

Correlations among visual analogue scale, neck disability index, shoulder joint range of motion, and muscle strength in young women with forward head posture

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This study investigated the correlation between the neck disability index (NDI) and visual analogue scale (VAS), which are indicators of neck pain, shoulder joint range of motion (ROM), and muscle strength in women with a slight forward head posture. This study was carried out on 42 female college students attending Uiduk University in Gyeongju, Korea. The neck pain and disability index for each subject was measured using VAS and NDI, respectively. Two physiotherapists measured the shoulder joint ROM and muscle strengths of the subjects using a goniometer and a dynamometer, respectively. External rotation, internal rotation, and abduction of the shoulder joint were measured for each

subject. A significant negative correlation between neck pain and shoulder joint ROM in external rotation and the muscle strength of the shoulder joint in abduction was found in the subjects. In addition, a significant positive correlation was observed between ROM in external rotation and muscle strength in abduction. This study showed a significant negative correlation between neck pain and ROM in external rotation as well as between neck pain and the muscle strength in abduction.

Keywords: Neck disability index, Visual analogue scale, Forward head posture, Muscle strength, Range of motion

INTRODUCTION

Neck pain is the most common clinical symptom (Iizuka et al., 2015) and is one of the most common musculoskeletal disorders following back pain (Nejati et al., 2015). Neck pain often has various causes, such as neck overuse, sports injuries, and car accidents (Kang et al., 2012). However, in recent years, the neck pain experienced by many people is primarily caused by incorrect posture in daily life. In particular, the overuse of computers and smartphones, which are easily accessible by modern people, is the greatest cause of incorrect posture that can result in neck pain.

Neck pain is steadily increasing worldwide, not only in specific populations, such as office workers who use computers while sitting, but also in the general population due to the recent universalization of smartphones (Kousaleos, 2015). Since office workers use computers frequently, they sit on chairs for long periods of time

and the constant load (stress) can cause musculoskeletal system disorders (Tunwattanapong et al., 2016). Increased use of smartphones is also regarded as a major cause of neck pain and neck disorders. Thus, neck pain causes postural deformity around the cervical vertebra, and most people with neck pain experience biomechanical changes in their cervical vertebra due to abnormal posture. The most prominent change is forward head posture, which has been reported in most neck pain patients (Ruivo et al., 2016). The forward head posture causes excessive extension of the cervical vertebra. It also results in the shortening of the sternocleidomastoid muscle, levator scapulae muscle, posterior cervical extension muscles, and upper trapezius (Lee et al., 2015), in addition to weakening of the anterior cervical vertebra muscle (Lynch et al., 2010). Thus, forward head posture not only increases neck pain but also effects a structural change in the shoulders (such as round shoulder posture) due to the change in the cervical vertebra curve and problems in

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the muscles attached to the cervical vertebra (Sahrmann, 2002).

Janda (1994) explained that forward head posture and round shoulder posture occur simultaneously, resulting in a condition known as upper crossed syndrome. There have been many studies on the relationship between forward head posture and round shoulder posture. In a broad sense, neck pain does not simply affect a localized region in the neck; rather, it can cause functional disabilities such as pain in other areas around the neck, shoulder pain, muscle weakness around the arms, reduced range of motion (ROM), and postural deformity.

In this study, we aimed to investigate the correlation between the neck disability index (NDI) and visual analogue scale (VAS), which are indicators of neck pain, shoulder joint ROM, and muscle strength in women with a slight forward head posture.

MATERIALS AND METHODS

Participant

This study was carried out on 42 female college students attending Uiduk University in Gyeongju, Korea. Their ages were 20.71 ± 0.99 years, heights were 160.89 ± 5.1 cm, and weights were 57.65 ± 9.5 kg. The selection criteria for the subjects were as follows: craniocervical angle of 54 degrees or less (Harrison et al., 1996) and mild neck pain without any specific diseases that could affect the study. We excluded people who had visual or auditory impairments or problems with the nervous system or vestibular organs and those who could not understand the experimental content. In accordance with the Helsinki Declaration of Ethics, all subjects were informed about the overall purpose and procedures of the study before the experiment. They voluntarily agreed to participate in the experiment (Table 1).

Procedures

The neck pain and disability index for each subject was measured using VAS and NDI, respectively. Two physiotherapists measured the shoulder joint ROM and muscle strengths of the

subjects using a goniometer and a dynamometer, respectively. External rotation, internal rotation, and abduction of the shoulder joint were measured for each subject. Each measurement was conducted 3 times, and the mean value was used. All measurement results were expressed as mean \pm standard deviation.

