

Introduction

The flexed posture of the lumbar spine increases the diameter of the spinal canal and neuroforamina and can relieve neurogenic claudication symptoms. No study has determined if sagittal imbalance may be secondary to a postural flexion to alleviate lumbar stenosis.



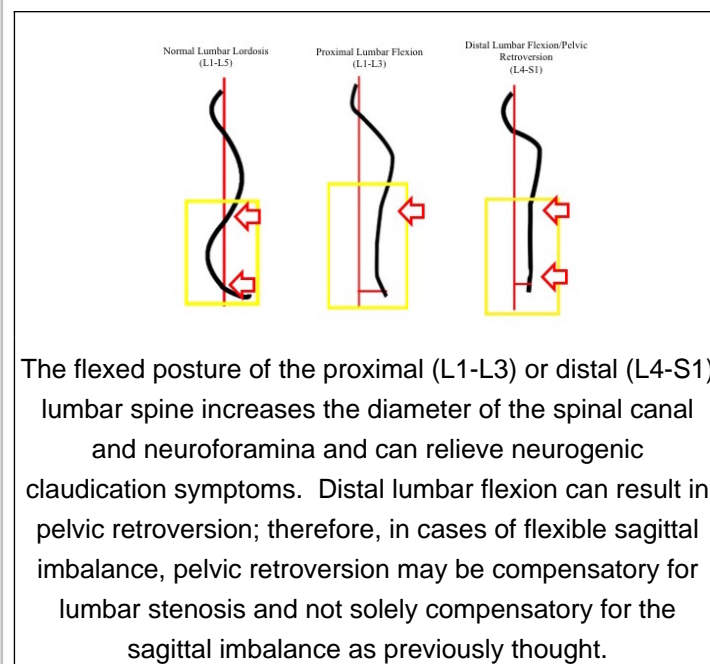
Patient with flexible sagittal imbalance: 6 cm C7 SVA and 30 PI-LL mismatch, with a 25 difference between LL on standing x-ray and supine MRI. Pelvic retroversion was 0.53. Pelvic incidence (a), pelvic tilt (b), and C7 SVA (d), were measured from standing x-rays. Pelvic retroversion (PT/PI) was increased in patients with lumbar stenosis as compared to those with no stenosis.

Methods

138 patients with sagittal imbalance, undergoing a total of 148 fusion procedures of the thoracolumbar spine were identified. Patient reported outcomes (PROs) were evaluated using the EQ-5D, Pain Disability Questionnaire, and Patient Health Questionnaire, preoperatively and at 12 months follow-up. Demographic, clinical, and radiographic parameters, including pelvic incidence, lumbar lordosis, pelvic tilt, and sagittal vertical axis were obtained from images preoperatively and at 6 and 24 months follow-up. Twenty-four patients with flexible sagittal imbalance were identified and individually matched with a control cohort with fixed deformities.

Results

Sixty-eight percent of the patients in the flexible cohort were diagnosed preoperatively with lumbar stenosis as compared to only 22% in the fixed cohort ($p=0.0032$). At 12 months, the flexible cohort exhibited pre- to postoperative improvement that was significant for the EQ-5D ($p = 0.0026$), PDQ ($p = 0.0048$), and PHQ-9 ($p= 0.018$). The fixed cohort showed no significant change in pre- to postoperative PROs at 12 months. There was no difference between the flexible and fixed cohorts with regard to the C2 ($p=0.95$) or C7 ($p=0.43$) SVA. The ratio of pelvic tilt to pelvic incidence was found to be significantly greater in the patients with stenosis ($p= 0.019$).



Patient Reported Outcomes*

Metric	Preoperative			12 month follow up		
	No.	Score	p Value [†]	No.	Score	p Value [†]
EQ-5D			0.7927			0.31
Flexible	20	0.441		20	0.658	0.0026 [‡]
Non-Flexible	18	0.461		17	0.58	0.1785
PDQ			0.5797			0.0392
Flexible	12	96.58		18	57.5	0.0048 [‡]
Non-Flexible	13	90.23		16	81.19	0.4354
PHQ-9			0.0459 [‡]			0.5169
Flexible	20	12.9		20	7	0.018 [‡]
Non-Flexible	18	8.28		18	8.61	0.8852

* Matched pair t-test was used to determine significance for postoperative values compared to preoperative values. Student t-test was used to determine significance for differences between flexible and non-flexible cohorts

[†] Difference between flexible and non-flexible cohorts
[‡] Pre- and postoperative PRO values within the cohorts
[§] $p \leq 0.05$.

Conclusions

Surgical treatment of lumbar stenosis in tandem with the treatment of sagittal imbalance was associated with favorable clinical outcomes. A portion of pelvic retroversion was found to be compensatory for lumbar stenosis for the flexible deformities.

Learning Objectives

- 1) Understand the underlying physiologic implications of pelvic retroversion in sagittal imbalance
- 2) Understand the utility of Pelvic Tilt in assessing for lumbar stenosis in sagittal imbalance

References

1. Panjabi, M. M. Clinical spinal instability and low back pain. *J Electromyogr Kinesiol* 13, 371–9 (2003).
2. Miyazaki, M. et al. Kinematic analysis of the relationship between sagittal alignment and disc degeneration in the cervical spine. *Spine* 33, E870–6 (2008).
3. Endo, K., Suzuki, H., Tanaka, H., Kang, Y. & Yamamoto, K. Sagittal spinal alignment in patients with lumbar disc herniation. *Eur Spine J* 19, 435–8 (2010).
4. Enomoto, M. et al. Increase in paravertebral muscle activity in lumbar kyphosis patients by surface electromyography compared with lumbar spinal canal stenosis patients and healthy volunteers. *J Spinal Disord Tech* 25, E167–73 (2012).
5. Lee, J. H. et al. Analysis of spinopelvic parameters in lumbar degenerative kyphosis: correlation with spinal stenosis and spondylolisthesis. *Spine* 35, E1386–91 (2010).