



## Spinal Arthrodesis with Acute Reduction in a High-grade Isthmic Type IIC Spondylolisthesis

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### ABSTRACT

The objective of this study was to present a case of Spondylolisthesis of the Isthmic Type (IIC), with Meyerding Grade III, high-grade dysplastic morphology, presenting with no neurologic deficits, which underwent spinal arthrodesis with acute reduction of L5-S1 segment. Spondylolisthesis itself is rare, presenting in 6% of the adult population with low back pain. Among these cases, 11.3% are characterized by high-grade spondylolisthesis, often accompanied by neurological deficits.

This study presents the case of a young adult woman (32 years old) with spondylolisthesis of the Isthmic Type (IIC - Acute Pars Fracture), Meyerding Grade III (slippage of >50%), presenting with no neurologic deficits. We present her outcomes after undergoing instrumented spinal arthrodesis with a reduction in terms of radiographic measurements, pain, presence of post-operative neurologic deficits, and return to work. Post-operatively, the lumbar lordosis angle improved from 84 degrees to 48 degrees. There was less pain, greater functional independence in terms of activities of daily living, and eventual return to work.

Even for high-grade spondylolisthesis, reduction of the affected level with instrumented fusion may provide excellent outcomes in terms of spinal alignment, pain, and return to work.

**Keywords.** pars fracture, high-grade, acute reduction, lumbar lordosis, spinal arthrodesis

### INTRODUCTION

Spondylolisthesis is the slippage of one vertebral segment over another in the anterior, posterior, or lateral direction.<sup>1</sup> It is a rare cause of low back pain in adults (6%), with most high-grade slips being of the isthmic type.<sup>2</sup> High-grade spondylolisthesis makes up 11.3% of adult cases with spondylolisthesis.<sup>3</sup> A literature search through PubMed reveals few reports about cases of young adults with neurologically intact high-grade isthmic spondylolisthesis (acute pars fracture) undergoing instrumented spinal arthrodesis with reduction. Most papers presented small case series of the isthmic or degenerative type, with high-grade spondylolisthesis presenting with neurologic deficits.<sup>2,4</sup> Spondylolisthesis is classified into the following types according to Wiltse (Figure 1).<sup>4</sup> The severity of the slip is also graded according to Meyerding (Figure 2).<sup>2</sup> This paper presents a case of a young adult woman (32 years old) with spondylolisthesis of the Isthmic Type (IIC: Acute Pars Fracture),<sup>4</sup> Meyerding Grade III (slippage of >50%),<sup>2</sup> presenting with no neurologic deficits, who underwent instrumented spinal arthrodesis with reduction.

Isthmic spondylolisthesis is more common in males and is most common at the L5-S1 level. Although there is a lower incidence in females, there is a higher risk for grade

