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Pedicle-sparing transforaminal thoracic spine wedge osteotomy for kyphosis correction

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Abstract

Background: Correction of a focal kyphotic deformity at times requires performing a pedicle subtraction osteotomy, which is accompanied by loss of pedicles as anchor points at the affected level in addition to significant blood loss. To help alleviate these two issues, a novel osteotomy technique for correction of kyphosis using a transforaminal approach to the thoracic vertebral body is described.

Methods: We describe a bilateral pedicle-sparing approach and demonstrate it in a patient with proximal junctional kyphosis.

Results: The proposed osteotomy resulted in a 28-degree Cobb angle improvement in the sagittal plane.

Conclusion: The operation resulted in a similar degree of correction as a pedicle subtraction osteotomy, with the added benefit of maintaining the pedicles closest to the kyphotic deformity.

Key Words: Proximal junctional kyphosis, scoliosis, spine osteotomy, sagittal balance, spine surgery, thoracic spine deformity

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INTRODUCTION

Correction of focal kyphosis in certain situations requires performing an osteotomy. Traditional osteotomies include Smith–Petersen osteotomy (SPO), which gives 10 degrees of correction per level;[5] pedicle subtraction osteotomy (PSO), which is estimated to correct deformities approximately 15–20 degrees per level in the thoracic spine;[4] and vertebral column resection (VCR), which is very effective for producing the largest degrees of correction.

As is evident from the classic osteotomies described, if a correction at a fixed focal kyphotic deformity of greater than 10 degrees is needed, a PSO or a VCR is the best surgical option. However, this requires removal of pedicles at the level of the osteotomy, causing increased blood loss and loss of anchor points for fixation. To address these two issues and still correct sagittal deformities with the same efficacy as a PSO, we describe a method for performing a thoracic wedge osteotomy via a transforaminal approach that spares the pedicles.

Illustrative case

A 45-year-old female, 4 months postoperatively after undergoing a T10-ilium fusion, presented with scoliosis X-rays showing proximal junctional kyphosis at the top of her construct and associated progressive loss of vertebral body height at T10 [Figure 1]. She had 4.2 cm of positive sagittal balance and a 35-degree Cobb angle in the sagittal plane. Thoracolumbar computed tomography (CT) scan was performed and concurred with X-ray findings, which showed hardware failure and proximal junctional kyphosis

at T10 [Figure 2]. The patient was offered surgery to correct the new deformity, prevent further kyphosis at that level, and re-establish neutral sagittal balance.

Description of the technique

The patient was taken to the operating room where she was placed in a prone position. Her previous incision was reopened and the T5-T11 levels were exposed. Thoracic pedicle screws were placed from T5 to T9 bilaterally with the exception of T7 on the right, where a transverse process hook was placed instead. The T10 screws were replaced bilaterally. Vertebroplasty material (polymethylmethacrylate) was placed bilaterally at T5, T6, and T10 prior to screw placement at those levels. Attention was then turned to performing the transforaminal osteotomy at the area of focal kyphosis at T10.

Bilateral T10-11 facetectomies were completed to give a corridor to the T10 vertebral body via a transforaminal approach to perform the osteotomy. The bilateral T10 nerve roots were ligated and sacrificed. A wedge osteotomy was performed through this corridor in a fashion similar to a PSO [Figure 3]. A new rod was placed and was attached to the previous inferior rod. Adequate kyphosis correction was achieved intraoperatively [Figure 4].

Postoperative course

The patient tolerated the procedure well with no new deficits. Postoperative scoliosis films demonstrated neutral sagittal balance and a 7-degree Cobb angle in the sagittal plane [Figure 5]. This neutral sagittal balance was maintained on her scoliosis films 9 months postoperatively [Figure 6]. The patient denied any back pain at that time.

DISCUSSION

Even though very efficient in correcting deformities, PSO and VCR do have their limitations. First, resecting the pedicles is required in these methods, causing the surgeon to

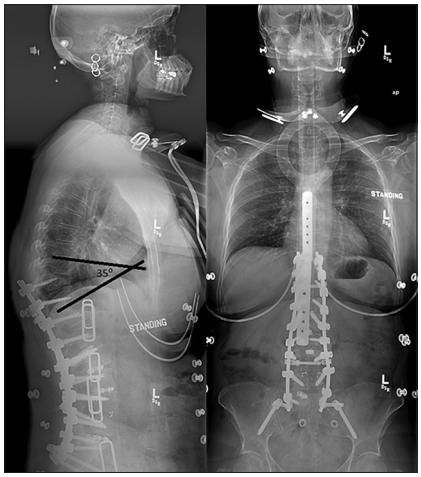

Figure 1: Preoperative sagittal (left) and coronal (right) scoliosis X-rays showing proximal junctional kyphosis and hardware failure

Figure 2: Preoperative thoracolumbar CT demonstrating hardware failure and loss of vertebral disk height at T10

