J. Phys. Ther. Sci. 28: 654–657, 2016

The Journal of Physical Therapy Science

Original Article

Effect of craniocervical posture on abdominal muscle activities

Jung Gil Su[1)], Shin Ji Won[1)], Hwangbo Gak[1)*]

[1)] *Department of Physical Therapy, College of Rehabilitation Science, Daegu University: 201 Daegudae-ro, Gyeongsan-si, Gyeongsangbuk-do 38453, Republic of Korea*

Abstract. [Purpose] The aim of this study was to investigate the influence of the craniocervical posture on abdominal muscle activities in hook-lying position. [Subjects] This study recruited 12 healthy young adults. [Methods] Each subject was asked to adopt a supine position with the hip and knee flexed at 60°. Surface electromyographic signals of transversus abdominis/internal oblique, rectus abdominis, and external oblique in different craniocervical postures (extension, neutral, and flexion) were compared. [Results] The transversus abdominis and rectus abdominis showed increased muscle activities in craniocervical flexion compared to craniocervical extension and neutral position. Greater muscle activities of the external oblique were seen in craniocervical flexion than in craniocervical extension. [Conclusion] Craniocervical flexion was found to be effective to increase the abdominal muscle activities. Consideration of craniocervical posture is recommended when performing trunk stabilization exercises.
Key words: Craniocervical, Stabilization exercise, Electromyography

(This article was submitted Oct. 13, 2015, and was accepted Nov. 19, 2015)

INTRODUCTION

In the modern world, people are often exposed to media devices such as smartphones and computers, and maintain incorrect postures for a long time while using these devices. These incorrect positions induce forward head postures[1)], which increase upper cervical lordosis, flatten the lower cervical spine, and change head balance that causes muscle imbalance, tension of the neck extensor, and weakness of the deep cervical flexors[1)]. The deep cervical flexors play a role in recognizing muscle tone and position sense because its muscle spindle density is high due to the stabilization muscles in the neck[2)]. Incorrect neck posture not only worsens the weakening of muscles in the neck and surrounding muscles but also induces pain and headache. To improve this condition, a deep cervical flexor exercise has been proposed[3–5)].

Postural chain refers to the position of a joint that is related to another joint when a body is correctly postured. Postural chains affect motions and positions because of structural and functional mechanisms. That is, a spine from the cervical vertebra to coccyx is connected organically with each other so that changes in one region can affect the activities of the other regions. Therefore, bad posture in one region can affect the overall spine from head to pelvis[6, 7)]. Slump sitting posture along with forward head posture results in kyphosis of the thoracic vertebrae, which in turn results in abnormal changes in the activities of the erector spinae muscle[8)]. Hamaoui et al. reported that muscle activities in the trunk and lower extremity change depending on the sitting posture[9)]. The human body is thought to be connected structurally so that changes in one region affect postures of adjacent regions, thus ultimately affecting changes in the surrounding muscle activities.

Abdominal muscles play a role in stabilizing the trunk. If abdominal muscles become weak, trunk stability also decreases and low back pain occurs. Therefore, abdominal muscle strengthening exercises have been used to reduce pain in patients with low back pain[10–12)].

Currently, only a few studies have been conducted to study the effect of craniocervical posture on abdominal muscle activities. Thus, this study aimed to measure abdominal muscle activities according to changes in craniocervical posture in the sagittal plane and to present the need for craniocervical posture control for trunk stabilization exercises.

*Corresponding author. Hwangbo Gak (E-mail: hbgak@daegu.ac.kr)

SUBJECTS AND METHODS

This study was conducted with 12 healthy male and female adults who attended Daegu University from August to September 2015. The selection criteria of the subjects were individuals with no musculoskeletal or neurological disorders in the trunk and lower extremity and those with no previous spinal surgical experience (Table 1). This study was conducted in accordance with the Declaration of Helsinki. All subjects were fully informed about the study objectives, and they all gave their consent to participate in the study.

Abdominal muscle activities according to craniocervical posture were measured in the hook-lying position. Subjects placed their hip and knee at 60° angles of flexion in the supine position while putting their lumbar vertebra in the neutral position. A towel was placed under the occiput to support the weight of the head and the cervical spine, and two hands were comfortably positioned on either side of the body[13)]. While the subjects maintained their craniocervical posture at neutral, flexion, and extension states, their abdominal muscle activities were measured. The craniocervical posture was controlled using a cervical range of motion device (CROM; Performance Attainment Associates, St Paul, MN, USA). The craniocervical neutral posture was described as follows: the head and neck were positioned to be a straight line from the floor, and the eyes were maintained to be horizontal to the line of the head and neck to have a CROM at 0°. The craniocervical flexion (CCF) posture was described as follows: the mid-cervical and lower-cervical were maintained at the neutral position, while the upper-cervical had a 10° flexion. The craniocervical extension (CCE) posture was described as follows: the mid-cervical and lower-cervical were maintained at the neutral position while the upper-cervical had a 10° extension[14)]. Muscle activities were measured while subjects maintained each of the postures for 10 seconds. Muscle activity in each posture was measured three times, and the order of the postures was selected randomly. The measured muscle activity obtained from the first two and last two seconds were removed, and data in the middle six seconds were analyzed. A mean value of the three-time measured muscle activities was used in this study.

