The effect of forward head posture on cervical joint position sense

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ABSTRACT

A number of studies have investigated the effect of age, trauma, disease and fatigue on cervical joint position sense. However, there is an absence in data regarding the role of posture on proprioception. The aim of the current study was to investigate the effect of Forward Head Posture (FHP) on cervical joint position sense. Twenty Forward Head Posture volunteers (14 women, 6 men), with the mean age of 23.94 (SD=3.26) years, and 17 normal head posture volunteers (8 women, 9 men) with the mean age of 23.50 (SD=2.68) years were asked to perform the Cervicocephalic relocation test (CRT) to the neutral head position (NHP). The aim of this test was to evaluate the participants' ability to relocate the head to neutral position after they actively rotated it to left and right sides. Three trials were performed for each rotation to the left and right. In order to assess cervical joint repositioning accuracy, Absolute, Constant and Variable errors were used. No significant difference in repositioning errors was observed between experimental and control group in absolute and constant errors ($P>0.05$); however, compared to normal group, Forward Head Posture subjects manifested significantly higher levels of variable errors ($P<0.05$). Forward Head Posture can significantly affect the positioning consistency of cervical proprioception. Nonetheless, further investigation on the effect of Forward Head Posture on cervical proprioception in altered situations is recommended.

Keywords: Neck Proprioception; Joint Position sense; Forward Head Posture; Cervicocephalic Relocation Test.

INTRODUCTION

Cervical Joint Position Sense has a tremendous effect on whole body balance, postural awareness and gait control. There are numerous reports on the effect of different factors such as age, trauma, pain, fatigue, and disease on proprioception in the literature.

Vuillerme et al. investigating the effect of age on cervical joint position sense found that joint position sense is impaired in older adults [1]. In another study by Pinsault et al. [2], cervical proprioception, assessed by the cervicocephalic relocation test to the neutral head position , was degraded with muscular fatigue. The same group additionally found that nontraumatic neck pain patients had increased errors in repositioning the head and neck to neutral head position, while bilateral labyrinthine-defective patients were not different in performing proprioceptive accuracy tests, compared to healthy subjects [3]. According to some other studies, position sense of the neck was affected in whiplashed injured patients [4, 5, 6]. However, Hertogh et al. did not find any significant difference in kinesthetic sensibility of cervicogenic headache patients and healthy subjects using the Revel et al. [12] method [7].

One of the most common postural deviations in the cervical region is Forward Head Posture (FHP), which is defined by Hertling et al. [8] as follows: "When the head is held anteriorly, the line of vision will extend downward if the normal angle at which the head and neck meets is maintained. To correct for visual needs there is a tilting of the head backwards (posterior cranial rotation [PCR]), flexion of the neck over the thorax, and posterior migration of the mandible."[p636]. In a study conducted on patients with neck pain, greater levels of disability were seen in patients with a more severe FHP [9]. According to Nemmers, there is an age- associated effect on FHP in elderly

women with the older women reflecting a more severe FHP [10]. Also, Quek et al. found out that greater FHP in older adults was associated with decreased cervical flexion and general cervical rotation [11]. In a recent study, conducted by Silva et al., induced forward head posture had no effect on postural control in healthy subjects; in their study, healthy volunteers were asked to perform a 6° anterior translation of their head to have exaggerated FHP [18]. As the above examples indicate, previous studies have mainly focused on factors affecting proprioception. Nonetheless, to the authors' knowledge, no specific study has thus far been formulated to investigate the possible effect of true FHP on neck position sense.

The purpose of the present study was to examine the effect of head posture on cervical joint position sense in young and healthy subjects. In order to do so, we used Revel et al.'s [12] method in measuring the accuracy of joint position sense, according to which patients were to relocate the cervicocephalic junction to the neutral head position after they actively rotated the head to the right and left sides.

MATERIALS AND METHODS

Study group and design

The current research was a randomized control trial study conducted in the Biomechanical Laboratory of the Rehabilitation school of Tehran university of Medical sciences in 2012.

Twenty subjects (14 women, 6 men) with Forward Head Posture (FHP) and the mean age of 23/5±3/26 years and BMI= 22/27±2/66, together with 17 healthy subjects (8 women, 9 men) with mean age of 23/94±2/68 years and BMI of 21/22±2, voluntarily participated in the experiment. An informed consent, designed and approved by the ethics committee of Tehran University of medical sciences, was signed by all participants. Those with chronic and acute neck pain, headache, vertigo, history of trauma to the neck, neck vertebra fracture, history of surgery in the cervical region and cardiac and neurological disorders were supposed to be excluded from the study. Nonetheless, none of the participants suffered from any such problems.

