5 times a week for 4 weeks. Muscular tone test and muscular fatigue test were conducted on both sides of upper trapezius and sternocleidomastoideus and visual analogue scale on the headache intensity was conducted before the intervention, after 2 weeks, and after 4 weeks. [Results] Difference from intervention was significant in muscular fatigue of upper trapezius and sternocleidomastoideus, muscular tone of sternocleidomastoideus, and headache intensity. Correlation between intervention duration and the groups showed significant difference in muscular fatigue, muscular tone, and headache intensity except left upper trapezius muscle. [Conclusion] From this study, 4 week application of craniocervical flexion exercise and suboccipitalis relaxation on cervicogenic headache patients was found to be effective in decrease of muscular fatigue of upper trapezius and sternocleidomastoideus, muscular tone of sternocleidomastoideus, and headache intensity.

Key words: Cervicogenic headache, Craniocervical flexion exercise, Suboccipital relaxation

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INTRODUCTION

Amongst all the headache patients, 15–20% suffer from cervicogenic headache and show similar symptoms as migraine and tension type headache¹⁾, but it is distinctive from other headaches as it originates from musculoskeletal problem in the area corresponding to the side of head where headache developed²⁾. The most general cause of cervicogenic headache is alternation of structure in neck due to bad posture^{1,3,4)}. Watson and Trott⁵⁾ found that cervicogenic headache patients generally have forward neck posture and deep cervical muscle weakening has high correlation from craniocervical joint analysis and muscular strength measurement studies. Such unstable state of cervical muscle increases stiffness and fatigue^{1,6)}, and induces discomfort such as headache and cervical pain⁷⁾.

Craniocervical flexion exercise, a type of spinal stabilization exercises, is a low-intensity exercise that contracts deep flexor in cervical spine within motion that does not induce pain and is very practical in sustaining normal cervical curvature⁸⁾. As for cervicogenic headache patients, it has been reported that they lack of cervical muscular strength and endurance⁹⁾ and their superficial cervical muscle is more active due to ineffective movement¹⁰⁾. Jull et al.¹¹⁾ and McDonnell et al.¹²⁾ treated

*Corresponding author. Da Haeng Kang (E-mail: mission012@hanmail.net)

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Table 1. General characteristics of each group

	CON (n=10)	CFE (n=10)	SOR (n=10)
Gender (M/F)	2/8	3/7	2/8
Headache site (Rt/Lt)	3/7	2/8	3/7
Height (cm)	164.3 ± 6.5	165.3 ± 6.9	166.6 ± 5.7
Age (years)	25.2 ± 4.3	23.6 ± 4.8	24.4 ± 4.7
Weight (kg)	57.1 ± 4.3	58.2 ± 4.8	63.0 ± 4.7

CON: control group; CFE: craniocervical flexion exercise group; SOR: suboccipital relaxation group

craniocervical flexion exercise to cervicogenic headache patient and found that the intensity of headache and cervical pain reduced significantly.

However, despite that most of cervicogenic headache patients showed abnormal posture alteration such as forward neck posture, which is accompanied by headache and cervical pain¹⁾, preceding studies only focused on reduction of pain with use of the interventions, not on changes in muscular fatigue and tone induced by abnormal posture. Therefore, in this study, cervicogenic headache patients were applied of craniocervical flexion exercise and suboccipitalis relaxation and their cervical muscular tension and fatigue, and headache intensity were compared in order to study effect of physical intervention in management of cervicogenic headache patient and find more effective intervention method.

SUBJECTS AND METHODS

This study was approved by institutional review board of Sehan University (Approval number: 2016-10). All participants received 30 verbal and written information about the study and signed a consent form. Subjects were outpatients who were diagnosed of cervicogenic headache and treated in T hospital, Jeonnam, and amongst the patients with cervicogenic headache or mixed headache with cervicogenic headache based on diagnostic criteria of Sjaastad et al.¹³⁾, thirty patients who willingly agreed to participate in the study were selected as the subjects (Table 1).

Before the experiment, the subjects were told of purpose of this experiment and instructions, and they were randomly assigned to 3 groups of 10; control group (CON), craniocervical flexion exercise group (CFE), and suboccipitalis relaxation group (SOR). All subjects were conducted of muscular muscular fatigue test, tone test, visual analogue scale (VAS) as preliminary tests and such tests were conducted again in same procedure and method after 2 weeks and 4 weeks. All subjects were applied of hot pack and low frequency therapy (200 μ s, 150 Hz and 5 mA) in the subjects' bilateral trapezius as a common intervention. Afterwards, CFE group and SOR group were applied of own intervention responsibly.

For measurement of muscular fatigue, BTS sEMG system (Bioengineering Inc., Italy) 4 channel, a wireless surface electromyography, was used on upper trapezius and SCM. For muscular fatigue, after applying FFT (fast fourier transformation), median frequency (MF) that was area of the spectrum divided by 2 was used.