Surface electromyographic (EMG) signals were measured using Telemyo2400T (Noraxon, Scottsdale, AZ, USA). EMG signal was full-wave rectified, and the root mean square value was calculated over 100-ms intervals. Throughout the tests, the EMG data were sampled at a frequency of 1,000 Hz. The EMG data were filtered using standard band-pass filtering techniques with cutoffs of 10 Hz and 500 Hz. The bipolar EMG signals of each muscle were converted from analog to digital using Myoresearch software (Noraxon). Surface electrodes were placed on the transversus abdominis (TrA)/internal oblique (IO), rectus abdominis (RA), and external oblique (EO) on the dominant side. Surface electrodes for the TrA/IO were attached to be aligned inferomedially toward the pubis from the inside of the anterior superior iliac spine. Surface electrodes for the RA were attached to the area 2 cm lateral to the navel. Surface electrodes for the EO were attached to be aligned inferomedially with the pubis under the rib angle[15)]. To normalize the EMG data, maximum voluntary isometric contractions of the above-mentioned muscles were conducted, and a mean value of the EMG signals was expressed as a percentage of the maximum voluntary isometric contractions.

To compare the differences in muscle activities according to the craniocervical posture, one-way repeated ANOVA was used. If the result was statistically significant, multiple comparisons were conducted. For statistical analysis, SPSS version 12.0 for Windows (SPSS Inc., Chicago, IL, USA) was used, and the significance level α was set to 0.05.

RESULTS

Table 2 summarizes the abdominal muscle activities according to the craniocervical posture. The repeated ANOVA result showed that the main effect of the craniocervical posture was revealed significantly in all muscles ($p < 0.05$). The muscle activities in the TrA, IO, and RA were larger in the craniocervical flexion posture than in the craniocervical extension and neutral positions ($p < 0.05$). The muscle activities in the external oblique were larger in the craniocervical flexion posture than in the craniocervical extension posture ($p < 0.05$).

DISCUSSION

This study measured abdominal muscle activities through surface EMG while maintaining the craniocervical posture in the craniocervical-extension (CCE), neutral, and craniocervical-flexion (CCF) postures in the hook-lying position to determine the difference in abdominal muscle activities according to changes in the craniocervical posture. The hook-lying position is a widely used position applied in cervical or trunk stabilization exercises in general.

TrA/IO and RA in the abdominal muscles had significant higher muscle activity in CCF than in CCE and neutral postures, while EO had higher muscle activity in CCF than in CCE. A study on the effect of lumbar spine adjustment on the craniocervical posture reported that a neutral posture of the lumbar spine influenced the cervical spine angle[16)]. Falla et al. also reported that muscle recruitment at the neck could be improved by performing neck exercise in a good lumbar posture[5)]. In the same context, the facilitation of good craniocervical posture through CCF can affect lumbar alignment, thus increasing the abdominal muscle recruitment that is responsible for lumbar stabilization. This finding indicates that the joint or muscle state in one region of the human body can affect the muscles or joints of other regions of the body as well[6, 16)]. Incorrect

Table 1. General characteristics of the subjects

Gender	Male	6 (50%)
	Female	6 (50%)
Age (years)		22.1±2.2
Height (cm)		170.4±7.0
Weight (kg)		67.2±13.0

Mean±SD

Table 2. Comparison of abdominal muscle activities among different craniocervical positions

Muscles	CCE a)	Neutral b)	CCF c)	Multiple comparison
TrA/IO*	1.03±0.67	0.98±0.56	2.47±2.54	a,b<c†
RA*	0.56±0.34	0.58±0.37	0.74±0.42	a,b<c†
EO*	1.01±0.61	1.51±1.78	2.60±1.72	a<c†

Data are percentages of the maximum voluntary isometric contraction (mean ± SD).
TrA: Transversus abdominis; IO: Internal oblique; RA: Rectus abdominis; EO: External oblique; CCF: Craniocervical flexion; CCE: Craniocervical extension
*$p<0.05$, †multiple comparison by Scheffe method

postures, such as forward head posture, not only cause neck pain but also change spinal alignment and prevent efficient muscle recruitment that leads to the weakening of abdominal muscles. Therefore, if, craniocervical posture is considered during trunk stabilization exercises, more effective muscle recruitment in abdominal muscles can be achieved.

