Spondyloptosis, or Grade V spondylolisthesis, is complete dislocation of the L-5 vertebral body on the sacrum anteriorly. Its optimal treatment is still controversial. In particular, choosing the optimal surgical technique is difficult in the osteoporotic elderly patient given the high incidence of instrumentation failure, pseudarthrosis, progressive slippage, and severe sagittal imbalance. The authors of this report used partial reduction and pedicular transvertebral screw fixation of the lumbosacral junction for the treatment of spondyloptosis in an osteoporotic elderly patient.

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Key Words • spondyloptosis • partial reduction • pedicular transvertebral screw fixation • degenerative disease

History and Examination. This 70-year-old woman was admitted with a 2-year history of low-back pain, bilateral leg pain, and intermittent urinary incontinence. On neurological examination, the straight leg raising test was positive at 45° on the left side and 60° on the right side. The anal sphincter tone was decreased. The patient also reported weakness of both feet and foot drop, correlated with weak anterior tibialis and extensor hallucis longus muscle groups. Motor strength was 2/5.

Dual-energy photon absorptiometry revealed severe osteoporosis (lumbar spine bone mineral density T-score –5.8). On standing lumbosacral radiographs, there was L5–S1 spondyloptosis and severe sagittal imbalance (Fig. 1). Lumbosacral CT sections showed bilateral discontinuity of the pars interarticularis, and CT sagittal reconstruction clearly showed the slippage (Fig. 2 left). On lumbosacral MR imaging examination, there was spinal
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canal stenosis at the L5–S1 level due to the slippage (Fig. 2 right).

We planned a 2-stage surgical technique including partial reduction, pedicular transvertebral screw fixation of the lumbosacral junction, and additional anterior lumbosacral fusion through the L-3 body to the L-5 body to correct the sagittal imbalance and prevent instrumentation failure, progressive slippage, and pseudarthrosis.

Operative Technique. Somatosensory evoked potential monitoring was performed from the beginning of the procedure until completion of the instrumentation.

Stage 1. After the satisfactory induction of general endotracheal anesthesia, the patient was positioned prone on a 4-poster frame, and all pressure points were well padded. The hips were placed into maximum extension to effect the initial positional reduction. Intraoperative radiographs were obtained after positioning to check the amount of reduction achieved. A standard posterior midline lumbosacral approach was used to expose the spine from L-2 to S-2. Decompression was performed by removing the loose arch of L-5 and the scar tissue that had formed around the area of the pars interarticularis. The L-5 nerve roots were completely decompressed bilaterally, aided by gentle distraction with a laminar spreader. Bilateral pedicle screws were inserted at L-2, -3, and -4, and iliac screw fixation was performed to correct sagittal imbalance (Medtronic/Sofamor Danek). This allowed access to the L5–S1 disc space, which was removed with rongeurs and disc shavers. The interbody spreader was placed, and the reduction maneuver was performed by lifting the L-5 body in a cranial posterior direction. Using image intensification and under direct visualization of the medial border of the S-1 pedicle via midline decompression, a guidewire (0.045-in Kirschner wire) was passed through the middle of the midaspect of the cephalad endplate of L-5, across the L-5 vertebral body and the L5–S1 disc space, docking into the S-1 body. In the S-1 vertebral body, the guidewire was passed 5 mm short of the posterior cortex to prevent inadvertent damage to the neural structures posteriorly. Then a cannulated drill was used over the guidewire. A drill sleeve was used during the procedure to avoid injury to the S-1 nerve root. We ensured that the drill hole was adequately tapped. A 6.0-mm-diameter half-threaded cannulated screw was passed into the track to stabilize and reduce the slippage between L-5 and S-1 by lag effect. A washer was used to prevent screw migration into the osteoporotic vertebral body. The same procedure was repeated on the other side to stabilize and reduce slippage between L-5 and S-1. Rods were prebent and connected to the screws with appropriately sized slotted connectors. After segmental instrumentation, autologous cancellous bone chips were placed for an interbody fusion between L-5 and S-1. Autologous bone graft for fusion was obtained from the spinous process and the laminae of L-5. Postoperatively, the patient was placed on bed rest.

Stage 2. Seven days later, the patient returned to the operating room for the second stage of the procedure. She was positioned supine. A left-sided paramedian, rectus-sparing retroperitoneal approach was performed by exposing the L3–4 and L4–5 discs, which were completely removed. A guidewire (0.045-in Kirschner wire) was passed through the middle of the midaspect of the cephalad endplate of L-5, across the L-5 vertebral body and the L5–S1 disc space, docking into the S-1 body. In the S-1 vertebral body, the guidewire was passed 5 mm short of the posterior cortex to prevent inadvertent damage to the neural structures posteriorly. Then a cannulated drill was used over the guidewire. A drill sleeve was used during the procedure to avoid injury to vital structures. Again, we ensured that the drill hole was adequately tapped. A 6.0-mm-diameter half-threaded cannulated screw was passed into the track to stabilize and reduce the slippage between L-5 and S-1 by lag effect. A washer was used to prevent screw migration into the osteoporotic vertebral body. Anterior lumbar interbody fusion with autologous iliac bone graft and a polyetheretherketone cage (Medtronic/Sofamor Danek) at L3–4/5 was performed to prevent fatigue failure of the implant due to the lack of an anterior mechanical buttress (Fig. 3). Autologous bone graft for fusion was obtained from the iliac crest.
Postoperative Course. After surgery the patient was braced in a thoracolumbosacral orthosis for a period of 3 months for comfort. At the 10-month follow-up, she had minimal back pain symptoms, did not require pain medication, had no urinary retention, and had recovered dorsiflexion of both ankles to 4/5. A CT scan revealed partial reduction and interbody fusion between L-5 and S-1 (Fig. 4 left). Radiography demonstrated improvement in sagittal balance, allowing the patient to stand fully upright (Fig. 4 right).

