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Investigating spinopelvic variables' function in lumbar intervertebral disc prolapse

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Abstract
Objectives: To describe the structure and position of the sacropelvis, one typically uses terms like sacral slope, pelvic tilt, or pelvic incidence. Changes in the pelvis' shape and direction can impact the progression of degenerative disc disease in the lower back. Consequently, we investigated the relationships between the degrees of disc degeneration in young people and several sagittal spinopelvic features.
Methods: A hospital-based cross-sectional study enrolled fifty individuals. Participants reported either back or leg pain and had magnetic resonance imaging (MRI) findings of prolapsed discs. This study was conducted at Department of General Medicine, Gouri Devi Institute of Medical Sciences and Hospital, Raj bandh, Durgapur, West Bengal, India. The LS spine was imaged from the dorsolumbar junction all the way to the mid-thigh while the patient was standing. The scannogram has a lot of spinopelvic characteristics measured.
Result: The typical age was 39.27 years old. It was Level L5S1 that was most common. There was a positive correlation between disc abnormalities at the L1L2, L2L3, and L4L5 levels and PT, PI, and LL. At the L5S1 level, PT and LL were positively associated with disc disease. An association between SS and degenerative spondylolisthesis at L4L5 was found to be statistically significant (P=0.023). An increased risk of degenerative spondylolisthesis at L4L5 is associated with higher SS. Elevated PT, PI, and LL exacerbate the L1L2 disc disease. As the levels of SS, PT, PI, and LL rise at L2L3, disc pathology will also increase. When the levels of SS, PT, PI, and LL rise at L4L5, disc pathology will become more severe. An increase in both PT and LL will exacerbate the disc disease at L5S1.
Conclusions: A standing lateral view radiograph, which extends from the dorso lumbar junction all the way to the middle of the thigh, is deemed equivalent to a standing whole spine radiograph when it comes to evaluating spinopelvic characteristics. There is a statistically significant correlation between elevated SS and L4L5 degenerative spondylolisthesis.

Keywords: Spinopelvic parameters, sacral slope, pelvic tilt, sacral incidence

Introduction

There are five lumbar vertebrae in a human spine, and they connect to each other via intervertebral discs and facets joints on the back. Physiologically, the intervertebral disc helps to maintain the lumbar spine's lordotic curve and acts as a shock absorber for the spine [1].

Lumbar lordosis is becoming an increasingly important function and clinical outcome metric. Problems with proper lordotic alignment can lead to pathologic changes in the spine as a result of weight bearing and hasten the degeneration of functional motion units [2]. The lumbar spine is supported by the first sacral vertebra, an important part of the pelvis. Because of the interdependent biomechanics of the pelvis and the lumbar spine, problems with any region can have an effect on the other. Pelvic shape and orientation may impact degenerative changes in the lumbar spine due to altered biomechanical forces [2-4].

Every person's unique anatomy is described by their sacropelvic morphology. Meanwhile, lateral radiographs taken while standing with the knees and hips extended are the gold standard for determining sacropelvic orientation. To describe the structure and position of the sacropelvis, one typically uses terms like sacral slope, pelvic tilt, or pelvic incidence. Every person's sacropelvis can be consistently and individually described by the PI, a morphological measure [5]. Duval Beaupère *et al*. first proposed this parameter, which is defined as the angle between the line perpendicular to the upper sacral endplate and the line connecting the midpoint of the endplate to the hip axis.

The average PI for the Indian population is 48.52 8.99, as reported by Singh *et al*. While the PI measures the Sacropelvis's orientation in the axial plane, the PT and SS assess it in comparison. The sacral endplate and the horizontal reference line (HRL) form the SS, whereas the vertical reference line (VRL) and the line from the midpoint of the sacral endplate to the hip axis form the PT [6, 7].

You may see SS and PT demonstrating acro pelvic balance when they stand stationary. Increased shear stresses at the lumbosacral junction would provide additional pressure on the intervertebral discs and facets joints at L5S1 in patients with elevated PI and SS. In theory, the extra strain at this level will hasten the degeneration and protrusion of the discs [8].