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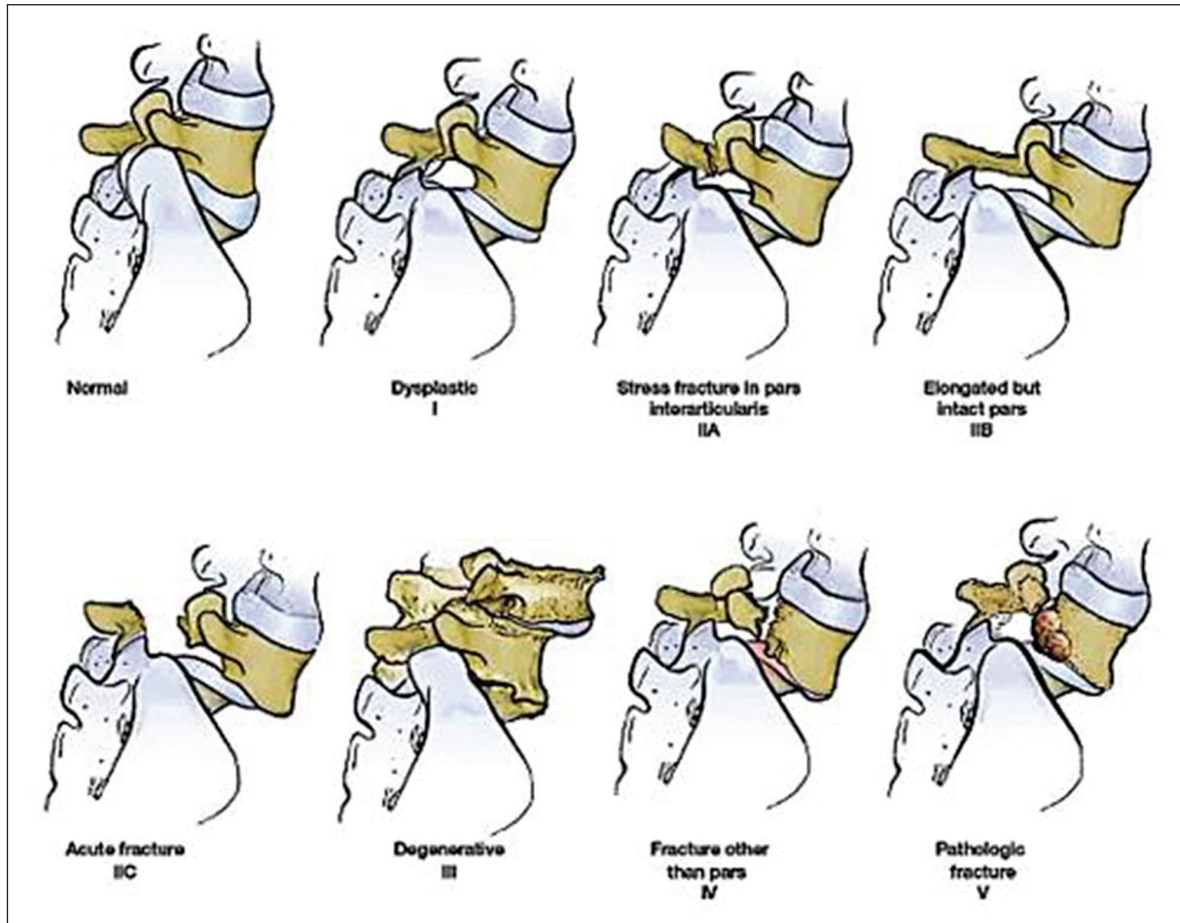
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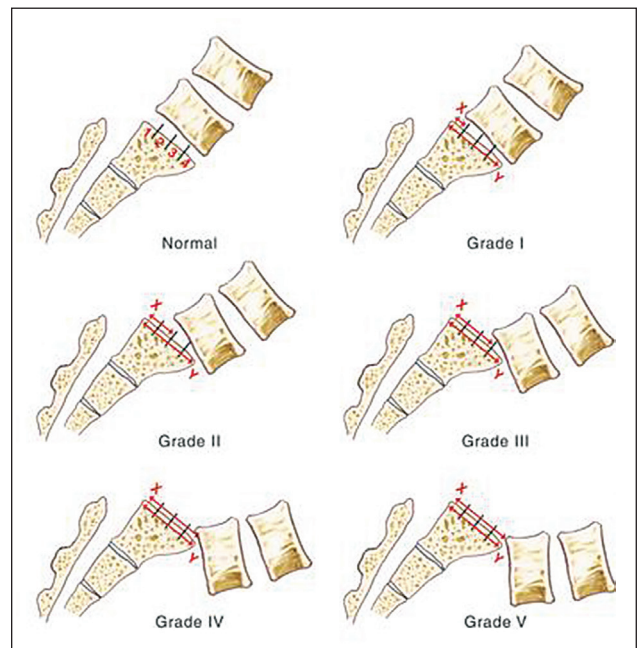


