Original Research Article

The role of spinopelvic factors in lumbar intervertebral disc prolapse: An analysis

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Abstract

Aim and Background: In general, sacral slope, pelvic tilt, and pelvic incidence are used to describe the anatomy and orientation of the sacropelvis. Degenerative alterations in the lumbar spine can be influenced by the pelvis' orientation and morphology. As a result, we looked into how different sagittal spinopelvic characteristics related to young adults' disc degeneration levels.

Methods: 50 patients were included in a cross-sectional study conducted at a hospital. The study comprised patients who had prolapsed discs on magnetic resonance imaging (MRI) and reported back or leg pain. A standing X-ray of the LS spine was taken from the dorsolumbar junction to mid-thigh. Many spinopelvic parameters were evaluated from the scannogram.

Result and Discussion: 39.27 years old was the average age. Level L5S1 was the most prevalent. PT, PI, and LL exhibited a positive connection with disc pathologies at the L1L2, L2L3, and L4L5 levels. PT and LL had a positive connection with disc disease at the L5S1 level. Data with P=0.023 revealed a statistically significant connection between SS and degenerative spondylolisthesis at L4L5. Degenerative spondylolisthesis at L4L5 is statistically more likely to develop with an increase in SS. The disc pathology at L1L2 will worsen when PT, PI, and LL rise. At L2L3, disc pathology will grow with an increase in SS, PT, PI, and LL. At L4L5, disc pathology will worsen when SS, PT, PI, and LL increase. The disc pathology at L5S1 will worsen as PT and LL increase.

Conclusions: For the purpose of measuring spinopelvic parameters, a standing lateral view radiograph from the dorso lumbar junction to the middle of the thigh is considered to be on par with a standing whole spine radiograph. An increase in SS has been found to have a statistically significant link with degenerative spondylolisthesis at the L4L5 level.

Keywords: Spinopelvic parameters, sacral slope, pelvic tilt, sacral incidence, and lumbar disc herniation

Introduction

The human lumbar spine is made up of five lumbar vertebrae that articulate with one another at facets joints in the back and intervertebral discs in the front. The intervertebral disc serves physiologically as the spine's shock absorber and aids in preserving the lordotic curve of the lumbar spine [1]. The significance of lumbar lordosis in terms of function and clinical outcomes is growing. Loss of appropriate lordotic alignment may speed up the deterioration of the functional motion units and cause pathologic alterations in the spine from load bearing [2]. The first sacral vertebra, which is a crucial component of the pelvis, supports the lumbar spine. Because of the biomechanical relationship between the lumbar spine and pelvis, one's pathology can impact the other and vice versa. As a result of changed biomechanical pressures, pelvic orientation and morphology may influence lumbar spine degenerative changes [2-4].

Sacropelvic morphology describes the individual anatomy (form) of each person. The best way to determine sacropelvic orientation, on the other hand, is from standing lateral radiographs taken with the hips and knees extended. In general, sacral slope, pelvic tilt, and pelvic incidence are used to describe the anatomy and orientation of the sacropelvis. The PI is a morphological measure that uniquely and consistently describes each person's sacropelvis [5]. The angle between the line perpendicular to the upper sacral endplate and the line connecting the midpoint of the upper sacral endplate and the hip axis is the definition of this parameter, which was introduced by Duval Beaupère *et al*. According to Singh *et al*., the mean value of PI in the Indian population is 48.52 8.99. The PT and SS measure how the Sacro pelvis is oriented in the sagittal plane, in contrast to the PI. While PT is the angle between the vertical reference line (VRL) and the line connecting the midpoint of the sacral endplate and the hip axis, SS is defined as the angle between the sacral endplate and the horizontal reference line (HRL) [6, 7]. The way SS and PT balance themselves while standing still is an example of acro pelvic balance. Patients with high PI and SS would increase the shear stresses at the lumbosacral junction, putting extra strain on the intervertebral discs and facets joints at L5S1. Theoretically, at this level, the additional stress will accelerate disc degeneration and prolapse [8].

Studies have revealed that in healthy individuals, the sacropelvic morphology determines the sacro pelvic orientation, which has a significant impact on the shape and orientation of the spine, particularly the lumbar lordosis. As a result, an open linear chain connecting the head to the pelvis is formed, with each succeeding anatomical segment's shape and orientation influencing the segment next to it to keep the centre of gravity above the femoral heads [9, 10]. Therefore, LL will be impacted by any change in SS. The lumbar spine's lordosis, which ranges between 40° and 60°, is the normal physiological alignment. Accelerated disc degeneration results from lumbar lordosis changes that are outside of the normal range because they influence how loads are transmitted along the lumbar spine [11-13]. According to a recent study by Keorochana *et al*., alterations in sagittal spinopelvic alignment may result in kinematic changes that affect load bearing and the distribution of disc degeneration at each level. Additionally, these changes may affect spinal load and mobility, which may affect segmental degeneration. Consequently, new research suggests that managing lumbar degenerative diseases requires a close look at sagittal balance. But little research has been done on the connection between sagittal balance and the level of disc degeneration. As a result, we looked into how different sagittal spinopelvic characteristics related to young adults' disc degeneration levels. Angles along the superior endplate of the L1 vertebra and the inferior endplate of the L5 vertebra are used to calculate LL [14-16].

