Original Article

Failures of lumbosacral instrumented fusions addressing degenerative lumbar disease

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ABSTRACT

Background: Here, we evaluated the failure to preserve or restore adequate spinopelvic alignment following lumbosacral instrumented fusions for degenerative disease.

Methods: Patients undergoing lumbosacral instrumented fusions for degenerative spine disease underwent; standing lumbopelvic X-rays and lumbar MRI scans obtained both preoperatively and 1 year postoperatively. Parameters measured included lumbar lordosis (LL), L4-S1 angle, pelvic incidence (PI), and LL-PI mismatch.

Results: Fifty patients were followed for 1 year following lumbopelvic fusion. There was a statistically significant difference in the L4-S1 angle between patients with good versus poor clinical outcomes at 1 year postoperative; the LL-PI mismatch showed a strong positive correlation with better outcome scores.

Conclusion: Preservation of an adequate LL/other lumbosacral parameters favorably impacts patients' outcomes following lumbosacral fusion for degenerative disease.

Keywords: Degenerative spine, Fixation, Lumbar lordosis, Outcome, Sagittal balance

INTRODUCTION

Here, we assessed spinopelvic sagittal alignment and outcomes for patients undergoing lumbosacral fusions addressing lumbar spondylosis. Consensus on the optimal lumbosacral alignment/parameters and optimal achievable sagittal alignment is lacking.[6] In an effort to further enhance surgical planning, we studied unique parameters correlating pelvic incidence (PI) and lumbar lordosis (LL) (e.g., in which PI-LL ≤±10).[5]

MATERIALS AND METHODS

Patients

We obtained the approval of an IRB (institutional review board). Fifty patients underwent lumbosacral spine decompressions/interbody fusions using pedicle screw instrumentation [Table 1].

Indications for instrumented fusion are outlined in [Table 2] and included sagittal rotation on lateral plain films of more than 10º and/or sagittal translation of ≥4 mm. Patients were divided

into those with degenerative spondylolisthesis (DSL) versus those with degenerative disc disease (DDD).

Methods

Clinical evaluation

Fifty patients with degenerative lumbar spine disorders and radiculopathy averaged 49.48 years of age, and 32 were female. There were 20 patients with DSL versus 30 patients (60%) with DDD [Figure 1]. The distribution of pre-operative symptoms for the entire cohort is presented in Table 3. Fusions were most commonly performed at the L4-S1 (17 patients – 34%) and L3-5 (15 patients – 30%) levels [Table 4].

Patients were assessed with the visual analog score and the Arabic version of the Roland Morris Disability Questionnaire (RMQ).[4] A RMQ outcome score of 4 or less was considered a good outcome. Postoperative patient evaluations were performed; 3 days postoperatively, and then at 1 month, 3 months, 6 months, and 1 year.

Table 1: Exclusion criteria and indications for instrumented fusion.

Exclusion criteria

- Age >75 years
- Incomplete preoperative and postoperative imaging and clinical data
- BMI of ≥36
- Known rheumatological disorders
- Known peripheral neuropathy
- Nondegenerative type spondylolisthesis
- Osteoporosis

Indications for instrumented fusion

- Degenerative flat back
- Bilateral facet violation for adequate decompression
- Spondylolisthesis with positive clinical correlation
- Facet effusion >2 mm on MRI
- Sagittal rotation on lateral plain films was more than 10° and/or sagittal translation of ≥4 mm

Table 2: Radiographic parameters.

Radiographic parameters	
Lumbar lordosis	Angle between the upper end plate of L1 and the sacral end plate
L4-S1 angle	Angle between the upper end plate of L4 and the sacral end plate
Pelvic incidence	Angle between the perpendicular to the sacral end plate and the line from the center of the femoral head to the mid-point of the sacral endplate
Mathematical difference between the measured values for LL and PI	Mathematical difference between the measured values for LL and PI

Radiological evaluation

All patients underwent preoperative X-rays (e.g., standing lateral dynamic lumbosacral X-ray and a free-standing whole spine lateral x-ray measuring lumbopelvic parameters) and MRI scans. Postoperative studies were similarly completed.

Surgimap Spine (Surgimap Spine, New York City, NY, USA) software was used to perform the Cobb angle measurements and measurement of pelvic parameters [Table 2].

Statistical analysis

Data were analyzed using Predictive Analytics Software (v. 18, SPSS, Inc., Chicago, IL, USA). Continuous data were
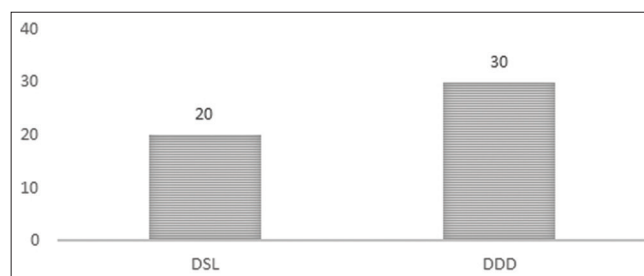

Figure 1: Distribution of studied cases into two groups according to presenting pathology. DSL: Degenerative spondylolithesis, DDD: Degenerative disc disease.

