J. Phys. Ther. Sci.
23: 103–105, 2011

Correlations between Cervical Lordosis, Vital Capacity, T-spine ROM and Equilibrium

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Abstract. [Purpose] This study used radiometry to examine the effects of cervical lordosis and forward head posture (FHP) angles on vital capacity, equilibrium and ROM of the thoracic spine, and to explore the correlations between each of these factors.[Subjects]The subjects of this study were 36 college students in their twenties (male=16, female=20). [Subjects and Methods]Cervical lordosis angles and FHPs were analyzed with lateral view radiographs. Measures were taken of vital capacity, equilibrium and the range of motion of the thoracic spine and the results were analyzed. [Results]As the absolute rotation angle (ARA) decreased, the anterior weight-bearing angle (AWB) increased while vital capacity (VC) decreased. The results of this study indicate that as the range of motion of the thoracic spine from neutral to flexion increases, the ROM from neutral to extension also increases, and as the ROM from neutral to extension increases, the angle from flexion to extension also increases. [Conclusion]As faulty head and neck postures of subjects affected not only the dynamic stress of their neck but also their vital lung capacity, it is recommended that ARA and AWB angles should be considered when aligning posture in the treatment of impaired vital capacity.
Key words: ARA, AWB, Forward head posture

(This article was submitted Jul. 13, 2010, and was accepted Aug. 14, 2010)

INTRODUCTION

With the increasing use of computers, the reporting of musculoskeletal system problems in the neck and shoulders is increasing, especially by students and others who frequently use computers[1)]. If the upper part of the thoracic spine is bent or rounded in standing or sitting postures, the positions of the head and the neck will change to compensate for the bending[2)]. It is understood that this kind of FHP imposes dynamic stress on the neck from the weight of the head[3)]. Due to the muscular imbalance caused by this stress, some muscles will be suppressed and weakened while other muscles will tense and lose extensibility. These muscular imbalances will consequently trigger a vicious circle of events, including FHP, bent shoulders, scapular elevation etc[4)]. Good respiration requires the stability of the cervical and thoracic spine; therefore, improper adjustments of muscles and limited ranges of motion will lead to impairment of the respiratory function[5)]. We know that musculoskeletal system pain is associated with reduced respiratory function and changes in breathing patterns appear when patients are in cervical pain[6)]. These patients also tend to have proprioceptor disorders that can affect the afferent input of the central nervous system, often leading to an impaired sense of balance[7)]. In other words, abnormal postures of the cervical spine will increase the muscle tone in the area of the upper thoracic spine, limiting the range of motion of the thoracic spine, and this limited range of motion will, in turn, reduce the ability to breathe and hence impair vital capacity. In this study, we established a hypothesis that abnormal postures of the cervical spine and limited range of motion of the thoracic spine will reduce the proprioceptive sensory functions of the areas near the cervical and the thoracic spine, thereby creating problems in equilibrium. To test the hypothesis, we examined the effects of absolute rotation angle (ARA) and anterior weight-bearing angle (AWB) on the vital capacity (VC), the sense of balance and the ROM of the thoracic spine of students who had been frequently exposed to postural stress. The aim was to collect basic data to assist with the future assessment of patients with dynamic stress on the neck, and to explore physical therapeutic approaches.

SUBJECTS AND METHODS

This study was conducted with 36 students (female: 20, male: 16) as subjects in the physical therapy department and the occupational therapy department of G college in Gyeongbuk, Korea. The ages of the subjects were (mean ± standard deviation) 21.36 ± 3.25, their heights were 166.75 ± 9.49 cm, and their weights were 58.50 ± 11.73 kg. Those with a history of surgical treatment of the neck, evidenced

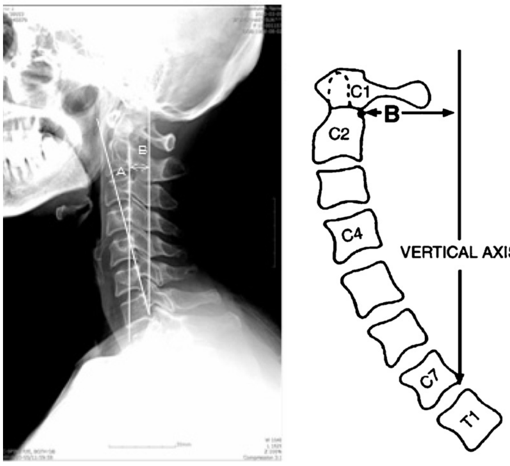

Fig 1. A: The ARA from the C2 through C7 vertebrae, using the posterior tangent method for analysis, depicts the angle of cervical lordosis. B: Measurement of the AWB. The horizontal displacement of the posterior superior body corner of the C2 vertebra is compared to a vertical line originating at the posterior inferior body corner of the C7 vertebra[8].

by radiometric analyses of the cervical spine, those with any chronic systemic disease and those with neck pain associated with any fracture were excluded from the sample. The subjects who were invited to participate in this study clearly understood the overall objectives and methods of the study before consenting to participate.

