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Instrumented Reduction and Monosegmental Fusion for Meyerding Grade IV Developmental Spondylolisthesis

A Report of 3 Cases

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Abstract: There are numerous reports of treatment methods for spondylolisthesis with a Meyerding Grade of more than III. In high dysplastic spondylosthesis, surgical treatment was selected because there is considered to be a high possibility of low back pain and lower limb neurological symptoms worsening if slippage progresses.

Monosegmental lumbar interbody fusion (L5–S1) with a pedicle screw system (PPS) was used to treat three cases of Meyerding Grade IV developmental spondylolisthesis. Patients gave written informed consent.

The spondylolisthesis was reduced to Meyerding Grade I and sagittal balance improved in all three cases. In two cases with severe spinal instability, there were no postoperative neurological complications and the course was favorable. However, in one case with little spinal mobility due to vertebral body dysplasia, despite performing sufficient decompression of the nerve root at L5 and slow reduction to avoid placing excessive tension on the nerve root, a transient neurological disorder was observed.

A PPS was used to increase the reduction strength and favorable reduction was possible. However, in the case with a long clinical course and the case with poor spinal mobility, since the mobility and plasticity of the nerve root itself may have been reduced, it was considered that reduction should be performed carefully using intraoperative neurological monitoring.

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Abbreviations: CT = computed tomogram, JOA = scoreJapanese Orthopaedic Association Score for Low Back Pain, PEEK = polyetheretherketone, PPS = pedicle screw, PPS = pedicle screw system, SLR = Straight Leg Raising.

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INTRODUCTION

There are numerous reports of the appropriateness of reduction, fixation, and other surgical procedures when treating Meyerding Grade IV spondylolisthesis.[1–15] This is a report of three cases of Meyerding Grade IV developmental spondylolisthesis favorably treated with monosegmental lumbar interbody fusion using a pedicle screw system (PPS).

SURGICAL PROCEDURE

The surgical procedure selected was posterior lumbar interbody reduction and fusion at L5–S1. Intraoperative body posture was in the prone position with knees and hips extended. A longitudinal incision was made in the lumbosacral region and, after separating the paraventral muscle, pedicle screws (PS) were installed at L5 and S1 under fluoroscopy. A reduction screw was used at L5 and a PS was inserted bicortically at S1 as far as the anterior sacral promontory. The vertebral arch at L5 and ligamenta flava between L4/5–5/S1 were excised and the dura mater was exposed. Following the courses of bilateral nerve roots at L5, scar tissue at the isthmus region and osteolytic factors contributing to the compression were excised, and sufficient posterior decompression was performed from inside the spinal canal to the extraforaminal zone. Curettage was then performed in intervertebral disc spaces at L5–S1 and intervertebral height was slowly reestablished using a disc spreader. The PS at L5 was raised dorsally toward the rod fixed to the previously installed PS at S1 to slowly achieve reduction. The courses and tension of nerve roots at L5 were appropriately verified. After performing reduction as much as possible, an intervertebral spacer (polyetheretherketone [PEEK] cage) filled with local autogenous bone was installed. The operation was completed with compression between the PS at L5 and S1 with the aim of forming lordosis in the lumbosacral spine. Before closing the wound, it was verified that there was no compression on bilateral nerve roots at L5 and no excessive tension.

CASE REPORTS

Case 1: 15-Year-Old Male

At the age of 10 years, a local doctor detected spondylolisthesis with 26% slippage, and the ensuing course was observed. Slippage progressed and the patient became aware of marked low back pain during movement and pain at the back of the left leg. He visited our department aged 15 years.

Physical Findings

Straight Leg Raising (SLR) Test results were 50°/20°, bilaterally positive. No loss of muscle strength in either lower limb, or bladder and rectal disturbance, were observed. The Japanese Orthopaedic Association Score for Low Back Pain (JOA) was 16.

Image Findings

Seventy-eight percent slippage, slip angle of 46°, lumbosacral angle of 21°, and pelvic tilt of 24°. Separation and elongation of bilateral facet joints at L5, trapezoid-shaped L5 vertebral body, hypoplastic first sacral vertebra, spina bifida at L5–S1, and marked compression of the dural canal at L5–S1 were observed.

