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Interaction between proprioception, forward head posture and neck pain in adult women

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Abstract

Background: One of the most common inappropriate postures is forward head posture (FHP), which the head is placed in front of the trunk in sagittal plane. Due to head and neck joints and muscles' impairments, it seems this postural disorder might affect neck proprioception. The purpose of the present study was to evaluate cervical proprioception in FHP subjects with and without neck pain and healthy subjects.

Methods: 31 subjects with FHP, 31 subjects with FHP and 31 healthy subjects were participated in this study. Craniovertebral (CV) angle was determined by photography. Cervical range of motion (CROM) device was used to measure active range of motion (AROM), joint reposition error of target angle (50 percent of the total AROM) and neutral angle in neck flexion, extension, left and right rotation and lateral flexion.

Results: The results of ANOVA test showed there was a significant difference between AROM of extension, right rotation, and left lateral flexion between groups ($p<0.05$). Furthermore, there was a significant difference between target and neutral angle reposition error in all directions in FHP groups and healthy group ($p<0.05$). Also, the result of Pearson correlation test showed a significant and inverse correlation between CV angle and repositioning error ($p<0.05$).

Conclusion: The results of our study showed that FHP, regardless of pain, increases the amount of joint reposition error. As a result, mechanical stability and normal kinematics are reduced.

Keywords: Posture, Proprioception, Neck pain

Conflicts of Interest: *The authors have no conflict of interest in this study.*
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Introduction

Forward head posture (FHP) is one of the most common abnormal postures of the head and neck (1, 2), which the head is distorted from natural position and placed in front of the trunk in sagittal plane, especially in women (3). It was shown in various studies that there is a relationship between FHP and neck pain (4-7). Keeping FHP for long period of time causes neck pain because of imposed low-intensity physical forces (8, 9). Due to position of head and neck joints and muscles in FHP, this postural disorder can affect neck proprioception (10, 11).

Proprioception is one of the somatosensory senses (12) which includes different senses such as sense of position, movement, force, weight, effort, pressure, vibration and stereognosis (13). The nervous system uses it to control the muscle function. (12). Proprioception is necessary for joint proper function in exercises, daily and occupational activities and helps with motor control, dynamic restrains and increases muscle stiffness and therefore provide joint

↑What is "already known" in this topic:
In Forward head posture (FHP) the head is distorted from natural position and placed in front of the trunk in sagittal plane. It was shown that there is a relationship between FHP and neck pain.

→What this article adds:
FHP with and without neck pain impresses reposition error and increases the error rate, as well. As a result, mechanical stability and normal kinematics are reduced.

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dynamic stability (14, 15). The loss of proprioception feedback leads to functional mobility limitation (14). Proprioceptive receptors are called mechanoreceptor and exist in the muscles, joints and skin (16). It is thought that the muscle receptors are the most important proprioceptive receptors (17, 18). The density of these receptors in the deep muscles of the neck is more than the superficial ones (19). Abnormal postures such as FHP change the length of neck, anterior and posterior muscles so that superficial muscles become short and deep muscles become long and weak (20, 21). Therefore, it seems that these pastoral disorders can affect the cervical proprioception. It was observed in previous studies that there is a relationship between FHP and impaired cervical proprioception (10, 11). Some studies indicated a relationship between proprioceptive disturbance and impairment in some factors such as reaction time (22), postural control and postural stability (23, 24). On the other hand, the studies examine proprioception in patients with neck pain, have reported different results. A few of them have reported limitation in proprioceptive sensibility following this type of pain (25-29) and others found no relationship between chronic neck pain and proprioceptive impairment (30-32). To our knowledge, the interactive effect of FHP, pain and proprioceptive function has not been considered so far. The aim of this study was to determine and compare the neck proprioception in subjects with FHP without neck pain, subjects with FHP with neck pain and healthy subjects through assessing head and neck repositioning error in these subjects.

