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# A pedicle subtraction osteotomy as an adjunctive tool in the surgical treatment of a rigid thoracolumbar hyperkyphosis; a preliminary report

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**Abstract**

**BACKGROUND CONTEXT:** A pedicle subtraction osteotomy can be considered as part of the surgical treatment of a symptomatic sagittal imbalance. The literature on the use of this technique is limited and thus far not applied to a rigid thoracolumbar hyperkyphosis.

**PURPOSE:** To evaluate our preliminary results of a pedicle subtraction osteotomy as an adjunctive tool in the surgical treatment of thoracolumbar kyphotic deformities.

**STUDY DESIGN/SETTING:** Case series

**METHODS:** Eleven patients with a symptomatic kyphotic deformity were treated with a thoracolumbar pedicle subtraction osteotomy in combination with a multilevel correction. The mean follow-up was 42.8 months (range 26–105). The clinical outcome, radiographic correction, and perioperative complications were analyzed. The results in six more traditional indications (ankylosing spondylitis, kyphoscoliosis, congenital and posttraumatic deformity), were compared with the results in a subgroup of five cases with a rigid thoracolumbar hyperkyphosis.

**RESULTS:** All patients had a kyphotic thoracolumbar junction. An average of 5.8 levels was involved in the corrective fusion. A pedicle subtraction was always performed between the level Th10 and L2 to correct the sagittal balance. A lordotic correction of 38.8 (range 25–49) degrees was established with this fusion. The osteotomy contributed 66% (26.9 degrees) of the correction, whereas the remaining correction came from multilevel facetectomies. The visual analogue scale for both pain and impairment improved significantly ($p<.005$) for the entire group. Statistical analysis on the results for both subgroups separately was inappropriate because of the small number of patients available; however, overall both subgroups appeared to do equally well. All patients were very satisfied with the result and would choose surgical treatment again. No major complications were encountered.

**CONCLUSIONS:** A pedicle subtraction osteotomy is a technically demanding but well tolerated operative procedure for the correction of a kyphotic deformity. This technique can also be considered as an adjunctive tool in the surgical treatment of a rigid thoracolumbar (Scheuermann's) kyphosis. 

*Keywords:* Thoracolumbar junction; Kyphotic deformity; Pedicle subtraction osteotomy; Case series

## Introduction

A symptomatic sagittal imbalance is commonly encountered in patients presenting to spine surgeons [1,2]. A kyphotic deformity can occur after thoracolumbar fractures [3], congenital vertebral anomalies [2,4], and in patients with ankylosing spondylitis [5–9] or idiopathic kyphoscoliosis [10–12]. Patients frequently complain of difficulty in standing erect or low back pain. The lumbar pain is related to fatigue of the spinal extensor muscles and excessive forces on the lumbosacral facet joints. Surgical

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treatment frequently is an option in these patients; two methods currently used to correct the sagittal balance are the Smith-Peterson osteotomy and the pedicle subtraction osteotomy [2,4,13]. To achieve lordosis with the Smith-Peterson osteotomy, the posterior column is shortened and the anterior column is lengthened through opening of the disc space. The pedicle subtraction osteotomy has the benefit of obtaining lordosis through both the anterior and posterior column without lengthening the anterior column. This way, there is a good consolidation potential, and stretch on the anterior vessels or the neural structures can be avoided [2,14]. On the other hand the pedicle subtraction osteotomy is technically more demanding because resection of the pedicles in combination with a V-shaped bony wedge from the anterior column has to be performed. Only a few studies are available in the literature on the use of a pedicle subtraction osteotomy. Most of these studies deal with patients with ankylosing spondylitis [6–8], and to our knowledge, there are no data available on the results of a pedicle subtraction osteotomy as part of a primary surgical intervention in patients with a rigid thoracolumbar kyphosis.

In our opinion, it is of key importance to obtain at least a straight, and preferentially a lordotic, thoracolumbar junction in these patients. Because we believe that correction of this sagittal alignment it not always possible through the posterior column only, we hypothesized that it may be beneficial to perform a subtraction osteotomy in addition to the more established multilevel Smith-Peterson-like procedure. The purpose of our study was to evaluate the clinical course of our first five patients with this combined approach for a rigid thoracolumbar kyphosis. We decided to evaluate a small number of patients before proceeding on a larger scale. The radiographic and clinical results in these patients were correlated to those obtained in a comparable subgroup of patients with a pedicle subtraction osteotomy for a more traditional indication.

## Materials and methods

The radiographs and clinical course of 11 consecutive patients undergoing a pedicle subtraction osteotomy for a kyphotic deformity were studied. All patients were operated on by the same surgeon (PvL). Five men and six women with a mean age of 52.2 years (range 27–77) were operated. The diagnosis was ankylosing spondylitis in three patients, idiopathic scoliosis in one, posttraumatic kyphosis in one, congenital deformity in one, and thoracolumbar kyphosis in five (Table 1). The mean follow-up was 42.8 (26–105) months. Complications were recorded for all patients.

### *Surgical technique*

A pedicle subtraction osteotomy was performed as previously described [4,15]. In summary, the patient was placed prone on a radiolucent table and the thoracolumbar junction was approached posterior. Somatosensory evoked potentials were used along the surgery. All patients had at least a straight, and sometimes a kyphotic, thoracolumbar junction (Th10-L2). The osteotomy was planned at the level where a harmonious lordotic correction of the thoracolumbar junction could best be achieved. In our opinion, this does not necessarily always have to be at the apex of the curve. Multilevel pedicle screws were placed proximal and at least at two levels distal to the osteotomy site. At the adjacent levels, a Ponte type posterior procedure, with extensive interlaminar decompression and total facetectomies, was performed. In this manner, additional lordotic correction through the disc space could be obtained at these adjacent levels.

Subsequently, a laminectomy was performed at the planned osteotomy level. The pedicles were then resected on both sides flush with the vertebral body. Care was taken to preserve the exiting nerve root running along the medial and inferior surfaces of the pedicle. A partial resection of the posterior wall of the vertebral body was performed, followed by a decancellation of a V-shaped wedge of bone. The pedicle subtraction osteotomy was finished by resection of the appropriate amount of bone from the lateral part of the vertebral body bilaterally. The anterior cortex of the vertebral body was preserved to prevent dislocation of the osteotomy during closure of the wedge. The spine was then reconstructed by securing rods to the pedicle screws. Subsequently, the osteotomy was closed by extending the table in combination with compression forces on the adjacent pedicle screws (Fig. 1A, B). In this way, closure of the osteotomy site was achieved with direct bone-on-bone contact.

Postoperatively, all patients had intensive care monitoring at least overnight and intravenous antibiotics for 48 hours. From day 2 patients were mobilized without an orthosis.

### *Subjective assessment*

All patients were administered a subjective questionnaire preoperatively and at the time of the most recent follow-up by an orthopedic resident not involved in the surgery. Both the preoperative and postoperative questionnaires included a visual analogue scale, rated on a scale from 1 to 10, for pain and impairment. In addition, the postoperative questionnaire included items on overall satisfaction and choice for repeated surgery when offered retrospectively.

### *Radiographic analyses*

Long-cassette standing anteroposterior and lateral radiographs were made preoperatively and at regular postoperative follow-up. The preoperative radiographs were analyzed to measure the thoracolumbar kyphosis and the