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SAGITTAL SPINOPELVIC PARAMETERS IN THE YOUNG ADULT TURKISH POPULATION

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ABSTRACT

Objective: A radiological analysis of the spinopelvic paramaters and sagittal balance in a young adult Turkish population.

Method: From radiology archive, full lateral spinal radiographs were scanned. The individuals who had no diagnosed of structural spine abnormality and no sign about spinal disorder from medical records were measured by Surgimap software on digital radiography. Sagittal spinal parameters (SVA, TK, LL) and Spinopelvic parameters (PI, PT) were measured. The unpaired t-test was used for comparison of measurements of genders. $p<0.05$ considered as statistically significant.

Results: A total of 860 full lateral spine radiographs in the database were assessed and finally, 126 individuals (72 female, and 54 male) were included in the study who met all the criteria. The mean age was 27.4 ± 6.88 (range 20-40). The mean sagittal vertical axis (SVA), thoracic kyphosis (TK), lumbar lordosis (LL), pelvic incidence (PI), and pelvic tilt (PT) were -46.9 mm ± 19.83, 35.5° ± 5.47, 57.8° ± 9.10, 47.4 ± 9,13, and 13.37 ± 7.32, respectively. The PI ($p=0.012$), and TK ($p=0.010$) values between females and males were statistically significant, but SVA ($p= 0.26$), PT ($p= 0.32$), and LL ($p=0.43$) were not.

Conclusion: This study was yielded to determine normative values of spinopelvic parameters in young adult Turkish population that would assist the clinical practice of spinal surgeons. The PI was found to be lower while LL was the same compared to the current literature from other countries and further studies were needed to clarify.

Key Words: Spino-pelvic parameters, pelvic insidence, sagittal balance, full lateral spine radiography.

Level of Evidence: Cross-sectional clinical study, Level III.

INTRODUCTION

Many authors have reported the importance of the sagittal plane contour in the normal function of the spine and in various disease states. [3,8,12] It is necessary to know the normative sagittal parameters in disease-free individuals in order to establish the correct diagnosis of spinal deformity, to follow up the progression and to make surgical planning. The spinopelvic sagittal parameters have a wide range of normal values and may vary with age, gender, weight, and race [1-2,15]. There are some studies on western and Asian populations, classifying the normal patterns of sagittal curvature, but very few studies on Turkish populations [13-14].

The aim of this study was to analyze the normal values of sagittal spinopelvic parameters in the young adult Turkish population.

MATERIAL – METHODS

A cross-sectional study of radiological analysis of the spinopelvic parameters and sagittal balance in a young adult Turkish population was conducted. After local Ethical committee approval, digital radiology archive was scanned. Inclusion criteria included: **1)** age between 20-40, **2)** the presence of full lateral spine radiography that was taken under appropriate dose and position, **3)** enable to access to all medical records of the individual, **4)** no previous spine surgery, **5)** no leg length discrepancy. Radiographic spinal abnormality detected

individuals, such as scoliosis more than 20°, spinal tumor and infection, ankylosing spondylitis, rigid kyphotic deformity were excluded. Finally, 126 full lateral spine radiography who met the all inclusion criteria were analyzed.

The Surgimap software (New York, New York, USA) was used to measure the sagittal spinal and pelvic parameters. Standing full-length lateral radiographs were measured by the author 2 times with 1-week interval and the average of measurements was calculated for each individuals.

The thoracal kyphosis (TK) was measured as Cobb angle between upper endplate of the T4 and lower endplate of the T12. The lumbar lordosis (LL) was measured between the upper endplates of L1 and S1by the Cobb method. The sagittal vertical axis (SVA) was measured from the distance between C7 plumb line and posterior corner of S1 endplate. It was marked as minus (-) SVA if the C7 plumb line was at the posterior of the sacrum (Figure-1).