Intraoperative Findings

Extremely severe spinal instability, but favorable reduction in the prone position during surgery reduced slippage by 50%.

Postoperative Course

Improvement of slippage to 0%, slip angle to 14°, lumbosacral angle to 26°, and pelvic tilt to 19°. At the final follow-up (postoperative year 2), there was no correction loss and bone union had been obtained (Figure 1). The JOA score was 28.

Case 2: 14-Year-Old Female

The patient became aware of low back pain at the age of 14 years and visited our department.

Physical Findings

SLR test results were 50°/50°, bilaterally positive. No loss of muscle strength in either lower limb observed and the JOA score was 25.

Image Findings

Ninety-one percent slippage, slip angle of 77°, lumbosacral angle of 23°, and pelvic tilt of 27°. As in Case 1, the S1 vertebral body was dysplastic, but marked osteophyte formation at the posterior border of the L5 vertebral body was observed as well as marked compression of the dural canal at L5–S1.

Intraoperative Findings

Spinal mobility was poor and there was no large change in mobility even after curettage of intravertebral disc space. Reduction was performed with difficulty.

Postoperative Course

There was improvement of slippage to 23%, slip angle to 8°, lumbosacral angle to 34°, and pelvic tilt to 14°, but transient postoperative loss of strength in muscles in the region innervated by bilateral L5 and S1 nerve roots was observed. At the final follow-up (postoperative month 18), there was no correction loss and bone union had been obtained (Figure 2). Paralytic symptoms observed after surgery were ameliorated and the JOA score was 28.

Case 3: 14-Year-Old Female

The patient visited our department after becoming aware of low back pain and pain in bilateral thighs at the age of 13 years and experiencing difficulty standing and walking.

Physical Findings

SLR test results were 20°/30°, bilaterally positive. There was no lower limb motor deficit, but spinal mobility was limited. The JOA score was 21.

