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Correlations between Cervical Lordosis, Forward Head Posture, Cervical ROM and the Strength and Endurance of the Deep Neck Flexor Muscles in College Students

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Abstract. [Purpose] This study was conducted in order to examine the correlations between cervical lordosis angles (Absolute Rotation Angle, ARA, forward head posture, FHP, Anterior Weight Bearing, AWB), the range of flexion and extension (RFEM), the strength and endurance of the deep neck flexor (DNF) and cervical pain. [Subjects] The study enrolled 24 university students (female: 12, male:12) aged in their 20s. [Methods] ARA, AWB and RFEM were analyzed using radiographs of lateral views. Strength and endurance were assessed using a Pressure Biofeedback Unit (PBU) and cervical pain and physical functions were assessed using the Neck Disability Index (NDI).[Results]As ARA increased, extension and RFEM also increased, and as AWB decreased, extension and endurance increased. As extension increased, RFEM and endurance increased and NDI decreased. As flexion became larger, RFEM and NDI increased, and as RFEM increased, endurance increased. [Conclusion] The study results indicate that the posture of the cervical spine affects the endurance rather than the strength of the DNF. Therefore, as therapeutic interventions to enhance the endurance of the DNF, posture control to reduce AWB and approaches to increase extension and RFEM should be considered.
Key words: Neck deep flexor, Range of flexion and extension, Endurance

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INTRODUCTION

Disuse atrophy resulting from changes in the position of the head and shoulders in normal resting head posture is considered as a factor that contributes to the onset and progression of dyspragia in the neck region[1)]. FHP, in which the head is positioned forward is a posture that commonly appears in cervical problem patients as a way of decreasing the curve of the cervical spine[2)]. The loss of the cervical curve is considered a significant factor in certain conditions such as mechanical cervical pain[3)]. It is also considered that as muscle contraction is constantly maintained and the fatigue caused by muscle weakness is a cause of chronic cervical pain[4, 5)]. T herefore, the strength of the muscles in the neck region plays an important role in the control of cervical stabilization. Along with the shoulder girdle muscle, the DNF is an important muscle for the control and support of the neck, supporting the weight of the head against gravity and stabilizing the head[6)]. Researchers at the University of Queensland developed the cranio-cervical flexion test (CCFT), which uses a pressure biofeedback unit (PBU) to measure DNF strength[7)]. Since only the neck, and not the head, is bent, this test method is said to be adequate for assessing the anatomical activities of deep muscles such as the longus colli and the longus capitis rather than the activities of the sternocleidomastoid (SCM) and the anterior scalenus, which are surface muscles[8)]. In this study, the CCFT was modified in order to examine the functions of the DNF[9)].

ARA and AWB are important factors in the maintenance of posture and the range of motion of the cervical spine and the strength and endurance of the DNF are known to be related to neck problems. Accordingly, this study examined the effects of ARA, AWB and the range of flexion and extension on the strength and endurance of the DNF and NDI and the correlations between them. The study should provide basic data for the functions of the DNF muscles in relation to the posture of the cervical spine and physical therapy approaches for cervical pain.

SUBJECTS AND METHODS

This study enrolled 24 university students (12 females, 12 males) in G College in Gyeongsangbuk-do, Korea. The age of the subjects (mean ± standard deviation) was 22.69±4.00, their height was 167.21±8.89 cm, and their weight was 61.39±11.35 kg. Those who had received a previous surgical treatment of the cervicospinal area, systematic disease patients, and those with neck pain accompanied by fracture

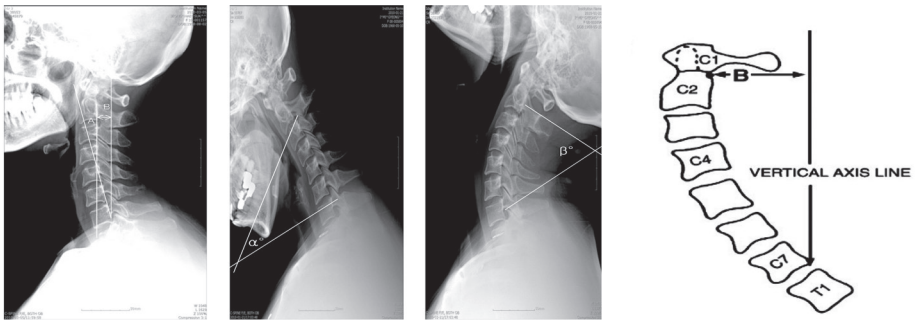

Fig 1. A, ARA from the C2 through C7 vertebrae using the posterior tangent method for analysis of the angle of cervical lordosis is depicted. B, A measure of AWB is shown. The horizontal displacement of the posterior superior body corner of the C2 vertebra is compared vertical line originating at the posterior inferior body corner of the C7 vertebra. C, drawing showing the technique for measuring the range of flexion and extension motions on plain lateral radiographs of the cervical spine range of flexion and extension = α°+β°

were excluded from radiometric analysis of the cervical spine. The subjects in this study sufficiently understood the purpose of the experiment and the study as a whole and voluntarily agreed to participate.

In the radiometric analysis of the cervical spine, the degrees of cervical lordosis were compared and analyzed through the lateral view. To examine the ARA of the forward head posture, the AWB was observed to measure the degree of cervical lordosis. The subject was asked to adopt a comfortable and natural posture as far as possible while standing with the base of the nose and the external occipital protuberance parallel to each other, with the eyes closed and the muscles on the neck, the shoulders and the arms maximally relaxed. Radiographs were taken by the same radiologist at a distance of one meter using 14×14 inch-sized films with X-ray equipment (MDXP-40, Medien, Korea) (Fig. 1).

