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Original Article

Effect of different head-neck-jaw postures on cervicocephalic kinesthetic sense

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Abstract

Objectives: To investigate the effect of different induced head-neck-jaw postures on head-neck relocation error among healthy subjects. **Methods:** 30 healthy adult male subjects participated in this study. Cervicocephalic kinesthetic sense was measured while standing, habitual sitting, habitual sitting with clenched jaw and habitual sitting with forward head posture during right rotation, left rotation, flexion and extension using kinesthetic sensibility test. **Results:** Head-neck relocation error was least while standing, followed by habitual sitting, habitual sitting with forward head posture and habitual sitting with jaw clenched. However, there was no significant difference in error between different tested postures during all the movements. **Conclusions:** To the best of our knowledge, this is the first study to see the effect of different induced head-neck-jaw postures on head-neck position sense among healthy subjects. Assuming a posture for a short duration of time doesn't affect head-neck relocation error in normal healthy subjects.

Keywords: Cervicocephalic Kinesthetic Sense, Posture, Clenched Jaw, Forward Head Posture

Introduction

Kinesthesia is the sense of position and movement of the body[1]. It is attributed to proprioceptors, mainly from muscle spindles and tendon organs, which involve consciously perceived sensations that provide peripheral feedback for unconscious, automatic adjustments during posture and locomotion, also known as proprioception[2-4]. Proprioceptive input is the quickest and most accurate input that plays an integral role in the process of preparing, maintaining and restoring stability of the entire body[5].

Extremely high concentrations of muscle spindles in the muscles, and to a lesser extent Golgi tendon organs, cutaneous receptors, and joint receptors in the cervical have been shown to provide information to CNS that is important for head-on-trunk orientation[6-8]. Cervical spine's unique role in head and eye movement control can be explained by exceptionally high density of muscle spindles in the sub occipital muscles[9,10].

Cervicocephalic kinesthetic sense has been shown to be affected in several musculoskeletal disorders and by multifactorial problems in the region including fatigue, injury, pain, effusion, disability[6,10-12]. Altered proprioception has adverse effect on motor control leading to balance disturbance and increased postural sway[10,13-16]. Multidisciplinary rehabilitation program including body awareness training, spinal manipulation, stretching of neck and shoulder muscles, endurance retraining, etc. has been shown to improve proprioception in such conditions[6,17-19]. Research has also shown that it can also be improved if upper extremities are supported such that shoulder joint is unloaded[20]. However, to the best of our knowledge there are no studies that show the effect of different head-neck-jaw postures induced in normal healthy subjects on cervicocephalic kinesthetic sense.

Excessive use of computers and smart phones in offices and homes, often lead to development of poor posture[21], of which forward heap posture (FHP) is the most common[21-23]. Maintaining poor head position for a long duration leads to musculoskeletal dysfunction through changes in the length of the anterior and posterior neck muscles and sustained loading on the cervical spine[24,25]. This condition can develop neck and shoulder pain, and indirectly affect joint position sense

