Observations on Sagittal Alignment of Lumbo-Sacral Spine in Asymptomatic Adults in Kashmir

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ABSTRACT

Introduction: Sacropelvic parameters in various spine and hip disorders have been published in various studies. We aimed to study the normal sacropelvic parameters and curvatures of the spine and their correlation in asymptomatic Indian adults in relation to variations in sex and age.

Material and Methods: 200 Volunteers were taken from general population with age ranging from 18-50. Patient was made to stand and left lateral radiograph exposing C7 to S1 and both the hips with a long 30x90 cm cassette placed at 230 cm from the X-ray tube was performed by a single radiographer to avoid bias.

Results: The average LL, SS, PI, PT, and SVA values were average 55.61±10.68, 38.38±8.33,47.94±10.24,10.16±6.2 3 and 17.27±9.72 respectively. No statistically significant difference was observed in statistical values with regards to sex. Our study showed that PI has significant positive correlations with SS, LL and PT, and also affects LL. SS has significant positive correlation with LL.

Conclusion: The current results could contribute to not only the understanding of normal sagittal spinal alignment, but also serve as a basis for realignment strategies in young Kashmiri adults.

Key words: Sacropelvic Parameters, Lumbar Lordosis, Pelvic Incidence, Pelvic Tilt, Sacral Slope, Sagittal Vertical Axis, Asymptomatic Adults.

INTRODUCTION

The sagittal spine balance is maintained by lordosis between L1 and L5 and kyphosis between T1 and T12.These curvatures in the spine absorb energy effectively and increase the efficiency of the spinal muscles, contributing to the erect posture of humans. Importance of the sagittal plane contour in the function of the spine and in its various pathological diseases is a subject of increasing debate.[1-6] In recent years, the number of spinal deformities treated surgically has emphasized the importance of examining spine contours in the frontal, transverse, and sagittal planes.[1-3,6] The oronal alignment of the human spine is well understood, like, its being normal when straight and pathological when curved, however, the sagittal alignment of the spine is need to be understood for the better diagnosis. The lumbar lordotic curve has a important role in maintaining sagittal spinal alignment.[6,7] Although the exact effects of its change in lumbar lordosis are not clear, many researchers believe that a reduced lumbar lordosis after spinal surgery, also known as a flat-back deformity, has a negative effect.[1,6,8] its relationship to low back-pain has also been emphasized.[7,9,10] Therefore, it is important and also should avoid subjectively evaluating the increase or decrease in lordosis and to determine the normal limits of the lumbar lordosis angle (LL). However, there is no standardized technique for measuring the LL, and the variation in the selection of the upper and lower vertebrae which is used to measure lumbar lordosis is responsible for the variation in the lordosis range.

Proper sagittal alignment is vital not only for the maintenance of a balanced standing posture but also to reduce the pain component of the quality of life.[11] It is important to understand these parameters in terms of racial and regional differences.[12-14] These parameters also have importance in better surgical planning and fixation of the spine.

The study aimed to know the normal sacropelvic parameters and curvatures of the spine and their correlation in asymptomatic Indian adults in relation to variations in sex and age.

MATERIAL AND METHODS

A prospective cohort of 200 normal asymptomatic adults who attended the outpatient department of SKIMS MCH Bemina from May 2016 to June 2017 with age between 18 and 50 years, no complaints related to spine and the ones who provided informed consent were included in the study after obtaining clearance from the Institute's ethical committee. Volunteers with any radiographic abnormality detected prior to or during the study,background of any spinal surgery or any contra-indication to radiation like pregnancy etc were excluded. Subjects included 72 men and 128 women with an average age of 34.59±8.13 years. Patient is made to stand left lateral radiograph exposing C7 to S1 and both the hips with a long 30x90 cm cassette placed at 230 cm from the X-ray tube was performed and this whole process is done by single radiographer to avoid bias. All the subjects were instructed to stand in a comfortable position like hips and knees fully

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extended and upper limbs raised horizontally forward at 45^0 of flexion at shoulder resting on two arm supports(Fig.1). The central ray was centred on the 12^{th} thoracic vertebrae and film was exposed during inspiration. The complete axial skeleton between external auditory ducts and superior third of femurs was visualized in these films. On marked X ray films, the following radiographic parameters were measured by two observers independently on different days:1) sagittal vertical axis (SVA), defined as the horizontal distance between the 2) lumbar lordotic angle (LL), the angle from the upper endplate of L1 to the upper end plate of S1; 3) sacral slope (SS), the angle between the superior endplate of S1 and a horizontal axis; 4) pelvic tilt (PT), the angle between the line connecting the midpoint of the sacral plate to the axis of the femoral heads and the vertical axis; and 5) pelvic incidence (PI), the angle between the perpendicular to the sacral plate at its midpoint and the line connecting the point to the middle axis of the femoral heads (Fig. 2 and 3). An unpaired *t*-test was used to analyze the differences in the spinal and pelvic parameters between men and women. The correlations between the variables of spino-pelvic parameters were examined using the Spearman's rank correlation coefficient. *p*-values <0.05 were considered as statistically significant difference.

