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COMPARISON OF SPINAL SAGITTAL PARAMETERS BY TIME OF DAY IN A HEALTHY WORKING POPULATION WITH HIGH BODY-MASS INDEX

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ABSRTACT

Object: To determine the change in spinal sagittal parameters which may occur throughout the day in healthy population with high body-mass index (BMI).

Methods: Twenty-one healthy hospital employees with high BMI were enrolled in the study. Two standing left lateral ortho-roentgenograms were obtained at 8.00 a.m and at 6.00 p.m. Six spinopelvic parameters were measured on the X-rays.

Results: Twenty-one subjects with a mean age of 32.72± 7.84 were evaluated. No significant change was found between morning and evening measurements for any of the parameters. As a result of the correlation of daily changes for study parameters for the high BMI cohort showed significant direct relationship between SS and PI, LL and SS, LL and PI and an inverse relationship between LL and PI minus LL, SS and PI minus LL. ($p < 0.05$).

Conclusion: Routine workload in a hospital environment does not cause significant change in the spinopelvic parameters throughout the day.

Key Words: sagittal balance, change, healthy, collapse, spinopelvic, parameters.

Level of Evidence: Prospective clinical study, Level II

INTRODUCTION

Optimal sagittal balance provides the minimum effort to stand upright [5]. The spinal column and disc complexes will resist physiological compression and maintain upright posture [6]. A degenerated disc or loss of anterior bone support can lead to deformation, which leads to flexion and lateral bending (scoliosis), often associated with torsion (rotation) [7]. For this reason, there is a high likelihood that the spinal alignment will be gradually lost during aging. Research on spinal sagittal parameters, which emphasize the importance of sagittal vertebral balance for better outcomes of spinal deformity surgeons, has become more popular among spinal surgeons [23,25]. The amount of improvement in sagittal parameters was directly related to clinical improvement [12,20]. For this reason, their anatomical and physiological characteristics have become more important than ever to recognize compensatory mechanisms that allow the sagittal balance to be preserved. The previous literature contains a number of focuses on the identification of compensatory mechanisms and the classification of sagittal imbalance [16,22]. We now know that the increase in thoracic kyphosis is compensated by an increase in lumbar lordosis, or that the anterior lobe in the center of gravity is compensated by retroversion of the pelvis [5,19]. Most sagittal parameter studies have focused on the treatment of degenerative spinal cases or other special conditions that cause sagittal imbalance such as idiopathic scoliosis and Scheuermann's disease [4,13]. To our knowledge, physiological sagittal changes may have occurred throughout the day as a possible consequence of working and muscle fatigue. Because of this opening, we tried to determine the change in spinal sagittal parameters that may occur during the day.

MATERIALS AND METHODS

Twenty-three operating room nurses with high BMI (>30) who had no back pain

at the time of the study, with no known spine, hip or pelvic disorders and without any contraindications for radiographic exposure were enrolled in the study. Among them two subjects with previous spinal surgery were excluded. The participants were mainly operating room nurses who work actively throughout the entire day. All participants provided informed consent and the study was approved by the ethical committee of Acibadem University (ATADEK 2016/1).

The radiographic protocol was standardized for all participants. For each subject, two standing left lateral ortho-roentgenograms including the whole spine and pelvis were obtained, with the subject standing 72 inches away from the X-ray tube. The participants were instructed to stand straight and relaxed, with their knees fully extended. The elbows were parked in 90 degrees flexion, with both elbows resting on a horizontal bar at the level of their shoulders. The first X-ray was obtained at 8 o'clock in the morning just before the work shift. The second X-ray was obtained at 6 o'clock in the afternoon at the end of the work shift. Six spinopelvic parameters were measured on the X-rays: thoracic kyphosis (TK), lumbar lordosis (LL), sacral slope (SS), pelvic tilt (PT), pelvic incidence (PI) and sagittal vertebral axis (SVA) [29]. The definition of the aforementioned study variables are provided in figure 1 to provide better apprehension. All radiographs were analyzed by the same surgeon and checked by two other surgeons with the aid of digital graphics software (The Surgimap software New York, NY, USA).

Data were analyzed using SPSS 14.0 software (SPSS Inc., Chicago, IL). Application of the Kolmogorov-Smirnov test showed no normal distribution of data sets, thus Wilcoxon test was utilized and median and range values were calculated and used instead of mean values. The Independent Samples test was utilized to assess comparison of the parameters. Relationships were assessed using Pearson's coefficients. A significance value less than 0.05 was considered to be significant.

