



Posterior Surgical Management of Thoracic and Lumbar Fractures

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Yann Philippe Charles

35.1 Introduction

Unstable thoracolumbar fractures and trauma leading to severe kyphosis are usually treated surgically. There is no clear consensus whether open or percutaneous instrumentation should be preferred, and the necessity of grafting remains debated [1]. Currently, there is an increasing trend towards Minimally Invasive Surgery (MIS), since percutaneous instrumentation decreases the risk for bleeding and infection during the perioperative period, and it shortens the length of hospitalization [2]. Clinical trials comparing open and percutaneous techniques indicate that MIS leads to lower pain and disability scores at short-term, whereas clinical results are similar after 6 months [3, 4]. There is only little evidence on long-term outcomes after posterior percutaneous instrumentation. However, clinical results and sagittal alignment are maintained effectively with MIS if the right surgical strategy has been chosen according to the fracture type, the patient's age and general health status [5, 6].

This case description will outline the management of an incomplete burst fracture at the thoracolumbar junction without neurological impairment. The rationale for a posterior surgical

treatment is discussed. The aim of the presented case is to emphasize specific aspects that should help the reader in clinical and technical decision making with an MIS approach. The discussion will focus on the following technical aspects:

- The different possibilities posterior closed fracture reduction techniques,
- The indication and limits for an additional anterior column support by vertebral body expansion and cement augmentation,
- The indication and specific need for an anterior column reconstruction and grafting with MIS,
- The use of percutaneous instrumentation as a temporary internal fixator.

35.2 Case Description

A 52-year old female patient was admitted at our emergency department after a motor vehicle accident with an estimated speed of 120 km/h. She was conscious and well oriented. Her blood pressure was 140/90 mmHg and her pulse rate 84/min. Clinical examination evidenced a hematoma at the right hypochondrium. Pulmonary auscultation remained normal and an abdominal tenderness was noted when palpating the right upper quadrant and epigastric region. She further reported back pain around the thoracolumbar junction. Her neurological status and examination

Y. P. Charles (✉)

Service de Chirurgie du Rachis, Hôpitaux Universitaires de Strasbourg, Strasbourg, France
e-mail: yann.philippe.charles@chru-strasbourg.fr

of the limbs were normal. Routine chest and pelvic x-rays were performed in the emergency room and evidenced fractures of the 9th and 10th right ribs, while a pelvic ring fracture was ruled out. Because of the high velocity trauma, a total body CT scan was performed with injection of contrast media. A small subcapsular liver hematoma was evidenced without active bleeding. CT imaging of the spine showed an incomplete burst fracture of T12 (Fig. 35.1), classified as A3 type according to the new AO classification [7].

An abdominal echography was performed after 2 days, showing that there was no progression of the liver hematoma prior spinal operation. Positioning the patient prone on a Jackson table with the thoracolumbar junction in slight lordosis allowed almost complete reduction of the fracture. She was then operated using a percutaneous approach that consisted of a balloon kyphoplasty at T12 in order to complete the reduction. Because of the posterior wall involvement, the vertebral body expansion was then followed by a percutaneous instrumentation in order to stabilize the segment T11-L1 (Fig. 35.2).

The patient ambulated without a brace from day one after surgery with the aid of a physical therapist. She gained full autonomy until day 5 and was discharged at home with paracetamol

and tramadol as pain medication. The first out clinic follow-up visit was scheduled 6 weeks postoperatively. The patient was pain free and did not require analgesics. Physical therapy was started aiming for strengthening of the paravertebral musculature. The patient was able to return to work as a schoolteacher after 2 months.

A routine follow-up visit was scheduled at 6-month follow-up. As the patient was very sportive, she asked if an implant removal might be considered prior starting horse riding competition again. A CT scan showed a complete bony consolidation of the T12 vertebral body (Fig. 35.3), and percutaneous removal of the instrumentation was performed after 9 months.

