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Research Article

# Radiographic Changes in Sagittal Spinopelvic Parameters Following Lumbar Canal Decompression: A Prospective Cohort Study

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## Abstract

**Background:** Sagittal spinopelvic alignment, encompassing parameters such as lumbar lordosis (LL), pelvic tilt (PT), pelvic incidence (PI), and plumb line-sagittal vertical axis (PL-SVA), is a critical determinant of outcomes following lumbar decompression surgery. While decompression is effective in alleviating neurogenic claudication in degenerative lumbar spinal stenosis (DLSS), its impact on sagittal alignment remains unclear. This study evaluates the radiographic and clinical outcomes associated with decompression surgery.
**Methods:** In this prospective cohort study, 24 patients who underwent decompression via laminectomy or laminotomy between July 2017 and July 2018 were included. Sagittal alignment parameters were assessed preoperatively and at follow-up, using Electronic Optical Scan (EOS) imaging. Pain and functional outcomes were evaluated using the Visual Analog Scale (VAS) and Oswestry Disability Index (ODI). Statistical comparisons were performed using paired t-tests.
**Results:** Postoperative evaluation showed significant improvement in LL (29.50 ± 15.02 to 51.58 ± 5.99, P < 0.001) and sacral slope (SS) (31.15 ± 2.05 to 26.99 ± 5.00, P < 0.001), and a significant decrease in PT (11.68 ± 2.91 to 6.06 ± 4.62, P < 0.001). No statistically significant changes were noted in PI (P = 0.264) or PL-SVA (P = 0.540). Improvements in LL and SS were negatively correlated with reductions in VAS scores (P = 0.034 and P = 0.028, respectively).
**Conclusion:** Lumbar decompression was associated with spinopelvic alignment and reduced pain in patients with DLSS. These findings suggest that realignment of sagittal parameters following decompression alone may contribute to improved clinical outcomes.

*Keywords:* Lumbar Vertebrae; Decompression; Spinal Stenosis; Pelvis

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## Background

Spinopelvic parameters, including lumbar lordosis (LL), pelvic tilt (PT), pelvic incidence (PI), and the PI-LL mismatch, are important predictors of pain, functional limitation, and postoperative outcomes in degenerative spinal conditions (1). Deviations from physiological alignment lead to compensatory recruitment of paraspinal and lower-limb musculature, contributing to increased energy expenditure, reduced walking endurance, and a decline in quality of life (QOL) (2). Consequently, preserving or restoring sagittal balance has become a cornerstone of contemporary spinal surgery.

While fusion surgeries aim explicitly to correct sagittal alignment, lumbar decompression, the most frequently performed procedure for degenerative lumbar spinal stenosis (DLSS), primarily targets neural decompression rather than realignment. DLSS, a prevalent condition in the aging population, significantly contributes to the global burden of low back pain (3, 4). In the United States (US) alone, over 38000 lumbar decompression procedures are performed annually, primarily in individuals older than 65 years who suffer from neurogenic claudication (5).

Patients with DLSS often present in a flexed-forward posture with reduced LL and increased PT-mechanisms that temporarily relieve symptoms by increasing canal dimensions (6). Following decompression, some evidence suggests patients may regain a more upright posture and improved sagittal balance. However, previous studies offer conflicting results, with some reporting radiographic improvement and others finding negligible change (7, 8).

Understanding whether decompression alone can improve sagittal alignment is clinically important. If such improvement is predictable, less invasive procedures could be confidently offered to suitable patients, avoiding the additional risks of fusion. Conversely, if decompression fails to correct a significant PI-LL mismatch, adjunct or staged correctional surgery may be necessary. Moreover, identifying radiographic changes associated with clinical improvement could inform both surgical planning and postoperative rehabilitation. Most existing studies focus on fusion-based techniques or evaluate sagittal alignment as a secondary outcome, making it unclear whether decompression alone can meaningfully modify sagittal balance or PI-LL mismatch. Therefore, to address this clinical question, we conducted a prospective cohort study examining radiographic changes and clinical outcomes following stand-alone lumbar decompression. By focusing on a homogeneous surgical technique and applying standardized imaging protocols, this study aims to clarify the effects of decompression surgery on sagittal alignment in patients with DLSS.

