J. Phys. Ther. Sci. 28: 355–359, 2016

The Journal of Physical Therapy Science

Original Article

Effects of asymmetric sitting on spinal balance

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Abstract. [Purpose] To investigate the effects of two common asymmetric sitting positions on spinal balance. [Subjects and Methods] Thirty-seven healthy subjects in their twenties were enrolled and randomly divided into two groups. Asymmetric positions of resting the chin on a hand and crossing the legs were performed by each group for 1 hour. After 1 hour, the subjects lay in the supine position again and spinal imbalance was measured using a device. [Results] After 1 hour of resting with the chin on a hand, sagittal imbalance, coronal imbalance, pelvic obliquity and lordosis angle presented spinal imbalance worsening of 1 hour of crossing legs, sagittal imbalance, pelvic torsion showed in mainly learned spinal imbalance living. [Conclusion] Good posture could be an innate ability, however it through habits. So this study is meaningful from the perspective of the importance of good posture.
Key words: Sitting position, Posture asymmetry, Spinal balance

(This article was submitted Aug. 25, 2015, and was accepted Oct. 30, 2015)

INTRODUCTION

Forty-three percent of adults and 83% of students stay in a sitting position for more than 10 hours per day[1)]. Sitting for long time affect musculoskeletal equilibrium, especially in the maintain posture case of asymmetric posture[3)]. In an asymmetric posture, need more power and energy and if posture maintained for a long time, would result in spinal imbalance[1, 3)]. Genevieve et al.[4)] demonstrated that sitting for a long time may provoke crossed leg posture, leading to spinal imbalances.

An asymmetric posture may cause permanent spinal deformity such as kyphosis, scoliosis, lordosis, and also result in chronic low back pain as well[5)]. The causes of 80–90% of low back pain are habitual asymmetric postures[6)]. In addition to lumbago, other complications could occur such as fatigue, impaired cardiopulmonary function, neurotic and psychiatric problems and matters of appearance[7)].

Common asymmetric sitting positions are sitting with crossed legs, with the chin resting on a hand, and with a purse in a hip pocket, and with lying prone on a desk[8)]. In sitting with crossed legs, asymmetric usage of abdominal internal and external oblique muscles may cause spinal imbalances. Moreover, as lumbar vertebrae are weak for flexing or twisting although they are well tolerable with pressing, sitting with crossed legs may also provoke lumbago[9, 10)].

Sitting with the chin rest on a hand is another type of asymmetric posture. It is known as more than 80% of adolescents sit resting their chin on a hand when they study behind a desk[11)]. As the spent with the chin resting on a hand gets longer, it is more likely to cause permanent disparity of shoulder height, placement of eyes, and position of hips[11, 12)]. Further, because resting the chin on a hand inevitably leads prone position, it could cause musculoskeletal non-equilibrium and spinal instability, and cause spinal injuries[13, 14)].

Asymmetric sitting such as sitting with the chin resting on a hand or with crossed legs, which arise from poor habits, may affect spinal balance. This study investigated the relationship between asymmetric sitting position and spinal balance.

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SUBJECTS AND METHODS

The study was conducted with healthy adult volunteers. This research was approved by Ethics Committee of Woosong University, and consent to participation was obtained from each subject after they had received detailed explanations of the study. We fully explained whole procedure of the experiment, and only included participants who agreed to participate. Subjects who had experience of surgery or trauma within 6 months, difficulty with sitting in the same position for more than 1 hour, limitation of spinal motion, or back pain, including lumbago were excluded.

Thirty-seven subjects were enrolled, and randomly divided into two groups: the sitting with the chin resting on a hand group and the sitting with legs crossed group (Table 1). The sitting with the chin resting on a hand group sat on a hard chair with their back straight at a table with a height of 110 cm from the ground. They rested their chin on the hand that was habitually used and favored. The elbow was firmly put on the table, and flexed at angle of 100–120 degrees, and the subjects used the palm of their hands to support the chin. The subjects sat with the soles of their feet flat on the floor, their most comfortable posture. The sitting posture with crossed legs, group sat on the same chair. The subjects crossed their legs in the way that they were habitually accustomed to, and adopted the most comfortable posture. They sat on the chair with their legs crossed, with both thighs fully crossed. The knee of lower leg was flexed at 90 degrees.