The postoperative follow-up was uneventful and the patient returned to sports activities. An MRI of the thoracolumbar spine was performed for research purposes at 2-year follow-up (Fig. 35.4). The sagittal T2 sequence showed that the T11-T12 disc remained well hydrated despite the compression fracture and the underlying cement augmentation in the T12 vertebral body. Furthermore, the aspect of the paravertebral musculature at the fracture and instrumented levels remained normal on axial views and low fat infiltration was evidenced. Although not routinely used in clinical practice, this MRI showed the

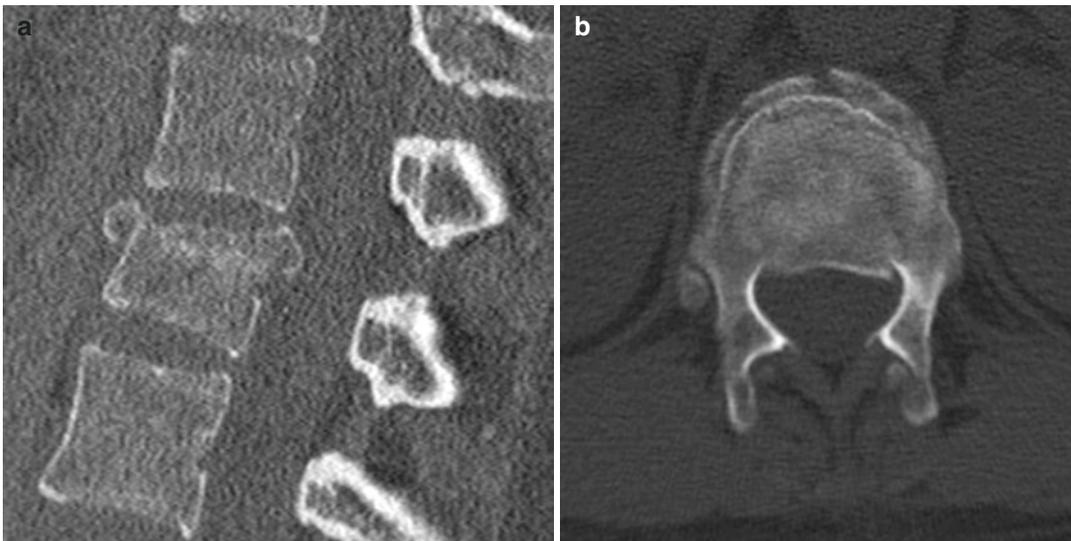


Fig. 35.1 CT scan performed at emergency admission showing an incomplete burst fracture on sagittal (a) and axial (b) reconstructions