Methods

Thirty-one females with FHP without any neck pain (group 1), 31 females with FHP and a history of neck pain (group 2) and 31 healthy females (group 3) aged between 18-30 years participated in this case-control study. Demographic characteristics of subjects were matched together (age, sex, height, weight and body mass index (BMI)). FHP with pain subjects had a history of neck pain which lasted at least six months and did not result in any absence from work during the last three weeks (33). No history of neck pain should be reported in FHP without neck pain and healthy subjects in the last six months. All subjects had no history of traumatic neck injury such as whiplash injury, acute neck pain, radiculopathy or cervical myelopathy, vestibular system disorders, cervical scoliosis and hearing impairment.

Samples were selected using convenience sampling. All subjects were informed of the purpose of the study. All participants gave written informed consent prior to participating in the study. This study was approved by the ethics committee of Iran University of Medical Sciences (Code number: IR.IUMS.REC.1394 .9211340206).

Pain intensity

Pain intensity was assessed using visual analog scale (VAS) that is a straight horizontal line of 100 millimeters which the subjects mark the intensity of pain on it (34). The ends are defined as the extreme limits of the pain with the end at left indicates no pain and the end at right shows the worst pain felt by the subjects. Neck pain in the present study was the mean intensity of pain among the episodes of neck pain in the last six months.

Evaluating of posture and preparing the subjects

Head and neck posture were evaluated by photography in standing position. For this purpose, a digital camera (Canon IXY 12 MP, Japan) was placed on the right side at a distance of 1.5 meters from the subject parallel to the shoulder of the subject on the fixed base and took a picture from the side view of her. Square-shaped fluorescent labels were taped on the skin of the spinous process of seventh cervical vertebra and tragus of ears to specify them in the photos (11). The subject stood near the plumb line and she was asked to look straight ahead and be in a very comfortable position in order to reach self-balance position. Then, the subject moved her head and neck from full range of flexion to full range of extension and gradually reduced the range until she stopped at neutral position. Self-balance was used for standardization of head and neck posture. The plumb line was also used in the photo to measure the vertical line and the actual horizon (35).

The carniovertebral (CV) angle was measured by the MB-Ruler software (36). The angle between the lines which pass through the spinous process of seventh cervical vertebra and tragus of the ear with the horizontal line, which passes through the spinous process of seventh cervical vertebra was determined (Figs. 1, 2). The subjects with CV angle less than 48 degrees were included in FHP

Figure 1. Cervical Range of Motion device (CROM) over the head

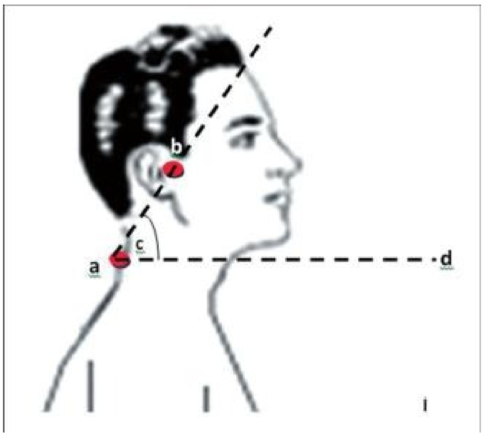

Figure 2. The method of the CV angle measuring

groups (37) (group 1 and 2) and those with CV angle greater than 48 degrees were included in healthy group 3. This method has a high reliability score (ICC = 0.88) (4).

Range of motion and neck reposition Error

To perform the test, Cervical Range of Motion device (CROM) (Deluxe model, made in USA) was used (Fig.1). The CROM is a plastic device that can measure the range of neck movements in all directions (38).

Previous studies have shown that the instrument has a high reliability score (ICC=0.89-0.98) and a high validity score that is between 0.9 – 1.2 degrees (39).

The CROM device was properly fitted to the head which was uncovered. The subjects were asked to sit in a comfortable position on the chair with backrest, then obtain self-balance position of head and neck as described above. Knees bent to 90 degrees and feet on the ground and thoracic spine contacted with the backrest.

