Pedicle Subtraction Osteotomy for Correction of Severe Thoracolumbar Kyphosis in Ankylosing Spondylitis

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Introduction
Ankylosing spondylitis (AS), a chronic inflammatory arthritis, primarily involves the axial skeleton and results in severe thoracolumbar kyphotic deformity.1–3. Treating AS-related kyphotic deformity typically involves one or more posterior wedge osteotomies and manipulation of the position of the spine by forceful manual extension to close them. Several types of osteotomy are available, including multiple Smith–Petersen osteotomies (SPOs) and pedicle subtraction osteotomies (PSOs), which are reportedly the two major techniques for correction of thoracolumbar kyphosis resulting from AS.4–7. However, for severe AS-related kyphosis, SPOs provide very little correction; more recently, PSOs have been widely used.

Case Presentation and Surgical Procedure
A 41-year-old male patient presented with an 8 year history of low back pain, morning stiffness and progressive thoracolumbar kyphosis. A lateral film showed a substantial thoracolumbar kyphosis (75°, Fig. 1). A diagnosis of AS was made based on inflammatory back pain and radiologic features. The severe kyphotic deformity prevented the patient from standing in an upright position or looking straight ahead, subsequently restricting his activities of daily living. PSO was performed to correct the thoracolumbar kyphosis secondary to AS.

To obtain satisfactory reconstruction of sagittal alignment and a favorable general back contour, of osteotomy was performed at the level of the apical vertebra. Under general endotracheal anesthesia, the patient was placed in a prone position on a bow-type frame, leaving the abdomen free from compression. A standard posterior approach was used. Once pedicle screws had been inserted into the four levels above (uppermost instrumented vertebra at T10) and three below (lowest instrumented vertebra at L3) the designated osteotomy level (L2), a V-shaped wedge resection of the laminae and articular processes at the planned osteotomy level was performed, followed by laminectomy at the osteotomized level. Prior to decancellation, a unilateral temporary short rod was placed across the osteotomy site opposite the osteotomy side to stabilize the spine and prevent premature closure of the osteotomy site. After identification of both pedicles to be excised, the cancellous bone in the osteotomized vertebral body was removed bilaterally while protecting the dura and nerve roots, after which the posterior cortex was pushed into the cavity created by bone decancellation using an angle-down curette. Prior to closure of the osteotomy site, care was taken to ensure that the dural sac and nerve roots were not constricted. The caudal pedicle screws were then grasped with towel clamps and the bow-shaped frame extended gradually to close the osteotomy site. Finally, the temporary rod was replaced by a permanent long rod to fix the spine in the corrected position. Both somatosensory- and motor-evoked potentials were continuously monitored during the operation. A wake-up test was performed shortly after correction of the deformity. The patient was placed in a thoracolumbosacral orthosis for 3 months.

Discussion
The biomechanical aim of correction of kyphosis in AS is to place the weight-bearing line through or posterior to the sacrum and for the osteotomies to achieve the best sagittal balance, so that gravity will maintain the correction and ensure rapid fusion. More recently, PSO has been widely used to manage AS-related kyphosis.8–12. This aggressive osteotomy involves removal of the posterior elements, including the pedicle and transverse process, and a transpedicular vertebral wedge resection with the apex at the anterior cortex of the vertebral body. After closure of the middle and posterior column bone defects, the length of the anterior vertebral cortex remains unchanged. Closure of the anterior, middle and
posterior bone surfaces of the osteotomy provides a substantial surface area for osseous union. With this technique, removal of up to 6 cm of bone is possible with resultant sagittal plane correction of up to 60°. With the PSO technique, correction is obtained through all three columns of the spine. The spine is not lengthened and the two cancellous surfaces of the vertebral osteotomy ensure rapid consolidation after closure, which reduces stress in the implants and decreases risk of loss of correction in the instrumented area.

**References**


**Fig. 1** (A) Standing lateral film of a 41-year-old male AS patient showing advanced global kyphosis of 75°. (B) Lateral radiograph immediately after L2 pedicle subtraction osteotomy showing global kyphosis of 14°. (C) Lateral radiograph at 1-year follow-up showing no loss of correction in terms of global kyphosis.

**Video Image**

Additional video images may be found in the online version of this article.

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