



Original Article

Correlation between head posture and proprioceptive function in the cervical region

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Abstract. [Purpose] The aim of the present study was to investigate correlation between head posture and proprioceptive function in the cervical region. [Subjects and Methods] Seventy-two subjects (35 males and 37 females) participated in this study. For measurement of head posture, the craniovertebral angle was calculated based on the angle between a horizontal line passing through C7 and a line extending from the tragus of the ear to C7. The joint position sense was evaluated using a dual digital inclinometer (Acumar, Lafayette Instrument, Lafayette, IN, USA), which was used to measure the joint position error for cervical flexion and extension. [Results] A significant negative correlation was observed between the craniovertebral angle and position sense error for flexion and extension. [Conclusion] Forward head posture is correlated with greater repositioning error than a more upright posture, and further research is needed to determine whether correction of forward head posture has any impact on repositioning error.

Key words: Craniovertebral angle, Head posture, Joint position sense

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INTRODUCTION

Posture is defined as the positioning of all body segments at a given point¹⁾. An ideally aligned posture is regarded as one in which there is perfect alignment of the weight-bearing segment, and it is commonly described by the vertical line of gravity passing anterior to the knee, posterior to the hip, through the bodies of vertebrae in both the cervical and lumbar spine, through the shoulder joint, and through the external auditory meatus²⁻⁴⁾. Proper posture is achieved by maintaining the musculoskeletal balance associated with minimal stress on the body and is considered an important factor in assessment of health condition. Among many factors, including vision, vestibular function, the somatosensory system, and the musculoskeletal system, proprioception is considered an essential factor for the maintenance of balance^{1, 5, 6)}. However, several factors, including neck pain and/or shoulder pain, can disrupt this balance, leading to development of a postural problem^{5, 7, 8)}.

Forward head posture (FHP), one of the most common abnormal head postures, is a postural head-on-trunk misalignment, which is defined as a head that is positioned anterior to a vertical line of gravity⁷⁻¹⁰⁾. It is commonly quantified by measurement of craniovertebral (CV) angle, which assesses the head posture^{2, 11, 12)}. FHP can lead to development of several musculoskeletal problems, including neck pain, cervicogenic headache, temporomandibular disorder, and muscular dysfunction^{7, 13)}. The close relation of FHP to chronic neck and shoulder pain has been well documented¹²⁾. In addition, FHP caused the inaccurate proprioception rather than proper head posture¹⁴⁾.

However, only a few studies investigating the correlation between FHP and proprioceptive function have been reported. Therefore, the question of whether there is a correlation between head posture and proprioceptive function in the cervical region was investigated in the current study.

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SUBJECTS AND METHODS

Seventy-two subjects (35 males and 37 females) with no history of fracture, neuromuscular disorder, or pain in the cervical region, participated in this study. Their mean age, height, and weight were 22.26 (± 2.10) years, 167.98 (± 11.89) cm, and 62.56 (± 11.89) kg, respectively. The purpose and procedures of this study were explained to all subjects, and they provided written informed consent prior to participation. This study adhered to the Declaration of Helsinki.

The CV angle was measured for assessment of head posture. All subjects were instructed to stand in a self-selected comfortable upright posture. Then, the skin overlying the spinous process of the seventh cervical vertebra (C7) and tragus of the ear was marked. A lateral view digital photograph of each subject was taken. The CV angle was calculated based on the angle between a horizontal line passing through C7 and a line extending from the tragus of the ear to C7. The x-axis values for the craniovertebral angle were measured prior to movement. Regarding measurement of FHP, a previous assessment of the test-retest reliability of the CV angle measurement revealed an ICC of 0.88–0.98¹⁵.

