Pedicular lumbosacral spine fusion for adult/adolescent lumbar developmental high-grade spondylolisthesis

Mohamed Atef Elnokaly¹, Mohammed M. Adawi², Ahmed M. Nabeel²

¹Department of Neurosurgery, Faculty of Medicine, Helwan University, Cairo, Egypt. ²Department of Neurosurgery, Faculty of Medicine, Benha University, Benha, Al Qalubia, Egypt.

E-mail: *Mohamed Atef Elnokaly - mohamed_elnokaly@hotmail.com; Mohammed M. Adawi - moh.adawi@yahoo.com; Ahmed M. Nabeel - ahmed_m_nabeel@yahoo.com

INTRODUCTION

Lumbar spondylolisthesis is a common spinal problem and is presented in about 5% of the population. However, high-grade spondylolisthesis (HGS) according to the Meyerding grading [1] remains a relatively uncommon subtype. When it presents in the pediatric and adolescent age groups, HGS is typically attributed to progressive congenital (dysplastic) spondylolisthesis.

The following pathology characterizes congenital spondylolisthesis; L5 subluxation over the sacrum due to pars defects, hypoplastic L5 and S1 facets, and a “dooming” sacrum. In both adolescents and adults, the majority of HGS has been managed utilizing posterior in situ/noninstrumented lumbosacral arthrodesis which has often been...
linked to significant pseudoarthrosis rates and other complications.⁷ Here, alternatively, we present six cases of pediatric/adolescent L5–S1 HGS successfully managed with transpedicular screw fixation.¹¹

**MATERIALS AND METHODS**

We retrospectively reviewed six consecutive patients with HGS (2016–2020), averaging 19.5 years of age [Table 2]. All had low back pain, with bilateral sciatica; 2 additionally demonstrated neurogenic claudication. Notable, none had focal neurological deficits. Preoperative radiographs uniformly showed congenital (dysplastic) bony anomalies resulting in Grade IV spondylolisthesis (HGS) at L5–S1 [Table 2].

All six patients underwent transpedicular L3 or L4 to L5–S1 fusions without reduction of the slip. Relief of symptoms (subjectively) was recorded over the minimum follow-up period of 6 postoperative months. Outcomes were evaluated utilizing the visual analog score (VAS) for low back pain and Oswestry disability index (ODI). Further, postoperative radiological bone fusion was documented over a minimum of 6 months on CT scans/plain radiographs. [Figures 1-3].

**Surgical technique**

Standard L3 or L4 through S1 laminectomies were performed [Figure 1c], accompanied by bilateral exposure of the transverse processes. Under C-arm guidance, 6.5mm thick, and 55–65 mm long lumbar pedicular screws were inserted bilaterally from the S1 pedicle and directed anteromedially through the sacral promontory, crossing the L5–S1 disc space toward the vertebral body of L5 anteriorly, but stopping before its anterior cortex [Figure 1d]. Two pedicular screws were then inserted in either L3 or L4 bilaterally and connected to the sacral screws utilizing two rods; in five cases the fusion extended from L4–S1, while in one case, where the L4 facets were severely dysplastic, bilateral L3 screws were applied.

**RESULTS**

There were no major intraoperative complications (e.g., infections, hemorrhages or nerve injuries, and motor deficits), or long-term postoperative complications (e.g., instrumentation failure, slippage progression, or pseudoarthrosis) in these six patients [Figures 1-3]. However, one patient with L4 facet dysplasia underwent bilateral L3 rather than L4 proximal screws [Figure 1c]. The length of hospital stay ranged from 3 to 5 days [Table 3].

**Outcomes**

In 5 of 6 patients, radiculopathy improved on VAS and ODI scores (e.g., the latter went from 22 to 64%, mean 40.5% preoperatively, to 5-22% (mean 13.5%) postoperatively) [Table 4]. Only one patient had worsening low back pain postoperatively that gradually improved within 3 months. Fusions were successfully achieved in all six patients, as documented on postoperative lumbar CT scans.

**DISCUSSION**

Most patients with high-grade developmental spondylolistheses (HGS) develop significant slippage and symptoms during the adolescent growth period. Symptoms typically include; the onset of low back and sciatic pain that can evolve into a full-blown sciatic crisis.¹¹⁴

---

**Table 1: The Meyerding grading of spondylolisthesis according to percentage of anteroposterior slippage in the sagittal.**

| Grade | % Slippage |
|-------|------------|
| I     | <25        |
| II    | 25–50      |
| III   | 50–75      |
| IV    | 75–100     |
| V (spondyloptosis) | >100 |