Selecting subjects with FHP

In order to select subjects with FHP, following the same method conducted by Raine et al [13], the volunteers were asked to stand in their comfortable posture in front of a plain and white wall looking forward, hanging their hands at their sides and their right side facing a 5.0 megapixel digital camera (Panasonic, Lumix, DMC-FZ5, Panasonic Inc. Japan) with a 35mm lens and 12x optical zoom and a built in flash, placed on a tripod 50 cm apart from the subject. The spinous process of C7 and tragus were palpated and marked with adhesive skin markers (fluorescent color adhesive squares of 1 cm diameter were used). A digital photo was taken and used to calculate the sagittal-C7-tragus angle. The angle between a horizontal line crossing the C7 and a line connecting the tragus to C7 was measured in degrees. According to Nemmer et al. [10] a young healthy adult is expected to exhibit an average normal head posture within a 10° range from 49° to 59° of the C7-tragus angle. Therefore, subjects encountering angles less than 49° were considered as FHP in this study.

Test procedure

In order to evaluate the accuracy of joint position sense of the neck, we used the Cervicocephalic relocation test (CRT) to Neutral head position (NHP), first time introduced by Revel et al. [12] and shown to have had fair to excellent reliability [14] and validity [12]. Blindfolded subjects were asked to sit comfortably on a chair facing a white, plain wall 1 meter apart, with their heads in a neutral position and their arms hanging by the side. Similar to the device used by previous studies [1, 2, 3, 14], a laser pointer was attached to the head and a button was given to the subject to turn the laser light on/off when necessary. Once the neutral head position was achieved and memorized, the subjects pressed the hand held button so that the laser light turned on and the mark left on the wall could be recorded with a digital camera. Then after actively rotating the head on the horizontal axis to both right and left sides in the comfortable end range of movement, the participants relocated their heads on the trunk to the beginning neutral position that they had memorized, [12, 2]. After each relocation, the subject pressed the button once more. No feedbacks were given during the procedure. Three trials were carried out for each right and left head rotation [12, 15].

Data analysis

After recording the laser impacts that characterized the head position at the initial neutral and post-relocation, by a digital camera, the researchers digitally processed the photographs taken. Absolute, constant and variable errors were computed in degrees to evaluate the accuracy and consistency of repositioning and therefore assessing the performance of the position sense. Each error contained three parts; horizontal, vertical and global component [3, 15]. The Absolute Error (AE) is the total amount of error between each relocated position and the initial neutral position, without considering the direction of the error [16, 17]. The Constant Error (CE) represents the total amount of error between each relocated position and the initial neutral position considering the direction of the movement; therefore, if the relocated position proceeds the neutral position the error is considered positive and overestimated; and if it doesn't reach the neutral position it is considered underestimated and negative [15]. The Variable Error (VE), represents the variability of the errors between trials and indicates the consistency of proprioceptive performance [14, 15]. The averages of AE, VE, and CE in the three trials performed were used for statistical analysis.

Statistical analysis

The data were analyzed using SPSS software version 16. Mean and Standard deviations were calculated for the variables under study. Independent t-test was used to compare AE, CE, and VE and their components between the two groups. The significance level of 0.05 was used for the statistical tests.

RESULTS

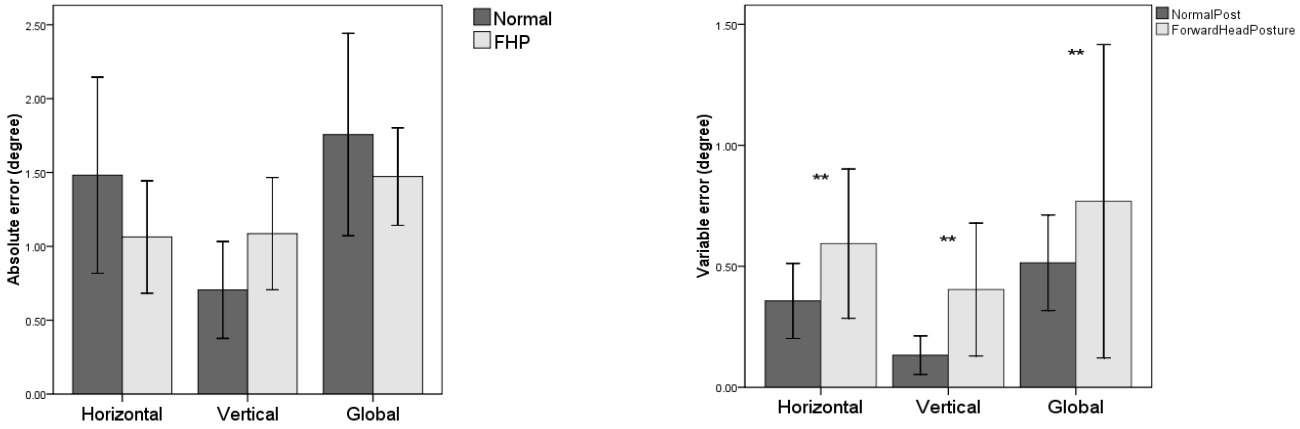
Demographic characteristics of the participants are presented in table 1.