## Methods

***Study Design and Patient Selection:*** This prospective, single-center cohort study enrolled 30 consecutive patients who underwent lumbar decompression via unilateral laminotomy between July 2017 and July 2018. Written informed consent was obtained from all participants. All procedures were performed by a single fellowship-trained spine surgeon. Patients were followed for a minimum of six months postoperatively.

Inclusion criteria included adult patients diagnosed with symptomatic DLSS, experiencing persistent pain for at least three months despite conservative treatment, and deemed candidates for surgical decompression. Lumbar stenosis was confirmed using magnetic resonance imaging (MRI). Exclusion criteria were the presence of neurological deficits or neuromuscular disorders, prior spinal surgeries, or spinal infections or tumors identified preoperatively.

***Surgical Technique:*** Lumbar decompression was performed using either standard laminectomy or the slalom technique for unilateral laminotomy, depending on the extent of canal stenosis. All surgeries were elective. Postoperative rehabilitation commenced within 24 hours of surgery, emphasizing early ambulation and a standardized home-based exercise program involving twice-daily repetitions.

***Radiographic Assessment:*** Radiological evaluation employed full-body lateral Electronic Optical Scan (EOS) imaging preoperatively and at three- and six-month follow-ups. Spinopelvic parameters measured included PI, PT, sacral slope (SS), LL, thoracic kyphosis (TK), and the plumb line-sagittal vertical axis (PL-SVA).

Standardized definitions were used: PI was defined as the angle between a line perpendicular to the midpoint of the S1 endplate and a line connecting it to the femoral head axis. PT was measured as the angle between the vertical and the line connecting the S1 midpoint to the femoral heads. SS was defined as the angle between the horizontal and the S1 endplate. LL was measured from the superior endplate of L1 to that of S1, and TK was measured from T4 to T12. PL-SVA represented the horizontal displacement from the C7 plumb line (PL) to the *posterosuperior corner of S1.*

***Clinical Outcome Measures:*** Demographic and perioperative data included age, sex, body mass index (BMI), operated level, duration of surgery, and estimated blood loss (EBL). Pain intensity was assessed using the Visual Analog Scale (VAS), and functional status was evaluated using the Oswestry Disability Index (ODI) and Zurich Claudication Questionnaire (ZCQ). Nerve function was assessed via electromyography (EMG) and nerve conduction velocity (NCV) testing.

***Statistical Analysis:*** Data analysis was performed using SPSS software (version 24, IBM Corporation, Armonk, NY, USA). Paired t-tests were used to compare preoperative and postoperative radiographic and clinical values. Pearson's correlation was used to examine relationships between radiographic and clinical outcome variables. A P-value < 0.05 was considered statistically significant.

## Results

***Study Population:*** Out of 30 enrolled patients, 24 met inclusion criteria and completed the six-month follow-up. The mean age was 36.9 years (± 6.0), with a range of 27 to 48 years. There were 14 men (58.3%) and 10 women (41.7%), and the average BMI was 27.7 ± 4.1 kg/m². The most operated level was L5-S1. The average duration of surgery was 71.9 minutes, with a mean blood loss of 26.2 ml. All patients were discharged within 24 hours postoperatively. The characteristics of the subject population are shown in table 1.

**Table 1.** Demographic data for the 24 patients included

| Demographic data | Value |
|---|---|
| No. of cases | 24 |
| Age (year) (mean ± SD) | 36.87 ± 6.00 |
| Sex (men/women) | 14/10 |
| BMI (kg/m2) | 27.70 ± 4.10 |
| Operation time (minute) (mean ± SD) | 71.90 ± 29.74 |
| EBL (ml) (mean ± SD) | 26.20 ± 42.60 |

BMI: Body mass index; EBL: Estimated blood loss; SD: Standard deviation

***Radiographic Outcomes:*** Preoperative measurements indicated a mean LL of 29.50 ± 15.02°, PT of 11.68 ± 2.91°, SS of 31.15 ± 2.05°, and PI of 42.24 ± 2.43° (Table 2).

