J. Phys. Ther. Sci. 28: 1657–1659, 2016

The Journal of Physical Therapy Science

Original Article

Three-dimensional change in the cervical spine in a cross-legged sitting position after a time lapse

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Abstract. [Purpose] The purpose of this study was to investigate the kinematic changes of the cervical spine during cross-legged sitting. [Subjects and Methods] In total, 19 healthy participants were recruited from among healthy students of Silla University. Each participant sat cross-legged with the right leg over the left and gazed at a target presented at 45° below the horizontal line of sight or at an object placed directly ahead, at 90° relative to horizontal for 10 minutes. [Results] With the 45° downward gaze, there was no significant difference in cervical angle between the 0–5-min and 5–10-min time periods. However, the angle in the sagittal plane increased with time, while the frontal and transverse plane angles decreased. With the 90° forward gaze, there was no significant difference in cervical angle between the 0–5-min and 5–10-min time periods. However, the frontal plane angle increased as time elapsed, while the sagittal and transverse plane angles increased between 0 and 5 min and decreased between 5 and 10 min. [Conclusion] Our results suggest that prolonged cross-legged sitting could produce malalignment of the cervical spine in three planes of motion.

Key words: Cervical spine, Cross-legged sitting position, Time lapse

(This article was submitted Jan. 18, 2016, and was accepted Feb. 6, 2016)

INTRODUCTION

Maintaining good alignment of the body while in the sitting position is important for reducing or preventing pain associated with poor posture[1–3]. Biomechanical studies have indicated that an incorrect sitting posture (e.g. sitting in a bent or oblique position, or habitually sitting cross-legged) can cause posterior rotation of the pelvis, resulting in decreased lumbar lordosis and sacral inclination as well as increased pressure on the discs[4, 5]. The pelvis is considered to be the base of the spine and its antero–posterior orientation affects the sagittal curves of the spine. This interaction of adjacent segments according to pelvic orientation is sometimes referred to as “bottom-up” postural adjustment. For example, increased posterior pelvic tilt is believed to result in increased lumbar kyphosis and compensatory increases in the thoracic curves. Moreover, in the sagittal plane, increased thoracic flexion during sitting is associated with increased forward lean in the neck and extension in the upper cervical spine[6, 7]. In the frontal plane, the left or right pelvic obliquity that occurs as a result of cross-legged sitting causes asymmetrical loading of the ischium, which can also result in unbalanced scoliosis[8].

One posture that can cause pelvic asymmetry is cross-legged sitting, which can also result in numerous generalized problems in the body. In the sagittal plane, pelvic posterior tilt can result from a decreased pelvic tilt angle, which increases kyphosis. Visual display terminal (VDT) workers who continuously engaged in cross-legged sitting showed cervical musculoskeletal problems due to forward neck posture[9]. In the frontal plane, long-term, habitual cross-legged sitting can cause kyphosis and scoliosis[10]. However, previous studies have not evaluated the cervical spine; even the studies on changes in the pelvic sagittal plane, failed to assess changes in the frontal and horizontal planes. Although numerous studies on cross-legged sitting have been conducted, there has been no report on the three-dimensional (3D) impact of cross-legged sitting on the cervical spine. Therefore, an investigation of the impact of cross-legged sitting on the cervical spine is required. The purpose

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of this study was to investigate the kinematic changes of the cervical spine in the sagittal, frontal, and horizontal planes during cross-legged sitting using objective, image-based analysis. In addition, this study determined the effects of cross-legged sitting on the kinematic changes of the cervical spine over time.

SUBJECTS AND METHODS

In total, 19 healthy young adults (10 females, 9 males; age range: 20–24 years) participated in this study. All subjects were recruited from Silla University. The volunteers were screened to exclude those with identifiable movement dysfunction, pain, and/or pathology in the spine or lower extremities. The project received approval from the Human Research Ethics Committee of Silla University. Informed consent was obtained from each participant.