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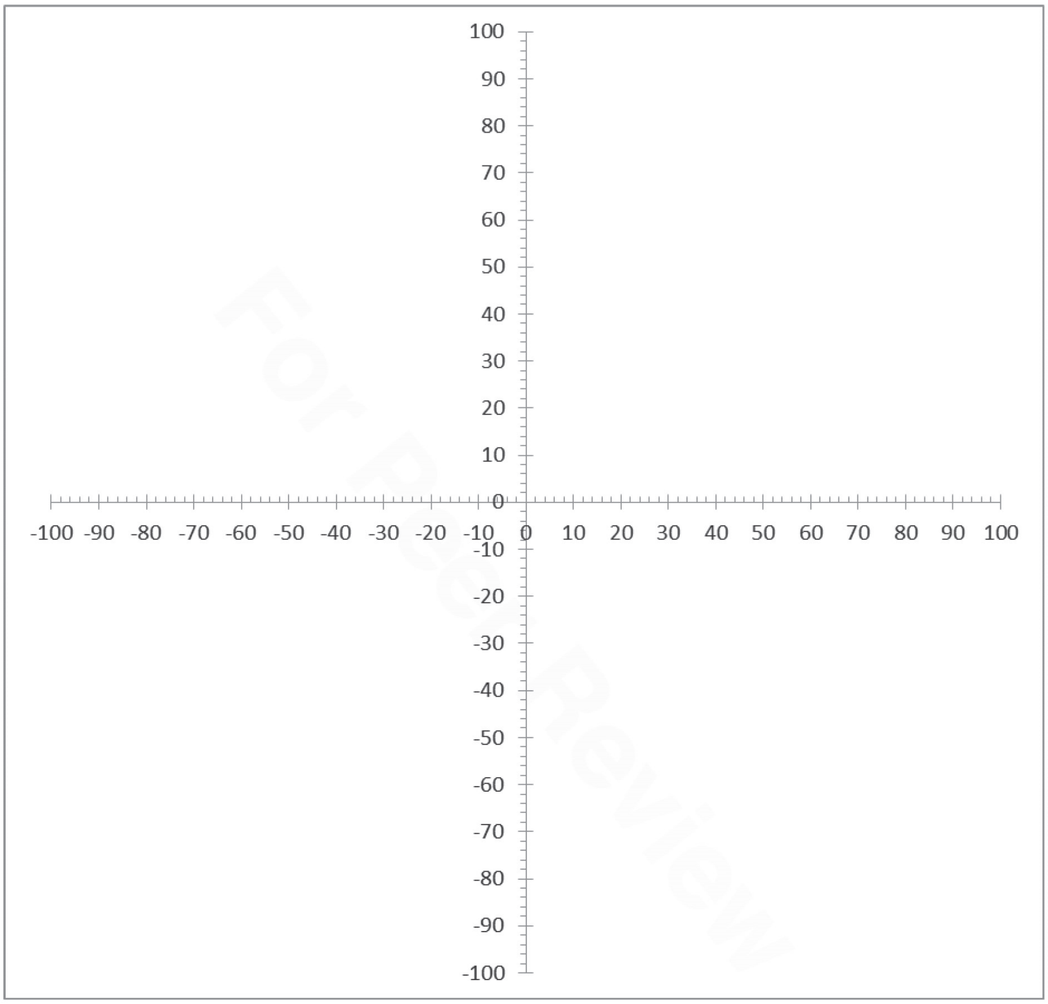

Figure 1. Illustration of the sample target, showing vertical and horizontal axis in centimeters. The positive values on horizontal axis represent right rotation and negative values left rotation. Similarly, on vertical axis the positive values represent extension and negative values represent flexion. The point at which the pointer corresponded on the target after the trial was noted and its distance from zero was measured as relocation error. It was assigned a positive or a negative sign if the pointer over or under shot the zero point depending on the test movement.

as well[12,26]. Functional jaw movements involve concomitant mandibular and head-neck movements caused by jointly activated jaw and neck muscles[27]. Research suggests that jaw clenching and chewing can modulate postural control mechanisms through the jaw sensory motor system[28,29]. Thus, it can be expected that changes in the jaw posture can also affect joint position sense in the cervical region. Hence, we hypothesized that jaw clenching would decrease the error sense while induced FHP would increase it. In this study we investigate the effect of different induced head-neck-jaw postures on head-neck relocation error among healthy subjects, which was measured while standing, habitual sitting, habitual sitting with clenched jaw and habitual sitting with FHP during right rotation, left rotation, flexion and extension movements.

Materials and methods

Subjects

Thirty healthy adult male university students aged between 20 to 30 years were invited to participate in this study. They were assessed for any musculoskeletal pain and dizziness and excluded if any associated sign or symptom was found. This study was approved by institutional research committee of our university for ethical consideration involving human subjects.