At first step, full AROM of the head in all directions (flexion, extension, right and left lateral flexion, right and left rotation), were measured three times by CROM device. Mean of three repetitions in each direction was used for statistical analysis.

In the next step, joint position sense was evaluated. One of conventional methods in joint position sense assessment is to measure active or passive joint reposition error angle (15, 18, 40). We evaluated the head and neck repositioning error angle by measuring absolute error. Absolute error was absolute value of the difference between target angle and estimated angle by a subject, which was considered without the error direction (18).

In order to minimize visual information, the subjects' eyes were closed by blindfold. At the same time as controlling the auditory information, evaluation was carried out in a quiet environment. In addition, to reduce the proprioceptive feedback from the upper limb and trunk, as well as to prevent movements of these areas during neck movement, shoulders were strapped to the backrest of the chair by a wide belt.

The five-step assessment process contained:

- Obtaining self-balance position of head and neck and putting the head and neck in neutral position.
- Moving head up to 50 percent of AROM (target position), identified by the examiner, in each of six directions and maintaining that position for 10 seconds to remember it and then returning to the neutral position.
- Repositioning the target angle (50 percent of active ROM) and maintaining that position for 10 seconds
- Moving head and neck to neutral position.

Movements were done at slow speed and recorded three times and mean of these three trials in each movement plane was used for statistical analysis.

Statistical analysis

A Shapiro-Wilk test was used for assessing normal distribution. Statistical ANOVA test was used to compare AROM and absolute error of reposition of target and neutral angle between groups, and Bonfferoni test was used as post hoc test. In addition, in order to investigate the relationship between the amount of FHP and pain and absolute error of joint reposition test, Pearson correlation test was used. In all tests, the confidence interval level was set at α ≤ 0.05. All statistical analyses were performed using SPSS version 22.

Results

The result of Shapiro-Wilk showed normal distribution in all variables. Subjects in three groups did not show any significant difference in terms of demographic characteristics (Table 1).

The result of ANOVA test indicated significant difference between AROM of extension (p=0.024), right rotation (p=0.029), left lateral flexion (p=0.012) between groups (Table 2).

The result of Bonfferoni post hoc test showed that AROM of extension (p=0.02) and right rotation (p=0.021) in group 1 was significantly lesser than the group 3. In addition, right rotation in group 2 was significantly lower than group 1 (p=0.021). Group 1 had lower left lateral flexion AROM in comparison with group 3 (p=0.047).

Table 1. Central index and dispersion of demographic characteristics of subjects

Group Demographic characteristics	Group 1 (31 subjects) mean±SD	Group 2 (31 subjects) mean±SD	Group 3 (31 subjects) mean±SD	P
Age (year)	21.35 ± 1.97	22.06 ± 2.77	22.06 ± 1.94	0.360
Height(m)	1.62± 4.88	1.62 ± 5.61	1.64 ± 4.58	0.301
Weight(kg)	57.35 ± 5.93	57.65 ± 5.49	58.16 ± 4.84	0.842
BMI (kg/m²)	21.83 ± 1.87	21.70 ± 1.61	21.53 ± 1.13	0.759

Table 2. Comparison of AROM in six directions in the three groups of subjects

	Six directions in the three groups of subjects	Group 1 (31 subjects) mean±SD	Group 2 (31 subjects) mean±SD	Group 3 (31 subjects) mean±SD	P
AROM (degree)	Flexion	63.55 ± 9.63	62.04 ± 8.19	61.30 ± 5.50	0.651
	Extension	79.01 ± 9.87	75.03 ± 10.98	82.03 ± 8.77	0.024
	Right lateral flexion	43.29 ± 5.23	44.32 ± 5.53	45.77 ± 5.47	0.198
	Left lateral flexion	43.91 ± 4.99	44.25 ± 6.44	47.44 ± 5.56	0.029
	Right rotation	71.36 ± 7.70	66.80 ± 5.80	71.84 ± 8.56	0.012
	Left rotation	73.09 ± 7.24	68.92 ± 7.51	72.11 ± 9.67	0.118