Table 3: Distribution of the studied cases according to symptoms.

	DSL	DDD	Total	%
Symptoms				
LBP only	0	3	3	6
LBP + Bilateral sciatica	10	7	17	34
LBP + Left sciatica	6	2	8	16
LBP + Right sciatica	6	3	9	18
LBP + Claudication	4	8	12	24
LBP + urinary incontinence	0	1	1	2

LBP: Low back pain, DSL: Degenerative spondylolithesis, DDD: Degenerative disc disease

Table 4: Distribution of the studied cases according to fusion segment.

	DSL	DDD	Total	%
Fusion Segment				
L1-3	0	1	1	2
L1-S1	0	3	3	6
L2-5	0	1	1	2
L2-Iliac	0	1	1	2
L2-S1	0	4	4	8
L3-5	9	6	15	30
L3-S1	2	3	5	10
L4-S1	9	8	17	34

DSL: Degenerative spondylolithesis, DDD: Degenerative disc disease

reported as mean ± SD and categorical data were reported as frequencies and percentages

RESULTS

Postoperatively, patients for both groups demonstrated comparable statistically significant improvement in pain and quality of life scores, and there were no significant differences in radiological parameters [Tables 5 and 6].

Patients with good outcome in both groups had a significantly higher L4-S1 angle and a lower LL-PI mismatch value [Tables 7 and 8]. There was a statistically significant correct between RMQ outcome scores and LL-PI mismatch, that is, patients with lower LL-PI values on postoperative evaluation had significantly better RMQ outcome scores [Figures 2 and 3]. An illustrative case example is shown in Figure 4.

DISCUSSION

Preservation of PI-LL mismatch within 10 degrees strongly correlated with good clinical outcomes in our study.[5,7]

Different cut-off points for PI-LL mismatch have been defined. Initially, Schwab *et al.* showed a significant correlation with outcome measures when a cut-off point for PI-LL mismatch is equal to or less than ±10; however, a later study by O'neill *et al.* showed PI-LL mismatched less than ±20 more appropriately correlated with good clinical outcome.[5,7] Other radiographic parameters correlate with clinical outcomes, including the SS, as described by Roussouly *et al.*, LL, and pelvic tilt.[1,2] However, we believe that the PI-LL is a more encompassing assessment and allows individualization of normal parameters with respect to the four variants of lumbopelvic alignment described by Roussouly *et al.*[5,6]

Correlations in this study though reaching statistical significance were moderate, suggesting the presence of other confounding factors [Table 9].[3]

A cause and effect relationship between outcome and radiological parameters are somewhat premature. Furthermore, understanding variations in lumbopelvic
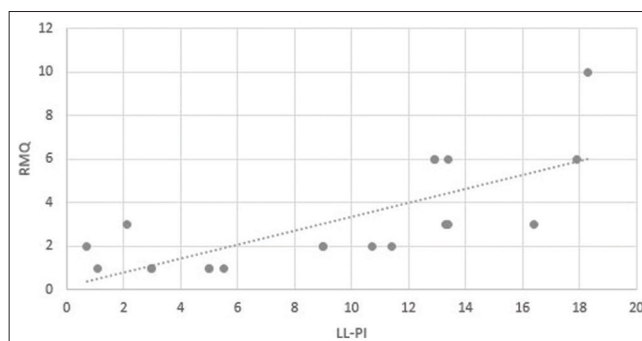
Figure 2: Scatter plot showing statistically significant positive correlation between radiological parameter (LL-PI) and functional outcome in patients with degenerative spondylolithesis. RMQ: Roland morris disability questionnaire, LL: Lumbar lordosis, PI: Pelvic incidence.
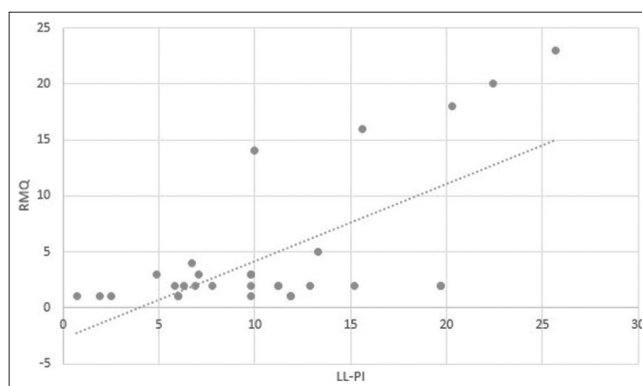
Figure 3: Scatter plot showing statistically significant positive correlation between radiological parameter (LL-PI) and functional outcome in patients with degenerative disc disease at 1 year postoperative. RMQ: Roland Morris disability questionnaire, LL: Lumbar lordosis, PI: Pelvic incidence.