Procedure

Cervicocephalic kinesthetic sense was measured by kinesthetic sensibility test[20,30,31]. A 100 cm x 100 cm

Table 1. Head-neck relocation error (mean ±SD) during maximum right rotation (RR), left rotation (LR), flexion (F) and extension (E) movements while standing (S), habitual sitting (HS), habitual sitting with clenched jaw (HSJC) and habitual sitting with FHP (HSFHP) (n=30).

Movement	S	HS	HSJC	HSFHP
RR	0.96±6.08	1.53±6.31	2.43±6.30	1.33±4.99
LR	0.96±4.28	1.10±5.72	1.92±9.00	1.01±10.49
F	0.07±4.57	1.25±5.21	0.71±4.56	0.41±7.50
E	3.40±9.41	6.35±8.61	8.12±7.47	7.85±6.68
Average error	1.35±3.57	2.56±4.77	3.29±5.33	2.65±5.91

All values in cm.

Table 2. Absolute head-neck relocation error (mean ±SD) during right rotation (RR), left rotation (LR), flexion (F) and extension (E) movements while standing (S), habitual sitting (HS), habitual sitting with clenched jaw (HSJC) and sitting with FHP (HSFHP) (n=30).

Movement	S	HS	HSJC	HSFHP
RR	4.78±3.89	4.55±4.78	4.89±4.83	4.48±8.02
LR	3.92±2.53	4.36±4.07	5.10±7.85	5.09±9.27
F	3.51±3.52	4.38±4.51	3.59±3.39	4.16±6.34
E	7.86±6.08	8.17±6.87	8.90±6.6	8.41±6.07
Average error	5.02±2.55	5.37±4.01	5.62±4.85	5.54±6.48

All values in cm.

adjustable target was hanged on the wall. Mid-point of the target was marked as zero and the axis was marked on both sides in centimeters (Figure 1). Subjects were made to sit without back support, 90 cm away from the target but facing it. Their eyes were closed using sleeping eye mask and were made to wear a baseball cap fixed with a laser pointer.

Head-neck relocation error was measured during different induced postures: standing, habitual sitting, habitual sitting with clenched jaw and habitual sitting with FHP. Before starting the test, procedure was explained to the subjects. After covering the eyes they were asked to keep their head at a point which they considered as a neutral position and remember it to relocate their head neck to it as accurately as possible after each trial. Position of the target was the adjusted according to the height and neutral point as suggested by the subject, such that the laser pointer corresponded to zero on it.

After concentrating to keep the head in neutral position for 30 sec, they were asked to perform maximum right rotation and then try to relocate the neutral position at their normal speed[12]. The point at which the pointer corresponded on the target after the trial was noted and its distance from zero was measured as relocation error. It was assigned a positive or a negative sign if the pointer over or under shot the zero point depending on the test movement. Three trials were performed and their mean was used for analyses.

Same procedure was repeated for maximum left rotation, flexion and extension. Before starting with the new movement, a 2 minute rest was given and a new neural position was established. Test movements were performed in a random order and all readings were recorded in one session in the same recoding area.

Data analysis

Mean head-neck relocation error (± standard deviation) was measured in centimeter using kinesthetic sensibility test. It was given a positive or negative sign depending on whether subject over or under shoots the neutral position. However, to compare the difference in error during different induced postures, absolute error was calculated. Our hypothesis was tested by Friedman test (Nonparametric repeated measures ANOVA) using Graph-Pad Instat 3.0 (GraphPad Software, La Jolla, CA, USA). It was rejected if the p-value was greater than 0.05.

Results

Mean age of subjects was 25.2 (SD 6.12). Mean and absolute head-neck relocation error during right rotation, left rotation, flexion and extension movements while standing, habitual sitting, habitual sitting with clenched jaw and habitual sitting with FHP has been shown in table 1 and 2 respectively. Total average head-neck relocation error while standing was 1.35, SD 3.57, habitual sitting was 2.56, SD 4.77, habitual sitting with jaw clenched was 3.29, SD 5.33 and habitual sitting with FHP was 2.65, SD 5.91.

