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Asymmetric T5 Pedicle Subtraction Osteotomy (PSO) for complex posttraumatic deformity

Ibrahim Obeid · Fethi Laouissat · Jean-Marc Vital

Keywords Thoracic PSO · Asymmetric PSO · Posttraumatic deformity · Kyphosis · Spinal deformities · Upper thoracic spine

Learning targets

- Posterior approach for vertebral body access
- Intraoperative navigation (O-arm) for insertion of high thoracic pedicle screws in major spinal deformities
- To learn correction strategy in complex fixed sagittal and coronal spinal deformities
- Performing an asymmetric PSO at the upper thoracic segment
- Managing the spinal cord for upper thoracic spinal osteotomies
- Correction technique by simultaneous internal and external manoeuvres.

Introduction

Kyphosis is a common sequel of neglected or inadequately managed thoracolumbar fractures. Patients with a kyphotic deformity have increased risk of developing chronic pain at the site of the deformity and neck pain, if the kyphotic region is located in the high thoracic region. Furthermore, the posttraumatic deformity may occur in both coronal and sagittal planes, and may lead to horizontal visual impairment.

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I. Obeid (✉) · F. Laouissat · J.-M. Vital
Bordeaux University Hospital, Bordeaux, France
e-mail: dr_iobeid@yahoo.com

Various techniques have been described to correct rigid posttraumatic kyphotic deformities. Furthermore, the high thoracic region, the anatomical site of the deformity, may present a further challenge regarding the correction technique, especially when a correction of both sagittal and coronal planes is mandatory.

Of the three posterior-only procedures [1] the Smith–Petersen osteotomy (SPO) may not be adequate to correct severe and rigid kyphotic deformities [2]. The posterior vertebral column resection (PVCR), performed in a single approach, allows an excellent correction of the sagittal plane deformity. However, PVCR appears to be a hazardous procedure, with the risk of extensive blood loss and neurologic impairment [3].

The pedicle subtraction osteotomy (PSO) appears to be a good surgical alternative to SPO and PVCR techniques. PSO, with an exclusive posterior approach, may allow good correction of the deformity in the sagittal plane, or even in both sagittal and coronal planes, if an asymmetric PSO is performed. To the best of our knowledge, few authors have described this technique in the thoracic spine above T5.

Case description

In August 2012, the patient, a 58 year-old male, had a high-speed car accident, resulting in a fracture of the 4th and 5th thoracic vertebra, without any sensory or motor deficits (Frankel E). This fracture did not undergo adequate treatment.

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In December 2012, the patient was first referred to us with a severe angular cervicothoracic kyphosis, over 80°, and a coronal head shift of 7 cm, resulting in an unbearable neck and high thoracic deformity with a horizontal visual impairment. The patient's sensory-motor status was still Frankel E. (Figs. 1 and 2).

A preoperative CT scan shows a malunion of a B type fracture at T4–T5 according to Magerl's thoracolumbar fracture classification (Fig. 3). Bending radiographies show a fixed stiff posttraumatic deformity (Fig. 4).

Fig. 1 Pre and postoperative photos of the patient, we can see horizontal sight restoration

Surgical procedure

The patient was carefully placed in prone position on a carbon radiolucent table with the head fixed on a Mayfield frame. The surgical procedure was performed with intra-operative neuromonitoring.

After skin preparation and draping, a midline skin incision was performed. A total sub-periosteal exposure of the posterior arches was performed from T1 to T8.