**Table 2: Patient demographics and symptomatology and pathology breakdown.**

| Patient | Case 1 | Case 2 | Case 3 | Case 4 | Case 5 | Case 6 | Mean |
|---------|--------|--------|--------|--------|--------|--------|------|
| Gender  | Male   | Female | Female | Male   | Female | Female | Male |
| Age     | 17     | 22     | 16     | 18     | 25     | 14     | 19.5 |
| Occupation | Student | Housewife | Student | Student | Housewife | student | |
| Preoperative LBP | + | + | + | + | + | + |
| Sciatica | Bilateral | Bilateral/claudicating | Bilateral | Bilateral | Bilateral/claudicating | Bilateral | Bilateral |
| Neurological deficit | Deformity | Flexion | Flexion | None | None | Flexion | None |
| Type | Dysplastic | Dysplastic | Dysplastic | Dysplastic | Dysplastic | Dysplastic | Dysplastic |
| Grade | Grade IV | Grade IV | Grade IV | Grade IV | Grade IV | Grade IV | Grade IV |
| Level | L5–S1 | L5–S1 | L5–S1 | L5–S1 | L5–S1 | L5–S1 | L5–S1 |
Table 3: Follow data breakdown.

| Patient         | Case 1 | Case 2 | Case 3 | Case 4 | Case 5                  | Case 6 | Mean  |
|-----------------|--------|--------|--------|--------|-------------------------|--------|-------|
| FU duration     | Months | 56     | 29     | 41     | 34                      | 21     | 11    | 32    |
| Operative duration | Minutes | 150      | 210     | 150    | 180                    | 200    | 210   | 183.3 |
| Blood transfusion | No     | No     | No     | No     | yes                     |        | No    |       |
| Early complications | None   | L4 Difficult screw | None | None | Prolonged postoperative back pain | None | None |
| Late complications | None   | None   | None   | None   | None                    | None   | None  |       |
| fusion          | Fused   | Fused   | Fused  | Fused  | Fused                    |        | Fused |       |

Surgical techniques for HGS management have included posterior instrumented fusion, posterolateral interbody fusion, stand-alone oblique interbody fusion, anterior fusion, L5 vertebrectomy with reduction and fusion, and...
circumferential in situ fusion (either two-staged or single staged posterior approach). Here, we successfully utilized transpedicular fusion from L3 or L4 to L5-S1 in six patients with HGS. Safe penetration of the anterior sacral cortex with longer sacral screws for deeper penetration of the bone mass, increased their pull-out strength. Further, no patients developed further slippage following the procedures over an average follow-up period of 32 months.

We, therefore, concluded that the transpedicular instrumentation technique was more effective than the typical in situ/noninstrumented L5-S1 HGS fusion for HGS.\(^\text{[5]}\)

**CONCLUSION**

Transpedicular lumbosacral L3 or L4 to L5-S1 instrumented fusions for grade IV spondylolisthesis/HGS without reduction was successfully performed in six adolescent/young adults. This resulted in favorable outcomes and was a useful alternative to in situ/noninstrumented HGS lumbosacral fusions.

**Declaration of patient consent**

Patient’s consent not required as patients identity is not disclosed or compromised.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**REFERENCES**

1. Boachie-Adjei O, Do T, Rawlins BA. Partial lumbosacral kyphosis reduction, decompression, and posterior lumbosacral transfixation in high-grade isthmic spondylolisthesis: Clinical and radiographic results in six patients. Spine (Phila Pa 1976) 2002;27:E161-8.
2. Greenberg MS, editor. Spine and spinal cord In: Handbook of Neurosurgery. 8th ed. New York: Thieme Publishers; 2016. p.
3. Hart RA, Domes CM, Goodwin B, D’Amato CR, Yoo JU, Turker RJ, et al. High-grade spondylolisthesis treated using a modified Bohlman technique: Results among multiple surgeons. J Neurosurg Spine 2014;20:523-30.

4. Kotil K, Tunckaya T, Bilge T. Reduction of high-grade spondylolisthesis using a transvertebral surgical approach in a child. A case report and review of the literature. Turk Neurosurg 2006;6:4197-201.

5. Lehmer SM, Steffee AD, Gained RW Jr. Treatment of L5-S1 spondyloptosis by staged L5 resection with reduction and fusion of L4 onto S1 (Gaines procedure). Spine (Phila Pa 1976) 1994;19:1916-25.

6. Meyerding HW. Spondyloptosis. Surg Gynecol Obstet 1932;54:371-7.

7. Pizzutillo PD, Hummer CD. Nonoperative treatment for painful adolescent spondylolysis or spondylolisthesis. J Pediatr Orthop 1989;9:538-40.

How to cite this article: Elnokaly MA, Adawi MM, Nabeel AM. Pedicular lumbosacral spine fusion for adult/adolescent lumbar developmental high-grade spondylolisthesis. Surg Neurol Int 2020;11:416.