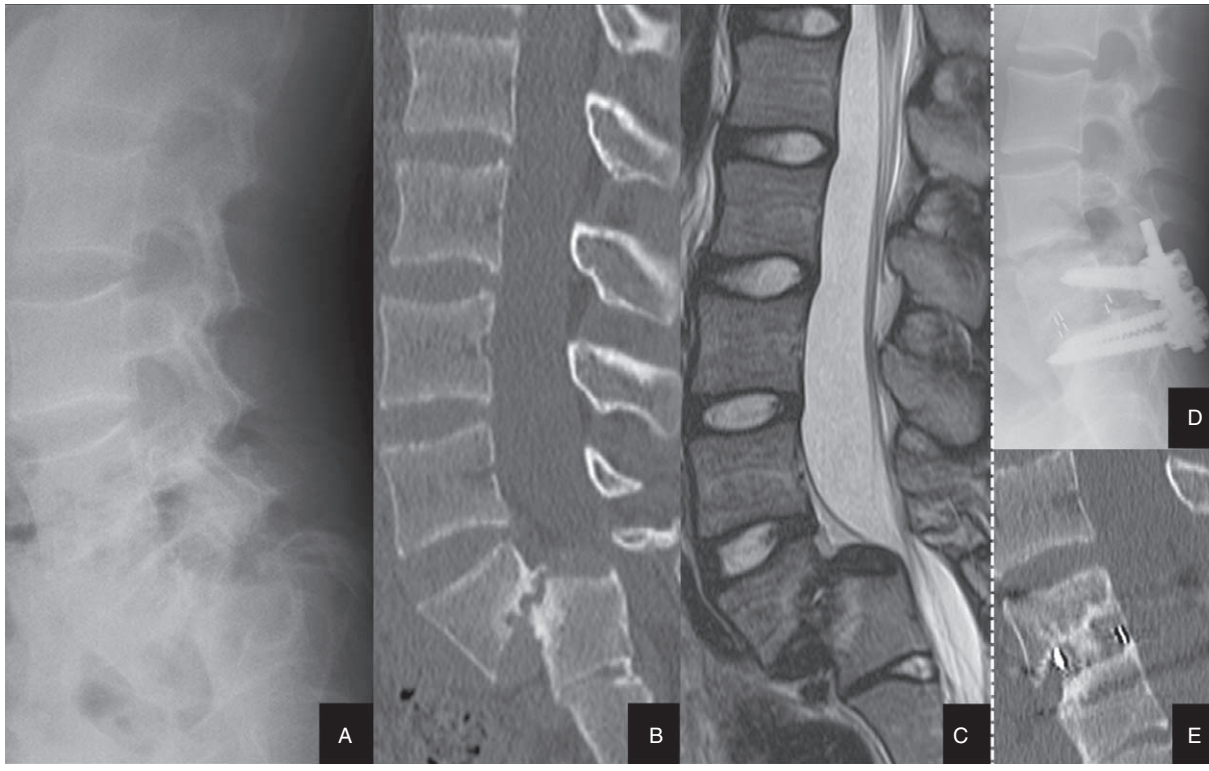

FIGURE 1. Case 1: Preoperative plain radiograph (A) and computed tomogram (CT) (B) images show bilateral separation and elongation of facet joints at L5. The L5 vertebral body was observed to be trapezoid-shaped and slippage was 78%. Marked spinal canal stenosis at the L5–S1 level was observed in a T2-weighted sagittal magnetic resonance image (C). Postoperative slippage improved to 0% (D) and CT at the final follow-up showed no correction loss with bone union obtained (E).