Once the anatomical landmarks were properly defined, wide facetectomies were performed at every level from T1 to T7, on both sides. Then, pedicle screws were positioned, according to the preoperative plan, using free hand technique from T5 to T8, and the O-arm for the pedicle screws from T3 to T1. Because of the severe kyphosis, the positioning of the screws was particularly challenging at T3, T2, and T1. An O-arm intraoperative CT scan was then performed and navigation was used in order to improve the accuracy positioning of the upper thoracic segment screws. The exposure of the posterior 4th and 5th rib was performed bilaterally, in order to achieve a bilateral and partial costectomy at T4 and T5, carrying away the rib heads. This large approach allows a good visualization of the lateral walls, and a horizontal view of the posterior wall of the T5 vertebral body, avoiding spinal cord mobilization manoeuvers during the osteotomy. A complete laminectomy of T5 was done. Then, the asymmetric osteotomy of T5 was performed, in order to obtain a good mobilization of the kyphotic spine. The T4/T5 disc was removed during the osteotomy. The correction was achieved by placing two pre-bent CoCr rods (internal manoeuvre) and extending the head of the patient (external manoeuvre) during the osteotomy closure. Construct on construct compression by domino connector, placed on the opposite site of the coronal deformity, allow an asymmetric closure and coronal plane correction. The neuro-monitoring did not reveal any changes during correction. Decortication of the posterior elements was then performed, and bone grafts with adjunctive 1 g Vancomycin powder was used in the fusion area. Two cross-links were then placed. Before the wound closure, deep drainage was positioned to reduce the risk of postoperative haematoma.

Postoperative information

The patient spent 2 days in ICU, and 5 days later he was transferred to a rehabilitation centre. No external immobilization was necessary. The post-operative radiographs show a good correction of the deformity in both coronal and sagittal planes (Fig. 5).

6 weeks postoperatively the correction was achieved without complications.

Fig. 2 Preoperative and post operative full-spine EOS radiographs showing both sagittal and coronal high thoracic deformity and correction

Discussion and conclusion

This work reports a correction of a post-traumatic severe and rigid deformity by an asymmetric high thoracic PSO. Posttraumatic high thoracic, rigid and angular kyphosis represents a challenging pathology. The most suitable correction technique has to be selected to achieve a good final result, taking potential risks and benefits of the procedure into consideration.

PSO represents one of several techniques to correct severe posttraumatic deformity, by a single posterior approach. Literature provides further techniques for correction of thoracic posttraumatic deformity by a single posterior approach.

