

# The Challenge of Creating Lordosis in High-Grade Dysplastic Spondylolisthesis



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## KEYWORDS

• High-grade spondylolisthesis • Dysplastic spondylolisthesis • Spondyloptosis • Sagittal balance

## KEY POINTS

- High-grade dysplastic spondylolisthesis (HGDS) is secondary to dysplastic lumbosacral morphology and frequently results in sagittal imbalance secondary to kyphosis of L5 relative to S1.
- Reduction at the time of fusion improves sagittal balance and decreases the rate of pseudarthrosis.
- As the lumbosacral kyphosis, rather than translation, drives the pelvis and spine into imbalance, the foremost focus in any reduction must be to restore lumbosacral lordosis.
- Most techniques for reduction achieve similar correction with similar complication rates.
- Recent literature demonstrates minimal difference in postoperative neurologic deficits in HGDS patients treated with reduction and fusion versus in situ fusion.

## INTRODUCTION

Dysplastic spondylolisthesis is a subset of L5-S1 spondylolisthesis that occurs because of dysplastic lumbosacral anatomy. Prior works have shown that more severe dysplasia is associated with higher grades of spondylolisthesis, with those slips greater than 50% (Meyerding grades III, IV, and V) classified as “high grade.”<sup>1</sup> Studies have shown that most patients with HGDS will develop pain and/or neural deficits over time if managed nonoperatively.<sup>2</sup> Surgical treatment of symptomatic high-grade spondylolisthesis is often appropriate to treat existing deformity and to prevent further progression of deformity. However, the optimal algorithm and technique remain controversial. The purpose of this article is to

review the modern understanding of HGDS with respect to its effect on spinal sagittal alignment, to detail several techniques for obtaining sagittal correction intraoperatively, and to evaluate current evidence regarding surgical complications.

## SAGITTAL ALIGNMENT IN HIGH-GRADE DYSPLASTIC SPONDYLOLISTHESIS

High-grade dysplastic spondylolisthesis (HGDS) results in significant deformity and compromise of the normal sagittal profile of the spine. Patients with HGDS have altered sacral and spinopelvic morphology with an increased pelvic incidence compared with the general population.<sup>3</sup> High-grade spondylolisthesis typically results in kyphosis of the L5 vertebra relative to S1. These

Disclosure Statement: No industry conflicts of interest. Dr D.W. Polly has been a clinical investigator in a clinical trial sponsored by SI-Bone, but has not received any financial remuneration. No funding was received for this work.

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Neurosurg Clin N Am 29 (2018) 375–387

<https://doi.org/10.1016/j.nec.2018.03.006>

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patients first compensate through increased intervertebral segmental lumbar lordosis (LL) leading to an overall increase in total LL. To further compensate for worsened focal L5-S1 kyphosis, increased LL is followed by increased pelvic retroversion, increasing the pelvic tilt (PT) while decreasing the sacral slope (SS). Once these 2 physiologic compensation mechanisms cannot adequately counteract the L5-S1 kyphosis, the patient acquires an overall positive sagittal imbalance, which is subsequently compensated for with hip flexion and knee flexion, caused by an extension block from hyperlordosis and a retroverted pelvis, leading to the Phalen-Dickson gait.<sup>4</sup>

Labelle and colleagues<sup>4</sup> in conjunction with the Spine Deformity Study Group developed a classification of L5-S1 spondylolisthesis, of which types 4, 5, and 6 reflect the overall pelvic and spinal balance of high-grade spondylolisthesis specifically (Fig. 1). Type 4 denotes an HGDS that is able to maintain a balanced pelvis; type 5 is a pelvis that has increased retroversion with maintenance of overall spinal sagittal alignment, and type 6 refers to an HGDS that has overcome the ability of LL and pelvic retroversion to adequately compensate, resulting in global spinal sagittal alignment.<sup>4</sup> The defining values of PT and SS demarcating a balanced or unbalanced pelvis were defined in a nomogram by Hresko and colleagues.<sup>5</sup> The spinal sagittal profile deteriorated from normalcy in the retroverted pelvic group, exhibiting greater L5 incidence, lumbosacral angle, length of LL, and less thoracic kyphosis than the balanced pelvic group.<sup>5</sup>

Harroud and colleagues<sup>6</sup> showed that worse global sagittal alignment parameters correlated with worse quality of life in nonoperatively managed HGDS patients, suggesting that global sagittal alignment should be critically evaluated in any HGDS patient. In addition, Blondel and colleagues<sup>7</sup> showed that the best health-related quality-of-life outcomes were achieved with near complete sagittal plane deformity correction, whereas patients with only modest correction achieved clinically insignificant improvement. Labelle classification types 5 and 6 represent

those patients who may merit more aggressive attempts at reduction during surgery, because they are the result of the patient's inability to adequately compensate for the HGDS. Therefore, in HGDS with an unbalanced pelvis (types 5 and 6), it is the authors' preferred technique to perform reduction to best accomplish these goals.

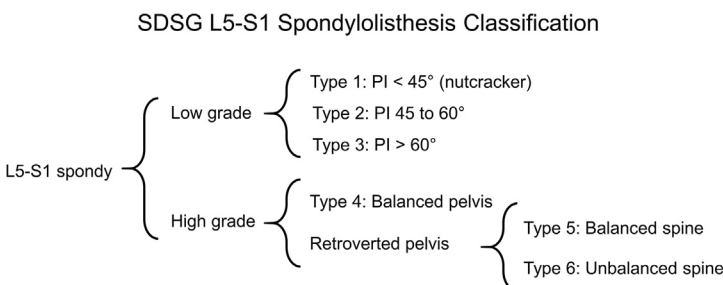
Before this modern understanding of the effect of the lumbosacral kyphosis on overall sagittal alignment, much of the emphasis during reduction was focused on reducing the translational slip grade. Because the lumbosacral kyphosis, rather than translation, drives the pelvis and spine into imbalance, the foremost focus in any reduction must be to restore lumbosacral lordosis.

## EVIDENCE FAVORING REDUCTION

Principal to the argument in favor of reduction is that the patient's sagittal parameters can be improved, as compared with an in situ fusion in which the sagittal malalignment is maintained. The authors' clinical experience has shown some patients with in situ fusions present decades later with severe global sagittal imbalance and pain, and subsequent surgical management is exceptionally challenging (Fig. 2). In addition, multiple studies have shown a lower rate of pseudarthrosis with reduction compared with in situ fusion. This finding was further borne out in a systematic review by Longo and colleagues,<sup>8</sup> who found a pseudarthrosis rate of 5.5% in HGDS patients treated with reduction, compared with 17.8% in those fused in situ. The explanation for this finding is that compared with an in situ fusion, a full or partial reduction of high-grade spondylolisthesis results in less shear at the lumbosacral junction and provides a better biomechanical environment for fusion.<sup>9</sup>

## SURGICAL REDUCTION TECHNIQUES

Multiple techniques have been described to aid in the reduction of HGDS. Most contemporary studies have used an interbody fusion, with many



**Fig. 1.** Classification of spondylolisthesis based on spinopelvic posture. PI, pelvic incidence. (From Labelle H, Mac-Thiong J-M, Roussouly P. Spinopelvic sagittal balance of spondylolisthesis: a review and classification. *Eur Spine J* 2011;20(S5):643; with permission.)

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