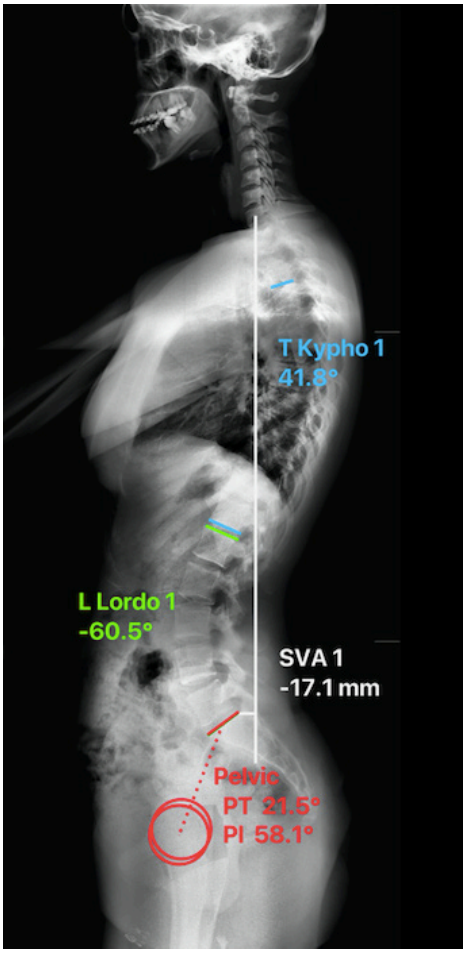

Figure-1. Demonstrates the measurement of spinal parameters (TK, LL, and SVA; measured by Surgimap software).

The pelvic tilt (PT) was measured as an angle between the vertical line and the line joining the middle of the sacral plate and the center of the bicoxo-femoral axis (the line between the geometric center of both femoral heads). The pelvic incidence (PI) was measured as an angle formed by two vectors: **1)** The line joining the bicoxo-femoral axis to the center of the sacral endplate and **2)** A line perpendicular to the sacral endplate. The sacral slope (SS) was defined as the angle between the horizontal and sacral plate, that could be calculated by the formula PI = PT + SS, therefore SS was not measured (Figure-2).

Statistical analyses were performed using SPSS software (Version 17, SPSS, Inc, Chicago, IL, USA). $p<0.05$ was considered statistically significant. All values are expressed as the mean ± standard deviation (SD). The unpaired T-test was used to analyze the differences in spinal and pelvic parameters between females and males.

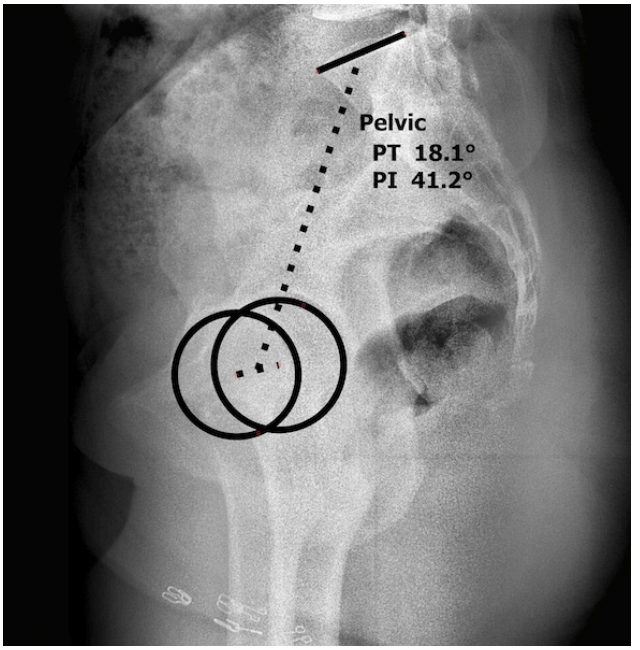

Figure-2. Demonstrates the measurement of pelvic parameters (PT, and PI; measured by Surgimap software).

RESULTS

A total of 860 full lateral spine radiographs in the database were assessed and finally, 126 individuals were included in the study who met all the criteria. The mean age was 27.4 ± 6.88 (range 20-40). There were 72 females with a mean age of 28.8 ± 7.47, 54 males with a mean age of 25.8 ±6.63. The age distribution by gender was not statistically significant (p= 0.35).

The Mean sagittal vertical axis (SVA), thoracic kyphosis (TK), lumbar lordosis (LL), pelvic incidence (PI), and pelvic tilt (PT) were -46.9 mm ± 19.83 mm, 35.5° ± 5.47°, 57.8° ± 9.10°, 47.4° ± 9.13°, and 13.37° ± 7.32°, respectively. The minimum, maximum, median, mean and standard deviation (SD) values were determined (Table-1).

All of the SVA values were on minus (-) balance. The distribution of spinal and pelvic parameters according to gender is measured (Table-2).

The PI (p=0.012), and TK (p=0.010) values between females and males were statistically significant, but SVA (p= 0.26), PT (p= 0.32), and LL (p=0.43) were not.

Table-1. The range, median, mean, standard deviation (SD) and 95% Confidence Interval (Descriptive stats.).