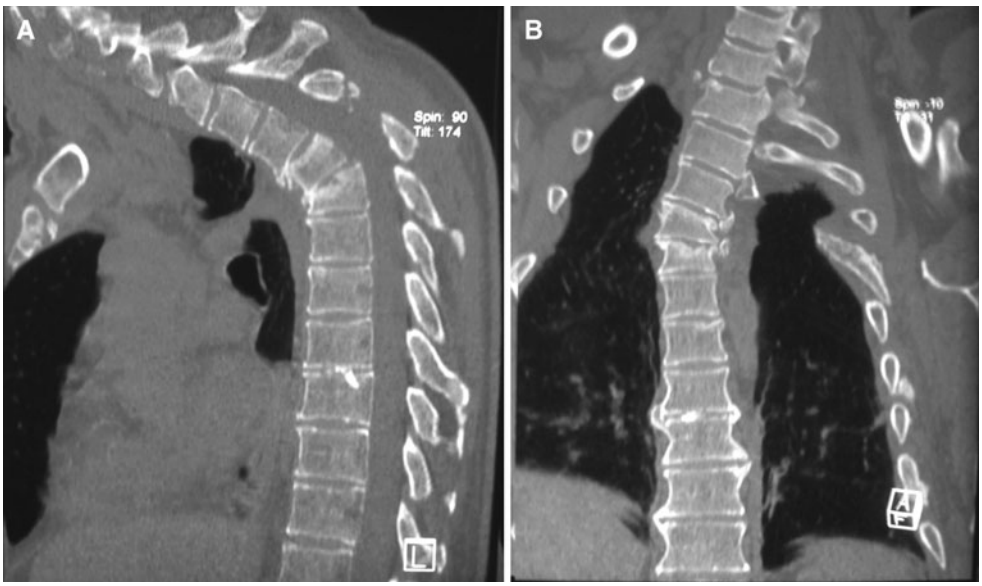

Fig. 3 Preoperative CT-scan showing T4 and T5 malunion

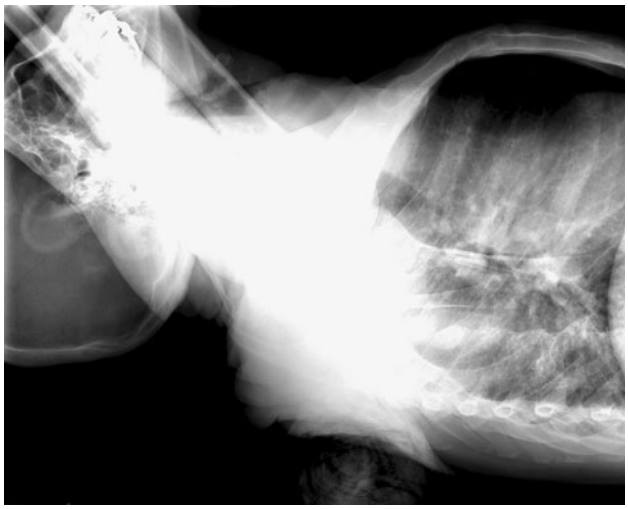

Fig. 4 Bending radiographs showing a fixed deformity

Multiple Chevron SPO is aimed for deformities, limited to the sagittal plane, with adequate disc height and residual flexibility within the intervertebral disc. However the SPO technique seems ineligible for surgical issues with severe rigid thoracic kyphosis.

PVCR appears to be an effective technique to correct severe kyphotic deformity. PVCR is a demanding procedure with high risk of complications, such as high blood loss, and a major risk of neurologic impairment. Traditionally, PVCR represents an appropriate technique in patients having a poor neurological status [4].

Asymmetric upper thoracic PSO represents a highly effective and appropriate correction technique for this particular posttraumatic upper thoracic kyphotic deformity case. It allows a good reduction of the deformity in both coronal and sagittal planes, with limited complication risks, especially neurologic ones. Upper thoracic PSO can also be the appropriate technique for iatrogenic kyphosis at the cervicothoracic region (Figs. 6 and 7). However, asymmetric upper thoracic PSO is a very demanding surgery, which has to be performed in a specialized spine surgery centre.

Preoperative planning and good cooperation between the surgical and anaesthesia teams will allow for good result whilst taking the patient's safety into account.