**Figure 1.** Meyerding classification for spondylolisthesis.

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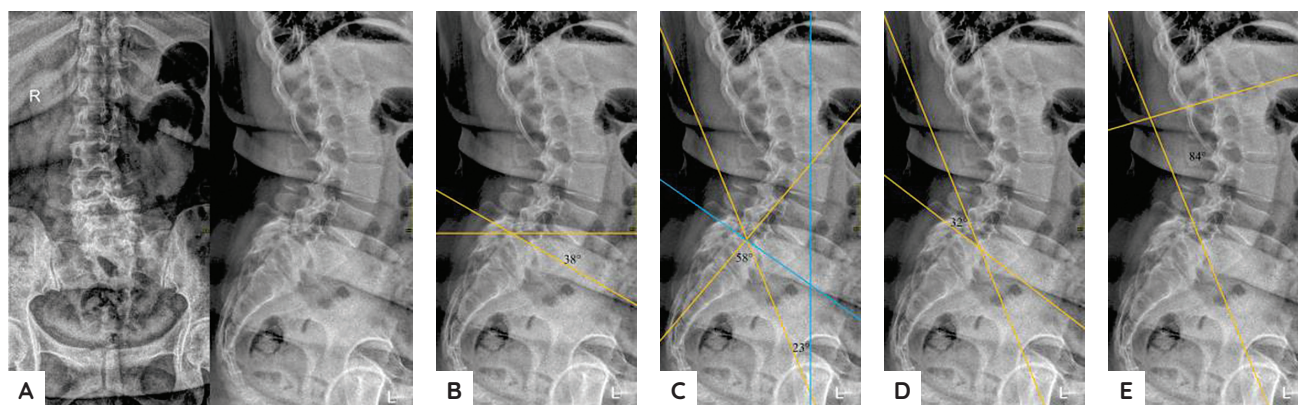
progression. Isthmic spondylolisthesis typically presents at five to seven years old. Adult isthmic spondylolisthesis is typically asymptomatic but may present with back pain, leg pain, numbness, paresthesia, or any combination thereof. The incidence of symptoms is related to grade – grade IV presents with low back in 55–91% and radicular symptoms in 44–55% of cases. Treatment options may include pharmacologic pain control, physical rehabilitation, and bracing. Should there be a failure of conservative management, severe leg or back pain, or evidence of instability or neurologic deficit, surgical treatment is advised.<sup>5-7</sup>

Whether or not surgical treatment is recommended would also depend on the morphology of the affected segment. In the low dysplastic type, the slip involves up to 50% of the anteroposterior distance of the endplate, the endplates of L5-S1 are parallel, and there is no kyphotisation of the lumbosacral junction. In the high-grade dysplastic type, there is a slip involving greater than 50% of the anteroposterior distance of the endplate, the L5 body has a trapezoidal shape with a concave inferior endplate, and there is doming of the superior sacrum. High-grade dysplastic spondylolisthesis has a high degree of progression – and thus is an indication for surgical treatment.<sup>8</sup>



**Figure 2.** Wiltse classification for spondylolisthesis.

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**Figure 3.** Showing lumbosacral AP-Lateral X-ray pre-operatively: anterior-posterior-lateral (A); sacral slope (B); pelvic incidence and pelvic tilt (C); slip angle (D); lumbar lordosis angle (E).

Controversy exists between in-situ arthrodesis, and reduction and arthrodesis. Proponents of reduction argue that with in-situ arthrodesis, there is a greater risk of decompensation and pseudoarthrosis (17.8% vs. 5.5%) due to the uncorrected positive sagittal balance. In contrast, proponents of in-situ arthrodesis argue that there is a higher risk of neural complications with reduction despite the evidence still being inconclusive.<sup>1,7</sup> It is hypothesized that the dural sleeve is stretched with reduction maneuvers, putting the upper roots in tension.<sup>5</sup>

The surgical indications seen in our patient were the following: high-grade spondylolisthesis, the trapezoidal body of L5, and rounding of the superior endplate of the sacrum, as demonstrated in the pre-operative radiographs.

**CASE**

Here, we present a case of a 32-year-old woman, a government office worker, who was injured last 2016, when she fell from standing height onto her buttocks. The radiographic examination determined that she had spondylolisthesis Grade 2. In September 2022, the patient experienced upper back pain, for which conservative management did not