Table 3. Comparison of absolute error of reposition of target angle and neutral angle in returning from middle of AROM in six directions in the three groups of subjects

	Six directions in the three groups of subjects	Group 1 (31 subjects) mean±SD	Group 2 (31 subjects) mean±SD	Group 3 (31 subjects) mean±SD	P
Absolute error of reposition of target angle (degree)	Flexion	3.81 ± 1.77	2.31 ± 0.92	1.24 ± 1.06	0.001
	Extension	5.05 ± 1.77	5.18 ± 2.59	2.53 ± 2.53	0.001
	Right lateral flexion	3.30 ± 1.91	3.32 ± 1.27	1.50 ± 1.06	0.001
	Left lateral flexion	2.82 ± 1.64	3.12 ± 1.31	2.01 ± 2.01	0.009
	Right rotation	3.84 ± 2.06	4.44 ± 1.69	2.93 ± 1.58	0.007
	Left rotation	3.93 ± 2.10	4.39 ± 1.38	2.29 ± 1.50	0.001
Absolute error of reposition of neutral angle (degree)	Flexion	3.56 ± 1.77	5.52 ± 1.65	2.43 ± 1.38	0.001
	Extension	4.42 ± 0.93	3.88 ± 1.87	2.80 ± 1.80	0.002
	Right lateral flexion	1.31 ± 0.90	2.73 ± 1.98	1.48 ± 1.20	0.002
	Left lateral flexion	2.80 ± 1.14	2.56 ± 1.62	1.69 ± 1.42	0.019
	Right rotation	3.68 ± 1.34	3.36 ± 1.80	1.64 ± 1.22	0.001
	Left rotation	3.40 ± 1.61	3.6 ± 1.51	2.08 ± 1.36	0.001

The result of ANOVA test showed there was statistically significant difference between absolute error of reposition of target angle ($p<0.01$) and neutral angle ($p<0.05$) in the three groups (Table 3). The result of Bonfferoni post hoc test indicated that absolute error of reposition of target angle of flexion, extension, right lateral flexion and left rotation movements in both FHP groups were significantly higher than those in the healthy subjects ($p=0.001$). In addition, reposition error of left lateral flexion ($P=0.009$) and right rotation ($p=0.005$) in the group 2 was significantly higher than that in the group 3. Also, the Bonfferoni post hoc test showed that absolute error of reposition of neutral angle in returning from middle of AROM of extension ($p<0.05$) and left and right rotation ($p<0.01$) in the group 1 and group 2 was more than that in the group 3. Also, the absolute error of reposition of neutral angle in returning from middle of AROM of right and left lateral flexion in the group 2 was more than that in the group 3 ($p<0.05$).

The result of Pearson correlation test showed that there was a significant inverse relationship between CV angle and absolute error of reposition of target and neutral angle ($p\leq0.05$). However, there was not a significant relationship between history and intensity of pain and absolute error of reposition of target and neutral angle ($p\leq0.05$) (Table 4).

Table 4. Results of the relationship between CV angle and intensity of pain with target and neutral angle reposition error in the three groups of subjects

	Variables	R	P
CV angle with	Target angle reposition error of flexion	- 0.58	0.001
	Target angle reposition error of extension	- 0.45	0.001
	Target angle reposition error of right lateral flexion	- 0.47	0.001
	Target angle reposition error of left lateral flexion	- 0.23	0.02
	Target angle reposition error of right rotation	- 0.16	0.1
	Target angle reposition error of left rotation	- 0.45	0.001
	Neutral angle reposition error from flexion	- 0.48	0.001
	Neutral angle reposition error from extension	- 0.21	0.03
	Neutral angle reposition error from right lateral flexion	- 0.31	0.002
	Neutral angle reposition error from left lateral flexion	- 0.22	0.02
	Neutral angle reposition error from right rotation	- 0.34	0.001
	Neutral angle reposition error from left rotation	- 0.46	0.001
Intensity of pain with	Target angle reposition error of flexion	- 0.19	0.28
	Target angle reposition error of extension	- 0.06	0.74
	Target angle reposition error of right lateral flexion	- 0.08	0.64
	Target angle reposition error of left lateral flexion	- 0.12	0.48
	Target angle reposition error of right rotation	- 0.17	0.33
	Target angle reposition error of left rotation	- 0.12	0.49
	Neutral angle reposition error from flexion	- 0.2	0.26
	Neutral angle reposition error from extension	- 0.13	0.44
	Neutral angle reposition error from right lateral flexion	- 0.11	0.52
	Neutral angle reposition error from left lateral flexion	- 0.01	0.91
	Neutral angle reposition error from right rotation	- 0.22	0.22
	Neutral angle reposition error from left rotation	- 0.02	0.91