RESULTS

Twenty-one subjects; 12 males (57.1 %), 9 females (42.9 %) with a mean age of 32.72 ± 7.84 were evaluated. The mean height and weight of volunteers were 166 ± 9.4 cm and 86.02 ± 21.03 kg and mean BMI was 33.21 ± 2.32.

The values of TK, LL, SS, PI, PT and SVA were not normally distributed in patients. All spinopelvic parameters were measured twice from X-rays obtained in the morning at 8 o'clock and in the evening at 6 o'clock. Descriptive values of all parameters are shown in Table 1 for better comprehension. No significant change was found between morning and evening measurements for any of the parameters. As a result of the correlation of daily changes for study parameters for the high BMI cohort showed significant direct relationship between SS and PI, LL and SS, LL and PI and an inverse relationship between LL and PI minus LL, SS and PI minus LL.

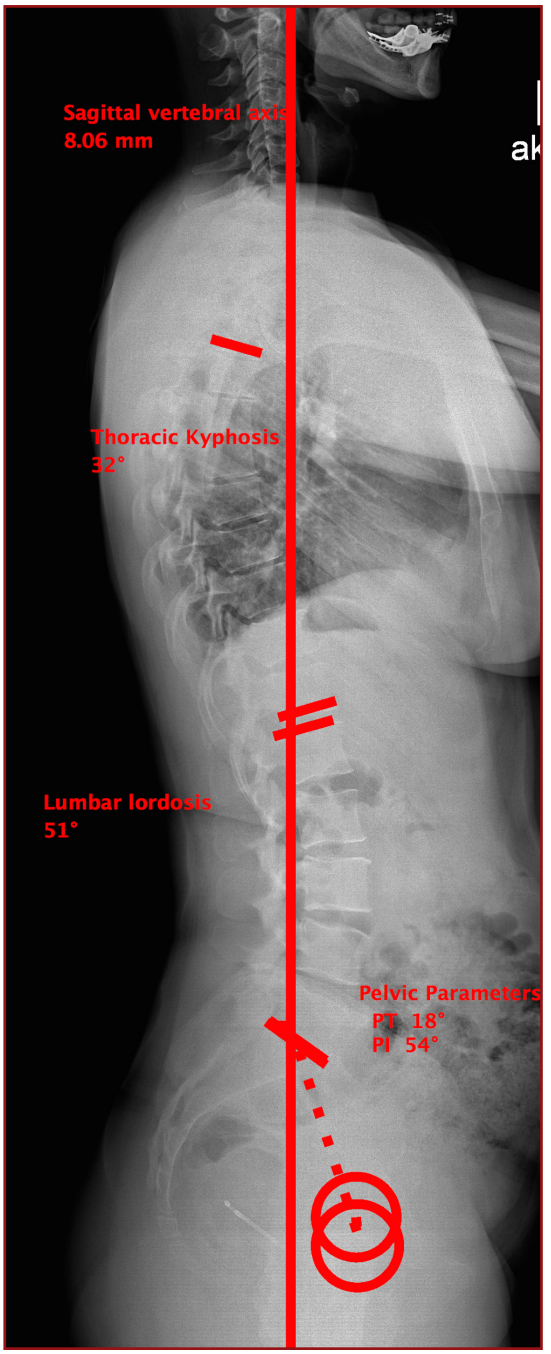

Figure-1. Thoracic kyphosis (TK), the angle between the superior endplate of T4 and the inferior endplate of T12; lumbar lordosis (LL), the angle between the superior endplate of L1 and the superior endplate of S1; sacral slope (SS), the angle between the superior endplate of S1 and the horizontal line; pelvic incidence (PI), the angle between the line perpendicular to the superior endplate of S1 and the line connecting the midpoint of the superior endplate of S1 to the hip axis (HA, the midpoint of the line connecting the centers of two femoral heads); pelvic tilt (PT), the angle between the vertical line and the line connecting the midpoint of the superior endplate of S1 to HA (considered positive if angulated behind the vertical line and otherwise negative); sagittal vertebral axis (SVA), the distance between the C7 plumb line and the posterosuperior corner of S1 in the sagittal plane

Table-1. Descriptive values for all parameters.