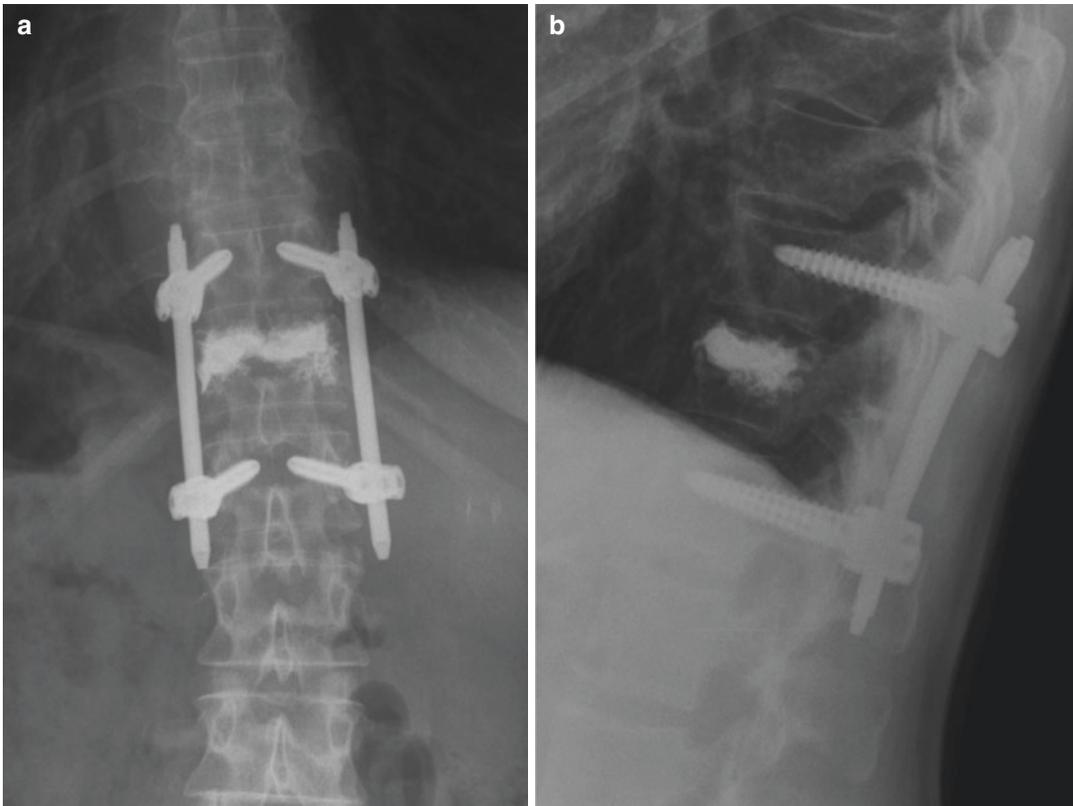


Fig. 35.2 Postoperative anterior-posterior (a) and lateral (b) radiographs showing percutaneous instrumentation between T11-L1 and kyphoplasty at T12

advantage of muscle preservation through an MIS procedure.

35.3 Discussion of the Case

35.3.1 Indication

This case illustrated a common incomplete burst fracture of the thoracolumbar junction. As there was no neurologic impairment and a minor posterior wall displacement, conservative treatment might have been discussed using a Böhler type brace for 3 months [1]. This treatment leads to consolidation, but a recurrent vertebral body collapse with loss of correction at the fractured level might be observed. In the case of A3 fractures at T12 or in the lumbar spine, short percutaneous pedicle screw instrumentation represents an adequate alternative, which stabilizes the fractured

segment and allows the patient to stand up postoperatively without the need for an additional brace. Longer instrumentation might be recommended in the thoracic spine by covering the kyphotic apex by instrumenting 2 levels above and below the fractured level. In cases of severe posttraumatic kyphosis at the thoracolumbar junction, multi-level instrumentation might also be considered if more reduction is needed through the instrumentation itself.

35.3.2 Reduction Techniques

MIS uses principles derived from classic fracture treatment principles, and similarities exist between open and percutaneous techniques. Prone positioning of the patient with a slight lordosis at the thoracolumbar junction reduces kyphosis at the fracture level. This closed