**Table 2.** Preoperative and postoperative sagittal parameters and clinical results (6-month follow-up)

| Parameters | Pre- and post-operative difference | SD difference | 95% CI of the difference | | P-value |
|---|---|---|---|---|---|
| | | | Lower | Upper | |
| PI | -0.88 | 3.79 | -2.49 | 0.71 | 0.264 |
| PT | -5.62 | 3.99 | -7.30 | -3.93 | < 0.001 |
| SS | 5.83 | 5.52 | 3.50 | 8.16 | < 0.001 |
| LL | 22.07 | 18.75 | 14.15 | 29.99 | < 0.001 |
| TK | 13.37 | 16.38 | 6.45 | 20.29 | 0.001 |
| PL-SVA | -4.50 | 35.45 | -19.47 | 10.46 | 0.540 |

PI: Pelvic incidence; PT: Pelvic tilt; SS: Sacral slope; LL: Lumbar lordosis; TK: Thoracic kyphosis; PL-SVA: Plumb line-sagittal vertical axis; CI: Confidence interval; SD: Standard deviation

At six months postoperatively, LL significantly increased to 51.58 ± 5.99° (P < 0.001), PT decreased to 6.06 ± 4.62° (P < 0.001), and SS rose to 26.99 ± 5.00° (P < 0.001).

There was no statistically significant change in PI (P = 0.264) or PL-SVA (P = 0.540) (Table 3).

**Table 3.** Comparison of radiographic parameters before and after surgery

| Parameters | Pre-op | Post-op (6 months follow-up) | P-value |
|---|---|---|---|
| PI | 42.24 ±2.43 | 41.35 ± 3.91 | 0.264 |
| PT | 11.68 ± 2.91 | 6.06 ± 4.62 | < 0.001 |
| SS | 31.15 ± 2.05 | 26.99 ± 5 | < 0.001 |
| LL | 29.50 ± 15.02 | 51.58 ± 5.99 | < 0.001 |
| TK | 36.62 ± 11.51 | 47 ± 10.03 | < 0.001 |
| PL-SVA | 31.68 ± 18.20 | 27.18 ± 21.80 | 0.540 |
| VAS | 6.16 ± 2.59 | 3.95 ± 1.66 | < 0.001 |

PI: Pelvic incidence; PT: Pelvic tilt; SS: Sacral slope; LL: Lumbar lordosis; TK: Thoracic kyphosis; PL-SVA: Plumb line-sagittal vertical axis; VAS: Visual Analog Scale

Figure 1 illustrates examples of improvement in sagittal vertical axis (SVA) after decompression surgery (EOS full-body radiographs).