Research has shown that in normally developing humans, the lumbar lordosis and other spinal abnormalities are strongly influenced by the sacropelvic morphology, which in turn dictates the sacro pelvic orientation. Consequently, a series of open linear segments is generated that link the skull to the pelvis. The shape and orientation of each segment affects the one below it, ensuring that the center of gravity remains above the femoral heads [9, 10].

So, any modification to SS will affect LL. The natural position of the lumbar spine, known as lordosis, falls somewhere between forty-five and sixty degrees. When lumbar lordosis variations are out of the ordinary, they affect the transmission of stresses along the lumbar spine, which speeds up disc degeneration [11-13].

A new study by Keorochana *et al*. suggests that variations in sagittal spinopelvic alignment can influence the distribution of disc degeneration at each level and the kinematic changes that impact load bearing. These alterations may also influence spinal mobility and load, which in turn may influence segmental degeneration. So, it seems that sagittal balance needs to be considered closely when lumbar degenerative disease management. However, there is a lack of data regarding how sagittal balance relates to the severity of disc degeneration. Consequently, we investigated the relationships between the degrees of disc degeneration in young people and several sagittal spinopelvic features. When calculating LL, angles along the superior endplate of the L1 vertebra and the inferior endplate of the L5 vertebra are used [14-16].

Methods

A hospital-based cross-sectional study enrolled fifty individuals. Participants reported either back or leg pain and had magnetic resonance imaging (MRI) findings of prolapsed discs. This study was conducted at Department of Radiology, Gouri Devi Institute of Medical Sciences and Hospital, Rajbandh, Durgapur, West Bengal, India, between July 2019 to June 2020. The LS spine was imaged from the dorsolumbar junction all the way to the mid-thigh while the patient was standing. The scannogram has a lot of spinopelvic characteristics measured.

Inclusion criteria

- Individual of 18–50 years age group having back or leg pain
- Without any history of other spinal disease or deformity
- Having prolapsed intervertebral disc on MRI

Exclusion criteria

- Patients not consenting for the study
- Patients with a history of trauma
- Pregnant females

Results

The participants in our study were all young individuals, ranging in age from 18 to 50. The mean age of 39.27 years was distanced from the mean by a standard deviation of 9.33. The largest proportion of patients were in the age bracket of 40 to 48. Women made up the majority of the study population. There were 37 female patients, accounting for 61.7% of the total, and 23 male patients, for 38.3% of the population. Patients with two levels of disc anomalies accounted for the majority of cases (58.1%). Level 5S1 was the most common level of disc disease in cases where only one level was affected, followed by levels 4 and 5. Cases involving two levels were most often involving L4L5 + L5S1, whereas L4L5 was more often included when paired with other levels in cases involving two levels. Among the patients, 31 (51.7%) were of diffuse disc bulging, the most common type of disc illness. In the second most common type, disc protrusion occurred in 20 cases (33.3%).

Table 1: LL, SS, PT, and PI values in studied population

Sr. No.	Mean (±SD)	Median	Range (min-max)
1.	36.28±8.21	38.12	12.41-55.36
2.	12.25±6.34	11.85	2.12-24.63
3.	50.20±9.62	52.10	31.21-75.52
4.	40.03±15.02	41.43	1.64-69.98

Relationship among SS, PT, PI, and LL

SS, PT, and PI are linearly connected, according to Pearson correlation. If the value of one changes, the other two will also change linearly in response.

With a P value of 0.05, this linear correlation is consistently statistically significant. SS exhibited a Pearson correlation coefficient of 0.303 with PT and a Pearson correlation coefficient of 0.798 with positive linear association with PI. Similar to PI and SS, PT also showed a positive linear connection with PI (Pearson correlation coefficient = 0.330) and a negative linear association with SS (Pearson correlation coefficient = 0.303). The Pearson correlation coefficient between PI and SS and PT was both positive (0.798 and 0.330, respectively). With a statistical significance level of P 0.05, it was discovered that LL was linearly correlated to SS and then to PI. The association between LL and PT was not statistically significant (Table 2).