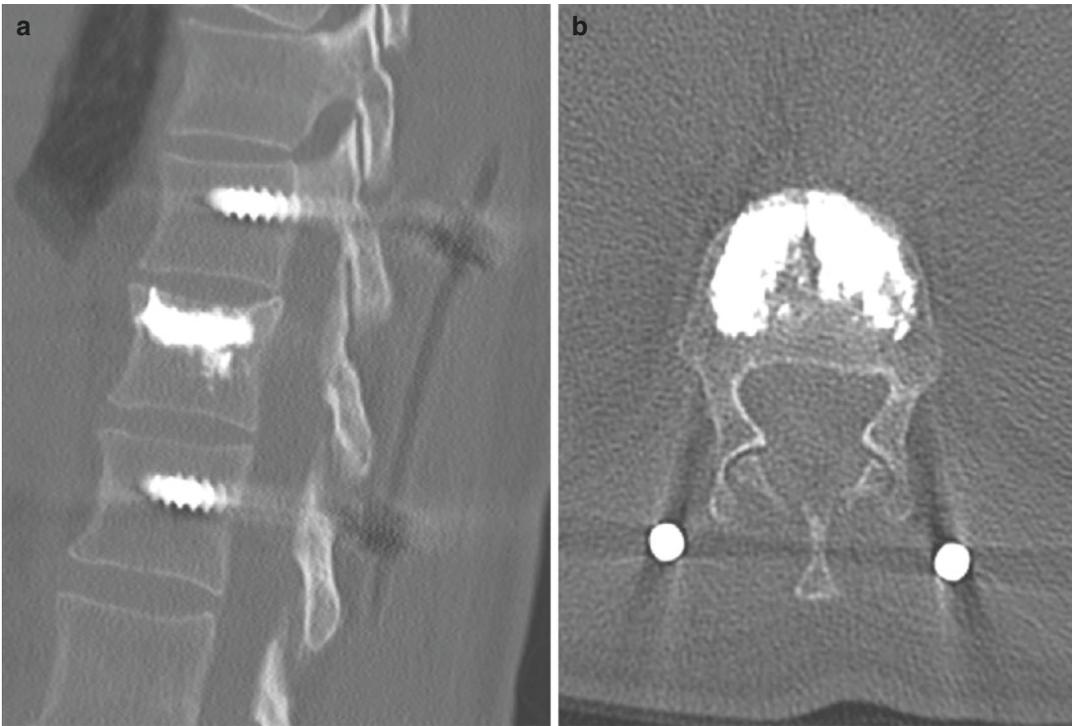


Fig. 35.3 CT scan performed at 6 months postoperatively showing an anatomic consolidation of T12 on sagittal (a) and axial (b) reconstructions

reduction can be enhanced by leg and halo traction depending on fracture instability. The AO-principle is commonly used in burst fractures. A parallel distraction is realized first on Schanz screws in open surgery or monoaxial screws when using an MIS technique. This maneuver creates ligamentotaxis and is followed by an angulation of the monoaxial system in order to restore lordosis in a second step [8]. As an alternative, MIS persuader systems or percutaneous monoaxial long arm screws are efficient for fracture reduction [6]. Pre-bent lordotic rods are progressively inserted into monoaxial screws above and below the fracture, which stretches the spine and creates lordosis with ligamentotaxis at the fracture (Fig. 35.5). Add-on techniques, such as in situ contouring corrects kyphosis by bilateral lordotic rod bending inside the patient, which lengthens the anterior column. The cranial end-plate and posterior wall fragments are reduced by ligamentotaxis. The use of pure titanium or cobalt-chromium rods with an appropriate elastic

modulus is mandatory for this technique [9]. Alternatively, monoaxial screws at the fracture level may enhance reduction by lifting the end-plate directly [3].

35.3.3 Anterior Column Support

If the fracture type represents a pure bony lesion like a Chance fracture, classified as B1 type according to the new AO classification [7], a single posterior percutaneous osteosynthesis is sufficient. An additional vertebral body expansion might be considered in order to maintain reduction at long-term if a vertebral body collapse was present in the fracture type. Kyphoplasty represent one option to consolidate incomplete burst fractures (A3) in combination with posterior instrumentation. Cement injection into the fractured cranial vertebral body would allow an immediate stabilization of the achieved reduction and prevent from recurrence



Fig. 35.4 MRI of the thoracolumbar spine performed after implant removal at 2-year follow-up, showing a well-hydrated T11-T12 disc on sagittal T1 (a) and T2 (b)

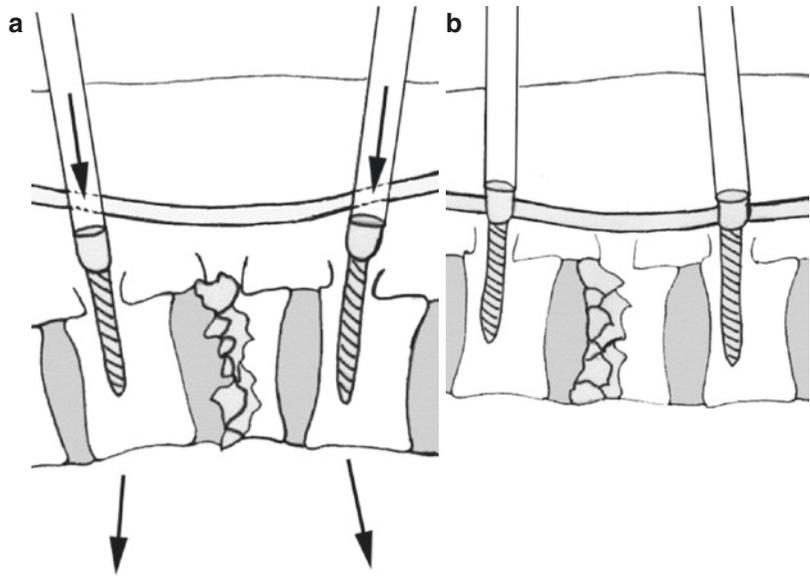
sequences, and a preserved paravertebral musculature with minor dystrophy at the fracture level (c) and instrumented level L1 (d)