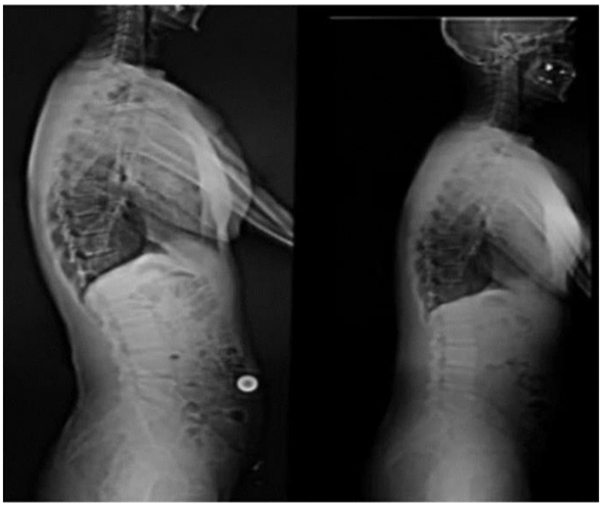

**Figure 1.** Example of an improvement before (left) and after (right) decompression surgery

**Table 4.** Correlation of sagittal balance parameters with pain before and after operation

| | | Post-op_PI | Post_OP_PT | Post_OP_SS | Post_OP_LL | Post_OP_TK | Post_OP_PL_SVA | Post_VAS |
|---|---|---|---|---|---|---|---|---|
| **Pre_OP_PI** | Pearson Correlation | 0.357 | 0.291 | -0.137 | -0.085 | 0.069 | 0.316 | 0.099 |
| | P-value (2-tailed) | 0.087 | 0.168 | 0.523 | 0.692 | 0.748 | 0.132 | 0.645 |
| **Pre_OP_PT** | Pearson Correlation | -0.010 | 0.517 | 0.207 | 0.125 | 0.102 | -0.171 | -0.099 |
| | P-value (2-tailed) | 0.962 | 0.010 | 0.331 | 0.561 | 0.637 | 0.425 | 0.647 |
| **Pre_OP_SS** | Pearson Correlation | 0.157 | -0.021 | -0.060 | -0.231 | 0.029 | 0.603 | 0.131 |
| | P-value (2-tailed) | 0.464 | 0.924 | 0.782 | 0.278 | 0.891 | 0.002 | 0.543 |
| **Pre_OP_LL** | Pearson Correlation | 0.304 | 0.247 | -0.368 | -0.499 | -0.267 | -0.153 | 0.070 |
| | P-value (2-tailed) | 0.149 | 0.244 | 0.077 | 0.013 | 0.208 | 0.474 | 0.744 |
| **Pre-OP_TK** | Pearson Correlation | 0.229 | 0.285 | -0.091 | -0.257 | -0.153 | 0-.367 | -0.090 |
| | P-value (2-tailed) | 0.281 | 0.177 | 0.672 | 0.226 | 0.476 | 0.078 | 0.676 |
| **Pre_OP_PL_SVA** | Pearson Correlation | 0.434 | -0.052 | 0.050 | 0.019 | 0.169 | 0.568 | 0.037 |
| | P-value (2-tailed) | 0.034 | 0.808 | 0.815 | 0.932 | 0.429 | 0.004 | 0.863 |
| **Pre_VAS** | Pearson Correlation | 0.006 | -0.142 | -0.296 | -0.024 | 0.216 | 0.147 | 0.816 |
| | P-value (2-tailed) | 0.978 | 0.508 | 0.161 | 0.913 | 0.310 | 0.493 | <0.001 |

PI: Pelvic incidence; PT: Pelvic tilt; SS: Sacral slope; LL: Lumbar lordosis; TK: Thoracic kyphosis; PL-SVA: Plumb line-sagittal vertical axis

***Clinical Outcomes:*** The average preoperative VAS pain score was 6.16 ± 2.59, which significantly improved to 3.95 ± 1.66 at final follow-up (P < 0.001). EMG findings revealed moderate chronic radiculopathy in most patients although no significant correlation was found between EMG results and radiographic parameters.

***Correlations between Radiographic and Clinical Measures:*** Statistical analysis showed a negative correlation between changes in LL and SS with VAS improvement. Specifically, reductions in pain were associated with increases in LL (P = 0.034) and SS (P = 0.028). Other notable findings included significant correlations between PT and TK (negative), PT and LL (negative), and SS and PL-SVA (negative) (Table 4).

## Discussion

This prospective study evaluated changes in sagittal alignment and clinical outcomes following stand-alone lumbar decompression. The results demonstrate that decompression significantly improves spinopelvic parameters –particularly LL, PT, and SS –while maintaining stable global alignment, as reflected by unchanged PL-SVA values.

Pain relief, reflected in significantly reduced VAS scores, correlated with improvements in LL and SS. These findings suggest that, even in the absence of instrumentation, decompression may allow patients to adopt a more upright posture, leading to partial restoration of sagittal balance and symptom improvement.

Our findings align with studies such as those by Le Huec et al. (9) and Lenz et al. (10), which underscore the clinical importance of restoring LL. While other researchers, including Bayerl et al. (11) and Fujii et al. (8), found limited radiographic change after decompression, our results suggest that measurable sagittal adjustments can occur, particularly in younger patients with flexible spines and no preexisting deformity.

Importantly, our study population was relatively young, with a mean age below 50, which may explain the more pronounced improvements in alignment. Additionally, consistent surgical technique, standardized imaging, and a uniform rehabilitation protocol likely contributed to the reliability of our outcomes.

Nevertheless, some limitations should be acknowledged. The sample size was relatively small, and the follow-up period limited to six months. Besides, the lack of a control group precludes direct comparison with other treatment modalities. Furthermore, our findings may not be generalizable to older patients or those with fixed sagittal imbalance.

Despite these limitations, this study adds to the growing body of evidence suggesting that decompression alone may positively influence sagittal alignment and improve clinical outcomes in selected patients with DLSS.