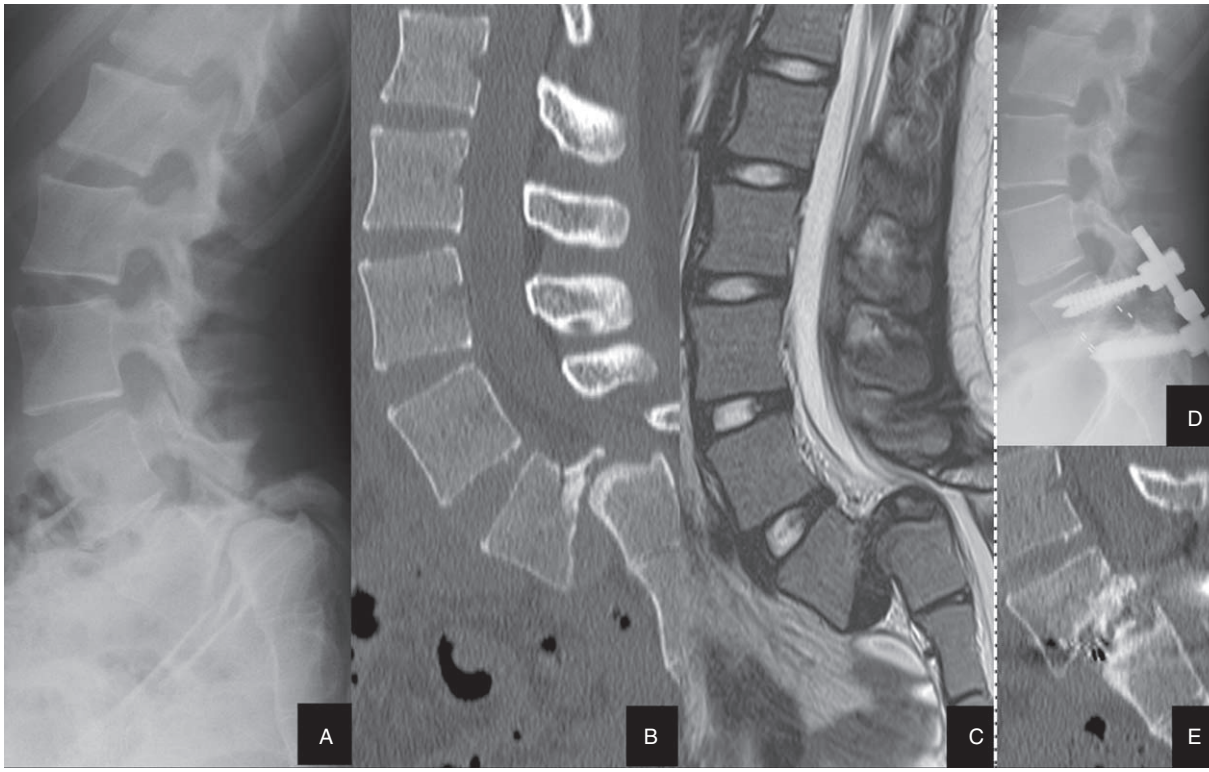

FIGURE 2. Case 2: Preoperative plain radiograph (A) and computed tomogram (CT) (B) images show bilateral separation and elongation of facet joints at L5. The L5 vertebral body was observed to be trapezoid-shaped and there was hypoplasia, with osteophyte formation at the posterior border of the L5 vertebral body and slippage of 91%. Marked spinal canal stenosis at the L5–S1 level was observed in a T2-weighted sagittal magnetic resonance image (C). Postoperative slippage improved to 23% (D) and CT at the final follow-up showed no correction loss with bone union obtained (E).

Image Findings

Eighty-two percent slippage, slip angle of 55°, lumbosacral angle of 26°, and pelvic tilt of 32°. Elongation of bilateral facet joints at L5, hypoplasia of L5, and marked compression of the dural canal at L5–S1 were observed.

Intraoperative Findings

As in Case 1, spinal instability was severe, and favorable reduction by positioning the body during surgery reduced slippage by 70%.

Postoperative Course

Improvement of slippage to 12%, slip angle to 21°, lumbosacral angle to 30°, and pelvic tilt to 30°. At postoperative month 6, there was no correction loss but, because the follow-up period was short, no bone union was observed (Figure 3). Clinical symptoms had improved and JOA score was 28.

DISCUSSION

Using the PPS improves reduction strength and stability, allowing a smaller area of fixation. We performed monosegmental lumbar interbody fusion to treat Meyerding Grade IV spondylolisthesis of the fifth lumbar vetebra. Favorable reduction and sagittal plane balance were obtained in all three cases and clinical symptoms had improved at the final follow-up.

There are numerous reports of treatment methods for spondylolisthesis with a Meyerding Grade of more than III.[1–14] The three cases here correspond to high dysplastic spondylosthesis with lysis or with elongation in the classification reported by Marchetti and Bartolozzi.[14] In such cases, surgical treatment was selected because there is considered to be a high possibility of low back pain and lower limb neurological symptoms worsening if slippage progresses.

Surgical procedures are broadly divided into in situ fixation and reduction and internal fixation. In situ fixation is less invasive than reduction and internal fixation and poses little risk of neurological complications. However, the possibility of postoperative lumbosacral scoliosis remains, as well as incomplete bone union and slippage progressing after bone union.[1–3] On the other hand, although improved sagittal plane balance and a higher rate of bone union can be expected with reduction and internal fixation, the procedure is very invasive and has been reported to result in nerve damage in 10% to 50% of cases, a comparatively high incidence.[1,4–13]

While Steffee and Sitkowski[4] reported useful reduction fusion using PPS at L4–S1, favorable outcomes were also reported with monosegmental reduction and fixation to treat severe spondylolisthesis.[5,6,9] We chose the same reduction and fixation procedure using the PPS to treat three cases. Postoperative alignment was favorable and sagittal plane balance was improved in all three cases.

It has also been reported that the risk of nerve damage is higher with reduction for dysplastic spondylolisthesis than with