Comparison of head-neck relocation error during different induced postures

There was no significant difference in head-neck relocation error while standing, habitual sitting, habitual sitting with clenched jaw and habitual sitting with FHP during right rotation, left rotation, flexion and extension movements.

Discussion

This study investigated the effect of different induced head-neck-jaw postures, i.e. standing, habitual sitting, habitual sitting with clenched jaw and habitual sitting with FHP on cervicocephalic kinesthetic sense during right rotation, left rotation, flexion and extension movements among healthy subjects. Results show that error was least while standing followed by habitual sitting, habitual sitting with FHP and habitual sitting with clenched jaw. Although there was a great variation in the mean absolute error between subjects, there was no significant difference in error between different tested postures during all the movements.

In the past, only few studies have seen the effect of different body postures on cervicocephalic kinesthetic sense. Teng et al investigated the effect of most frequently adopted postures during day on neck proprioception but did not found any association between the two[32]. Another study investigated the effect of different sitting postures on cervicocephalic kinesthetic sensibility and reported that sitting with arms supported decreased the head-neck repositioning error[20]. However, to the best of our knowledge this is the first study to see the effect of different induced head-neck-jaw postures on head-neck relocation error among healthy subjects.

While head repositioning, a person can either over or undershoot the target position due to over or under estimation of the actual position of the head[33,34]. Changes in head, neck and shoulder posture causes insufficiency in neck musculature due to change in its length tension relationship[20]. Changes in the working capacity of the neck musculature can affect its proprioceptive function[35]. Research has shown that muscle relaxation allows proprioceptors to perform relatively better while one feels unsteady and has difficulty in carrying out skilled activities after performing intense exercises, which is due to disturbance in proprioception[36-38]. Similarly, maintenance of an induced posture for a considerable duration of time, as in our study during data collection, could lead to local fatigue and deteriorate joint position error.

Good posture needs efficient muscular and skeletal balance that protects the other structures of the body from stress, injury and deformity[39]. Poor posture exploits body structures beyond their capacity and any change in one segment of the body affects its overall posture[40]. Poor head, neck and shoulder posture sustained for a longer duration of time leads to changes in the muscle length further leading to development of musculoskeletal problems such as FHP and torticollis[24,41,42]. FHP leads to development of neck pain due to reduction of length of muscle fibers and its capacity to generate optimal tension[12,43,44]. Lee et al[12] examined the patients with FHP and reported that it is associated with decreased joint position error of the cervical spine. This implies that neck and shoulder pain associated with changes in the muscle length in patients with FHP causes abnormal proprioception along with poor postural balance[25,26,39]. Literature also shows that head-neck reposition error is also associated with neck dysfunction or higher disability scores[6,13,45]. Results of the current study also show that compared to standing and habitual sitting, head-neck relocation error was higher when subjects assumed FHP. However, there was no significant difference among the studied postures which could be due to the fact that it was conducted on normal healthy subjects who were instructed to assume these positions at the time of data collection only.

In order to perform newly learned motor activities with greater precision, proprioception can be modulated[46]. This modification is accompanied by motor learning which is a process of sensorimotor adaptation consisting of changes in motor signals and modulation to sensory systems[47]. Muscle proprioceptive messages provide the main information necessary for coding postural configurations and body movements as well as for exerting both reflex and automatic controls on these configurations and movements[48]. Voluntary jaw clenching has been known to improve distal muscle strength, sports performance and postural balance instantly[49,50]. However, current study did not find any significant difference in head-neck relocation error during different movements while jaw clenching.

Going by the trend of the results that show head-neck relocation error was least while standing, followed by habitual sitting, habitual sitting with FHP and habitual sitting with clenched jaw, we can expect significant results if similar study is conducted in patients with balance disorders.

Conclusion

Although there was a great variation in the mean head-neck relocation error between subjects during different movements in various head-neck-jaw postures, there was no significant difference in the absolute error. Assuming a posture for a short duration of time doesn't affect head-neck relocation error in normal healthy subjects.

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