The strength and endurance of the DNF were measured using modified CCFTs. We defined strength as the time over which the maximum voluntary contractile strength (MVCS), which is the maximal pushing pressure, could be maintained and endurance as the time during which a pressure halfway between the base pressure and the MVCS could be maintained. The modified CCFT was conducted by three examiners using a PBU (Chattanooga Group, Australia) and a stopwatch. The PBU was positioned on the back of the neck with subjectgs in the supine position. When 80 mmHg had been established as the base pressure, subjects were instructed to draw in their chins while pushing their heads against the ground. At this time, Examiner 1 monitored the pressure gauge and Examiner 2 monitored the posture to ensure maintenance of static muscle contraction in the region of the cervical spine. They checked the contraction of the SCM by palpating the SCM with the index and the middle finger while ensuring that the subject's chin was not lifted. Examiner 3 measured the time using a stopwatch. The times for strength and endurance were measured until the chin of the subject was lifted, the SCM was over-contracted or a change of ± 2 mmHg or larger was reported by the pressure gauge. Cervical pain and physical functions were assessed using the NDI, which is the most commonly used and recommended outcome measuring tool for assessing the disabling effects of cervical spinal disorders.

The measured data were analyzed using the SPSS 12.0 KO (SPSS, Chicago, IL, USA) statistical program, and data are presented as means and standard deviations. In order to identify correlations between ARA, AWB, extension, flexion, RFEM, strength, endurance and NDI, we conducted a Pearson correlation coefficient analysis. The statistical significance level α was chosen as 0.05.

RESULTS

The means ± standard deviations of ARA, AWB extension, flexion, RFEM, strength, endurance and NDI are presented in Table 1. We studied correlations between each of the factors of interest. Extension (r=0.52) and RFEM (r=0.51) were positively correlated with ARA, and extension (r=–0.42) and endurance (r=–0.41) were negatively correlated with AWA. RFEM (r=0.70) and endurance (r=0.48) were positively correlated with extension, while NDI (r=–0.33) was negatively correlated with extension. RFEM (r=0.52) and NDI (r=0.52) were strongly positively correlated with flexion, and endurance (r=0.46) was positively correlated with RFEM (Table 2).

DISCUSSION

In this study, we analyzed ARA, AWB, RFEM, DNF and NDI in college students and then examined the correlations between the values. It has been reported that ARA and RFEM of patients with herniated nucleus pulposus (HNP), are remarkably decreased compared to normal persons[10]. However, in the present study, which evaluated normal young adults, as ARA increased, extension and RFEM also increased. It has been reported that FHP is associated with the weakening of the isometric strength and endurance of the neck flexors[11] and our study gave a similar result in that as AWB increased, extension and endurance of the DNF

Table 1. Mean ± standard deviation (Unit-ARA, Ex, Fle, RFEM: ° AWB: mm, St, End: mmHg)

ARA	AWB	Ex	Fle	RFEM	St	End	NDI
16.95 ± 9.68	16.60 ± 9.72	65.13 ± 10.78	18.95 ± 8.97	84.08 ± 12.25	68.43 ± 39.02	73.47 ± 83.62	7.04 ± 5.84

ARA, absolute rotation angle; AWB, anterior weight bearing; Ex, extension; Fle, flexion; RFEM, range of flexion and extension motions; St, strength; End, endurance; NDI, neck disability index.

Table 2. Correlation of the ARA, AWB, Ex, Fle, RFEM, ST, END and NDI.

Category	ARA	AWB	Ex	Fle	RFEM	St	End	NDI
ARA	1							
AWB	-0.12	1						
Ex	0.52*	-0.42*	1					
Fle	-0.16	0.18	-0.24	1				
RFEM	0.51*	-0.17	0.70**	0.52*	1			
St	-0.05	-0.03	-0.04	0.14	0.06	1		
End	0.18	-0.41*	0.48*	0.06	0.46*	-0.17	1	
NDI	0.00	-0.01	-0.33	0.52*	0.09	0.05	0.01	1

** $p<0.01$, * $p<0.05$. Abbreviation key as for Table 1

decreased.

The endurance of the DNF has been shown to be poor in subjects with hyper lordosis of the upper cervical region[12]. Moreover, Barton et al. reported that the strength and endurance of the DNF were much weaker in patients with cervical pain[13]. The results of our present show that as extension and RFEM increased, the endurance of DNF increased, and as extension increased, NDI decreased. Therefore, we consider that extension is an important factor for enhancing the endurance of DNF. Besides, it has been reported that neck flexion and cervical pain are correlated with each other in people with sedentary jobs[14]. The results of this study indicate that as flexion increased, RFEM increased, and NDI, which is a cervical pain index, increased. Given that the subjects were college students, we consider this to be the result of neck flexion stress caused by work in the sitting position, such as studying at a desk and using computers. Although the aim of this study was to examine the correlations of cervical ARA, AWB, flexion and extension with the strength of DNF, none of these factors were correlated with the strength. In contrast, it was shown that as AWB increased, endurance decreased, and as extension or RFEM increased, endurance increased. Thus, it can be said that the posture of the cervical spine has a greater effect on the endurance than on the strength of the DNF. Therefore, as therapeutic interventions enhancing the endurance of the DNF, posture control to reduce AWB and approaches to increase extension and RFEM should be considered.

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