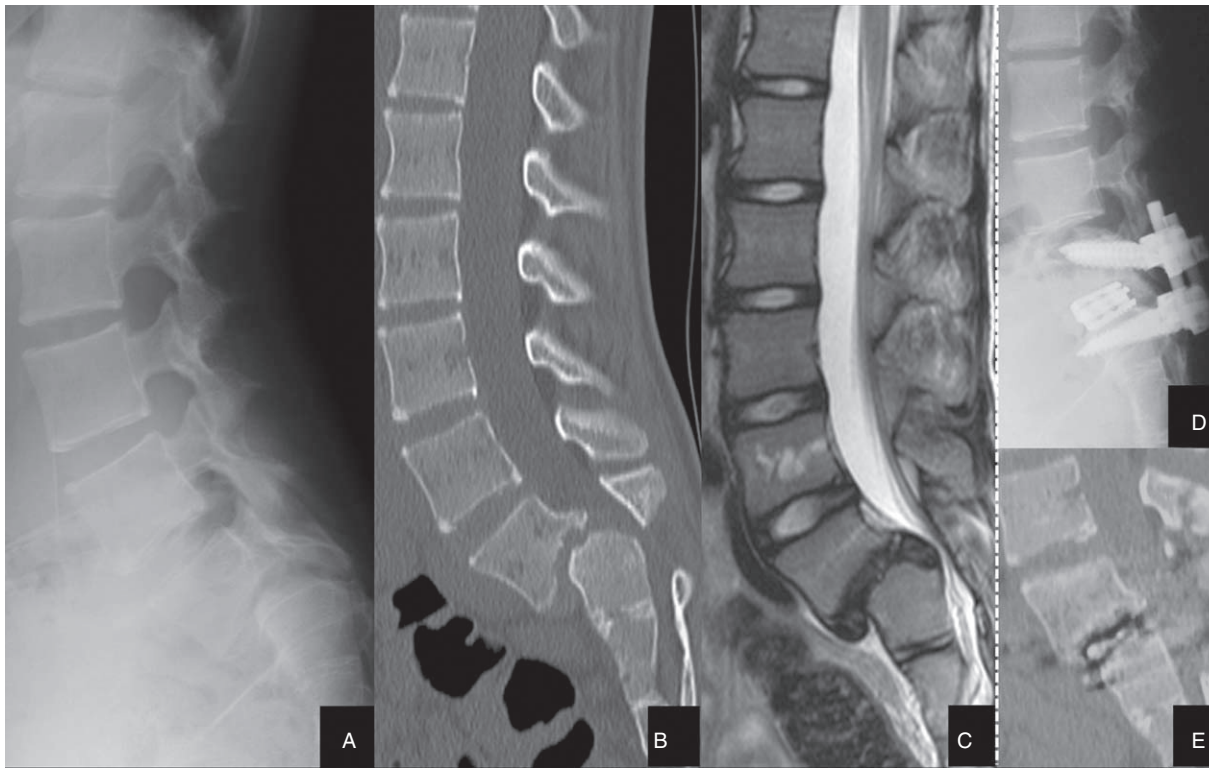

FIGURE 3. Case 3: Preoperative plain radiograph (A) and computed tomogram (B) images show bilateral elongation of facet joints at L5. There was S1 vertebral body hypoplasia with slippage of 82%. Marked spinal canal stenosis at the L5–S1 level was observed in a T2-weighted sagittal magnetic resonance image (C). Postoperative slippage improved to 12% and to date no correction loss has been observed (D and E).

reduction for acquired spondylolisthesis, and that, during the latter half of reduction, only partial reduction should be performed because of the high rate of elongation of L5 nerve roots.[13] The case with postoperative nerve damage had marked dysplasia, poor spinal mobility, and postoperative bilateral SLR was markedly limited. It was surmised that nerve root mobility and plasticity had decreased, resulting in excessive tension on the nerve roots.

The importance of evaluating the instability shown on flexion–extension radiographs was indicated by Lonstein.[15] However, clearly determining spinal mobility by evaluating preoperative flexion–extension radiographs taken in the standing position was difficult. With one of the cases, examining the patient in the prone position under general anesthesia enabled the degree of spinal instability to be clarified for the first time.

There is a report of performing reduction and fixation using intraoperative electorophysiological monitoring, such as transcranial electric motor-evoked potentials, to prevent nerve damage and of completing the procedure without postoperative nerve damage.[12] This kind of measure was considered to be necessary. We also believe that using findings from the monitoring is required to limit surgery to partial reduction.

CONCLUSION

This is a report of the surgical procedures required to treat three cases of Meyerding Grade IV spondylolisthesis. With monosegmental reduction and fixation using the PPS, favorable spinal alignment was obtained.

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