Fig. 5 Showing 2 planes correction

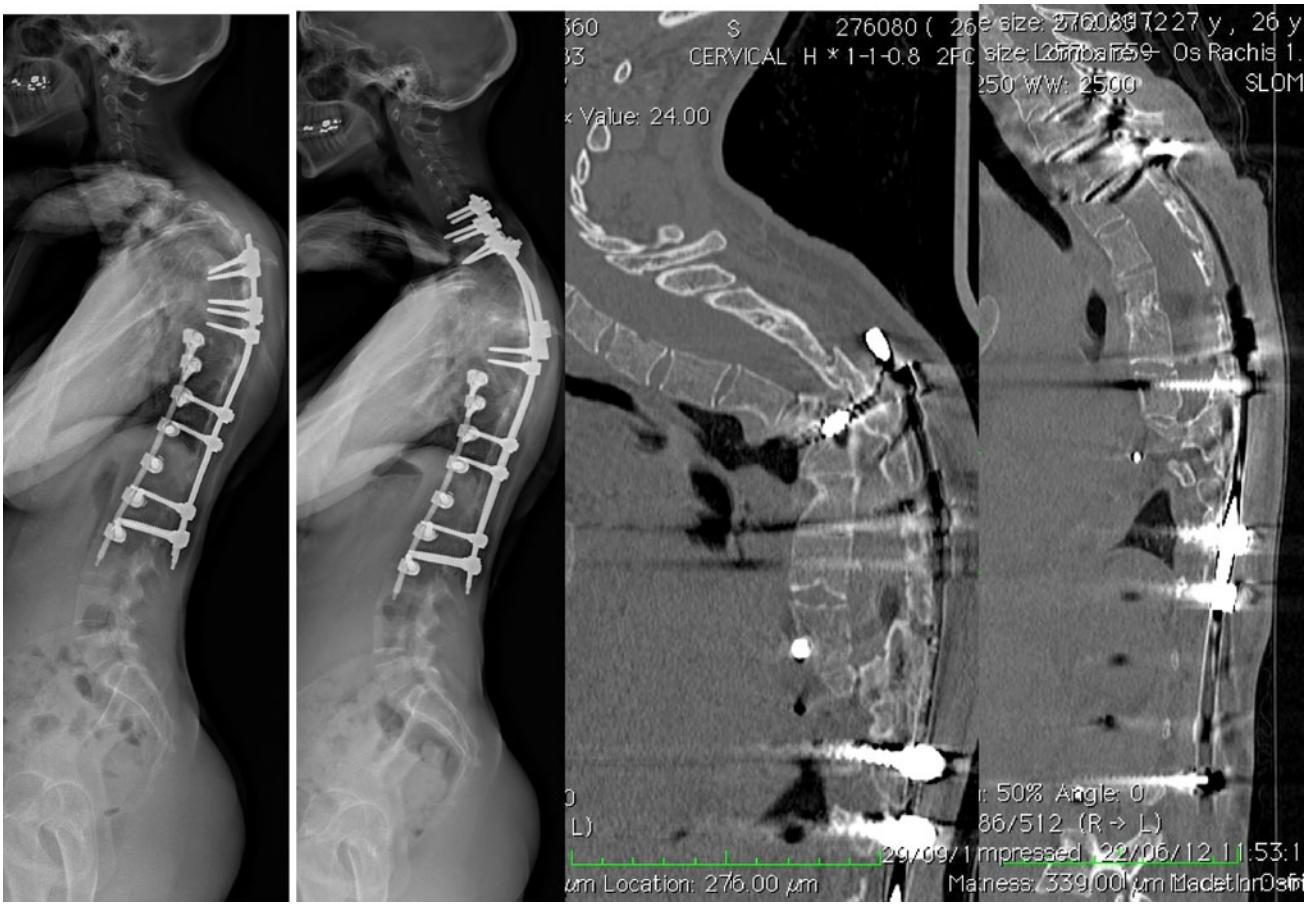

Fig. 6 Preoperative and postoperative radiographs and CT scan showing high thoracic T5 PSO for iatrogenic kyphosis

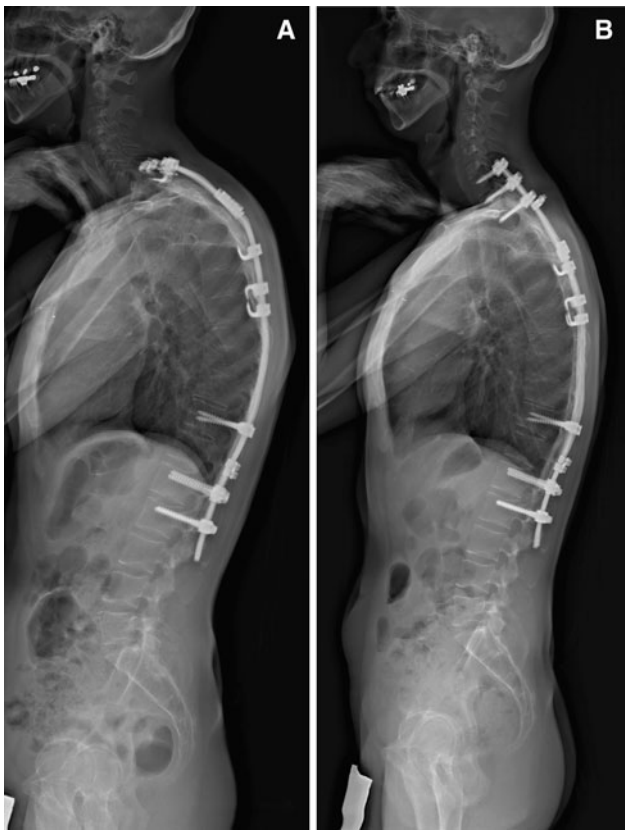

Fig. 7 Preoperative (**a**) and postoperative (**b**) radiographs showing high thoracic T5 PSO for iatrogenic kyphosis

Conflict of interest None.

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