Mean intensity of pain in subjects with neck pain was between 30 and 50 mm during the last six months.

Discussion

This study investigated neck AROM in FHP subjects compared with healthy subjects. Results showed that extension AROM in subjects with FHP was less than that in the healthy subjects, although, this difference was statistically significant only in group 2 subjects compared with group 3 subjects. Therefore, it is likely that pain would be one of the limited movement factors in these individuals. In this regard, Lee et al. reported cervical extension and left rotation AROM reduction in subjects with FHP and subclinical neck pain (41). They believed that the movements in the horizontal plane are affected at the highest extent by pain and the AROM reduction in this direction is prominent. Also, extension AROM had been often less than that in the healthy subjects. Another possible reason for this phenomenon in our study was shortness of muscles. In other words, the cumulative effect of pain and shortness of the muscles may cause further AROM limitations in group 2 compared to group 1 and group 3.

Based on our findings, AROM of left lateral flexion and right rotation in FHP subjects was less than that in the healthy subjects, but this difference was significant only for left lateral flexion in group 1 and right rotation in group 2 both relative to group 3. Given that most of the subjects were right-handed, therefore it is likely ongoing work in this position may lead to shortness of muscles like upper trapezius and sternocleidomastoid on the right side. Consequently, shortness of these muscles may result in left lateral flexion and right rotation (3). On the other hand, FHP by itself can lead to shortness of these muscles (42) and this can affect the incidence of AROM limitation pattern. The above results are consistent with previous research reports stating that as the amount of the FHP increases (the CV angle deceases) the cervical ROM reduces (42-44). Hyolyn Ro et al. found that in patients with protruded disc nucleus polposus, cervical ROM (flexion, extension right and left rotations) significantly decreased. They believed changes in alignment of cervical spine following FHP would be responsible for it (45). According to previous studies (46, 47), horizontal plane movements are affected at the highest extent in the persistent pain. Thus, it seems the cumulative effect of pain and muscle shortness caused further limitation of the cervical right rotation AROM in group 2 compared with group 1 and group 3.

Evaluation of the cervical position sense and assessment of the relationship between FHP and reposition error were two of main objectives in this investigation. The results showed that target and neutral angle reposition error in two groups of subjects with FHP were more than that in the healthy subjects in most directions. Therefore, postural disorder probably increased reposition error and consequently proprioception impairment. FHP causes changes in length of anterior and posterior cervical structures included the neck muscles, ligaments and joint capsules (3, 48-51) and also it causes compressive loads on zygapophyseal joints, discs and nerve roots (3, 52). Since muscle spindles are the most neck proprioceptive receptors in this structure (53), any functional disruption may lead to impairment in proprioceptive inputs (54). Although the role of the receptor in the joints, ligaments and skin are more important in end of the range of motion, but the muscle receptors are less important in middle of the range of motion and they affected the final input of the proprioception (17, 55). As FHP influences the function of all of these receptors (3, 48, 50, 56, 57), the proprioception is probably disturbed in FHP patients.

We found there was a significant and an inverse relationship between CV angle in standing position and absolute error of target and neutral angle reposition. In other words, lower CV angle was correlated with greater reposition error and greater FHP. In fact, it can be stated that increased FHP will have more side effects on deep head and neck muscle function, muscle spindles and finally on reposition error in subjects with more FHP (48, 50, 53, 54).