The movements of each subject during cross-legged sitting were videotaped using five video cameras. Twelve spherical reflective markers were attached to the following: the middle of the forehead, bilateral temples, bilateral acromioclavicular joints, the C7 spinous process, the T12 spinous process, the rib cage next to the T12 spinous process, bilateral sides of the posterior superior iliac spine (PSIS), and bilateral anterior superior iliac spine (ASIS). Data for the cervical sagittal, frontal, and horizontal plane angles were measured and recorded at 60 Hz by motion capture cameras. Motion analysis software (Qualisys Track Manager; Qualisys Medial AB, Gothenburg, Sweden) was used to analyze the kinematic data. To reduce variability, all procedures were performed by a single researcher. To ensure that the hips and knees were flexed at 90°, a height-adjustable chair with no back- or armrest was used to set the initial sitting posture. The participants were instructed to maintain a comfortable position and to cross the right leg completely over the left leg during the experiment. A standardized arm position was also used during sitting, with participants resting their hands on their thighs and fingertips touching the knees. A 5-min adjustment period was provided. The 25-min experimental period consisted of gazing at a target positioned directly in front of the participant at 90° relative to horizontal and another target positioned at a 45° angle below horizontal, both while in the cross-legged sitting position. Each gaze position was maintained for 10 minutes, with a 5-min rest period between positions.

All data were analyzed using SPSS for Windows software (ver. 12.0; SPSS, Inc., Chicago, IL, USA). To determine the differences between changes during the 0–5-min period and those during the 5–10-min period, paired t-tests were used for each axis of movement. The independent variable was gaze angle: forward gaze at 90° and downward gaze at 45°. The dependent variable was change in angle in the x-, y-, and z-axes (0–5 min vs. 5–10 min). The results were expressed as mean ± SD, and $\alpha = 0.05$ was taken to indicate statistical significance.

RESULTS

In downward gaze with the target at 45° during cross-legged sitting, between 0 and 5 min, the cervical angle changed by 0.8 ± 4.8° (sagittal plane), −0.1 ± 2.4° (frontal plane), and −0.5 ± 0.9° (transverse plane). Between 5 and 10 min, the cervical angle changed by 1.1 ± 3.4° (sagittal plane), 0.6 ± 3.4° (frontal plane), and −0.1 ± 0.9° (transverse plane). There was no significant difference in the change in angle between the 0–5-min and 5–10-min time periods.

In forward gaze with the target at 90° during cross-legged sitting, between 0 and 5 min, the cervical angle changed by 1.1 ± 3.2° (sagittal plane), 0.5 ± 2.5° (frontal plane), and 0.7 ± 6.2° (transverse plane). Between 5 and 10 min, the cervical angle changed by −0.6 ± 1.9° (sagittal plane), 0.1 ± 1.4° (frontal plane), and −0.5 ± 1.5° (transverse plane). There was no significant difference in the change in angle between the 0–5-min and 5–10-min time periods (Table 1).

DISCUSSION

This study measured cervical spine angle in 3D planes during cross-legged sitting and determined the effects of cross-legged sitting over time. Gazing at the target in the 90° forward position was associated with decreased sagittal plane angle during the 5–10-min period, whereas 45° downward gazing was associated with an increased sagittal plane angle over time. This result corresponded to that of a previous study[9], in which the craniocervical angle in the sagittal plane was significantly

Table 1. Cervical angle (°) in downward gaze with the target at 45° and 90° during cross-legged sitting

Gazing at lower of 45°	X	Y	Z
0 to 5 min	0.8 ± 4.8	−0.1 ± 2.4	−0.5 ± 0.9
5 to 10 min	1.1 ± 3.4	−0.6 ± 3.4	−0.1 ± 0.9
Gazing at front of 90°	X	Y	Z
0 to 5 min	1.1 ± 3.2	0.5 ± 2.5	0.7 ± 6.2
5 to 10 min	−0.6 ± 1.9	0.1 ± 1.4	−0.5 ± 1.5