### *Conclusion*

Decompression surgery for DLSS appears to result in significant improvements in local sagittal spinopelvic parameters, particularly LL and pelvic orientation. These radiographic changes are associated with clinically meaningful reductions in pain. Given the anatomical stability of PI and the minimal effect on PL-SVA, the results support decompression as a viable option in younger patients without fixed deformities. Future research should explore long-term outcomes and validate these findings in older and more diverse populations.

## Conflict of Interest

The authors declare no conflict of interest in this study.

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## References

1. Ames CP, Smith JS, Scheer JK, Bess S, Bederman SS, Deviren V, et al. Impact of spinopelvic alignment on decision making in deformity surgery in adults: A review. *J Neurosurg Spine*. 2012;16(6):547-64. doi: 10.3171/2012.2.Spine11320. [PubMed: 22443546].
2. Sai Krishna M, Sharma D, Menon J, Barathi D. Low Back Pain-How Significant are the Spinopelvic Parameters? *Global Spine J*. 2016;6(1_suppl):s-0036-1582699-s-0036-. doi: 10.1055/s-0036-1582699.
3. Silvers HR, Lewis PJ, Asch HL. Decompressive lumbar laminectomy for spinal stenosis. *J Neurosurg*. 1993;78(5): 695-701. doi: 10.3171/jns.1993.78.5.0695. [PubMed: 8468598].
4. Lenga P, Gülec G, Bajwa AA, Issa M, Oskouian RJ, Chapman JR, et al. Lumbar Decompression versus Decompression and Fusion in Octogenarians: Complications and Clinical Course With 3-Year Follow-Up. *Global Spine J*. 2024;14(2):687-96. doi: 10.1177/21925682221121099. [PubMed: 36148681]. [PubMed Central: PMC10802554].
5. Ball JR, Gallo MC, Kebaish K, Hang N, Ton A, Hernandez F, et al. National Trends in Lumbar Degenerative Spondylolisthesis With Stenosis Treated With Fusion Versus Decompression. *Neurospine*. 2024;21(4):1068-77. doi: 10.14245/ns.2448624.312. [PubMed: 39765242]. [PubMed Central: PMC11744538].
6. Deer T, Sayed D, Michels J, Josephson Y, Li S, Calodney AK. A Review of Lumbar Spinal Stenosis with Intermittent Neurogenic Claudication: Disease and Diagnosis. *Pain Med*. 2019;20(Suppl 2):S32-s44. doi: 10.1093/pm/pnz161. [PubMed: 31808530]. [PubMed Central: PMC7101166].
7. Jeon CH, Lee HD, Lee YS, Seo HS, Chung NS. Change in sagittal profiles after decompressive laminectomy in patients with lumbar spinal canal stenosis: a 2-year preliminary report. *Spine (Phila Pa 1976)*. 2015;40(5):E279-85. doi: 10.1097/brs.0000000000000745. [PubMed: 25901983].
8. Fujii K, Kawamura N, Ikegami M, Niitsuma G, Kunogi J.

Radiological improvements in global sagittal alignment after lumbar decompression without fusion. *Spine (Phila Pa 1976)*. 2015;40(10):703-9. doi: 10.1097/brs.0000000000000708. [PubMed: 25394314].

9. Le Huec JC, Faundez A, Dominguez D, Hoffmeyer P, Aunoble S. Evidence showing the relationship between sagittal balance and clinical outcomes in surgical treatment of degenerative spinal diseases: a literature review. *Int Orthop*. 2015;39(1): 87-95. doi: 10.1007/s00264-014-2516-6. [PubMed: 25192690].
10. Lenz M, Oikonomidis S, Hartwig R, Gramse R, Meyer C, Scheyerer MJ, et al. Clinical outcome after lumbar spinal fusion surgery in degenerative spondylolisthesis: a 3-year follow-up. *Arch Orthop Trauma Surg*. 2022;142(5):721-7. doi: 10.1007/s00402-020-03697-9. [PubMed: 33372234]. [PubMed Central: PMC8994725].
11. Bayerl SH, Pöhlmann F, Finger T, Onken J, Franke J, Czabanka M, et al. The Sagittal Balance Does not Influence the 1 Year Clinical Outcome of Patients with Lumbar Spinal Stenosis without Obvious Instability after Microsurgical Decompression. *Spine (Phila Pa 1976)*. 2015;40(13):1014-21. doi: 10.1097/brs.0000000000000928. [PubMed: 25893354].