Lee et al. found that FHP causes an increase in absolute error of neutral angle reposition in returning from full range of flexion, extension and left and right rotation (10). They expressed because of the length of deep muscles change in FHP (3), muscle spindles function distributed. In their study, subjects with CV angle less than 53 degrees were considered as FHP group, while in the present study the cutoff point was 48 degrees which is more sensitive. Moreover, their subjects moved their head and neck to the end of AROM. In this position, posterior neck muscles, joint capsules and ligaments were placed in stretched length and transfer of proprioceptive information might increase (58). Finally, they did not control movement speed (preferred speed was chosen). Therefore, vestibular system was ignored in this method. We controlled the vestibular system by moving at slow speed (vestibular system will be stimulated in speeds faster than 35 degrees in seconds) (59). Similar to the findings of our study, Shaqayeq-fared et al. found that neutral angle reposition error in subjects with FHP in returning from flexion was more than that in the healthy subjects (11). They suggested FHP changed length of neck flexor-extensor muscles and this biomechanical changes, increased craniocervical extensor torque, and then subjects tended to extend more movement repositioning. Also, only movements in sagittal plane were assessed in a limited number of subjects. Cut-off angle (48 degrees) in our study was less than that in theirs (49 degrees).

Young et al. found that as the CV angle decreased the head and neck reposition error of neutral angle in directions of flexion and extension increased (60). They explained changes in afferent inputs of muscle spindles following FHP causing proprioception impairment. Participants in this study were FHP subjects with mean CV angle about 53/7 degree that was less sensitive. Also, the result was not compared with the control group. Young et al. just evaluated the sagittal plane movements that were preformed from end range. In this condition, transmissive structures of proprioception were in a stretched position (58). As a result, the precision of evaluation was less than that of our study. Also, Young et al. did not control the vestibular system.

Zafar et al. studied the neck relocation error in various postures induced by healthy subjects, including: standing, habitual sitting, habitual sitting with clenched jaw, and habitual sitting with the FHP. They determined that the reposition error of the neutral position in the induced FHP was greater than that in other positions, but there was no statistically significant difference between the different postures used. They attributed this to the modulation ability of the proprioceptive system in new positions and motor learning (61). Therefore, it can be said changes caused by the FHP in the proprioception are gradually created over time.

Panjabi has introduced the neutral zone as an area with some degrees of freedom, which the movement of the spine were controlled by the neuromuscular reflexes of the proprioception (62). In addition, evidence suggests that the reflective activity of the proprioceptive structures and viscoelastic components of the tissues around the spine are altered by the elongation and it will change the posture (63, 64). So possibly FHP alters sensory reflexes and affects the neutral zone by changing the biomechanics of the muscles and ligaments.

Impairment of the proprioception can lead to mechanical instability and disturbance of normal kinematic. Also, this neurological control prevents excessive strain on tissues. Hence, postural correction leads to increase stability and improve joint kinematics and prevent degenerative damages to the joint (65).

In rehabilitation, recently special attention has been devoted to proprioception (65). Thus, therapists are recommended being retrained in proprioception in the rehabilitation program.

As one of the research's objectives, the relationship between history and intensity of neck pain and proprioceptive error was assessed. Our findings showed no significant relationship between history and intensity of neck pain and absolute error of reposition of target and neutral angle. The reasons for conducting this investigation could be that the intensity of pain in subjects with neck pain was not high, also pain was felt at the end of the range and there was no significant pain in the midrange.

Some previous studies also showed the same result (6, 25, 26, 30). Otherwise, Lee et al investigated the relationship between head and neck kinesthesia and pain frequency in patients with subclinical neck pain. They showed patients with more frequency of neck pain had a more reposition error of neutral angle. They believed that pain can change the message transfer done by the muscle spindles and also features of proprioceptive neurons in the brainstem (66).