Parameters	Minimum	Maximum	Median	Mean	Standard Deviation ±	95% Confidence Interval
Age	20	40	25	27.4	6.88	24.4-30.3
SVA (mm)	-17	-79	-49	-46.9	19.83	(-) 38.4-55.38
TK (°)	22.8	43.7	36.5	35.5	5.47	33.16-37.84
LL (°)	-32.4	-69.1	-58.2	-57.8	9.10	(-) 53.9-61.6
PI (°)	30.7	63.2	48.8	47.4	9.13	43.49-51.30
PT (°)	1.8	29.3	14	13.3	7.32	10.14-16.45

Table-2. Sex distribution of spino-pelvic parameters.

Parameters	Female	Male	p Value
Age	28.8 ± 7.47	25.8 ±6.63	0.354
SVA (mm)	-44.2 ± 23.1	-49.9 ±16.12	0.260
TK (°)	33.1 ±5.09	38.39 ± 4.60	0.010
LL (°)	(-) 57.4 ± 7.43	(-) 58.1 ± 11.07	0.430
PI (°)	48.27 ± 8.73	46.44 ± 9.93	0.012
PT (°)	14.09 ± 8.46	12.57 ± 6.18	0.320

DISCUSSION

Due to ethical concerns, this study was designed as a cross-sectional radiological analysis of sagittal spinopelvic parameters to prevent unnecessary radiation exposure to healthy individuals.

Spinal sagittal balance and spinopelvic parameters may vary with age, gender, and race. Sagittal parameters are variable, especially in children and adolescents. As the PI increases with the aging process, the SVA becomes anteriorly [3,14]. A more stable age range was sought to measure normative values. Thence, this study involved young adult Turkish population before the onset of degenerative changes that may affect sagittal alignment. The mean age was 27.4 ± 6.88 (range 20-40).

The correct positioning of the patient is essential to assess spinopelvic parameters. The knees and femurs should be in extension and parallel to film while the arms flexed forward to 45° and resting on supports. In addition, both femoral heads and the upper endplate of T4 and sacrum must be visible to obtain accurate results [11,15].

The effect of ethnicity on skeletal growth has been demonstrated by previous studies [2,4,9]. In this study, the mean sagittal vertical axis (SVA), thoracic kyphosis (TK), lumbar lordosis (LL), pelvic incidence (PI), and pelvic tilt (PT) were -46.9 mm ± 19.83 mm, 35.5° ± 5.47°, 57.8° ± 9.10°, 47.4° ± 9.13°, and 13.37° ± 7.32°, respectively. Comparison of the studies of sagittal spinopelvic parameters from different countries is compared (Table-3). The PI was measured lesser while LL was the same in the current study. There is only one study from Turkey that can be compared with the current study. Tonbul et al conducted a study with juvenile, adolescent, and adults and reported similar results in the adult group [14].

Table-3. Comparison of the studies from different countries.

	Current	Lee at al. [8]	Endo et al [2]	Vialle et al [15]	Schwab et al. [12]
Country	Turkey	Korea	Japan	France	US
Age	27 (20-40)	28 (19-39)	35(23-59)	35(20-70)	49 (18-80)
TK (°)	35.5	32	27.5	40.6	41
LL (°)	57.8	49.6	43.4	60	60
PI (°)	47.4	47.8	52	51	52
PT (°)	13.3	11.5	15	13	15
No	126	80	86	300	75

The impact of sex on spinopelvic parameters remains controversial. Vialle et al. reported significant differences in LL and PI between male and female subjects [15]. While some publications were in the same conclusion [1,3,16], conversely, other researchers did not demonstrate significant sex differences in any spinopelvic parameter [6-7,10]. The variations in lumbar lordosis and sacral slope observed in those studies may be explained by a pelvic incidence that was slightly higher in women than in men. In the current study, only significant results were obtained that the TK was higher in males while the PI was higher in females (p=0.010 and p=0.012, respectively).

Asai et al reported that all parameters were significantly associated with age in men and women. The SVA, TK, and PT increased with age, and LL decreased with age [1]. Once the sagittal alignment is abnormal, more energy is required so that the body can remain balanced without external support. Therefore, abnormal sagittal spinal alignment should be restored to normal [5].

In clinical practice, radiographic reference values help identify regional angulations and linear displacements that can be considered as within the normal alignment range for a given patient [12,15]. It is very important to evaluate the sagittal balance and patterns of sagittal curvatures to estimate the normality of sagittal alignment [8].

In conclusion, this study was yielded to determine normative values of spinopelvic parameters in young adult Turkish population that would assist the clinical practice of spinal surgeons. Especially, the PI was found to be lower while LL was the same compared to the current literature from other countries and further studies were needed to clarify.

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