For assessment of proprioceptive function, joint position sense was evaluated using a dual digital inclinometer (Acumar, Lafayette Instrument, Lagatette, IN, USA), which used to measure the joint position error between the starting standard position and the returned standard position. This method has been well established in previous studies^{16–18}. Notably, joint position sense becomes more inaccurate as the degree of position sense error increases. Subjects were instructed to stand upright and to memorize their head position as a neutral start position. While keeping their eyes closed, the main unit of the dual digital inclinometer was placed on the top of their head in the sagittal plane, and the companion unit of the inclinometer was placed on the C7 spinous process. Next, the ZERO button on the dual digital inclinometer was pressed. Then, subjects performed a maximal cervical range of the movement (flexion/extension) for approximately 2 seconds and returned to their memorized neutral position. To measure the reposition error value, the HOLD button of the dual digital inclinometer was pressed. This was repeated three times, and the sequence of movement (flexion/extension) was assigned randomly.

Demographic data (age, weight, and height) were collected for descriptive statistics. Spearman's correlation coefficient was used to examine the correlation between the joint position sense and CV angle. Statistical analyses were performed using SPSS ver. 14.0, and statistical significance was set at $p < 0.05$.

RESULTS

Subjects had an average CV angle of 53.70 (± 5.05) degrees, an average position sense error for flexion of 2.86 (± 1.74) degrees, and an average position sense error for extension of 2.65 (± 1.58) degrees. In addition, there was no significant difference between genders and head posture ($p = 0.734$). Significant negative correlation was observed between the CV angle and position sense error for flexion ($r = -0.655$, $p = 0.000$) and extension ($r = -0.557$, $p = 0.000$). A summary of the statistical values is shown in Table 1.

DISCUSSION

The present study investigated the CV angle and joint position error in the cervical region to elucidate the correlation between head posture and proprioceptive function. In this study, the position-reposition error in the cervical region after cervical flexion and extension was measured. As a result, negative correlation was observed between the CV angle and joint position error. Since FHP can be quantified by the CV angle^{2, 11, 12}, this result implies that severe FHP might be relevant to poor proprioceptive function.

Use of visual display terminals is associated with an increase of musculoskeletal disorders accompanying posture problems. In particular, one of the most common postural problems is FHP^{2, 19}. The combination of extension in the upper cervical region and flexion in the lower cervical region appears in patients with FHP because of a misalignment in head posture. Changes in the cervical region, induced by sustained poor head posture, cause excessive joint and muscle loading, and subsequently influencing weakness of the deep cervical muscles^{8, 20, 21}. Among many body structures located in the cervical region, the muscle is regarded as a main element for position sense through its receptors, such as muscle spindles²².

Mechanoreceptors, including muscle spindles, are densely concentrated in the cervical region, and therefore play a key

Table 1. Correlation between craniovertebral angle and cervical joint position error

	Craniovertebral angle (degree)
	Correlation coefficient (r)
Cervical joint position error (degree)	
Flexion	-0.665*
Extension	-0.557*

* $p < 0.05$

role in providing proprioceptive information²³). Furthermore, several studies have reported that precise movement requires proper input from the muscle spindle^{24, 25}). Muscle imbalance, including weakness of cervical flexors and shortening of cervical extensors, has been reported in patients with FHP^{8, 26}). These abnormal changes in the muscles can lead to disruption of afferent input from the muscle spindles, which may have an adverse effect on joint position sense²⁷). Thus, it is suggested that FHP may influence joint position sense via muscle spindles influenced by muscle conditions.

Consequently, the current study concluded that FHP is correlated with greater repositioning error than a more upright posture. Our results imply that changes of muscle condition following FHP can lead to disruption of afferent input from the muscle spindles. Thus, it is suggested that this alteration in the muscle spindle plays a major role in the poor proprioceptive function shown in FHP.

However, the current study had several limitations. Firstly, as it did not report any measured values of muscle conditions such as muscle length and activity, the results of the current study might not be sufficient to demonstrate the effect of muscle spindles on position-reposition error. Secondly, there are various types of receptors that receive sensory information in the human body. Since the muscle spindle is just one of the sensory receptors, it is necessary to investigate whether there are other receptors that influence repositioning error. The present study did not consider effects of other sensory receptors. Thus, it is thought that further study is needed to elucidate the effects of the other sensory receptors. Also, further research is needed to determine whether correction of forward head posture has any impact on repositioning error.

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