Table1. Demographic characteristics of subjects; mean (and standard deviation) of both groups

Demographical Characteristics	Normal Head posture group (n=17)	Forward Head Posture group (n=20)
Age (years)	23.93 (2.68)	23.50 (3.26)
Height (meters)	1.72 (9.50)	1.66 (11.13)
Weight (kg)	63.70 (11.54)	61.97 (13.13)
BMI (kg/m^2)	21.22 (2.00)	22.27 (2.66)
C-H angle (degree)	54.04 (2.37)	44.65 (3.37)

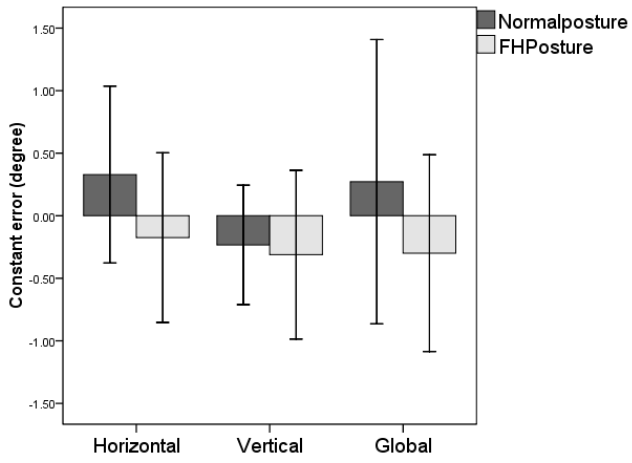
*BMI= Body Mass Index

*C-H angle= C7- Horizontal angle



a **b**

Figure1. Mean and standard deviation of horizontal, vertical and global components of a) absolute b) variable and c) constant errors in normal head posture (darker bar) and forward head posture (lighter bar) subjects. Significant p-value for comparison is set at **p<0.05.



C

Figure1. Continued

Similar to previous studies [10-15], in the three trials performed, no significant difference was seen between right and left side rotations in both groups using independent sample t-test (p>0.05). Between groups comparison of AE and CE revealed no significant difference between each compartment (horizontal, vertical and global) (p>0.05) (figure 1).

However, VE was considerably higher in the experimental group compared to normal subjects (horizontal error p=0.029, vertical error p=0.003, global error p=0.003)(figure1).

DISCUSSION

The purpose of this study was to compare cervical joint position sense accuracy and consistency between forward head posture subjects and control group. As such, twenty FHP (14 women, 6 men) and seventeen NHP (8 women, 9 men) subjects were asked to perform the CRT test. Absolute, Constant and variable errors were used to evaluate proprioception accuracy and consistency.

The variable error which is indicative of the consistency of results for each subject was higher in the forward head posture group. This result is in line with the results seen in studies comparing this variable between older and younger subjects [1], neck pain and control subjects [3, 12] and whiplash injured and control subjects [4, 5]. It seems that different types of perturbations from the normal condition such as disease, age, or abnormal posture, can result in variable responses in different trials. However, there was no significant difference between both groups in absolute and constant errors, indicating that FHP has no effect on joint position sense accuracy.

One possible reason for a higher amount of VE in FHP subjects is that FHP may lead to the use of different motor synergy strategies when trying to relocate the head to neutral position and this can lead to a higher variability in responses and therefore a higher VE error [19]. In other words, due to changes in muscle length and orientation followed by a change in joint position, as a result of poor habitual posture, the outcome of bad variables overcomes good variables, when performing a particular task more than once [19].

Another possible reason for the results is a change in muscle spindle signaling as a result of FHP. Previous studies have also mentioned muscle spindle mal-signaling as adverse effects of age, fatigue and disease on joint position sense [2, 3].

An interesting finding was that, experimental group had slightly lower, but insignificant AE, compared to control group (figure 1). Silva et al. [18], in a study on the effect of induced FHP on postural control, had the same results. They saw that postural sway and COP distance were less when FHP was induced. They argued that the postural control system of young subjects can adapt itself to the situation known as FHP. The same explanation can be used here. Young subjects with FHP may use compensatory activation of other muscle synergies; therefore, it may lead to a more overall precise response of proprioception task.

Our results suggest that variable error is a more accurate and delicate indicator to be used for studying joint position sense. Future studies are recommended to investigate the role of other postural deficiencies such as scoliosis, or lordosis, on joint position sense.

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