RESULTS

The mean values of SVA, LL, SS, PT, and PI were 17.27±9.72 mm, 55.61±10.68°, 38.38±8.33°, 10.16±6.23°and 47.94±10.24° (mean±SD), respectively (table 1).

Our results did not reveal any gender differences in pelvic morphologic angle or lumbar and pelvic alignment (LL,PI, PT,SS,SVA) (table 2).

The correlation coefficients between PI and PT, SS, LL were r =0.388 (p=0.000), r=0.833 (p<0.001), r=0.578(p=0.000),

Figure-1: AP and lateral radiograph taken on a vertical film 30x90 cm

Parameters	N	Min.	Max.	Mean	Standard deviation
Age(yr)	200	18	50	34.59	8.23
Body mass index (kg/m)	200	16.73	27.06	22.85	1.75
Lumbar lordosis	200	37	77	55.61	10.68
Sacral slope	200	20	53	38.38	8.33
Pelvic incidence	200	26	70	47.94	10.24
Pelvic tilt	200	02	27	10.16	6.23
Sagittal vertical axis	200	0.3	45	17.27	9.72

Table-1:

	Males (n=72)	Females (n=128)	T-value	
Lumbar lordosis	56.33± 9.83	55.19 ±10.05	0.78	0.436, not sig.
Pelvic incidence	48.31 ±10.12	47.73 ±9.47	0.40	0.691 not sig
Pelvic tilt	9.99 ±6.41	10.25 ± 6.15	0.28	0.780 not sig
Sacral slope	39.13 ±8.49	37.96 ±8.24	0.95	0.346 not sig
SVA	18.01 ±9.83	16.83 ±9.59	0.82	0.412 not sign

Table-2:

Parameters	LL	SS	PI	PT	SVA
LL	1				
SS	0.757 0.000	1			
PI	0.578 0.000	0.833 0.000	1		
PT	-0.071 0.318	-0.009 0.895	0.388 0.000	1	
SVA	-0.120 0.090	-0.045 0.531	-0.011 0.882	0.126 0.076	1

Table-3:

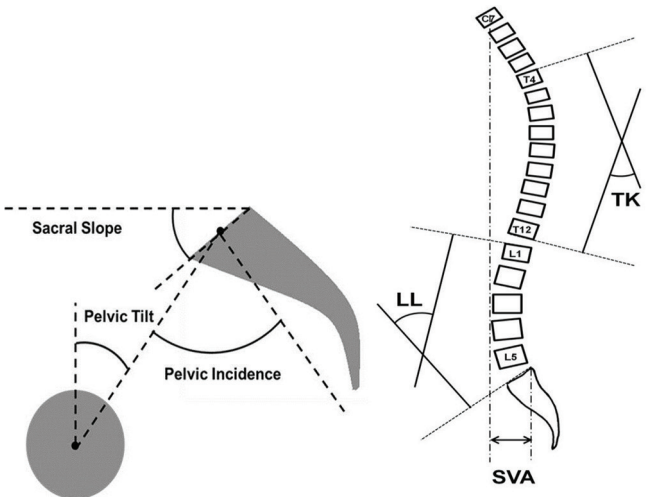

Figure-2: AP and lateral radiograph taken on a vertical film 30x90 cm

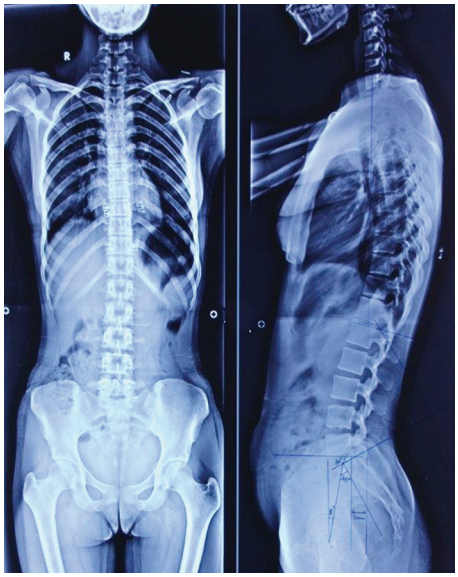

Figure-3: AP and lateral radiograph taken on a vertical film 30x90 cm

respectively (table 3). LL is closely related to the orientation of the pelvis, expressed by the SS, which is in turn affected by the PI. There is interdependence among the pelvic and spinal parameters PI, SS, and LL.