X: Sagittal plane, Y: Frontal plane, Z: Transverse plane increased between 10 and 20 min compared with the initial angle ($p<0.05$). Another study found that cross-legged sitting for more than 3 hours per day caused shoulder and pelvic lateral tilt and forward head posture; that study measured the changes in craniocervical and trunk flexion angles during performance of VDT work in a cross-legged sitting position[11]. In our study, the duration of sitting was shorter. However, with respect to head position, the participants in this study showed a tendency toward small and gradual increases in forward flexion, left-sided flexion, and rotation while gazing downward at the 45° target. Additionally, this study observed small and gradual increases in right-sided flexion. Furthermore, while gazing straight forward at the 90° target, there was a tendency toward a small degree of flexion, extension, and rightward rotation between 0 and 5 min, with leftward-rotation observed between 5 and 10 min. These results suggest that over time, the cervical spine tends to show increased forward flexion, left-sided flexion, and leftward rotation while sitting in a cross-legged position with the right leg above the left leg.

A limitation of this study was that no significant difference was observed between the measured time periods due to a large standard deviation and small differences in angles. The reason for this is that all subject's starting position was not consistent, which was due to habitual sitting posture. Furthermore, little movement was observed during sitting due to the unnatural posture caused by gazing at a target presented in one position only. The short observation time may also be a factor in this result. Finally, the variability in the joint angle measurement values may have resulted from marker placement and skin movement artifacts. This study found no significant difference between the two measurement periods due to the large standard deviation and small difference in angles. However, our results suggest that over time, there is a tendency toward increased forward flexion, left-sided flexion, and leftward rotation of the cervical spine during cross-legged sitting with the right leg above the left leg. Therefore, prolonged cross-legged sitting could result in malalignment of the cervical spine in three planes of motion.

REFERENCES

1) Watanabe S, Kobara K, Yoshimura Y, et al.: Influence of trunk muscle co-contraction on spinal curvature during sitting. J Back Musculoskeletal Rehabil, 2014, 27: 55–61. [Medline]
2) O'Sullivan K, O'Sullivan P, O'Sullivan L, et al.: What do physiotherapists consider to be the best sitting spinal posture? Man Ther, 2012, 17: 432–437. [Medline] [CrossRef]
3) Kendall FP, McCreary EK, Provance PG, et al.: Muscles: testing and function with posture and pain. 2005.
4) Watanabe S, Kobara K, Ishida H, et al.: Influence of trunk muscle co-contraction on spinal curvature during sitting cross-legged. Electromyogr Clin Neurophysiol, 2010, 50: 187–192. [Medline]
5) Lord MJ, Small JM, Dinsay JM, et al.: Lumbar lordosis. Effects of sitting and standing. Spine, 1997, 22: 2571–2574. [Medline] [CrossRef]
6) Kuo YL, Tully EA, Galea MP: Video analysis of sagittal spinal posture in healthy young and older adults. J Manipulative Physiol Ther, 2009, 32: 210–215. [Medline] [CrossRef]
7) Waongenngarm P, Rajaratnam BS, Janwantanakul P: Perceived body discomfort and trunk muscle activity in three prolonged sitting postures. J Phys Ther Sci, 2015, 27: 2183–2187. [Medline] [CrossRef]
8) Drummond D, Breed AL, Narechania R: Relationship of spine deformity and pelvic obliquity on sitting pressure distributions and decubitus ulceration. J Pediatr Orthop, 1985, 5: 396–402. [Medline] [CrossRef]
9) Lee JH, Park SY, Yoo WG: Changes in craniocervical and trunk flexion angles and gluteal pressure during VDT work with continuous cross-legged sitting. J Occup Health, 2011, 53: 350–355. [Medline] [CrossRef]
10) Kang Sy, Kim SH, Ahn SJ, et al.: A comparison of pelvic, spine angle and buttock pressure in various cross-legged sitting postures. Phys Ther Kor, 2012, 19: 1–9.
11) Park Y, Bae Y: Comparison of postures according to sitting time with the leg crossed. J Phys Ther Sci, 2014, 26: 1749–1752. [Medline] [CrossRef]