Measurement

Visual analogue scale

VAS is the most commonly used method for assessing pain intensity. The leftmost value on the 10-cm horizontal line used for VAS indicates a painless condition, which is represented by 0. The rightmost value is 10, which represents extreme pain. The subjects rated their feelings of pain on the line by themselves, thereby quantifying the pain. The test-retest reliability was very high, with an intraclass correlation coefficient (ICC) of 0.97 (Bijur et al., 2001).

Neck disability index

NDI is a self-assessment tool developed to evaluate the ability of patients with neck pain to perform daily activities. The tool consists of 10 items related to pain intensity, lifting, concentration, reading, headache, self-management, driving, working, sleeping, and leisure activities. The score for each item is 0–5, and the total score is recorded by adding the scores of all the items. The lower the total score, the less the performance of daily activities is affected. The higher the score, the greater the limitations are to daily activities. The test-retest reliability was very high, with ICC = 0.96 (Shaheen et al., 2013).

Range of motion

A manual goniometer was used to measure the shoulder joint ROM. The external rotation, internal rotation, and abduction of the shoulder joint were measured. All subjects were measured in a supine position. The external rotation and internal rotation were measured with the arms extended at 90 degrees. The axis was the olecranon of ulnar, and the fixed arm was parallel to the test strip. The exercising arm was pointed in the direction of the styloid process of the ulnar and measured. In terms of the shoulder joint abduction, the axis was in front of the acromion, and the fixed arm was parallel to the front center line of the sternum. The exercising arm was placed in the center line of the humerus and measured.

Manual muscle testing

Manual muscle testing (MMT) was performed by using a hand held dynamometer (Commander Muscle Tester, JTech Inc., Chester Springs, PA, USA) to obtain measurements of the shoulder

Table 1. General characteristics of subjects (n = 42)

Variable	Mean \pm SD
Age (yr)	20.71 \pm 0.99
Height (cm)	160.89 \pm 5.16
Weight (kg)	57.65 \pm 9.50
VAS (score)	6.71 \pm 3.54
NDI (score)	10.57 \pm 9.14

SD, standard deviation; VAS, visual analogue scale; NDI, neck disability index.

joint. The external rotation, internal rotation, and abduction were measured. All subjects were measured in a supine position. The external rotation and internal rotation were measured with the arms extended at 90 degrees. For the measurement of internal rotation, the dynamometer was attached to the area just proximal to the wrist joint on the flexor surface of the forearm. For external rotation measurement, it was attached to the area just proximal to the wrist joint on the extensor surface of the forearm. For abduction measurement, the shoulder was placed in an abduction state, and the dynamometer was attached to the area just proximal to the elbow on the lateral surface of the arm (Bohannon, 1986).

Statistical analysis

IBM SPSS Statistics ver. 22.0 (IBM Co., Armonk, NY, USA) was used to analyze the data in this study. The correlations of VAS with the ROM and muscle strength of the shoulder joint, in addition to those of NDI, were examined. The correlation between ROM and muscle strength was also investigated. Pearson correlation coefficient was used for correlation analysis, and the statistical significance was set at $\alpha = 0.05$.

RESULTS

Correlation analysis between VAS and ROM showed a negative correlation, with $r = -0.423$ ($P < 0.01$) for the ROM in external rotation. In addition, a negative correlation between VAS and MMT was observed, with $r = -0.339$ ($P < 0.05$) for the MMT in abduction.

In the correlation analysis between NDI and ROM, $r = -0.328$ ($P < 0.05$) for the ROM in external rotation. In the analysis between NDI and MMT, $r = -0.412$ ($P < 0.01$) for the MMT in abduction. Thus, both results showed a negative correlation (Table 2).

A positive correlation, with $r = 0.345$, was observed between the ROM in external rotation and the MMT in abduction. A positive correlation, with $r = 0.357$, was also observed between the ROM in internal rotation and the MMT in internal rotation (Table 3).

Table 2. Correlations among the VAS, NDI, ROM, and MMT

	ROMex (°)	ROMint (°)	ROMabd (°)	MMTex (kg)	MMTint (kg)	MMTabd (kg)
	83.48 ± 15.26 ^{a)}	69.33 ± 11.84 ^{a)}	112.92 ± 3.53 ^{a)}	10.15 ± 2.42 ^{a)}	11.39 ± 2.69 ^{a)}	13.62 ± 2.71 ^{a)}
VAS (score)						
6.71 ± 3.54 ^{a)}	-0.423**	-0.162	0.176	-0.094	-0.235	-0.339*
NDI (score)						
10.57 ± 9.14 ^{a)}	-0.328*	0.008	0.104	-0.005	-0.124	-0.412**

VAS, visual analogue scale; NDI, neck disability index; ROM, range of motion; MMT, manual muscle test; ex, external rotation; int, internal rotation; abd, abduction.