Before the intervention, the spinal balances of the subjects were evaluated. Then, they were randomly divided into the two groups of asymmetric sitting. Sitting with the legs crossed and sitting with the chin resting on a hand were performed by each group, and these postures are commonly observed in real life. Each position was maintained for 1 hour, and during that time the subjects read books or watch videos. At the end of 1 hour the spinal balances was immediately re-evaluated. Then, the subject laid the supine position for another 1 hour at the end of which spinal balance was evaluated again in order to investigate the relationship between the time and effects of asymmetric sitting. The Formetric 4D (DIERS, German) device was used to analyze spinal balance. Formetric 4D takes a picture of the subjects from behind using light with a strip pattern, and then three-dimensionally analyzes spinal balance based on contour of the back. It is intrinsically safe because it does not emit radiation, and it can analyze sagittal imbalance, coronal imbalance, pelvic obliquity, pelvic torsion, and angles of kyphosis and lordosis[15, 16].

For statistical analysis, SPSS Windows version 21.0 was used. In order to identify differences between times points (pre-intervention, directly after, 1 hour later), the data of each position was analyzed by repeated measures of ANOVA, with α=0.05 as the level of significance. Bonferroni's method was used for post hoc analysis for matching analysis among variables.

RESULTS

After sitting for 1 hour with the chin resting on a hand, there were statistically significant differences in sagittal imbalance, coronal imbalance, pelvic obliquity, and lordosis angle. However there were no statistically significant differences in pelvic torsion and kyphosis angle (Table 2). These were compared those results with graphs and with the results of post hoc analysis, and sagittal imbalance, coronal imbalance, pelvic obliquity and lordosis angle there were statistically significant, and there

Table 1. General characteristics of the subjects

			Mean ± SD
Total (N = 37)	Gender (%)	Male	18 (47.6%)
		Female	19 (51.4%)
	Age (years)		22.62± 3.7
	Height (cm)		166.2 ± 9.6
	Weight (kg)		62.9 ± 10.7
Sitting with the chin resting on a hand (N = 20)	Gender (%)	Male	9 (45.0%)
		Female	11 (55.0%)
	Age (years)		21.8 ± 4.7
	Height (cm)		165.6 ± 5.3
	Weight (kg)		62.3 ± 10.4
Sitting with the legs crossed (N = 17)	Gender (%)	Male	9 (52.9%)
		Female	8 (47.1%)
	Age (years)		23.6 ± 1.6
	Height (cm)		166.9 ± 9.9
	Weight (kg)		63.6 ± 11.3

Data are expressed as mean ± SD

were significant differences compared with ‘Directly after’; however, no significant differences when compared with ‘1 hour later’.

After sitting for 1 hour with crossed legs, there were statistically significant in sagittal imbalance, coronal imbalance, pelvic obliquity and lordosis angle. However, there were no statistically significant differences in pelvic torsion and kyphosis angle (Table 3). These were compared results with graphs and with the results of post hoc analysis. Sagittal imbalance, pelvic torsion were statistically significant, and there were significant differences compared with ‘Directly after’; however, no significant difference when compared with ‘1 hour later’.

DISCUSSION

The effects of asymmetric sitting positions represented by resting the chin on a hand and crossed legs, which are commonly observed in real life, on spinal balance were investigated at two time points. The pelvis and spine would anatomically comprise the spino-pelvic complex[17]. Therefore, it was our assumption that asymmetric sitting position would affect pelvic balance and consequently spinal balance as well.

For sitting with the chin resting on a hand, ‘directly after’ the intervention, sagittal imbalance, coronal imbalance, pelvic obliquity and lordosis angle presented statistically significant differences and they all out of normal ranges, so they could be a cause health problems. In other words, cervical spine imbalances resulting from resting the chin on a hand would have caused lordotic spinal imbalances. Those unexpected contour changes were presented laterally and frontally as well, increasing the lordosis angle to a degree that could be regarded as illness.

