

Reduction of High-grade Spondylolisthesis Using a Transvertebral Surgical Approach in a Child. A Case Report and Review of the Literature.

ABSTRACT

OBJECTIVE: The English literature describes no pediatric cases of reduction of high-grade spondylolisthesis using the transvertebral surgical approach. We report a case of a high-grade spondylolisthesis in a child and provide a review. The aim of this study was to determine the efficacy of a specific reduction with the transvertebral surgical approach to treat patients with high-grade spondylolisthesis where there is loss of sagittal balance, intractable pain, and/or a neurological deficit.

METHODS: The patient was a 11-year-old girl who presented with recurrent back pain, urinary incontinence, and bilateral leg pain due to L5-S1 high-grade spondylolisthesis. The pre-and postoperative neurological status was evaluated and radiographic films were reviewed. **RESULTS:** She was treated by total L-5 laminectomy with foraminotomy and posterior fusion through the transvertebral approach. The lumbosacral dislocation was partially reduced. The percent slip and slip angle were measured pre- and postoperatively. The patient was doing well 16 months postoperatively with no further deterioration in neurological function and excellent fusion.

CONCLUSIONS: This procedure is technically easy and does not have the known risks of the surgical treatment of high-grade spondylolisthesis. The technique is a safe and effective single-stage procedure, and employs posterior instrumentation fundamentals as used by spinal surgeons. It is simpler to perform in high-grade slips than the other methods of lumbosacral stabilization.

KEY WORDS: Spondylolisthesis, Child, Posterior fusion.

INTRODUCTION

Surgical stabilization for symptomatic dysplastic or isthmic-lytic spondylolisthesis in pediatric age is controversial, but posterolateral fusion is a satisfactory and well-established method of treatment (1, 5, 7-11, 20-22). However, many possible approaches to surgical stabilization exist for high grade slips of grades 3 and greater. These approaches include posterolateral fusion, posterior instrumented fusion, anterior fusion, circumferential fusion from either a combined two-stage approach, or from a single-stage posterior approach. The treatment of high grade spondylolisthesis in adults or children is controversial. There are many suggested methods in the literature. Outcomes of the Gain procedure in the pediatric age group show that there is some neurological deficit that does not improve (12) . This surgical technique using reduction for high-degree spondylolisthesis in

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the pediatric age group has not been described before. This report documents this technique.

SURGICAL TECHNIQUE

Pedicular transvertebral screw fixation of the lumbosacral spine is performed after routine exposure of the posterior vertebral elements and transverse processes of L4 to the sacrum. After decompression, pedicle screws are inserted obliquely through the pedicles of S1 in anteromedial direction through the sacral promontory. Using fluoroscopic guidance, the pedicle screws are then directed across the L5-S1 intervertebral disc space and into the anterior aspect of the L5 vertebral body. The screws do not penetrate the anterior L5 vertebral body cortex. Two additional pedicle screws are placed on L4 and connected either by plates or by a rod system (figure 1A, B, C). Using a spondylolisthesis screw may help the reduction of high-grade slippage. The technique that we have used for reduction and stabilization is described below. The L-5 posterior arc, L-5 disc, and posterior longitudinal ligament must first be removed, followed by placing the sacral and L-5 pedicle screws. Finally last the reduction maneuver is performed in three steps: distraction, pulling back of the L-5 vertebral body, and compression after the

graft with or without placement in the intervertebral space. This distraction maneuver itself may allow partial correction of the forward slippage. We performed only a standard posterolateral intertransverse process fusion, and placed an autologous iliac or resected spinous process bone graft from L4 to the sacral ala.

CASE REPORT

An 11-year-old girl presented with back and bilateral leg pain and urinary incontinence which she had experienced for 2 years. There was no history of trauma Radiographic examinations, computed tomography (figure 2A) and lumbosacral magnetic resonance imaging (figür 2B) showed a grade 4 dysplastic spondylolisthesis of L5 on S1. Her perianal sensation was normal with no motor weakness. She subsequently underwent surgery which achieved stabilization by pedicular transvertebral screw fixation using pedicle screws and rods. No postoperative casts were used. A posterolateral fusion of L4 to sacrum using an autologous iliac crest bone graft was performed. No intraoperative or postoperative complications were observed. Postoperative X- rays showed subtotal reduction (figür 2C). Mean correction of the initial slipping was 79.5 +/- 7% of the initial deformity. Sagittal computed tomography studies showed

