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. 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).

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). 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.

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...
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 mismatch 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

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

| Clinical outcome for LBP | Preoperative | 1 year postoperative | P-value |
|-------------------------|---------------|-----------------------|---------|
| VAS                     | RMD           | VAS                   | RMD     |<0.05 |
| Mean                    | 8±0.56        | 20.3±1.5              | 1.5±0.69| 3.1±2.4 |

**Radiological Parameters**

| Preoperative | 1 year postoperative | P-value |
|--------------|----------------------|---------|
| LL           | L4-S1                | LL-PI   |<0.05 |
| 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 |

LBP: Low back pain, VAS: Visual analog scale, RMQ: Roland Morris disability questionnaire
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.

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

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

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.

**Financial support and sponsorship**

Publication of this article was made possible by the James I. and Carolyn R. Ausman Educational Foundation.

**Conflicts of interest**

There are no conflicts of interest.

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**How to cite this article:** Helal A, Madkour A, Yehia A. Failures of lumbosacral instrumented fusions addressing degenerative lumbar disease. Surg Neurol Int 2020;11:443.