Table 2: Pearson plot correlation among LL and PI, SS, PT

Correlation			
Sr. No.	**PT**	**PI**	**SS**
LL			
1.	0.049	0.781	0.759
2.	0.712	<0.001	<0.001
3.	50	50	50

Relationship among Disc pathology at L1L2 and pelvic parameters: The mean SS, PT, PI, and LL in cases with L1L2 disc pathology were 36.59 8.23, 16.22 5.06, 53.18 7.10, and 41.07 13.90, respectively. PT, PI, and LL were positively monotonically correlated with disc pathologies at the L1L2 level (Spearman's rho correlation coefficients: 0.173, 0.083, and 0.016, respectively). However, these associations lacked statistical significance (Table 3).

Table 3: Spearman's rho correlation coefficient between disc pathologies at various levels and LL, PT, PI, and SS

Correlations						
Disc Level			**LL**	**SS**	**PI**	**PT**
Spearman's rho	L1-L2	Correlation coefficient	0.016	-0.042	0.083	0.173
		P	0.903	0.752	0.526	0.186
		N	50	50	50	50
	L2-L3	Correlation coefficient	0.136	0.031	0.074	0.042
		P	0.301	0.813	0.576	0.747
		N	50	50	50	50
	L3-L4	Correlation coefficient	0.027	-0.035	-0.004	-0.013
		P	0.839	0.79	0.979	0.922
		N	50	50	50	50
	L4-L5	Correlation coefficient	0.106	0.106	0.086	0.014
		P	0.422	0.422	0.516	0.913
		N	50	50	50	50
	L5-SI	Correlation coefficient	0.003	0	-0.04	0.038
		P	0.982	0.994	0.764	0.775
		N	50	50	50	50

Relationship among Disc pathology at L2L3 and pelvic parameters

Mean values for SS, PT, PI, and LL in cases with L2L3 disc pathology were 39.42 9.26, 13.86 8.09, 53.36 8.39, and 46.92 13.89, respectively. Positive monotonic correlations between disc pathologies at the L2L3 level and SS, PT, PI, and LL were observed (Spearman's rho correlation coefficients of 0.031, 0.042, 0.074, and 0.136, respectively). However, these associations lacked statistical significance (Table 3).

Relationship among disc pathology at L3L4 and pelvic parameters

The mean SS, PT, PI, and LL in cases with L3L4 disc pathology were 37.41 6.21, 13.86 7.56, 51.34 5.39, and 42.09 7.49, respectively. Only LL (Spearman's rho correlation coefficient of 0.027) and SS, PT, and PI (Spearman's rho correlation coefficients of -0.035, 0.013, and -0.004, respectively) demonstrate positive monotonic correlations with disc pathology at the L3L4 level. However, these associations lacked statistical significance (Table 3).

Discussions

The development of a more upright posture is the most significant shift in human evolution. Bipedalism and vertical posture both owe a great deal to the spinal column and the spinopelvic complex's evolutionary contributions. A remarkable accomplishment is the ability of the human trunk to take an upright position, made possible by the series of opposing curves that make up the spine. The lumbar lordosis is a unique trait that sets this species apart from all others. In order to take a vertical posture, the pelvis also underwent substantial alterations. While standing, the pelvis tries to bring hip extension and lumbar lordosis together as efficiently as possible. On the other hand, certain pelvises excel at this function more than others [17].

Recent studies have demonstrated that the unique lumbar lordosis of each individual is affected by their pelvic geometry and its relationship to the SS. The discovery of the link between pelvic position and pelvic geometry was made possible by the work of Duval Beaupère and others. Some writers have recently brought up the connection between spinopelvic organization and lumbar disc disorders and degeneration. The most important thing is the pelvic incidence (PI) angle. The importance of the PI and the SS in determining the kind of lumbar lordosis in a given individual is now readily apparent. The unique spinopelvic form causes mechanical stress on the lumbar spine [18].