Table 5: Clinical and radiological assessment of degenerative spondylolithesis patients; preoperative and 1 year postoperative.

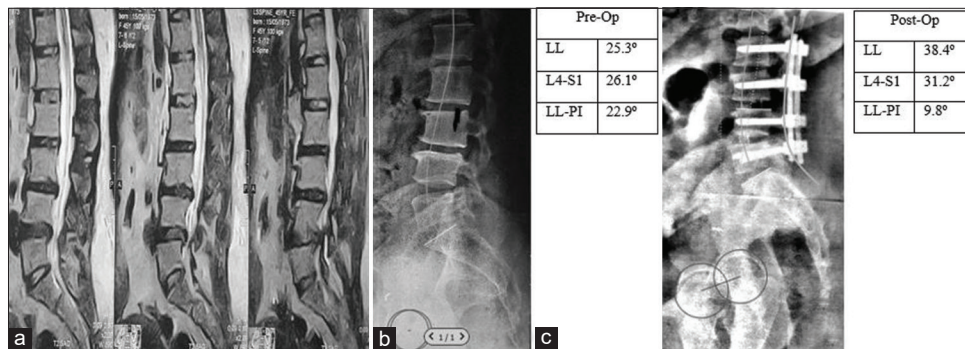|	Clinical outcome for LBP						
	Preoperative			**1 year postoperative**			**P-value**
	VAS	**RMD**		**VAS**	**RMD**		
Mean	8±0.56	20.3±1.5		1.5±0.69	3.1±2.4		<0.05
	Radiological Parameters						
	Preoperative			**1 year postoperative**			**P-value**
	LL	**L4-S1**	**LL-PI**	**LL**	**L4-S1**	**LL-PI**	
Mean	51.9±7.3	33.0±6.6	7.88±6.3	49.8±6.0	34.1±6.5	9.2±5.7	>0.05
LBP: Low back pain, VAS: Visual analog scale, RMQ: Roland Morris disability questionnaire							

Figure 4: Showing preoperative and postoperative imaging and radiological measurements. (a) Preoperative lumbosacral sagittal MRI, (b) preoperative lumbosacral lateral X-ray, and (c) postoperative lumbosacral lateral X-ray.

Table 6: Clinical and radiological assessment of degenerative disc disease patients; preoperative and 1 year postoperative.

	Clinical outcome for LBP					
	Preoperative			1 year postoperative		*P*-value
	VAS	RMQ		VAS	RMQ	
Mean	7.5±1.1	19.4±3.2		2.0±2.1	4.7±6.3	<0.05
	Radiological parameters					
	Preoperative			1 year postoperative		*P*-value
	LL	L4-S1	LL-PI	LL	L4-S1	LL-PI
Mean	36.3±12.6	23.8±8.1	14.1±6.2	37.9±11.0	23.2±6.6	10.8±6.1	>0.05

LBP: Low back pain, VAS: Visual analog scale, RMQ: Roland Morris disability questionnaire, LL: Lumbar lordosis, PI: Pelvic incidence

Table 7: Radiological parameters for DSL patients with good versus poor outcome at 1 year postoperative. Good outcome was defined as RMQ ≤4.

	Good outcome RMQ ≤4	Poor outcome RMQ >4	*P*-value
LL	49.8±5.1	45.4±6.6	0.28
L4-S1	32.3±5.3	25.6±2.3	0.01
LL-PI	7.2±4.8	15.1±2.5	0.0007

RMQ: Roland Morris disability questionnaire, LL: Lumbar lordosis, PI: Pelvic incidence

Table 8: Radiological parameters for patients with DDD good versus poor outcome at 1 year postoperative. Good outcome was defined as RMQ ≤4.

	Good outcome RMQ ≤4	Poor outcome RMQ >4	*P*-value
LL	41.4±8.8	24.0±7.9	0.001
L4-S1	25.2±5.6	15.5±4.6	0.001
LL-PI	9.0±4.8	17.9±5.9	0.01

RMQ: Roland Morris disability questionnaire, LL: Lumbar lordosis, PI: Pelvic incidence

Table 9: Confounding factors contributing to low back pain and poor outcome.

Confounding factors
• Reduced muscle volume
• Fatty infiltration of muscles
• Facet arthropathy,
• Presence of degenerative changes at other levels
• Psychological and occupational status

parameters in the sitting verse standing positions should be evaluated for postfusion patients with a fixed lumbar spine and failure to adapt to different postures.

CONCLUSION

Spinopelvic radiological parameters play an important role in predicting clinical outcomes following instrumented lumbosacral fusions for degenerative lumbar spine disease.

Declaration of patient consent

Institutional Review Board permission was obtained for the study.

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Conflicts of interest

There are no conflicts of interest.

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