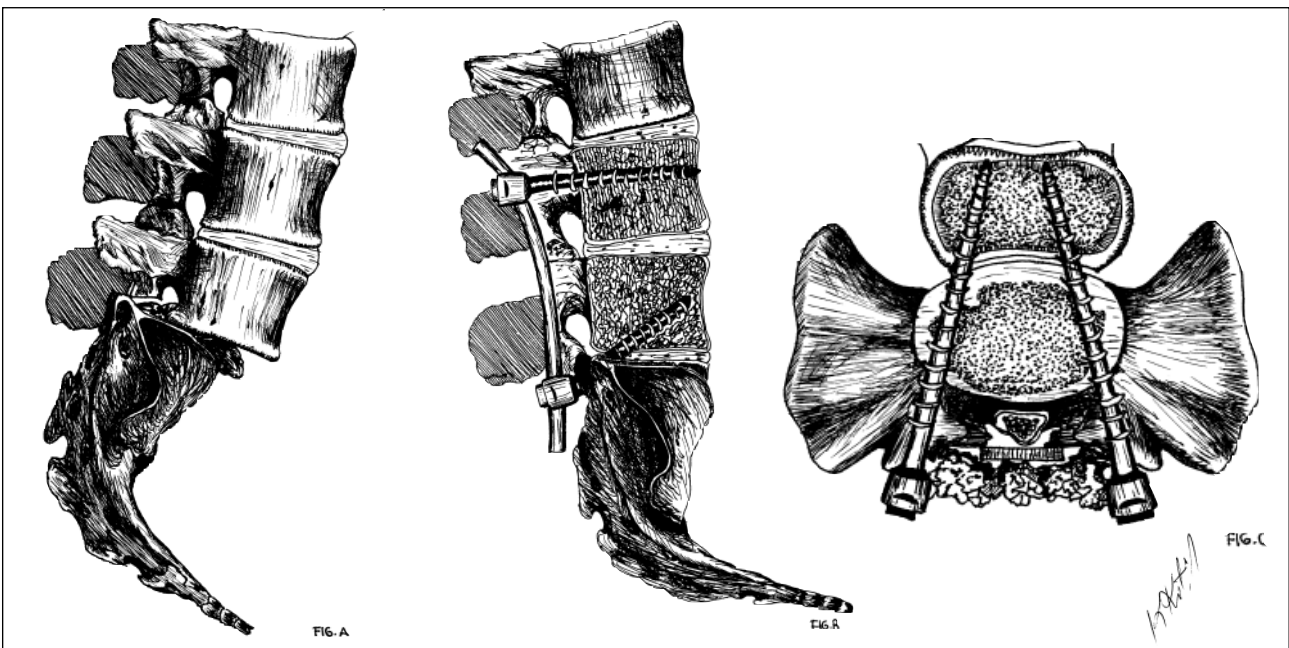


Figure 1: (A) Sagittal plane drawing; pedicular transvertebral screw fixation of the lumbosacral spine in high-grade spondylolisthesis is shown before reduction. The lumbosacral junction is mobilized by a pedicle screw placed from the S1 pedicle, across the L5-S1 intervertebral disc space, into the anterior-inferior aspect of the L5 body. (B) postoperatively, spine alignment was partially reduced. (C) Axial plane.



Figure 2: Preoperative sagittal computed tomography (A) and magnetic resonance imaging (B) of lumbar spine. High-grade (grade 4) spondylolisthesis is shown. (C) Postoperative sagittal direct radiography, (D) Postoperative sagittal computed tomography. The high-grade spondylolisthesis was partial reduced.

partial reduction (figür 2D) while the fusion was solid 16 months later as shown on radiographs (flexion-extension views) and tomography. However, the patient experiences mild low back pain and minor leg pain.

CONCLUSION

The etiology of high-grade spondylolisthesis is largely unknown, but may be of congenital (1-8). A morphologic defect in the cartilaginous portion of the neural arch and incompetence of the facet joints

at the olisthetic level have been implicated as the precursors of these deformities.

The clinical indications for surgical treatment of spondylolisthesis include pain, progressive deformity or slippage and neurological abnormality. Our patient presented with low back and bilateral leg pain, urinary incontinence, and lumbosacral posture deformity.