Methods

From September 2021 to February 2022, the Department of Radiodiagnosis conducted a hospital-based cross-sectional study**.** The study consisted of 50 instances in total. The study included all outpatients with chronic prolapsed intervertebral discs between the ages of 18 and 50 who visited the Department of Radiodiagnosis. All patients had clinical and radiological evaluations using MRI and X-rays. All patients provided their previous informed consent as well as approval from the institutional ethical committee. The study comprised patients who had prolapsed discs on their MRIs and were complaining of back or leg pain. A standing X-ray of the LS spine was taken from the dorsolumbar junction to mid-thigh. Every patient was instructed to stand in their own neutral position. Straight knees were maintained. In order to obscure the arms from view, the arms were crossed over the chest. Software was used to analysed the scannogram's spinopelvic characteristics. The following inclusion and exclusion criteria were taken into account during this study.

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
- Patients with scoliotic deviation
- Patients with congenital anomalies
- Post-polio residual paralysis
- Neuromuscular dystrophy

Results

Young adults between the ages of 18 and 50 made up our study's sample population. A 9.33 standard deviation separated the mean age of 39.27 years from the mean. The age range from 40 to 48 years old had the highest percentage of patients. The study population's dominant sex group was female. A total of 23 male patients made up 38.3% of the population, while 37 female patients made up 61.7% of the overall group. The majority of instances (58.1%) were patients with two degrees of disc abnormalities. In instances with a single level of disc diseases, L5S1 was the most prevalent level, followed by L4 and L5. While L4L5 + L5S1 were the most frequently involved levels in cases involving two levels, L4L5 was more frequently involved in cases involving two levels when combined with other levels. There were 31 (51.7%) cases of diffuse disc bulging, the most prevalent kind of disc disease. The second most frequent form had 20 (33.3%) incidences of disc protrusion.

In the study population, the mean SS was 36.28°, with a standard deviation of 8.21. (Table 1). SS had a median value of 38.82° with a range of 12.41–55.36. The average PT for the study population was 12.25°, with a standard deviation of 6.34. PT has a median value of 11.85° with a range of 2.12 to 24.63. In the population in the study, the mean PI was 50.20°, with a standard deviation of 9.62°. The range of PI values was 31.21 to 75.52, with 52.10 being the median. With a standard deviation of 15.02 and a mean LL of 40.03° in the study population. SS had a range of 1.6 to 69.98 degrees, with 41.43 being the median value. The SS and PT means added together equal the PI mean. As a result, our study's findings support the association between SS, PT, and PI, which is PI = PT + SS.

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 (Figures 1).

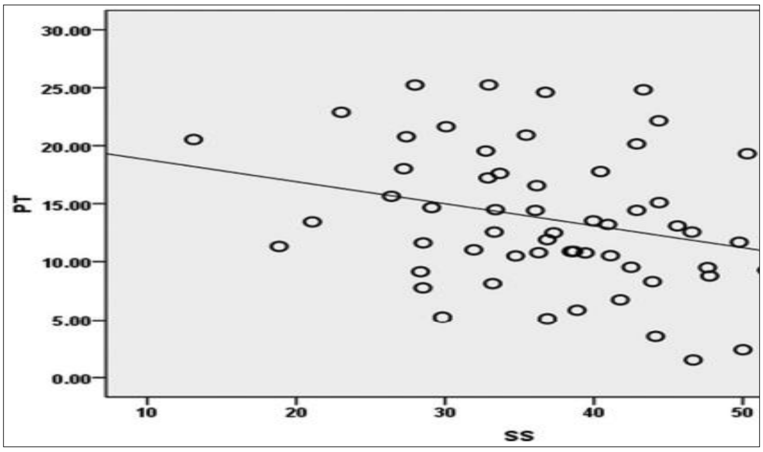

Fig 1: Pearson plot correlation among PT and SS

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 and Figures 2 and 3).