N=21	Morning measurement	Evening measurement	P values
Thoracic kyphosis	37.72(46-28)	38.81(48-28)	0.385
Lumbar lordosis	54.18(68-37)	53.45(66-34)	0.878
Sacral slope	36.09(45-24)	34.54(42-24)	0.124
Pelvic tilt	12.36(19-5)	13.37(19-8)	0.322
Pelvic incidence	48.45(61-38)	48.63(61-39)	0.567
PI minus LL	-5.72(11-(-20)	-4.81(12-(-18)	0.759
Sagittal vertebral axis	18.72(83-(-34)	18.62(45-(-19)	0.921

DISCUSSION

In recent years, recognizing the importance of sagittal balance, which affects quality of life significantly, has led to the identification of new targets in deformity surgeons [10,20-21,24-25]. Schwab et. al. defined new values for correction for spinal deformity surgery such as PT <20, SVA <45 mm and PI minus LL <10 [1]. These developments led to an increase in the number of surgeries performed. For this reason, understanding the compensatory mechanism that takes place during a day is an important step in the evaluation of symptomatic patients who visit clinics at different times of the day.

Mac-Thiong et al. [19] when the spinopelvic parameters were evaluated in a study conducted on 709 subjects without any spinal symptoms, the PI range ranged from 32 ° -74 °, PT value 0 ° -27 ° and SS 25 ° -55 °. Lee et al. [17], the LL value was 49.4 °, the SS value was 36.3 ° and the PI was 47.8 °. Finally, LaFage and colleagues [4] reported mean values of 50.7 °, SS 37.9 ° and PI 50.2 ° LL. Parallel to these findings, our study gave a morning mean TK of 37.72 ° and 38.81 ° in the morning, 54.18 ° in the evening LL, 53.45 ° in the evening, 34.09 ° in the morning SS and 34.54 ° in the evening and 12.36 ° in the PT in the morning. and 13.37 ° in the evening, 48.45 ° in the morning and 48.63 ° in the evening. Our study of sagittal vertebrae compliance showed that 18.72 in the morning decreased to 18.62 in the evening and slightly above normal values. Moreover, the literature contains other studies paralleling our definition of SVA that define only the anterior of the posterosuperior corner of the sacrum in a healthy community as two sections [8,11,18].

Thoracic kyphosis is well defined by a series of studies focusing on the correlation of the cervical or lumbar region with hyperlordosis and the relationship of sagittal vertebral parameters to global kyphosis, which can be compensated for by increased pelvic tendency due to pelvic retroversion [16], 10, 17, 23-25. Mac-Thiong and colleagues [19] showed a direct correlation between C7 translation quantity and other spinopelvic parameters such as PT, SS and PI. Ghandhari and colleagues [9] found a direct relationship between TK-LL, LL-PI and LL-SS and an inverse relationship between LL-SVA and PT-PI. In our study, we found a direct relationship between SS and PI, LL and SS, LL and PI, and an inverse relationship between LL and PI minus LL, SS and PI minus LL [15,26].

Our main goal in this study is to investigate the change in sagittal balance between morning measurements and evening measurements and thus to make conclusions about spinopelvic equilibrium of compensating mechanisms. When the main cohort measurements were taken into consideration, there was no significant change in sagittal spinopelvic parameters during the day, the lowest level (18.72 mm to 18.61 mm) between the morning and evening measurements of the SVA value in the high BMI cohort. Boulay and colleagues [2] showed a strong correlation between BMI and LL, SS and PI. Parallel to their findings, we have shown that compensatory mechanisms in high-BMI individuals may be less effective, but we have decided that this difference is insignificant. We believe that surgery can play a role in decision-making since corrective surgery in high-BMI populations can increase complication rates.

This is the first study in the literature to focus on sagittal vertebral alignment changes during the day; for this reason, we think that the results we produce are important for the spinal research community. However, our work has its own limitations. First, the number of participants is limited, but when we consider that morning and evening measurements of our study are parallel to the latest literature findings, we think this is a very worrying source. Second, measurements made with computer software can have their own measurement errors. We tried to address this problem by repeatedly performing measurements with multiple surgeons. Finally, we believe that changing the spinopelvic parameters during the day or in certain occupational study scenarios should be investigated with more subjects with more planned cohorts for age and body mass index.

CONCLUSION

When we collect the all data, we observed no significant change in the spinopelvic parameters throughout the day. This showed that compensatory mechanisms will work to prevent collapse of spinal sagittal balance.

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