Muscular tone was measured of relaxation tone, using MyotonPRO (Myoton AS, Tallinn, Estonia). While the subject was resting, the measurement was taken in the central muscle belly area identical to muscles for electromyography. Amongst collected data, stiffness (N/m) that shows level of muscular tone was used.

Headache intensity was evaluated with VAS (0 mm-no pain–100 mm-unbearable pain).

Craniocervical flexion exercise uses biofeedback machine (StabilizerTM, Chattanooga Group Inc., USA). The subject executed craniocervical flexion exercise with his/her knee bent and transverse abdominalis. contracted while in hook lying position. Craniocervical flexion exercise consists of 10–12 repetitions per set and 10 minutes per set, in total of 2 sets and 20 min. Pressure of 20 mmHg, the standard in start of the exercise, is sustained and additional pressure of 2 mmHg was applied. In identical manner, the exercise was conducted in gradual manner that increased pressure over 5 steps, with maximum pressure of 30 mmHg¹⁴⁾.

For application of suboccipitalis relaxation, therapist positioned him/herself over head of the subjects, placed fingertip just subocciput of subjects and supported occiput of the subjects with his/her palm. Suboccipital region was protracted with fingertip so that it would make an axis and the head was lightly supported with palm so that the neck wouldn't be fully extended for 20 min, releasing the suboccipitalis¹⁵⁾.

Data analysis was conducted with Windows SPSS 22.0 (IBM Corporation, USA). Test of normality on the subjects' general traits were processed in ANOVA and two-way Repeated ANOVA was conducted to analyze difference in muscular fatigue, tone, and headache intensity depending on interventional period and interventional method. Post-hoc analysis was processed with Tukey, with level of significance $\alpha=0.05$.

Table 2. Change of median frequency means (Hz)

	Group	Pre	2 weeks	4 weeks	Source ^b	Post-hoc ^c
RT UT	CON	20.9 ± 1.0 ^a	21.6 ± 1.3	22.3 ± 1.5	T***	
	CFE	18.8 ± 1.6	19.8 ± 1.9	22.1 ± 1.9	G*	a<b,c
	SOR	18.1 ± 0.9	19.5 ± 1.1	21.6 ± 1.8	T×G*	
LT UT	CON	20.9 ± 1.3	21.4 ± 1.0	22.8 ± 1.5	T***	
	CFE	17.6 ± 1.4	19.4 ± 1.5	23.2 ± 1.7	G*	a<b,c
	SOR	18.7 ± 1.1	19.3 ± 1.4	21.9 ± 1.8	T×G***	
RT SCM	CON	26.4 ± 1.0	27.2 ± 1.1	27.7 ± 1.3	T***	
	CFE	24.5 ± 1.1	25.9 ± 1.2	27.4 ± 1.3	G*	a<b,c
	SOR	24.9 ± 1.0	26.6 ± 1.1	27.2 ± 1.3	T×G*	
LT SCM	CON	26.6 ± 0.7	26.7 ± 0.9	26.9 ± 0.8	T***	
	CFE	24.0 ± 1.5	24.7 ± 1.1	26.6 ± 0.5	G***	a<b<c
	SOR	25.9 ± 0.6	25.7 ± 1.1	26.1 ± 0.6	T×G***	

*p<0.05, **p<0.01, ***p<0.001, ^aMean ± SD, ^bTwo-way repeated ANOVA, ^cTukey's test, CON: control group; CFE: craniocervical flexion exercise group; SOR: suboccipital relaxation group; RT: right; LT: left; UT: upper trapezius; SCM: sternocleidomastoideus

Table 3. Change of muscular tone means (N/m)

	Group	Pre	2 weeks	4 weeks	Source ^b	Post-hoc ^c
RT UT	CON	418.2 ± 27.8 ^a	409.5 ± 28.8	393.7 ± 13.8	T***	
	CFE	436.4 ± 28.0	391.8 ± 45.5	369.7 ± 45.3	G	
	SOR	434.0 ± 28.2	396.3 ± 24.1	383.6 ± 22.6	T×G	
LT UT	CON	366.2 ± 39.7	362.7 ± 33.8	354.6 ± 35.1	T***	
	CFE	359.6 ± 56.5	325.0 ± 37.7	311.4 ± 35.6	G	
	SOR	360.9 ± 32.2	359.9 ± 27.0	340.0 ± 29.4	T×G*	
RT SCM	CON	227.3 ± 25.5	222.2 ± 23.9	216.9 ± 20.3	T***	
	CFE	225.3 ± 20.6	199.3 ± 10.1	183.2 ± 6.9	G*	a<b,c
	SOR	225.8 ± 15.5	214.5 ± 12.4	204.3 ± 8.1	T×G***	
LT SCM	CON	241.1 ± 29.4	214.7 ± 8.9	179.9 ± 5.2	T***	
	CFE	242.6 ± 26.4	216.7 ± 18.8	210.2 ± 13.3	G*	a<b,c
	SOR	235.7 ± 23.5	228.6 ± 18.0	225.5 ± 18.7	T×G***	