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

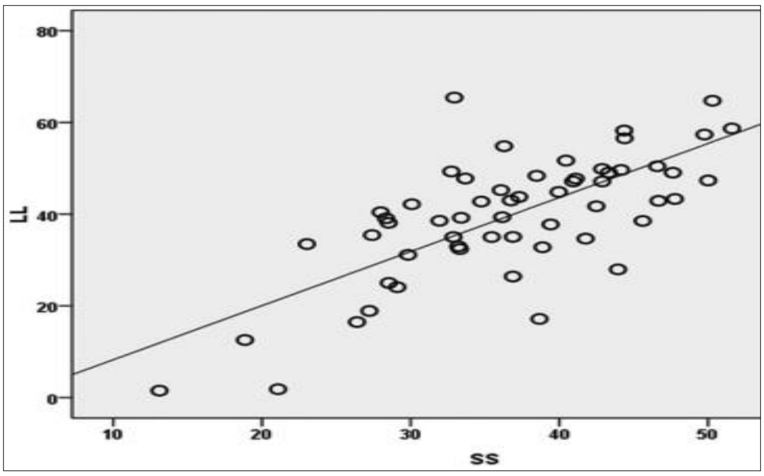

Fig 2: Pearson plot correlation among LL and SS

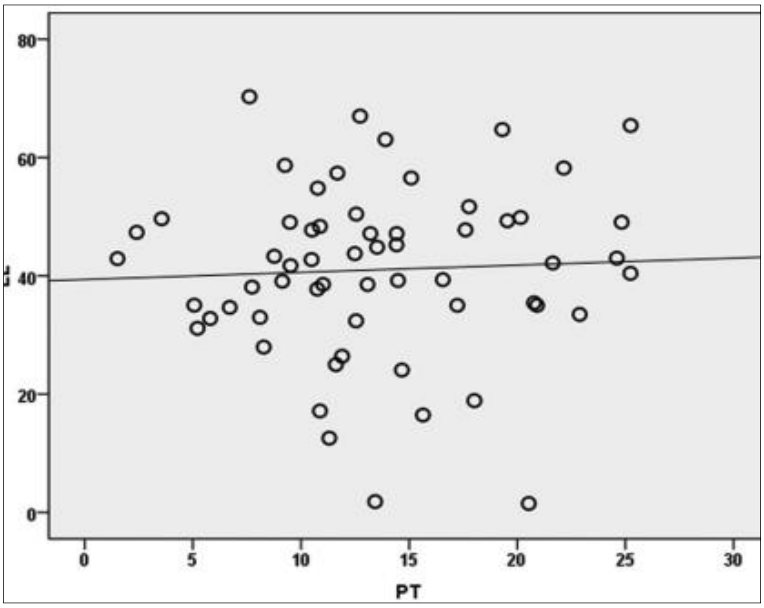

Fig 3: Pearson plot correlation among PT and LL

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).

Relationship among Disc pathology at L4L5 and pelvic parameters

The mean SS, PT, PI, and LL in cases with L4L5 disc pathology were 38.36 9.43, 13.58 5.77, 51.93 9.69, and 41.92 15.06, respectively. The positive monotonic association between disc pathology at the L4L5 level and SS, PT, PI, and LL is demonstrated by Spearman's rho correlation coefficients of 0.106, 0.014, 0.086, and 0.106, respectively. However, these associations lacked statistical significance (Table 3).

Relationship among Disc pathology at L5S1 and pelvic parameters

Mean SS, PT, PI, and LL in cases with L5S1 disc pathology were 37.44 10.35, 13.63 5.10, 51.06 10.23, and 40.49 15.18, respectively. The Spearman's rho correlation coefficients for the L5S1 level disc pathology and PT and LL are 0.038 and 0.003, respectively. However, disc pathology at L5S1 displayed a -0.004 Spearman's rho correlation coefficient negative monotonic connection with PI. However, these associations lacked statistical significance (Table 3).

Relationship among degenerative spondylolisthesis at L4L5 and LL, SS, PT, PI

Degenerative listhesis was present in all four (6.7%) cases and was all found to be at the L4L5 level. With a P value of 0.023, data showed a statistically significant connection between SS and degenerative spondylolisthesis at L4L5. With a Spearman's rho correlation coefficient of 0.293, it was discovered that this correlation was monotonic and direct. The correlation between PI and LL's lordosis and the likelihood of developing degenerative spondylolisthesis at L4L5 is similar, with a Spearman's rho correlation coefficient of 0.177 and 0.201, respectively. However, neither PI nor LL's increase in lordosis was found to be statistically significant.