There is never a steady pattern to the degenerative spine. Because of its spatial orientation, it experiences biomechanical forces generated by dynamic forces. In anatomy, positioning, and function, the pelvis and spine are very related. PI influences pelvic morphology, which in turn influences spinal morphology. Degenerative changes may progress in a person's body over time in accordance with their individual morphology. One way to look at sagittal features is as potential predictors of the shape of the pelvis and spine. A greater understanding of this link could lead to more accurate diagnoses of degenerative spine diseases and more successful treatment plans. The typical age of participants in our study is in the bracket of young adults. The participants in the Endo *et al*. study were of a similar age range, with an average age of 32.7. In earlier studies conducted by Barrey *et al*., the average ages were lower (47.70 ñ 14.15 years and 49±12 years, respectively), but they still comprised a younger age bracket. A male-dominated sex distribution was seen in a study by Endo *et al*., in contrast to a female-dominant one by Barrey *et al*. We found a monotonic direct connection between SS and L4L5 degenerative spondylolisthesis that was statistically significant. Degenerative spondylolisthesis at L4L5 is defined by an increase in the independent variable leading to an increase in the dependent variable; neither of these variables can stay constant nor decrease, as shown in our study, which means that an increase in SS statistically significantly increases the probability of developing this condition [19].

There is a similar trend in PI and LL, although it was not statistically significant. Wang *et al.* corroborated these results, reporting that PI and SS were higher in patients with single level degenerative spondylolisthesis compared to healthy controls. Degenerative spondylolisthesis patients had higher PIs compared to symptom-free participants, as reported by Ferrero *et al*. In a similar vein, Lai *et al*. found that SS is higher in patients with degenerative spondylolisthesis compared to a control group, and that PI is associated with the condition. Furthermore, they found a linear relationship between SS, PI, and PT that was statistically significant. Our study found that a linear

increase in SS led to a corresponding linear increase in PI, which is the mathematical sum of SS and PT. Conversely, greater SS resulted in less PT since the pelvis had to compensate for the increased SS by maintaining an upright position. This is achieved by the pelvis reducing its tilt, or PT. When PT was raised linearly, PI, the mathematical sum of PT and SS, also rose linearly. Conversely, SS dropped as PT increased because maintaining proper posture requires the spine to compensate for the increased PT. To achieve this, the spine lowers SS, so SS. Statistically significant linear correlation was seen with SS and PI in LL. An increase in SS will cause LL to rise. Since a more upright standing posture requires the lumbar spine to curve more in response to the higher SS, this is consistent with expectations [20].

On average, the SS was 36.28°, the PT was 12.25°, the PI was 50.20°, and the LL was 40.03°. At the L1L2 level, disc abnormalities were positively and monotonically associated with PT, PI, and LL. It implies that L1L2 disc pathology will grow monotonically in response to increasing PT, PI, and LL; in other words, it will never go down or stay the same as PT, PI, and LL go up. Disk diseases at the L2L3 and L4L5 levels were positively and monotonically associated with SS, PT, PI, and LL. Disc pathology at L2L3 and L4L5 is expected to increase monotonically with increasing SS, PT, PI, and LL, according to this. Disc disease at the L3L4 level is positively correlated with LL and LL alone, but negatively correlated with SS, PT, and PI. To ensure that the arms were not in the way when obtaining radiographs, our investigators stood with their knees bent and their arms crossed over their chests [21].

We are all aware that PI must be equal to SS plus PT, or that is, PI = SS + PT. So, the mean PI we got was 51.33, and the result is 51.3, which is the same as 37.78 plus 13.52. This proves that our radiography method was fairly accurate. We were able to accurately measure angles using the radiography method's high-quality pictures, which we then used to create lines using computer software. This suggests that our method can be used as a routine procedure and that complete spine radiographs are unnecessary for calculating spinopelvic parameters [19, 20].

Conclusion

A herniated disc has a complicated and multi-factoral pathogenesis. The association between sacropelvic features and disc herniation in young people is an innovative research paradigm that needs to be further investigated using prospective randomized controlled trials to confirm the findings. A standing lateral view radiograph, which extends from the dorso lumbar junction all the way to the middle of the thigh, is deemed equivalent to a standing whole spine radiograph when it comes to evaluating spinopelvic characteristics.

Conflict of Interest

None

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None

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