Stabilization of the lumbosacral spine in high-grade spondylolisthesis can be achieved using

multiple techniques (5-13). These techniques range from in situ posterolateral fusion to the use of posterior instrumentation. Anterior and posterior stabilization techniques are also popular and have been performed from the posterior approach as described by Smith and Bohlman (1), the anterior approach as reported by Jones et al (2), and the two-staged approach as reported by Bradford and Gotfried (3).

Partial reduction followed by posterior fusion is an effective technique for the management of high-grade spondylolisthesis in pediatric patients as assessed by radiographic and clinical criteria. Pedicle screw instrumentation with the sacral screws capturing L5 is recommended when this technique is used for the treatment of high-grade spondylolisthesis. According to the clinical and radiographic results from this study, partial reduction and posterior fusion with autograft supplemented with pedicle screw instrumentation is an effective technique for selected patients with high-grade spondylolisthesis at L5-S1 (18, 19, 23). The spinal deformity may induce abnormal compensatory postural changes, involving neurological deficits from stretching or compression of neural elements, and chronic pain. One of the central goals of spine surgery is to correct spinal deformity to alleviate all these symptoms. The quality of fusion construct is optimized when the deformity is corrected (23).

The pedicular transvertebral screw fixation technique uses the concepts of three-column fixation (9, 13-18), the sacral promontory and the anteromedially directed sacral screw placement providing a three-dimensional locking effect (10, 14). This triangular construct of screw-to-screw and screw-to-plate or rod provides superior fixation strength as it relies on the mass of bone between

hardware, rather than on the amount of bone purchased by screw threads alone. In addition, the purchase of the anterior cortex, rather than cancellous bone, increased the pull-out strength of pedicle screw fixation significantly (19). Severe spondylolisthesis can be treated by the reduction and pedicular fixation method, but we preferred a single-stage operation with the posterior approach in our patient. Both fixation and reduction (partial) was achieved by this approach. This procedure was first reported by Abdu et al (20). This study is the second clinical study and review (Table I). The posterior transvertebral approach has been used with good success and no serious complications (20).

Reduction of L-5 onto S-1 fusion is a treatment option (3, 6, 9, 20-22). However, such L-5 reduction procedures are associated with L-5 or S1 root deficit, and more serious complications of bowel, bladder, or sexual dysfunction, which can occur when L-5 is restored onto S1(13). This multiple nerve root lesion seems to be the result of the marked stretching of the cauda equina (7, 12). In the anterior approach, the anterior pelvic structures are placed at potential risk with anterior sacral screw purchase. There are no vital anterior anatomical structures in this surgical approach of screw fixation across the lumbosacral junction, as they are protected by the anteriorly displaced L5 vertebral body. Thus, the strength of this construct arises from the following: the triangular arrangement of the screw placement, the ability to safely purchase the anterior sacral cortex, and the use of longer screws for deeper purchase of bone through the anterior sacrum and into the L5 vertebral body. At the same time, the overall risk (20-22) of pedicle screw placement is diminished since only four screws are used for the L4 sacral fusion. There are no adverse biomechanical effects with the use of only four screws. Due to the placement and

Table I: Summary of operated cases of high-grade spondylolisthesis in patients undergoing transvertebral screw fixation.

| Case No | Author | Age/sex | Clinical findings | Radiological findings | Reduction | Outcome | Follow-up time |
|---------|--------------|---------|-------------------|-----------------------|-----------|-----------|----------------|
| 1 | W. Abdu | 33/M | BP, RD | Grade 3 | No | Excellent | 28 mo |
| 2 | W. Abdu | 63/F | BP, BRD | Grade 3 | No | Mild BP | 22 mo |
| 3 | W. Abdu | 55/M | BP, BRD | Grade 3 | No | Mild BP | 12 mo |
| 4 | Present case | 11/F | BP, BRD | Grade 4 | Yes | Excellent | 16 mo |

Abbreviations: BP; Back Pain, RD:Radiculopathy, BRD; Bilateral radiculopathy, mo; Month

direction of the lumbosacral screws, this technique is simpler to perform with high-grade slips, as compared with traditional fusion techniques using instrumentation.

Postoperative improvement and no limitation in daily activities were achieved. Improvements in pain, daily life, and cosmetic appearance were also achieved after a single stage reduction and fixation surgery. It may therefore be used for the successful treatment of this spine disorder. She had no postoperative motor deficit, incontinence of the bowel or bladder, or sexual dysfunction. No radiological or clinical deterioration was observed during the 16-month follow-up.

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