*p<0.05, **p<0.01, ***p<0.001, ^aMean ± SD, ^bTwo-way repeated ANOVA, ^cTukey's test, CON: control group; CFE: craniocervical flexion exercise group; SOR: suboccipital relaxation group; RT: right; LT: left; UT: upper trapezius; SCM: sternocleidomastoideus

Table 4. Change of VAS means (mm)

	Pre	2 weeks	4 weeks	Source ^b	Post-hoc ^c
CON	76.4 ± 3.9 ^a	71.60 ± 4.4	393.7 ± 8.2	T***	
CFE	79.4 ± 5.3	52.60 ± 6.7	369.7 ± 9.5	G***	a<b<c
SOR	80.1 ± 5.0	65.20 ± 7.6	383.6 ± 11.7	T×G ***	

*p<0.05, **p<0.01, ***p<0.001, ^aMean ± SD, ^bTwo-way repeated ANOVA, ^cTukey's test, CON: control group; CFE: craniocervical flexion exercise group; SOR: suboccipital relaxation group; Rt: right; Lt: left; UT: upper trapezius; SCM: sternocleidomastoideus

RESULT

Changes in muscular fatigue of upper trapezius and SCM were eminent in both interventional methods, and interventional period and interaction in each interventional method was significant in both groups (p<0.05) (Table 2).

Changes in muscular tone of upper trapezius and SCM were eminent in only bilateral SCM, with interventional period and interaction in each interventional method was only significant in left upper trapezius and bilateral SCM (p<0.05) (Table 3).

Changes in headache intensity was eminent between both interventional methods, and interventional period and interaction in each interventional method was significant in both groups ($p < 0.05$) (Table 4).

DISCUSSION

Damage of soft tissue and increase of tension in neck limits stationary contraction of deep cervical muscle, posing difficulty in sustaining upright neck posture^{16, 17}. With this process, cervical pain and cervicogenic headache occurs and as pain occurs or aggravates from the motion of returning to normal posture²³, most of cervicogenic headache patients take forward neck posture⁵. Janda¹⁸ explained that SCM receives overactive tension due to Upper-Cross Syndrome and upper trapezius is in contractile short-axis tension from forward neck posture. Therefore, muscular activity of SCM is increased while that of trapezius is decreased, increasing muscular fatigue and tone of both muscles¹⁹.

Significant reduction of muscular activation in superficial muscles with therapeutic intervention signifies increase of activation in deep cervical muscles²⁰ and can be interpreted in decrease of fatigue and tone in superficial muscles^{19, 21}. Falla et al.⁸ argued that craniocervical flexion increases activity of deep muscle in muscle and shoulders, decreasing fatigue in superficial muscles and Chao et al.²² reported that application of relaxation treatment in soft tissue decreases muscular tone and pain intensity, which was similar to the result of this study. However, in this study, only muscular fatigue and headache intensity in left SCM showed difference between groups, in order of CFE, SOE, and CON, based on post-hoc analysis. Headache patient generally limits flexion and rotation of neck in one side, inducing concentric tension and pain in SCM and suboccipitalis²⁰. In other words, amongst the participants in the study, more patients complained of headache in left side, which led to interventional difference in muscular fatigue and headache in left SCM. Jull et al.¹¹ grouped 200 cervicogenic headache patients into control group, joint movement group, Craniocervical flexion group, and compound intervention group. The researchers applied the intervention for 6 weeks and conducted test on the 7th week, which showed subjects with craniocervical flexion exercise and compound intervention showed significant difference in cervical curvature sustainment, functional recovery, and headache intensity (pain intensity, illness duration, headache period) than control and joint movement group, which was identical to the outcome with the most prominent reduction in craniocervical flexion exercise group in this study.

In this study, there was no difference between intervention groups in regard to muscular tone, along with muscular fatigue in upper trapezius. Such unexpected outcome is considered to be due to relatively higher content of I-type muscular fibers than in other cervical muscles²⁰ which increases the threshold of muscular fatigue and muscular tone, therefore, increasing resistance to the intervention.

Cervicogenic headache patient with forward neck posture has high muscular tone and fatigue in superficial muscles to keep unstable head from gravity, which easily induces postural disorder and pain^{5, 19}. Consequently, effort to keep upright posture is necessary and exercise intervention is most crucial^{23–25}.

Therefore, application of craniocervical flexion exercise and suboccipitalis relaxation in cervicogenic headache patient is effective in decreasing fatigue of cervical muscles, tone of SCM, and headache intensity and craniocervical flexion that can directly influence postural sustainment is considered to be more effective in reduction of SCM fatigue and headache intensity. Further studies are required in effect of therapeutic intervention on patients with identical headache region and are to be conducted on correlation between biomechanical postural change and muscular fatigue and tone in cervicogenic headache patient after kinetic intervention.

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