Discussion

Spondyloptosis can be a very debilitating condition for the patient and presents a great challenge to the treating spinal surgeon. Specifically, the surgical treatment of spondyloptosis in an osteoporotic elderly patient is very difficult because of a higher rate of comorbidities, vertebral fractures after instrumentation, pseudarthroses, and hardware failure due to poor fixation in osteoporotic bone.2

The goals of surgical treatment in symptomatic spondyloptosis is to relieve pain and the neurological deficit, to prevent the progression of deformity, and to provide long-term stabilization by solid fusion.2,4,5,15 Various techniques to treat spondyloptosis have been described, including isolated posterior in situ fusion, posterior decompression and posterolateral fusion without reduction, staged anteroposterior circumferential arthrodesis, anterior reduction combined with posterior stabilization, L-5 vertebrectomy with posterior stabilization from L-4 to the sacrum, posterior instrumented reduction, and decompression with posterior arthrodesis.2,3,6,8,10,15,18

Most authors agree that posterior in situ fusion techniques are safe and reliable for the treatment of spondyloptosis. However, these techniques are associated with a high incidence of instrumentation failure, progressive slippage, and pseudarthrosis in the osteoporotic elderly patient.2–4,12,15,20 To overcome the high risk of pseudarthrosis and progression associated with posterior in situ fusion in such patients, different techniques and novel instruments designed to increase purchase and reduce instrumentation failure have been proposed.6,17 These include anteroposterior circumferential arthrodesis; reduction of the slip angle; multiple-level fixation; differential screw angulation; blade-type implants; hollow screws for osseointegration; pullout-resistant nuts; variations in screw dimensions, diameter, and pitch; bicortical screw purchase; screw head locking mechanisms; iliac screws; hydroxyapatite-coated pedicle screws; expandable screws; and a cement-augmented screw as a means of increasing screw pullout strength.6,17 Anterior column support via an additional anterior approach or supplemental posterior interbody fusion is a crucial step in obtaining a solid arthrodesis.2,3

Reduction of a high-grade spondylolisthesis allows direct neural decompression by reducing canal and foraminal stenosis, correction of the lumbosacral kyphosis, and improvement of the fusion rate by decreasing the tension on the fusion mass. But the rate of neurological complication with reduction has been reported to be as high as 20%–31%.2,21 In an anatomical evaluation of the L-5 nerve root, Petraco et al.16 noted that 71% of the strain occurred during the second half of the reduction. On av-
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erage, the mean nerve strain was 4% during the first half of the reduction, which increased to 10% during the remaining half of spondylolisthetic manipulation. In addition to nerve root damage, stretching of the cauda equina after reduction has also been reported. Based on these anatomical findings, partial reduction of the high-grade spondylolisthesis was recommended.

According to these previous studies, interbody fusion not only improves the fusion rate but also appears to provide the best long-term results, and full reduction may cause neurological deficits due to compression of the roots during distraction and reduction maneuvers. Therefore, partial reduction and interbody fusion is currently recommended for high-grade spondylolisthesis. The combination of partial reduction, pedicular transvertebral cannulated screw fixation of the lumbosacral junction, and additional anterior lumbar interbody fusion through the L-3 body to the L-5 body is a safe and reliable option in an osteoporotic elderly patient.

By using strong and durable posterior segmental instrumentation supplemented by multiple-level conventional pedicle screw fixation, iliac screw fixation, and cannulated screw fixation from S-1 through the disc and lumbosacral junction into the vertebral body of L-5, we were able to provide the 3-column support necessary to ensure a solid fusion mass without the need for postoperative spica cast treatment. And by using partial reduction to decrease neurological complications, we were able to safely restore sagittal alignment. The slipped vertebral segments were healed in the patient, with no evidence of deterioration in the results over the intermediate follow-up period.

The 2-stage procedure of partial reduction, pedicular transvertebral screw fixation of the lumbosacral junction, and additional anterior lumbar interbody fusion through the L-3 body to the L-5 body provides a solid arthrodesis without neurological injury progression of the deformity as well as improvements in global sagittal balance and cosmetic appearance.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: all authors. Drafting the article: Seo. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Seo. Study supervision: all authors.

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