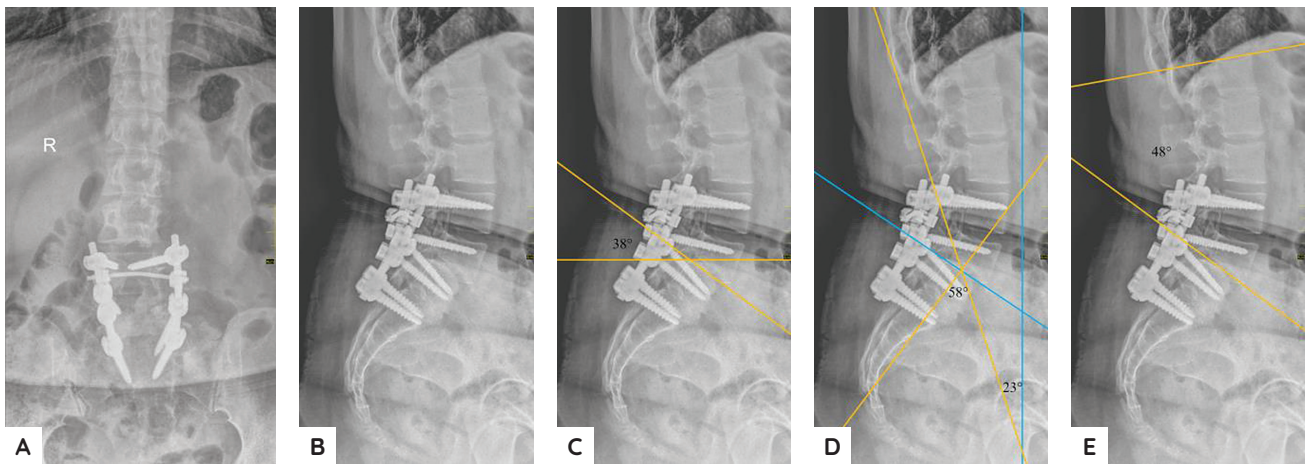
afford any relief. Intermittent and transient loss of muscle power and sensation over the left lower extremity was also a common occurrence. At the time of initial evaluation by an orthopedic surgeon, she did not exhibit any motor or sensory deficits, nor did she manifest with pathologic reflexes, or a positive straight leg raise test. Repeat radiographic examination revealed a Meyerding III, spondylolisthesis, L5-S1 level (Figure 3). Also seen on the radiograph were features of high-grade dysplastic spondylolisthesis, including a slip exceeding 50%, a trapezoidal-shaped L5 with a concave inferior endplate, and a doming shape of the superior endplate of S1. Additionally, magnetic resonance imaging demonstrated a spondylolisthesis of the isthmic type at the level of L5-S1, with moderate bilateral neural foraminal stenoses, worse on the left (Figure 4). Surgical management was then advised.

The operative technique proceeded as follows: the patient was placed prone on a Wilson frame with adequate padding. The hip joint was extended while the knees were flexed to avoid tension in the paralumbar muscles. An image intensifier was used to acquire anteroposterior and lateral X-ray views. From positioning alone, some reduction (one level) of the lumbosacral junction was achieved.

Dissection was carried out in the usual fashion. Intra-operatively, the surgeon noted a bilateral pars defect with a floating L5 lamina, with minimal motion at the L5-S1 segment. Pedicle screws were initially placed at L5 and S1 bilaterally. Laminectomy of L5 was performed, followed by discectomy and preparation of the disc space. The L5-S1 space was tight and could not initially accommodate the 8 mm disc shaver. A bilateral annulotomy was done to achieve release. Using a small Cobb elevator, a space was created for disc space preparation. After the disc space preparation, a bilateral facetectomy was performed. Motion was then appreciated at the L5-S1 segment. A trial of reduction was done; however, it was deemed necessary to extend the anchors superiorly to the L4 level and inferiorly to the S2 level to avoid screw pull-out and to ensure a good arthrodesis. The reduction was performed using translation. The rods were placed bilaterally at S1-S2. Using reduction screws placed at L4-L5, gentle



**Figure 4.** Plain magnetic resonance imaging pre-operatively.



**Figure 5.** Showing lumbosacral AP-lateral X-ray post-operatively: AP (A); lateral (B); sacral slope (C); pelvic incidence and pelvic tilt (D); lumbar lordosis angle (E).

translation was done, watching out carefully for screw pull-out. The L5 exiting roots were checked during and after the reduction. A two-level reduction was achieved. An interbody cage was not placed because it could not fit into the disc space. A local bone graft was used instead to allow interbody fusion. An onlay bone graft was also placed bilaterally (Figure 5). A satisfactory acute reduction was achieved intraoperatively – a two-grade reduction in the degree of slip, and a much-improved lordosis angle from 84 degrees to 48 degrees.

Post-operatively, the patient underwent physical rehabilitation composed of balance training, gait training, and muscle strengthening, while maintaining a chairback brace. There were no complications attributable to the index surgery. Regularly monthly radiographic examinations demonstrated the maintenance of the surgical reduction at the L5-S1 level, with no implant migration or failure (Figure 6). Although there was no loss in reduction after nine months post-surgery, the patient continued to wear a chairback brace as a precaution. The patient's compliance with rehabilitation facilitated an early return to independent function. Nine months postoperatively, the patient was already pain-free, fully independent in her activities of daily living, and had returned to work as a fully functioning member of the workforce.