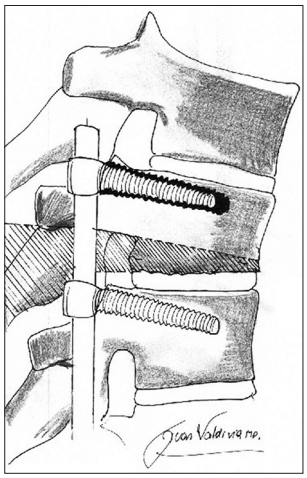

Figure 3: Diagram showing kyphotic deformity, haloing of screw, and planned osteotomy

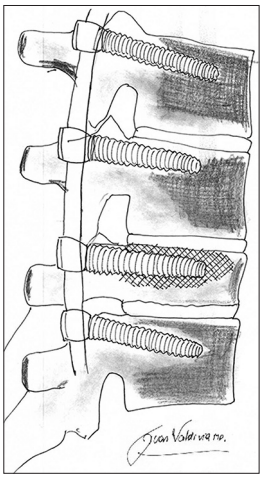

Figure 4: Sketch showing reduction of kyphosis with supplementation of pedicle screw utilizing vertebroplasty cement

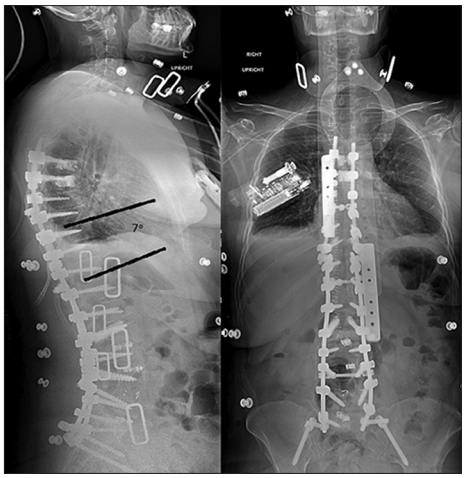

Figure 5: Postoperative sagittal (left) and coronal (right) scoliosis X-rays showing adequate correction of Cobb angle in the sagittal plane and neutral sagittal balance

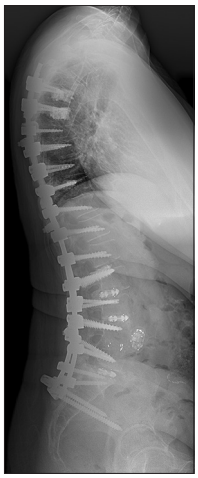

Figure 6: Sagittal scoliosis X-ray taken 9 months postoperatively indicating neutral sagittal balance is being maintained

lose them as anchor points for pedicle screw fixation to the construct, thus decreasing its strength. Moreover, entering the pedicular cancellous bone early in the osteotomy can lead to profound blood loss, which may prohibit continuation of the operation in a minority of cases.[1,6]

To combat these issues, we describe a transforaminal, pedicle-sparing approach that resulted in a 28-degree change in Cobb angle in the sagittal plane. The benefits of this procedure include ability to maintain two points of fixation in close proximity to the site of the osteotomy, thereby strengthening the construct and decreasing blood loss by keeping the pedicles intact. However, there are limitations to this operation. First, this operation is likely only useful in the thoracic spine. Because the pedicle is not resected, the neural foramen can become stenotic enough to cause radicular symptoms. In the thoracic spine, the nerve roots can by ligated and sacrificed to alleviate that problem, as was performed in our case. This action obviously cannot be performed in the lumbar spine. Second, even though predicted to decrease operative blood loss, more data are needed to strengthen this claim. Third, more patients with longer follow-up periods are needed to determine whether the rate of successful fusion is similar to the more traditional methods.

Nonetheless, there is substantial evidence in the literature to reinforce this operation as an alternative to a PSO in the correct patient. Enercan *et al*.[3] describe a bone-disk-bone osteotomy (BDBO), where a wedge osteotomy is performed centered at a disc present at the kyphotic deformity apex and includes the superior and inferior endplate of the adjacent vertebrae. They describe an average 38 degrees of correction in the sagittal plane without any neurological injury or pseudoarthrosis during a 2-year follow-up period after BDBO, with a range between 35 and 60 degrees based on type of BDBO performed.[2-4] The technique described in our report can be seen as a modified type I BDBO, where the disk space is not removed. Similar to our claim, Enercan *et al*. state the advantage of a type I BDBO when compared with PSO, which includes better stability, since there are four pedicle screws close to the osteotomy site.[3]

In summary, a novel transforaminal pedicle-sparing approach for focal kyphotic deformity correction in the thoracic spine is presented, using a case of proximal junctional kyphosis as an example. The operation resulted in a similar degree of correction as a PSO, with the added benefit of maintaining the pedicles closest to the kyphotic deformity.

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