First, radiometric analyses of cervical spines were carried out and the degrees of cervical lordosis were compared by means of lateral view radiographs. To examine the ARA of the forward head posture, the AWB was observed to measure the degree of cervical lordosis. 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). 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, the eyes closed and the muscles on the neck, the shoulders and the arms maximally relaxed.

The subject's ability to balance was measured in terms of the whole path length (WPL): The subjects stood for one minute and looked steadily at a focal point displayed on the monitor while their balance was measured with a balance measuring system (BioRescue AP 153. RM INGENIERIE, France). Then, subjects' noses were blocked with a special grip to allow vital capacity to be measured with special equipment (CardioTouch 3000s, BIONET, Korea). The measurements were taken three times and the average value was used for the analysis. The range of motion of the thoracic spine was measured by measuring angles from neutral to flexion (N-F), from neutral to extension (N-E) and from flexion to extension (F-E). These measurements were taken with a spinal motion analyzer (Spinal Mouse version 2.3, Idiag Inc, Swiss).

The measured data were analyzed using SPSS 12.0 KO (SPSS, Chicago, IL, USA) statistical software and are presented as mean values with standard deviations. To observe correlations between all the measurements (i.e., ARA, AWB, VC, WPL, N-F, N-E, F-E, height and weight), Pearson's correlation coefficients were calculated. The statistical significance level α was chosen as 0.05.

RESULTS

The mean ± standard deviation of each factor of interest (i.e., ARA, AWB, VC, WPL, N-F, N-E, F-E, height and weight) is presented in Table 1. We studied correlations between each of the factors of interest: When ARA decreased, AWB increased, showing a strong negative correlation($r=-0.70$), while vital capacity decreased, showing a weak positive correlation ($r=0.32$). When N-F increased, F-E also increased ($r=0.77$), and when N-E increased F-E also increased ($r=0.80$). Vital capacity had no correlation with ARA or AWB but showed strong positive correlations with height ($r=0.80$) and weight ($r=0.81$). These findings are shown in Table 2.

DISCUSSION

Lung function deficiency is common in patients suffering from chronic pain or multiple sclerosis[9,10]. Neck pain not only leads to respiratory insufficiency, decreased ranges of motion and proprioceptor dysfunction but also affects the patient's psychological health[5]. In this study we aimed to examine the ARA and AWB of the cervical spine, vital capacity, the range of motion of the thoracic spine, balance ability and the correlations between these factors in a group of college students.

Ro et al. conducted correlation analyses on C-HNP patients and their results indicate that as ARA decreases, AWB increases ($r= -0.80$): The results of our present study also showed a strong negative correlation ($r= -0.70$) in that as ARA decreased, AWB increased[11]. The fact that the results of the present study are similar to the results of the study by Ro et al. even though the subjects of our study were not C-HNP patients indicates the severity of the stress imposed on the cervical spines of college students. In addition, in the present study, when ARA decreased, vital capacity also decreased showing a weak negative correlation ($r= 0.32$). According to a study by Kapreli et al. of chronic neck pain patients, as forward head postures

Table 1. Mean ± standard deviation

ARA	AWB	VC	WPL	N-F	N-E	F-E	H	W
12.16 ± 9.16	26.86 ± 10.98	5.64 ± 1.57	23.63 ± 4.96	18.88 ± 13.27	14.69 ± 14.03	33.11 ± 21.62	166.75 ± 9.49	58.50 ± 11.73

Unit -ARA: °, AWB: mm, VC: L, WPL: mm, N-F, N-E, F-E:°, H: cm, W: kg.

ARA: absolute rotation angle, AWB: anterior weight bearing, VC: vital capacity, WPL: whole path length, N-F: neutral to flexion, N-E: neutral to extension, F-E: flexion to extension, H: height, W: weight.

Table 2. Correlations of ARA, AWB, VC, WPL, N-F, N-E, F-E, Height and Weight

Category	ARA	AWB	VC	WPL	N-F	N-E	F-E	H	W
ARA	1								
AWB	–0.70**	1							
VC	0.32*	–0.27	1						
WPL	0.09	–0.16	0.14	1					
N–F	0.15	–0.25	0.15	–0.25	1				
N–E	–0.05	–0.10	0.01	0.06	0.25	1			
F–E	0.05	–0.021	0.10	–0.07	0.77**	0.80**	1		
H	0.10	0.01	0.80**	0.08	0.06	0.12	0.10	1	
W	0.23	–0.06	0.81**	0.06	0.12	0.06	0.10	0.81**	1

** $p<0.01$, * $p<0.05$.

increased, the maximum tidal volume and respiratory muscle power significantly decreased[12]. That result is comparable to the results of the present study. In our study, when AWB increased, vital capacity decreased, showing a weak negative correlation (r= –0.27). Based on this it can be seen that although the study subjects were young and healthy with no neck pain, the imbalance of neck and the muscles of the upper back due to forward head postures was affecting their vital capacity. Even though the participants in this study were not patients suffering from chronic neck pain or the elderly but young college students, the results showed a weak negative correlation between AWB and VC, something which we attribute to the increased use of computers and mobile phones as well as a lack of exercise.

It is recommended that similar experiments in the future should be conducted on subjects of diverse age ranges and on patients suffering from cervical functional disorders.

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