

Original Article

Characteristics of Cervical Position Sense in Subjects with Forward Head Posture

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Abstract. [Purpose] The purpose of this study was to investigate the effect of forward head posture (FHP) on proprioception by determining the cervical position-reposition error. [Subjects and Methods] A sample population was divided into two groups in accordance with the craniovertebral angle: the FHP group and the control group. We measured the craniovertebral angle, which is defined as the angle between a horizontal line passing through C7 and a line extending from the tragus of the ear to C7. The error value of the cervical position sense after cervical flexion, extension, and rotation was evaluated using the head repositioning accuracy test. [Results] There were significant differences in the error value of the joint position sense (cervical flexion, extension, and rotation) between the FHP and control groups. In addition, there was an inverse correlation between the craniovertebral angle and error value of the joint position sense. [Conclusion] FHP is associated with reduced proprioception. This result implies that the change in the muscle length caused by FHP decreases the joint position sense. Also, proprioception becomes worse as FHP becomes more severe.

Key words: Forward head posture, Joint position sense, Proprioception

(This article was submitted Mar. 24, 2014, and was accepted May 16, 2014)

INTRODUCTION

Proprioception provides sensory feedback from the body to the nervous system; therefore, it contributes to the maintenance of optimal body alignment¹⁻⁴⁾. It includes several submodalities such as joint position sense, kinesthesia, and sense of tension. Joint position sense is used for not only recognizing the location of joints, but also for measuring proprioception. Sense of tension is also used to measure proprioception, and kinesthesia is considered to perceive active and passive movements^{2, 5)}. Various receptors such as Ruffini receptors and Pacinian corpuscles are involved in the relay of information to the central nervous system; however, the receptors in the muscle called muscle spindles, particularly play a major role in proprioception^{2, 6)}. Changes in the muscle length caused by poor posture for a sustained period of time result in musculoskeletal problems such as forward head posture (FHP)^{7, 8)}.

FHP is defined when that the head is anterior to a vertical line through the center of gravity. It is considered a common postural disorder related to abnormalities in musculoskeletal balance^{9, 10)}. Many studies have reported that FHP

is correlated to headache, temporomandibular disorders, myofascial pain syndrome, and abnormal scapular movement. Neck pain resulting from a reduction not only in the length of muscle fibers, but also in the capacity to generate tension in muscles is also attributed to FHP¹¹⁻¹³⁾. Since there are many mechanoreceptors in the cervical muscle, the cervical region is considered to play a crucial role in the transmission of information. Multifactorial problems in this region are mainly caused by decreased joint sense^{7, 14, 15)}.

Thus far, many studies have been conducted investigating the correlation between FHP and pain^{8, 9, 16, 17)}. However, investigations concerning whether FHP can affect proprioception are few. In the current study, we investigated the effect of FHP on proprioception via the measurement of cervical position-reposition error.

SUBJECTS AND METHODS

Thirty-nine subjects with no history of neuromuscular disorder, fracture, or moderate or severe scoliosis were recruited for this study. They were divided into two groups in accordance with their craniovertebral angles: the FHP group (n=19) and the control group (n=20) (Table 1). The craniovertebral angle of all subjects was measured, and when the angle was less than 53°, subjects were included in the FHP group^{10, 11, 18)}. All subjects were informed of the purpose of this study and provided their written informed consent prior to their participation. This study adhered to the ethical principles of the Declaration of Helsinki.

A very common method for the assessment of FHP is

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taking a picture of the lateral view of the subject^{18, 19}). This study used this method. The base of the camera was set at the height of the subjects' shoulder. The tragus of the ear was marked, and a plastic pointer was taped to the skin overlying the spinous process of the C7 vertebra. We measured the craniovertebral angle, which is defined as the angle between a horizontal line passing through C7 and a line extending from the tragus of the ear to C7.

The error value of cervical position sense was evaluated using a head repositioning accuracy (HRA) test²⁰⁻²³). The HRA test was used to measure the difference between the start (0 position) and return positions. A laser pointer attached to a cycling helmet was firmly placed on the subjects' heads. With their head in a natural resting position, the subjects were requested to focus on a target that was positioned at eye level. All subjects were then instructed to close their eyes, and the target was moved so that the laser pointer's beam projected onto the target. The subjects were told to memorize this position because this was the reference position. Then they performed a cervical full flexion at their preferred speed and held this position for 5 seconds. Following this, the subjects, with their eyes still closed, were instructed to return to the reference position at their preferred speed. The stopping point of the laser beam was marked with a dot. The absolute error value was measured as the distance between the two marked points. Three repetitions of HRA to reference 0 were done following the same procedure. The same procedure was followed to assess extension, right rotation, and left rotation, which were performed at random.

