

Correlation between Spino-Pelvic Alignments and Degenerative Spondylolisthesis: A Radiographic Study

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Abstract: This cross-sectional observational study investigates the correlation between spinopelvic parameters—pelvic incidence (PI), pelvic tilt (PT), sacral slope (SS), and L1-S1 lordosis and degenerative spondylolisthesis (DS) in 32 patients compared to a control group with low back pain but no DS. Conducted from August to December 2024 at the Department of Radiodiagnosis, MIMS, the study utilized digital radiography to measure these parameters, alongside demographic factors like BMI and sex. Results indicate significantly higher PI, PT, SS, and lordosis in DS patients ($p < 0.05$), with obesity and female predominance noted. These findings underscore the role of spinopelvic alignment in DS progression, offering insights for potential surgical interventions to restore sagittal balance.

Keywords: degenerative spondylolisthesis, spinopelvic alignment, pelvic incidence, sacral slope, lumbar lordosis

1. Introduction

- 266 million individuals (3.63%) worldwide have degenerative spine disease (DSD) and low back pain (LBP) each year; the highest and lowest estimated incidences were found in Europe (5.7%) and Africa (2.4%), respectively.
- Based on population sizes & statistical inadequacy, low- and middle-income countries have 4 times as many cases as high-income countries.
- Thirty-nine million individuals (0.53%) worldwide were found to have spondylolisthesis, 403 million (5.5%) individuals worldwide with symptomatic disc degeneration, and 103 million (1.41%) individuals worldwide with spinal stenosis annually.^{1, 12}
 - Spinopelvic morphology and orientation balance the mechanical stress over lumbosacral junction.¹
 - L5 slippage over S1, leading to L5-S1 spondylolisthesis disrupts sacropelvic orientation, resulting in **sagittal imbalance** of the spine.¹
 - This condition is more frequent among women and patients **younger** than 50 years.²
 - According to Wiltse and Newman the degenerative form of the disease involves **L4-L5** level more.^{2, 3}
 - Multiple pathologic factors have been described including elevated body mass index (BMI), facet joint osteoarthritis,⁴
 - incompetence of the paraspinal muscles and ligaments, and effect of **female** sexual hormones.⁵
 - Spondylolisthesis leads to decreased capacity of compensatory balance mechanism.²
 - Untreated patients develop structural abnormalities in vertebrae, adjacent nerve roots and soft tissue, reflecting as low back pain along with radicular neurologic deficit and sagittal pelvic imbalance.^{6, 7}
 - In recent few years, the presence of high pelvic incidence (PI) and sacral slope (SS) have been highlighted in the setting of degenerative spondylolisthesis (DS). With focus on predisposing role
 - Increasing pelvic tilt (PT) reimburses high PI as a compensatory mechanism.^{9, 10}

- The combination of overweight and vertical displacement of S1 endplate leads to anterior slippage of L4 over L5.
- This study evaluated radiographic spinopelvic parameters and demographic features in DS patients compared to a control group with low back pain but no DS of patients with low back pain but no evidence on X-ray, CT & MRI.

2. Aim & Objectives

Aim

Analyse the **spino-pelvic alignment** parameters and how it effects the **course** of degenerative spondylolisthesis

Objectives

- To analyse the pelvic incidence (PI), pelvic tilt (pt), sacral slope (ss) and its correlation with DS.
- to calculate the L1-s1 lordosis angle and its effects on DS.
- To calculate the p value of these spinal parameters and its significance.

3. Methodology

- Study design: Cross sectional observational.
- Place: Dept. of Radiodiagnosis, MIMS.
- Period: AUG' 24 to DEC' 24 (06 m)
- Sample size: 32 DS CASES (65 patients)

Technique:

- ALLENGERS DIRECT DIGITAL RADIOGRAPHY, FP 4343R - 560MAS, XRAY MACHINE.
- DDR SOFTWARE – Synergy DR, version V22.0.1.0 dt: 03/08/2023

We recorded BMI (weight [kg] divided by height [m²]), sex, and age of all patients.

On lateral lumbosacral X-ray, we measured PT, SS, and PI
DDR SOFTWARE – Synergy DR, version V22.0.1.0 L1-S1 lordosis

The Presence of malalignment and changes on CT and MRI is considered as spondylolisthesis.

SPSS software version 21; IBM Corp. The significance cutoff was $p > 0.05$.

Inclusion criteria

- All **degenerative** spondylolisthesis cases listed in the MRI section, radiology, MIMS during the study period.
- All **non** - traumatic Lumbo sacral pain cases attending the dept of radiology, MIMS during the study period.

Exclusion criteria

- Developmental spondylolisthesis
- Past H/O spinal neoplasm/fractures
- Past spinal surgical interventions with or without prosthetic material deployment

4. Results

- In this study, we enrolled two groups of patients. DS patients with average BMI of 29.92 ± 5 were significantly obese, compared with non - DS patients with average BMI of 28.29 ± 4.28 ($p = 0.031$).
- The radiologic parameters are detailed. As shown in Table PI, SS, and PT were significantly **higher** in DS group than in non - DS patients ($p = 0.00, 0.001, 0.04$, respectively).
- Significant **increase** in L1–S1 lordosis in DS patients was another finding (41.83 vs. 32.92 , $p = 0.001$).
- Nearly **83%** of DS patients had osteoarthritis, compared to 30% of non - DS patients showing similar X - ray findings.

5. Discussion

- In my study, the mean age of the patients was 54.42 ± 13.61 yrs SD with range of 32 - 86 yr's.
- In **Babak Alijani** et al ^[3] study, the mean age of the patients was 52.22 ± 8.81 yrs SD with range of 40 to 84 years.
- My results are almost similar to study by Babak Alijani et al ^[3] in mean age and other parameters
- Spondylolisthesis, characterized by abnormal sacropelvic morphology and orientation, leads to **disturbed global sagittal balance** of the spine.¹¹
- The most commonly used spinal parameters include **PI, PT, SS, and lumbar lordosis**.^{8, 11}
- Labelle et al found a significant increase in all of these parameters in DS patients, compared with control population.¹¹

Conflicts of Interest

- This is a not a sponsored study and they are no conflicts of interest.

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6. Limitations

- Limited sample
- Software & Data limitations
- X - Ray exposure – inadequate film.

7. Conclusion

- Markedly increase PI, PT, and SS are the main features in DS.
- Increasing segmental lordosis is evident in many of these patients.
- Notably, this study insists that female sex and obesity are more frequent in this population.
- Surgical interventions may correct abnormal loading, and consequently would diminish the symptoms.

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