of kyphosis when the patient stands up postoperatively [5, 10]. In the present case, kyphoplasty was used prior to instrumentation since fracture reduction was mainly obtained by prone positioning of the patient. If this first step of closed reduction had remained insufficient on lateral fluoroscopy, it might have been recommended to complete the reduction by percutaneous instrumentation first. This sequence enhances the ligamentotaxis effect at the anterior column, thus creating an “eggshell” which is then completed by a kyphoplasty.

Anterior fusion might be considered in major anterior column defects. A select mono-segmental

fusion is indicated in incomplete burst fractures (A3) if reduction occurred mainly in the cranial adjacent disc rather than in the fractured vertebra. Single level anterior fusion might also be indicated in hyperextension one-level discoligamentous injuries (B3). A complete anterior column reconstruction might be preferable in pincer type fractures with disc incarceration in the vertebral body (A2), complete burst fractures (A4) or flexion-distraction fractures with an anterior burst component (B2) [6]. Select anterior fusion with MIS is essential when treating unstable thoracolumbar fractures associated with ligamentous injuries, since percutaneous

Fig. 35.5 Percutaneous fracture reduction using monoaxial long arm screws and pre-bent lordotic rods which are progressively pushed into the screw heads (a). This maneuver creates an elongation of the fractured spinal segment with ligamentotaxis and lordosis once the 90-degree connection between rods and screws is achieved (b)



instrumentation does not enable bone grafting like open posterior fusion [3, 4].

35.3.4 Temporary Internal Fixation

Percutaneous instrumentation can be used as temporary internal fixator, which is removed through small skin incisions after consolidation. This allows treating thoracolumbar fractures without damaging paravertebral muscles as posterior dissection is avoided [11]. When using a combined approach of posterior osteosynthesis and select anterior column fusion, removal of the instrumentation is beneficial in younger patients if motion of non-fused lumbar segments can be restored [6]. The combination of kyphoplasty and percutaneous osteosynthesis with subsequent removal of instrumentation allows a management without fusion of incomplete burst fracture. It might be legitimist, when questioning cement injection in younger patients. However, this practice led to adequate clinical and radiologic outcomes without long-term adverse events [5, 10]. Furthermore, this strategy seems justified in A3 fractures as the cranial intervertebral disc is usually contained during the compression mechanism of the

injury [12]. It remains unclear, whether cement injection under the cranial endplate inhibits nutrition of the disc by diffusion. The follow-up MRI of this case has shown that the nucleus remained well hydrated. This finding underlined that an incomplete burst fracture does not necessarily lead to cranial disc degeneration if the segment is temporarily maintained by percutaneous instrumentation.

35.4 Conclusions and Take Home Message

Incomplete thoracolumbar fractures without neurologic impairment can be treated efficiently with an MIS procedure. Fracture reduction and stabilization is achieved by percutaneous instrumentation in combination with kyphoplasty within the first days after trauma. This approach has the advantage of preserving the paravertebral musculature. Clinical outcome and sagittal alignment are usually satisfactory on short- and long-term. In younger and physically active patients, instrumentation removal might be discussed if range of motion of non-fused segments can be expected in the lumbar spine or at the thoracolumbar junction.

Pearls

- Preoperative analysis of CT images should rule out facet joint and discoligamentous injuries if percutaneous instrumentation without fusion is indicated.
- Proper prone positioning and reduction using monoaxial screws represent efficient techniques for fracture reduction.
- Expansion and cement augmentation of the fractured vertebral body allow an immediate anterior column strengthening, which lowers the risk for recurrent kyphosis in the early postoperative period.

Editorial Comment

This article illustrates nicely the concept of “internal bracing” as an alternative to external bracing of an incomplete burst fracture. The only thing I would have made differently is to use no cement and short index screws instead.

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