^{a)}Mean ± standard deviation. * $P < 0.05$. ** $P < 0.01$.

DISCUSSION

This study was conducted to examine the correlations between VAS and NDI (indicators of pain), shoulder joint ROM and muscle strength in young women with a slight forward head posture. A significant negative correlation between neck pain and shoulder joint ROM in external rotation was found in the subjects. There was also a significant negative correlation between neck pain and the muscle strength of the shoulder joint in abduction. In addition, a significant positive correlation was observed between ROM in external rotation and muscle strength in abduction. A significant positive correlation was also observed between ROM in internal rotation and muscle strength in internal rotation.

The results above can be explained by several mechanisms described in previous studies. Many previous studies have demonstrated that forward head posture changes scapular kinematics. Ha et al. (2011) reported that forward head posture affects the alignment of the scapula, which transfers weight to the cervicospinal muscle area (such as upper trapezius and levator scapulae), resulting in excessive load on the posterior cervical structure and subsequently, neck pain. Additionally, Kwon et al. (2015) reported that muscle activity in the upper limb is lower with forward head posture compared to normal neck posture. Due to the change in the alignment of the scapula, the muscle activity in the serratus anterior muscle is decreased in people with forward head posture during shoulder flexion or upward movement of the arm over the head. Furthermore, the scapula undergoes more internal rotation,

Table 3. Correlations among the ROM and MMT

	MMTex (lbs)	MMTint (lbs)	MMTabd (lbs)
ROMex (°)	0.295	0.272	0.345*
ROMint (°)	0.175	0.357*	0.184
ROMabd (°)	-0.033	-0.153	0.024

ROM, range of motion; MMT, manual muscle test; ex, external rotation; int, internal rotation; abd, abduction.

* $P < 0.05$.

and anterior tilting occurs (Thigpen et al., 2010). Kilbom et al. (1986) reported a correlation between upper limb abduction time and neck pain. It has also been reported that scapular anterior tilting caused by forward head posture further shortens the pectoralis minor length. The lack of muscle activity in the serratus anterior muscle limits the external rotation of the shoulder (Borstad and Ludewig, 2005; Ludewig and Cook, 2000). Consistent with the results of previous studies, this study also showed that the change in scapular alignment increased pain in women with forward head posture. It seems that this change in scapular kinematics results in the reduction of muscle strength and ROM.

Previous studies have reported that neck pain caused by forward head posture is associated with changes in spinal alignment. For example, Chansirinukor et al. (2001) reported that deformation of scapular kinematics not only causes scapula deformation but also increases lordosis of the cervical vertebra and kyphosis of the upper thoracic vertebra, thereby increasing neck pain. Holmgren et al. (2012) reported that increased lordosis of the cervical vertebra and kyphosis of the upper thoracic vertebra place the acromion of supraspinatus and infraspinatus tendons close to the anterior, resulting in increased subacromial impingement.

Neck pain has been reported to be associated with gender, mental stress, musculoskeletal pain, and especially with spinal alignment in the sagittal plane (Takasawa et al., 2015; Tsunoda et al., 2013). Nejati et al. (2015) reported that neck pain is associated with inadequate posture of the cervical and thoracic vertebra in the sagittal plane.

Previous studies have demonstrated that forward head posture causes spinal deformation, which increases scapula deformation, lordosis of the cervical vertebra, and kyphosis of the upper thoracic vertebra. They have also shown that such deformation causes neck pain and deformation of the muscles around the shoulders. Therefore, the results of this study support the clinical theories claiming that there is a correlation between neck pain and the abduction and external rotation of the shoulder joint in patients with forward head posture. The results suggest that the movement of the upper limb in addition to neck pain should be considered when treating these patients.

There may be limitations in generalizing the study results because of the small number of subjects involved. In addition, since there was no evaluation of exact muscle activity for the muscles around the shoulder in relation to neck pain, we could not determine the extent of muscle involvement. Follow-up studies need to evaluate the muscles associated with neck pain by measuring muscle activity as well as neck pain and muscle strength in the shoulders.

In conclusion, the present study showed a significant negative correlation between neck pain and ROM in external rotation as well as between neck pain and the muscle strength in abduction. These results indicate that shoulder joints should also be considered when treating and assessing patients with forward head posture complaining of neck pain.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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