Panjabi et al.[17] also reported there was asymmetric shortening or stiffness of the spinal erector muscles when the spine was consistently imbalanced. This is similar to the results of our study and may indicate that long term lateral spinal flexion could be a risk factor of spinal illness. These asymmetric positions may lead to rotational deformity in the horizontal plane which would provoke positional changes of the head, shoulder, and pelvis and deformation of the trunk and thoracic cage as well. These changes could ultimately affect the spinal equilibrium[18].

For sitting with crossed legs, ‘directly after’ the intervention, different from the resting the chin on a hand, sagittal imbalance, and pelvic torsion presented statistically significant differences. Both it appears results were close to abnormality of balance, and since pelvic torsion increased, it appears that crossed legs generate pelvic torsion[19].This could affect lumbar-pelvic rhythm, and pelvic torsion increment resulting from asymmetric posture could accelerate pelvic posterior tilting for a long time, and could also increase thoracic kyphosis exacerbating abnormal posture[9, 18].

A positive aspect of this study was that, for both asymmetric sitting positions, 1 hour after the intervention spinal balance and returned to the original position. However, when an asymmetric position becomes habitual, a subject may consider it comfortable and stay in the asymmetric posture consistently. Then the muscles, ligaments, bone, vertebral discs, pelvis would

Table 2. Spinal balance analysis of the different time points of the chin resting on a hand group

	Pre intervention (Mean±SD)	Directly after (Mean±SD)	1 hr later (Mean±SD)
Sagittal imbalance(mm) *	26.3±9.7	37.5±11.9	28.5±8.4
Coronal imbalance(mm) *	6.0±4.9	10.5±4.2	7.6±4.9
Pelvic obliquity(mm) *	2.3±2.5	4.5±3.5	3.2±2.3
Pelvic torsion(angle)	1.0±0.8	1.4±0.9	1.6±1.1
Kyphosis angle(angle)	43.1±10.4	41.9±9.8	40.4±12.5
Lordosis angle(angle) *	34.8±7.1	32.8±7.8	34.0±7.3

Data are expressed as mean ± SD. *$p < 0.05$

Table 3. Spinal balance analysis of the different time points of the sitting with legs crossed group

	Pre intervention (Mean±SD)	Directly after (Mean±SD)	1 hr later (Mean±SD)
Sagittal imbalance (mm) *	18.7±11.3	26.1±13.7	22.6±15.5
Coronal imbalance(mm)	7.3±6.4	9.0±6.9	8.9±6.7
Pelvic obliquity(mm)	2.8±2.2	3.4±2.9	3.4±3.1
Pelvic torsion(angle) *	1.8±1.3	2.8±1.5	1.9±1.2
Kyphosis angle(angle)	38.7±13.3	38.5±11.9	38.4±10.7
Lordosis angle(angle)	37.4±10.7	37.1±11.1	38.5±9.9

Data are expressed as mean ± SD. *$p < 0.05$

be under stress and could be permanently deformed[20]. Ultimately it could lead to musculoskeletal symptom and disease as well. Although spinal deformity needs some time to progress, secondary results such as pain and neurotic complication could cause problems of appearance and psychiatric trouble, and could shorten life expectancy[21].

In this study, the Formetric 4D device was used. This device emits no radiation and it was used to analyze the relationship between asymmetric position and spinal balance at different time points. This study has demonstrated that a habitually maintained asymmetric position could be a risk for spine disease. Good posture could be an innate ability, however it would mainly be made up of learning through life habits[7, 17]. So this study is meaningful from the perspective of the importance of good posture.

A limitation of the study was that we only checked changes at preset time points so small temporal differences were not observed. Another limitation was that we did not consider the spinal imbalances subjects already had. Further studies addressing these issues should be conducted.

ACKNOWLEDGEMENT

This paper was supported by Wonkwang University in 2015.

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