Jung et al. reported the activation of RA during trunk stabilization exercises using a Swiss ball, and Kim et al. reported the activation of RA and IO during trunk stabilization exercises on an unstable surface[10, 12]. In this study, increases in activities of the abdominal muscles were observed while maintaining a CCF posture similar to that observed during trunk stabilization exercises. This finding indicates that CCF is helpful in trunk stabilization. Furthermore, high-intensity trunk stabilization exercises for acute back pain or for the early stage of rehabilitation after lumbar spine surgery can aggravate pain by inducing motions of the lumbar vertebra. Under these circumstances, lumbar stabilization can be assisted by activating the abdominal muscles indirectly by maintaining the CCF posture.

The limitations of this study are the small number of subjects and the difficulty in generalizing the study results, as this study measures the activation of abdominal muscles only in the hook-lying position according to the changes in the craniocervical posture. Therefore, studying the activation of abdominal muscles according to changes in the craniocervical posture in various positions is necessary in the future.

REFERENCES

1) Kwon JH, Cho MJ, Park MC, et al.: Cervical stabilization exercise using the sling system. J Korean Acad Orthopecic Man Ther, 2002, 8: 57–71.
2) Hong JS: Cerebral palsy from the normal development, Gunja, Korea, 2014.
3) Lee KJ, Han HY, Cheon SH, et al.: The effect of forward head posture on muscle activity during neck protraction and retraction. J Phys Ther Sci, 2015, 27: 977–979. [Medline] [CrossRef]
4) Fernandez-de-las-Peñas C, Pérez-de-Heredia M, Molero-Sánchez A, et al.: Performance of the craniocervical flexion test, forward head posture, and headache clinical parameters in patients with chronic tension-type headache: a pilot study. J Orthop Sports Phys Ther, 2007, 37: 33–39. [Medline] [CrossRef]
5) Falla D, Jull G, Russell T, et al.: Effect of neck exercise on sitting posture in patients with chronic neck pain. Phys Ther, 2007, 87: 408–417. [Medline] [CrossRef]
6) Page P, Frank CC, Lardner R: Assessment and Treatment of Muscle Imbalance: The Janda Approach. USA: HumanKinetics, 2010.
7) Liebenson C: Rehabilitation of the Spine: A Practitioner's Manual: Briigger Methods for Postural Correction. Philadelphia: Lippincott Williams & Wilkins, 2007.
8) Caneiro JP, O'Sullivan P, Burnett A, et al.: The influence of different sitting postures on head/neck posture and muscle

activity. Man Ther, 2010, 15: 54–60. [Medline] [CrossRef]
9) Hamaoui A, Hassaïne M, Zanone PG: Sitting on a sloping seat does not reduce the strain sustained by the postural chain. PLoS ONE, 2015, 10: e0116353. [Medline] [CrossRef]
10) Jung JH, Yu JH, Kang HK: Differences in trunk muscle activities and ratios between unstable supine and prone bridging exercises in individuals with low back pain. J Phys Ther Sci, 2012, 24: 889–892. [CrossRef]
11) Lee WH, Lee YM, Gong WT: The effect of lumbar strengthening exercise on pain and the cross-sectional area change of lumbar muscles. J Phys Ther Sci, 2011, 23: 209–212. [CrossRef]
12) Kim SG, Yong MS, Na SS: The effect of trunk stabilization exercises with a swiss ball on core muscle activation in the elderly. J Phys Ther Sci, 2014, 26: 1473–1474. [Medline] [CrossRef]
13) Jull GA, O'Leary SP, Falla DL: Clinical assessment of the deep cervical flexor muscles: the craniocervical flexion test. J Manipulative Physiol Ther, 2008, 31: 525–533. [Medline] [CrossRef]
14) Mark C, Sarah M: Kinetic control: the management of uncontrolled movement. Australia: Elsevier, 2012.
15) Ng JK, Kippers V, Richardson CA: Muscle fibre orientation of abdominal muscles and suggested surface EMG electrode positions. Electromyogr Clin Neurophysiol, 1998, 38: 51–58. [Medline]
16) Lee TH, Lee JH, Lee YS, et al.: Changes in the activity of the muscles surrounding the neck according to the angles of movement of the neck in adults in their 20s. J Phys Ther Sci, 2015, 27: 973–975. [Medline] [CrossRef]