Kristjansson et al. reported that the neutral angle reposition error in head rotation in patients with neck pain it was more than that in the healthy subjects (27). In addition, they used more complex movements to assess position sense, such as a figure of eight movements to create more turmoil in proprioception. This hypothesis failed. Therefore, it seems that the familiar target position may have better effects on reposition accuracy. Also, Cheng et al. found out root mean square (RMS) error and absolute error of cervical repositioning in sagittal plane movements were higher in subjects with chronic neck pain than those in the healthy subjects. They stated that frequent neck pain can lead to changes in neck mechanoreceptors function and consequently may affect the sensitivity of muscle spindles (28). In this study, movements were done up to end of the range. In this range, proprioceptive structures were stretched (17, 55). In addition, evaluation with open eyes interferes with control of the visual system effect. Finally, vestibular system was not controlled by moving the head at the desired speed which reduced the accuracy of evaluation.

Probably, such results' discrepancy in studies regarding the effects of pain on cervical proprioception may be due to the followings: personal differences in subjects, and variation in target ROM in different studies.

One of the limitations of this study was lack of assessment of the relationship between FHP and proprioception disorders in men and in other age groups. It is also possible that subjects with neck pain had avoided to move to the end of the ROM because of fearing avoidance behaviors.

It is suggested to do similar studies in both sexes (male and female) and in different age groups. In addition, effects of postural corrective exercises and effects of pain reduction methods on proprioceptive inputs can be assessed to plan an integrated rehabilitation program.

Conclusion

It can be concluded that FHP with and without neck pain impresses reposition error and increases the error rate, as well. As a result, mechanical stability and normal kinematics are reduced. But pain without FHP did not cause more error.

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Conflict of Interests

The authors declare that they have no competing interests.

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تعامل بین حس عمقی، پوسچر جلو آمده سر و درد گردن در زنان بزرگسال

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چکیده

مقدمه: یکی از شایع ترین پوسچرهای نامناسب پوسچر جلو آمده سر است که در آن سر در صفحه ساجیتال جلوتر از تنه قرار دارد. به دلیل اختلال در مفاصل و عضلات سر و گردن، به نظر می رسد این اختلال پوسچرال ممکن است بر حس عمقی گردن تاثیر گذارد. هدف از این مطالعه بررسی حس عمقی گردن در افراد مبتلا به جلو آمدگی سر با و بدون گردن درد و افراد سالم بود.

روش‌ها: ۳۱ فرد مبتلا به جلو آمدگی سر با گردن درد، ۳۱ فرد مبتلا به جلو آمدگی سر بدون گردن درد و ۳۱ فرد سالم در این مطالعه شرکت نمودند.زاویه کرانیوورتبرال با استفاده از روش عکس برداری تعیین شد. برای اندازه گیری دامنه حرکتی فعال، خطای بازسازی زاویه هدف (۵۰ درصد از دامنه حرکتی کامل) و زاویه نوترال در حرکات خم شدن به جلو، خم شدن به عقب، چرخش و خم شدن جانبی به راست و چپ، از دستگاه *Cervical range of motion (CROM)* استفاده گردید.

یافته‌ها: نتایج آزمون *ANOVA* نشان داد که بین دامنه حرکتی فعال خم شدن به عقب،چرخش به راست و خم شدن جانبی به چپ در بین گروه ها تفاوت چشمگیری وجود داشت. علاوه بر این، تفاوت چشمگیری در بازسازی زاویه هدف و نوترال در تمام جهات، در گروه افراد مبتلا به جلو آمدگی سر و گروه سالم وجود داشت. همچنین، نتایج آزمون همبستگی پیرسون نشان داد که ارتباط معکوس و معناداری بین زاویه کرانیوورتبرال و خطای بازسازی وضعیت وجود داشت.

نتیجه‌گیری: نتایج مطالعه ما نشان داد که جلو آمدگی سر، صرف نظر از وجود درد، باعث افزایش میزان خطای بازسازی وضعیت می شود. در نتیجه، ثبات مکانیکال و کینماتیک نرمال کاهش می یابد.

کلیدواژه‌ها: پوسچر، حس عمقی، گردن درد

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