Discussion

The primary change in human evolution can be seen in the acquisition of a vertical posture. The evolution of vertical posture and bipedalism was significantly influenced by the spine and spinopelvic complex. The human spine's series of opposing curves allows the trunk to assume an upright position, which is a marvellous feat. There is no other species that has the lumbar lordosis, which makes it special. Pelvis experienced significant changes as well in order to adopt a vertical position. The pelvis makes an effort to efficiently combine hip extension and lumbar lordosis while it is in an upright position. However, certain pelvises are better than others at performing this role [17]. Modern research has shown that a person's specific lumbar lordosis is significantly influenced by the geometry of the pelvis and how it relates to the SS. The work of Duval Beaupère and colleagues made it feasible to determine pelvic geometry and its relationship to pelvic position. Recently, some authors have drawn attention to the link between the spinopelvic organisation and disc diseases and degeneration in the lumbar spine. The pelvic incidence (PI) angle is the key. It is now abundantly obvious that the PI and the SS have a significant role in identifying the type of lumbar lordosis present in a particular person. Mechanical stress in the lumbar spine will result from the particular spinopelvic shape [18]. The degenerative spine's patterns are never static. Due to its spatial orientation in space, it is subject to dynamic forces that produce biomechanical forces. The pelvis and the spine have a close relationship in terms of form, location, and function. PI determines the morphology of the pelvis, which has an impact on the morphology of the spine. According to a person's unique morphology, specific degenerative evolutions may take place throughout time. Sagittal characteristics may be regarded as predictive of the spine's and the pelvis' respective shapes. An improved diagnosis of degenerative spine illnesses and a more effective treatment plan may result from a better knowledge of this relationship. Our study's mean age falls under the young adult age range. The study by Endo *et al*. had a comparable age range, with a mean age of 32.7 years. Even while the mean ages in previous investigations by Barrey *et al*. were higher-47.70 14.15 years and 49 12 years, respectively-they still included a higher age group. In contrast to a study by Barrey *et al*., which had a female-dominant sex distribution, a study by Endo *et al*. had a male-dominated sex distribution. In our investigation, we discovered a statistically significant monotonic direct association between SS and L4L5 degenerative spondylolisthesis. Our study indicates that a rise in SS statistically significantly increases the risk of developing degenerative spondylolisthesis at L4L5, which is characterised by an increase in the independent variable leading to an increase in the dependent variable; never to remain constant or decrease [19]. PI and LL also exhibit a comparable tendency, albeit one that was not statistically significant. Wang *et al*. confirmed similar findings, stating that single level degenerative spondylolisthesis sufferers had higher PI and SS than those without the condition. According to Ferrero *et al*., individuals with degenerative spondylolisthesis had greater PIs than volunteers who had no symptoms. Similar findings were made by Lai *et al*. who discovered that PI was connected to degenerative spondylolisthesis and that among individuals with the condition, SS is higher when compared to a control group. They also discovered a statistically significant linear link between SS, PI, and PT. Because PI is the mathematical sum of SS and PT, a rise in SS in our study resulted in a linear increase in PI. On the other hand, a rise in SS decreased PT because the pelvis had to make up for the increase in SS in order to keep the body's posture straight. The pelvis does this by lessening its tilt, or PT. PT and SS are mathematically added to get PI, which climbed linearly as PT increased. On the other hand, a rise in PT decreased SS because the spine has to make up for the increase in PT in order to keep the body's posture straight. The spine does this by lowering SS. i.e., SS. With SS and PI, LL displayed a linear association that was statistically significant. Any rise in SS will lead to a rise in LL. This is in line with what is expected, as the lumbar spine will need to curve more to maintain an upright standing position due to the higher SS [20].

The average SS, PT, PI, and LL were 36.28°, 12.25°, 50.20°, and 40.03°, respectively. PT, PI, and LL exhibited a positive monotonic connection with disc pathologies at the L1L2 level. It suggests that disc pathology at L1L2 will increase monotonically as PT, PI, and LL increase; that is, disc pathology at L1L2 will never decrease or remain constant with increased PT, PI, and LL. Positive monotonic connection was found between disc pathologies at the L2L3 and L4L5 levels and SS, PT, PI, and LL. It suggests that disc pathology at L2L3 and L4L5 will rise monotonically as SS, PT, PI, and LL increase. Only LL and LL alone exhibit a positive monotonic link with disc disease at the L3L4 level; SS, PT, and PI show a negative monotonic correlation. In our investigation, we used a neutral standing position, straight knees, and arms crossed over the chest to eliminate the arms from the field of view when taking radiographs [21]. As we all know, PI must equal the product of SS and PT, or PI = SS + PT. Consequently, 37.78 plus 13.52 (SS + PT) equals 51.3, which is the same as the mean PI we obtained, 51.33. This demonstrates how reasonably accurate our radiography method was. The radiography technique produced excellent images that allowed us to draw lines clearly on computer software to calculate angles. This can be taken to mean that entire spine radiographs are not necessary to calculate spinopelvic parameters and that our method can be utilised as a standard method (SS, PI, and PT).

Conclusion

The etiology of a herniated disc is complex and involves multiple factors. A novel paradigm for research, the correlation of sacropelvic characteristics with disc herniation in the young population should be examined further with prospective randomised controlled studies to validate the results. For the purpose of measuring spinopelvic parameters, a standing lateral view radiograph from the dorso lumbar junction to the middle of the thigh is considered to be on par with a standing whole spine radiograph.

Conflict of Interest: None

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