## DISCUSSION

Reviewing the literature, our case demonstrated a two-grade improvement in the Meyerding classification as compared to Rivollier's case series, which showed a one-grade level improvement (Meyerding III).<sup>2</sup> They achieved a two-level improvement only at the Meyerding Grade IV level. No significant postoperative complications were seen.<sup>2</sup>

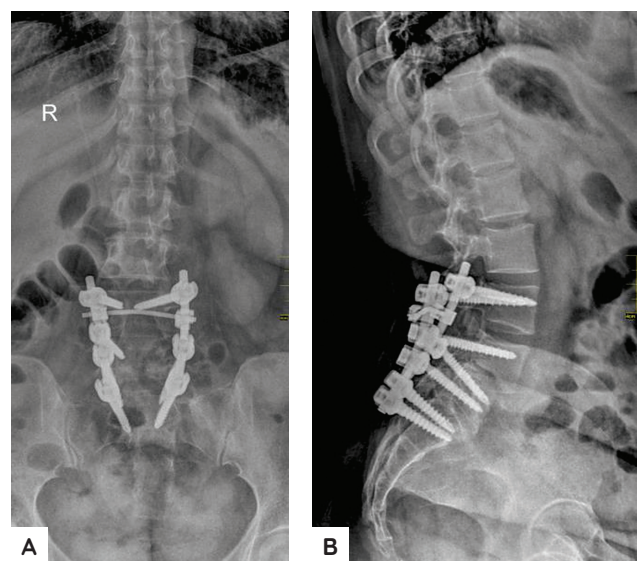
To date, regular patient re-evaluations reveal no loss of reduction and no early or late complications aligning with proponents advocating reduction before arthrodesis.<sup>1,9</sup>

In a paper by Barsotti et al., only one out of the 16 patients with high-grade spondylolisthesis who underwent an instrumented

spinal fusion with reduction had an L5 radiculopathy motor deficit at one-year follow-up, none at two-year follow-up.<sup>10</sup>

Overall, the surgery achieved what it was designated for: to lessen pain, improve functional independence, avoid neural complications,<sup>5</sup> lessen slip grade, and prevent the progression of the slip. In addition, the normal lumbar lordosis angle achieved would protect the posterior spinal ligament from excessive forces and would absorb vertically oriented loads. Excessive lumbar lordosis could cause postural and facet pain in our case due to the excessive compression forces at the apophyseal joints and anterior shear at the lumbosacral junction.<sup>11-17</sup>

Improving the spinal alignment and decreasing lumbosacral shear force would increase the chances of fusion. However, instrumented spinal arthrodesis with reduction is more technically demanding, requiring longer surgical times and increased blood loss. Our surgery lasted 9 hours and 45 minutes with an estimated blood loss of 1.2 L.<sup>10</sup>



**Figure 6.** Lumbosacral AP (A) and lateral X-ray (B) 8 months post-surgery.

Lian et al. randomized patients into reduced and in-situ groups, which showed no difference in terms of pain and functional outcomes. However, on closer scrutiny of this paper, the population consisted mostly of Grade I and II spondylolisthesis and a much smaller portion of Grade III.<sup>18</sup>

A meta-analysis by He et al. yielded 10 articles on isthmic, moderate, and serious spondylolisthesis. There was a significantly higher union rate, improvement in slippage, and shorter hospital stays in the reduction group.<sup>19</sup>

The strengths of this paper were that it presented an interesting case of a young adult with a neurologically intact high-grade spondylolisthesis who underwent acute reduction with posterior instrumented fusion and had no post-operative neurologic complications. This paper also had practical applications which could be reproducible in a similar case. The techniques employed were not novel.

The weaknesses noted in this paper are the lack of functional outcome measures done pre-operatively, immediately post-operatively, and in intervals post-operatively. We did not acquire a whole spine x-ray which would better show whole spine alignment.

## CONCLUSION

From the current literature, spinal arthrodesis with reduction in a high-grade spondylolisthesis is a viable option for surgical treatment. Although neurologic deficits (such as L5 radiculopathy) may occur post-operatively, the incidence is low, and the effects are transient. There is also the advantage of a higher union rate and improvement of slippage. As demonstrated in our case, there was a reduction of pain, a return to a full functional status, and no post-operative complications.

## ETHICAL CONSIDERATION

Patient consent form was obtained before manuscript submission.

## STATEMENT OF AUTHORSHIP

All authors certified fulfillment of ICMJE authorship criteria.

## AUTHORS DISCLOSURE

The authors declared no conflict of interest.

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