DISCUSSION

It is very important to understand the spinal sagittal alignment for the treatment of spinal disorders. Failure to recognize misalignments in this plane can lead to spinal deformity and reduced quality of life.[15] It has been documented that abnormal sagittal spinal alignment is affected by aging[16], spinal degeneration[17-19], and hip joint disease.[20,21] Offierski and MacNab[20] described a causal link between arthritis of the hip joint and lumbar spondylosis, naming the mosiac of hip, low back pain, and sciatica as the "hip-spine syndrome". Recently, it has become clear that in order to analyze sagittal spinal alignment, the pelvic alignment should be included because of the large effects of individual pelvic morphologies.[22] However, there may be possible differences in spinal sagittal posture based on age, gender, and race differences.[12] Anatomical problems in the pelvis result in individual characteristics of spino-pelvic alignment. A geometric construction of complementary angles showed that the anatomical parameter 'PI' can be expressed as the algebraic relation PI=SS+PT[22]

Lafage et al has shown he importance of the spinopelvic parameters and its importance in the treatment of patients with deformities and also their effects on osteotomies in these patients.[23] Glattes et al in his study observed that patients who were slightly kyphotic at the proposed proximal junction compared with the average sagittal alignment in a normal population were not at a higher risk for developing a junctional kyphosis.[24] In order to correct the spinal deformities, surgeries should be aimed at a proper relationship between the sacropelvic parameters and the TK and LL, but its significant change can result in a less favorable clinical outcome. Only few studies in the literature have given the correlation between these parameters and the spinal curvatures, especially in asymptomatic subjects. It has been found that a strong correlation between the SS and the PI (r = 0.8), between the LL and SS (r = 0.86), between the PI and PT (r =0.66), and between the LL and PI, PT, and TK (r=0.9) in their study. Our results in our study showed that PI has significant positive correlations with SS, LL and PT, and also affects LL and also SS has significant positive correlation with LL. A positive correlation between the PI and SS indicates that subjects with a high PI tend to have higher values of SS. Similarly, a negative correlation between the SS and PT implies that as the SS increases, the PT decreases and vice versa to maintain a constant PI. PI correlations have shown that the relationship of the spinal anatomical portion is interdependent on its adjacent structures, particularly at the lumbo-pelvic level. However, PI had less effect on SVA; this is because the spinal alignment, including the thoraco-lumbar region, can compensate for the pelvic shape in order to maintain a smaller SVA. This study thus helps to correlate these parameters, which will give its importance about the proper value of osteotomy angles that needs to correct deformities and also define parameters in cases requiring long segment instrumentation and fusion. Hence, while planning for fixation and fusion in patients with a high PI, an adequate SS should be attained intraoperatively by maintaining adequate lordosis, failure of which will result in pelvic retroversion as a result of compensatory increase in the PT. However, because of aging or overload to the spine, that resulted in loss of spinal compensatory function would lead to a pathological spinal deformity. In order to achieve harmonized and esthetic, spino-pelvic alignment in the surgical planning for spinal deformity, the PI-LL value can be used to determine the amount of correction needed.

In a recent study, a excessive PI-LL mismatch was revealed an increased risk of spinal imbalance.[25] Results of multiple regression analysis which were done in different studies also demonstrated that the SVA and PI-LL are related to age.

Recently, there has been some studies that support racial differences in sagittal spinopelvic parameters[26], and most of them depicted exaggerated the smaller PI and LL in Asian

populations than in Caucasian populations.[14,27,28] However, our cohort did not have a significantly smaller PI than did the Caucasian population. There may be regional differences in sagittal spino-pelvic parameters as well. Therefore, there must be strong correlations among spino-pelvic parameters. Our study, admittedly, has some limitations. The number of subjects was relatively small. Thus, we cannot extrapolate our results to be representative of Kashmiri standard values; however, it is a beginning in the quest for understanding regional normal values.

CONCLUSION

The current results could contribute to not only the understanding of normal sagittal spinal alignment, but also serve as a basis for realignment strategies in young Kashmiri adults.

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