

## Cervical Position Sense in Forward Head Posture versus Chronic Neck Pain: A Comparative Study

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### Abstract

**Introduction:** Chronic Neck Pain (CNP) and Forward Head Posture (FHP) are two common musculoskeletal problems of the modern society. Previous studies reported several complications both in CNP and FHP including Joint cervical position sense dysfunction, sensorimotor disturbance, and altered muscle function. However, still, the extent of cervical proprioceptive dysfunction in FHP and CNP is not well known. Therefore, the aim of the present study was to investigate the cervical position sense in individuals with FHP and patients with CNP. **Method and Materials:** A total of 25 individuals with FHP and 25 patients with CNP participated in the present study. Craniovertebral Angle (CVA) was measured to identify individuals with FHP. Participants' cervical position senses were calculated performing Head Repositioning Error (HRE) test. Also, independent t-test was run to compare the HRE between the two groups. Finally, in order to evaluate the association between pain and CVA with HRE, Spearman correlation was conducted. **Results:** The results of the present study revealed a significant difference between the two groups in terms of HRE ( $p=0.02$ ), with higher HRE in patients with CNP. A moderate positive correlation was observed for CVA and HRE. No significant relationship was found between pain and HRE. **Conclusions:** The results of the present study showed that patients with CNP have higher HRE, indicating more cervical proprioceptive dysfunction in such patients compared with those in individuals with FHP. This finding may be of interest for those researchers investigating the effects of pain and mechanical loads on cervical position sense.

**Key words:** Joint position sense; Forward head posture; Chronic neck pain; Proprioception; Repositioning Error

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### Introduction

The prevalence of neck pain is estimated to be about 67% of the general population [1]. Its prevalence is even higher in women (22%) than in men (16%) [1]. Persistent pain, disability, and motor dysfunction are common complications associated with neck pain [2, 3]. Muscular weakness, fatigue, and morphological changes were also reported in patients with Chronic Neck Pain (CNP) [4]. They may negatively affect the cervical spine stability [5-7] and mechanoreceptors function [8]. Therefore, it is believed that the impairment in muscles and mechanoreceptor functions results in cervical position sense dysfunction [8].

On the other hand, Forward Head Posture (FHP) is a common postural deviation in the modern society. Prolonged sitting posture in front of computers is considered as one of the most common reason for FHP [9, 10]. It is claimed that FHP increases the compressive forces to the cervical structures

including apophyseal joints, ligaments, and posterior neck structures [11, 12]. Consequently, degenerative changes of intervertebral and facet joints are expected. Given that cervical structures consist of a huge amount of mechanoreceptors [13], it is believed that the neck proprioceptive function is disturbed in individuals with FHP [14].

However, to the best of our knowledge it is not clearly studied whether compressive forces imposed to the cervical spine in individuals with FHP has more negative impacts on the neck proprioceptive function or the muscle weakness and reflex inhibition of neck muscles induced by pain in patients with CNP. Therefore, the first aim of the present study was to compare the cervical position sense in individuals with FHP and CNP. Second, we aimed to investigate the relationships between FHP/pain severities with the neck proprioception. As such, the following hypotheses were put forward: (1) Patients with CNP show bigger Head Repositioning Error (HRE) (as the primary



**Figure 1.** Revel's method for HRE measurement

measure of the cervical proprioception) than individuals with FHP. (2) There is a positive association between the Craniovertebra Angle (CVA) (as the measure of FHP severity) and pain intensity and the HRE.

## Materials and Methods

### Participants

A total of 25 patients with CNP and 25 individuals with FHP, matched in terms of weight, height, and age, volunteered to participate in the present study. Demographic information of the participants is given in Table 1. Any history of trauma to the cervical spine, neck surgery, inflammatory diseases, like rheumatoid arthritis, and congenital deformities were identified as exclusion criteria. Furthermore, a positive history of neck pain in the year prior to the study was considered as exclusion criterion for individuals with FHP (Table 2) [9, 15]. Study objective and procedures were explained to the participants, and then they signed an informed consent form. The present study was approved by the Ethics committee of University of Social Welfare and Rehabilitation Sciences, code no: USWR.REC.11393.192.

### Pain assessment

Visual Analogue Scale (VAS) was used to evaluate the pain intensity in patients with CNP. VAS is a 100 mm ruler on which zero indicates no pain at all and 100 is the maximum tolerable pain. Patients with CNP, who reported VAS of 3 or more, participated in the study.

### Postural assessment

Craniovertebra angle was measured to identify individuals with FHP. CVA less than 49 degrees was considered as FHP [10]. CVA is defined as the angle between the line passing C7 and

the midpoint of the ear tragus with the horizontal line. To measure CVA, the following procedure was conducted. A trained physiotherapist palpated the C7 cervical vertebra and attached a plastic pointer on. Then, participants were asked to flex and extend their heads with their full range of motion and then gradually reduce it until their head rested at neutral position in order to achieve their self-balanced head position [10]. Pictures of the participants' lateral view was taken using a digital camera (Canon, model IXUS) placed and fixed 1.5 m away from the participants at their shoulders' level. The angle measurements were carried out using Autocad Software Version 12 [10, 16].

