INTRODUCTION

Post-traumatic spinal deformity most often presents after major trauma resulting in spinal column fractures, however, it can also present after minor trauma in patients in whom bone quality is diminished such as osteoporosis, ankylosing spondylitis, osteogenesis imperfecta, and other endocrine or genetic disorder. The most common late complaints include deformity in the sagittal and/or coronal plan, increasing pain, or an increasing neurologic deficit. The most common post-traumatic spinal deformity is kyphosis, which typically occurs in the thoracic and thoracolumbar regions of the spine. In some patients, significant kyphosis can be functionally limiting and associated with severe chronic pain despite the absence of neurological involvement. Frequently used surgical treatment options in these patients are lengthening the anterior elements, shortening the posterior elements, or a combination of the two. We reported a case of late posttraumatic thoracolumbar kyphosis which was treated by modified pedicle subtraction osteotomy (PSO) with posterior interbody fusion in one stage.

CASE REPORT

Patient introduction
A 57-year-old woman presented with back pain, pain in both buttocks, and leg pain on the left side which had persisted for 2 years. The pain aggravated when she stood up and forward bending posture. She also had progressive kyphotic posture which started 10 years ago and aggravation 1 year ago. In her past history, she had slipped down 10 years ago. If she walked for 10 minutes, her back was bended forward and back pain developed. She underwent many kinds of conservative therapy, however, her symptoms were not improved. On image studies, she had T12 compression fracture, 34 degree of local rigid kyphosis between T11 and L1, and ossified ligamentum flavum at T10-11 level. We performed posterior lumbar interbody fusion at T11-12 level, modified pedicle subtraction osteotomy at T12 level, posterior pedicle screw fixation at T11 and L1 level with kyphosis correction, and bilateral partial hemilaminectomies at T10-11 level. Postoperatively, the local kyphosis between T11 and L1 was corrected to 0 degree. Patient’s symptoms improved.

Key Words: Modified pedicle subtraction osteotomy ・ Post-traumatic kyphosis ・ Sacroiliac joint block ・ Thoracolumbar kyphosis.
posterior interbody fusion at T11-12 level. We did bilateral subtotal laminectomies and facetetctomies at T11-12 level and excision of upper half of T12 pedicle with posterior half of body (Fig. 3). After then, posterior wall was removed using reverse angle curette. Posterior interbody fusion with cage filled with allograft was performed at T11-12 level. Posterior pedicle screw fixation at T11 and L1 level and kyphosis correction with table extension were done. Bilateral hemipartial laminectomies and OLF removal at T10-11 level was performed. Intraoperative blood loss was estimated 740 cc and the operative time was 4 hours. Postoperative-

ly, the preoperative local kyphosis between T11 to L1 was corrected to 0 degree and previous TL junction kyphosis was corrected to 8 degree of kyphosis (Fig. 4). Patient’s symptoms improved and discharged after 2 weeks of operation. Plain radiography after 3 months of operation showed well preserving state of correction and patient’s symptoms disappeared.

**DISCUSSION**

There are several forms of surgery to correct posttraumatic kyphosis. Conceptually, the procedure must produce lor-
dosis. This can be achieved by lengthening the anterior elements, shortening the posterior elements, or a combination of these two.\(^2\)

Stiff or inflexible posttraumatic kyphosis is more difficult to correct and often requires osteotomy. Surgical approaches include a combined anterior/posterior approach or an all posterior approach with an osteotomy. The most commonly used osteotomies are Smith-Petersen osteotomies (SPO) and PSO.\(^1\)

The potential of a SPO to restore a lordotic TL junction is limited. One millimeter of resection will equate to approximately 1° of lordosis once the osteotomy is closed.\(^3\) It can achieve lordosis as much as 10° at each level.\(^4\) In comparison, the PSO can be a powerful tool to achieve lordotic realignment of TL junction. It can achieve lordosis of approximately 24° to 29.5° at each lower thoracic level.\(^5\)

The PSO has also been utilized for sagittal plane deformities associated with ankylosing spondylitis, degenerative deformities, idiopathic scoliosis, post-surgical iatrogenic flat-back syndrome, and post-traumatic kyphosis.\(^7\) Interestingly, the PSO procedure was developed as a method of accessing and debriding an infected vertebral body via an all posterior approach.\(^2\) Since 1949, the procedure has been adapted and modified for the treatment of spinal deformities, and these changes have been facilitated by the development of rigid internal spinal fixation.\(^2\)

In addition to the PSO for achieving sagittal deformity correction, the surgeon must provide adequate support to the anterior column and sufficient instrumentation posteriorly to support the correction until a solid fusion occurs.\(^3\) If there is not anterior support, excessive tensile force can be placed on the posterior instrumentation. In such situations, loss of fixation, implant failure, loss of correction, and pseudarthrosis often result.\(^5\)

Anterior interbody support not only assists in load sharing to improve the fusion rate, but also aids in the restoration of lordosis close to the normal sagittal contour.\(^3\) The total number of instrumented levels can be minimized through anterior support. Interbody placement can be achieved by using the more traditional anterior approach or through a posterior transforaminal or posterior interbody fusion approach.

Thoracic PSO is performed at the level of the spinal cord. This limits the amount of safe posterior osteotomy and posterior closure that can be performed without excessive dural kinking which may result in spinal cord dysfunction or injury. 20 to 25 mm of posterior laminar closure in a thoracic PSO can be tolerated without adverse neurologic consequence.\(^3\) This extent of posterior osteotomy closure is notably less than that of a typical lumbar PSO.

We performed T12 modified PSO which excised upper half of T12 pedicle with posterior half of body and posterior interbody fusion at T11 to 12 levels. As we performed the posterior interbody fusion at T11 to T12 levels, anterior column support and lengthening were achieved. Through the

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**Fig. 4.** Postoperative whole spine plain radiography showed well correction of T12 local kyphosis.
modified PSO and anterior support, the spinal cord can be safed and the kyphosis correction can be achieved effectively. The preoperative kyphosis was corrected mainly by posterior column shortening by modified PSO, however, anterior support also contribute to the kyphosis correction. In addition, despite of performing PSO, short posterior instrumentation had been possible due to anterior interbody support. The TL junction was corrected to 0 degree postoperatively. After 3 month of operation, the patient’s TL junction was hold to 0 degree.

CONCLUSIONS

In posttraumatic kyphosis correction, the lordosis can be achieved by PSO with anterior column support. Especially, in case of thoracic spine, the correction degree using PSO has limitation because it is performed at the cord level and it can be cause cord compression and neurologic complications. In our case, the modified PSO with posterior interbody fusion provides excellent kyphosis correction and allows short segment fusion.

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• Conflicts of Interest
The authors report no conflict of interest. The authors alone are responsible for the content and writing of this paper.

REFERENCES