Data satisfying the normal distribution were examined with a parametric test. To assess the differences in the error values of the joint position sense (cervical flexion, extension, and rotation) between the FHP and control groups, the independent t-test was performed. In addition, Pearson correlation coefficients were used to assess the degree of correlation between the craniovertebral angle and the error value of each joint position sense. Statistical analyze were performed using SPSS 14.0 for Windows (SPSS Inc., Chicago, IL, USA) with a significance level of $\alpha=0.05$.

Table 1. General characteristics of the subjects

	FHP group	Control group
Gender (M/F)	7/12	12/8
Age (years)	22.2±1.9	22.7±2.1
Height (cm)	166.0±7.4	169.7±7.3
Weight (kg)	63.8±12.3	64.0±12.6

Values are expressed as the Mean±SD.

Table 3. The correlations between the craniovertebral angle and the error values of position sense

	Flexion	Extension	Right rotation	Left rotation
Pearson's correlation (r)	-0.597*	-0.421*	-0.428*	-0.389*

An asterisk (*) indicates a significant correlation ($p<0.05$).

RESULTS

There were significant differences between the error values of the joint position sense (cervical flexion, extension, and rotations) of the FHP and control groups ($p<0.05$). In addition, there was an inverse correlation between the craniovertebral angle and the error values of position sense ($p<0.05$). The statistical values are shown in Tables 2 and 3.

DISCUSSION

Nowadays, the use of visual display terminals (VDT) of computers and smart phones in almost all homes and organizations is very common²⁴). Excessive use of VDTs results in musculoskeletal disorders. Among these disorders, FHP is one of the most common conditions^{10, 16, 25}).

FHP is characterized by both an upper cervical extension and lower cervical flexion. These changes in the cervical region may lead to musculoskeletal dysfunction such as an "upper crossed syndrome" resulting from maintaining poor head position for a long duration of time^{24, 26, 27}). In addition, patients with FHP commonly complain of neck and shoulder pain⁸). These pains cause a reduction of joint sense which influences abnormal proprioception and poor postural balance⁷).

The present study examined the position-reposition error of the cervical region in order to investigate whether FHP affects joint position sense. Higher error rates were shown by the group with FHP compared to the group without FHP. In all movements (flexion, extension, and rotation), there were significant differences in repositioning errors between the two groups. This result suggests that FHP affects joint position sense. The present study also demonstrated that there is a correlation between the degree of FHP and joint position sense, additionally suggesting that as FHP becomes more severe, joint position sense becomes worse.

Joint position sense is regarded as one of the components of proprioception. It is the ability to recognize the joint location, and influences body alignment and joint stabil-

Table 2. Comparison of the cervical position sense errors of the FHP and control groups (Unit: cm)

	FHP group	Control group
Flexion	6.23±1.91*	4.14±1.74
Extension	6.23±2.20*	4.56±1.62
Right rotation	7.08±2.27*	5.13±1.51
Left rotation	5.60±2.03*	4.23±1.62

Values are expressed as the Mean±SD.

An asterisk (*) indicates a significant difference ($p<0.05$).

ity²⁻⁵). This sense is particularly influenced by receptors in the muscles called muscle spindles. Muscle spindles have a primary ending which responds to changes in the length and speed of muscle stretch as well as a secondary ending that responds only to changes in the muscle length^{2, 28-30}.

In general, FHP leads to changes in the lengths of the anterior and posterior neck muscles, and prolonged FHP causes sustained loading on the cervical spine^{8, 26}. In this regard, the results of the present study imply that changes in the lengths of muscles, as a result of FHP, have a bad influence on the activity of the muscle spindles, and this is the reason why poor joint position sense is induced by FHP. Further studies of the effect of therapeutic exercise for improving position sense of subjects with FHP should be encouraged.

In conclusion, FHP is associated with reduced proprioception. This result implies that a change in the muscle length caused by FHP affects decreases joint position sense. Furthermore, the present study also found a correlation between FHP and proprioception. This indicates that proprioception becomes worse as FHP becomes more severe.

ACKNOWLEDGEMENT

This research was supported by the Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science, ICT & Future Planning (No. 2013R1A1A3007734).

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