### Cervical position sense assessment

Participants were asked to sit relaxed on the experimental chair while putting their hands on their legs and keeping their heads and necks in their self-balanced position. The chair was located 1 m away from the wall. Participants were asked to wear a custom made hat on which a laser pointer was attached. The point that the laser pointer showed on the wall was considered as the participants' reference point. In order to familiarize participants with the test procedure, they were asked to rotate their heads to the maximum range of the right side on the horizontal plain, keep it for two seconds, and return to their first self-balanced head position very precisely while their eyes were open [17]. The new point on the wall was named the target point. When participants got enough familiar with the test procedure, they were asked to perform the abovementioned procedure with their eyes closed. The Arc tangent of the distance between the reference and target points divided by the distance between reference point and the laser pointer was considered as HRE (Figure 1). This method was first described by Revel et al. [18]. Each participant performed three trials. The average amount of three HRE was used for data analysis [8, 18]. No discomfort or complication was reported by participants after HRE test. The CVA and HRE were measured by two different physiotherapists.

### Statistical analysis

SPSS, version 20.0, was used for data analysis. The Kolmogorov-smirnov test was run to estimate normality. Intraclass Correlation of Coefficient (ICC) was used to evaluate the examiner reliability in measuring HRE and CVA. Also, independent t-test was carried out to compare the participants' demographic data and the HRE between the two groups. Moreover, Spearman correlation was conducted to evaluate the relationships between CVA and the pain intensity with HRE. The level of significance was set at  $p < 0.05$ .

## Results

The results of the Kolmogorov-smirnov revealed normal distribution of all data except for pain and CVA, which were

not normally distributed. The intra raters ICCs for measuring HRE and CVA ranged between 0.93-0.97 and 0.91-0.94, respectively. Independent t-test showed that there were no significant differences between the two groups in terms of demographic characteristics including age, weight, and height (Table 1). However, a significant difference was found for HRE with higher error in patients with CNP in comparison to individuals with FHP ( $P=0.02$ ) (Table 3). Spearman correlation revealed a moderate positive correlation between CVA and HRE ( $P=0.03$ ,  $r=0.43$ ). Moreover, no significant correlation was observed between pain intensity and HRE.

## Discussion

The aim of the present study was to evaluate and compare HRE in individuals with FHP and patients with CNP. The results of the study approved our hypothesis predicting the higher HRE in patients with CNP. It is believed that neck pain is accompanied by several sensorimotor impairments [19, 20]. Proprioceptive disturbance is one of those complications occurring due to impaired afferent input to the brain. However, in a systematic review, Stanton *et al.* reported that this afferent disturbance is more likely to be altered at spinal or supraspinal levels. In other words, mechanoreceptor and muscle spindle dysfunction play less significant roles in proprioceptive disturbance in patients with CNP [21]. Stanton *et al.*, also, reported that the relationship between the muscle spindle function and the position sense in neck pain is a complicated issue, which needs further investigation [21]. Some evidences revealed that patients with idiopathic neck pain have implicit imagery performance dysfunction. In other words, in comparison with healthy individuals, they are less accurate in identifying images of left/right neck and head rotation [21]. The results of the present study showed cervical proprioceptive impairment in patients with CNP, which is in agreement with the previous findings [21, 22].

Another finding of the present study was impairment in HRE in individuals with FHP. This finding is in line with the results of the study by sajjadi *et al.* who did not observe any significant difference in the absolute HRE between individuals with FHP and healthy controls [23]. In the present study, we did not investigate the HRE in healthy controls, but, compared to patients with CNP, the FHP group performed the repositioning test similar to healthy individuals. One explanation for such a finding is that young individuals with FHP might use compensatory strategies to recruit other muscle synergies so that they can have more precise head repositioning than patients with CNP [23]. Furthermore, the mean CVA of our participants with FHP was  $47.05 \pm 1.26$ , which was very close to the cutoff degree (49 degrees). Therefore, individuals with mild FHP

performed the HRE test very similar to healthy controls. As a result, the effects of length alteration in neck muscles and its consequence on muscle spindles and mechanoreceptors could not be evaluated well. This finding is different from that reported by Lee *et al.*, who reported a higher HRE in individuals with FHP [24]. The possible explanation for such a discrepancy between the results could be the different method of measuring the HRE. Lee *et al.* [24] reported the distances between the reference and target points as repositioning error while in the present study we measured the error angle. Moreover, they did not report the mean value of CVA so we could not judge about the severity of FHP.

The other aim of the present study was to investigate the relationship between FHP severity and the HRE. We observed a moderate positive relationship which is in agreement with the result of a previous study by Lee *et al.*, who observed a moderate relationship between the CVA and HRE [24]. Therefore, the more severe the FHP, the worse the HRE. This may be explained by the fact that FHP alters the cervical spine alignment and neck muscles length. FHP also imposes extra loads to facet joints and the posterior capsule [9]. Therefore, as a result of altering mechanical loads to the articular and muscular structures, muscle spindles and other mechanoreceptors afferent signals are negatively affect [23].

We did not observe any relationship between the pain severity and HRE in patients with CNP. The possible interpretation could be mild pain in our participants. The mean VAS in our participants was  $4.68 \pm 1.68$  which is very close to our cutoff (VAS=3) level of pain. Therefore, it is assumed that participants' pain was not that severe to affect spinal and supraspinal pathways of proprioception [21].

The results of the present study should be interpreted bearing in the mind the following limitations. First, our participants were collected from a young population; therefore, we could not evaluate the effects of aging on HRE. Future studies on larger population are recommended to investigate different age groups. The second limitation regarding the current study was that we did not include a healthy control group to investigate to what extent the resulted HREs are different in normal population.

## Conclusion

The results of the present study revealed a higher HRE in patients with CNP than in individuals with FHP. We also found that there is a positive moderate association between the FHP severity and the HRE in individuals with FHP. The present study can be a preliminary study for those researchers interested in investigating the effects of pain and mechanical loads on the human sensorimotor function.

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**Authors' contributions:**

All authors made substantial contributions to conception, design, acquisition, analysis and interpretation of data.

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