Surgical technique

Technical notes on reduction of thoracic spine fracture dislocation

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Fracture dislocation of the thoracic spine is a rare spinal injury often resulting from high-energy trauma. Associated soft-tissue thoracic injuries are common and are compounded by the often-associated paraplegia. Exceptionally, there are some cases of thoracic spine dislocations without neurological injuries.[1] A major challenge in the surgical management of such spinal fractures is achieving reduction and then maintaining it after stabilization. The goals of surgical management of these unstable spine fractures are 4-fold: (1) achieving reduction; (2) immediate stabilization and maintenance of reduction, coupled with spine fusion; (3) decompression of the neurological elements (if indicated); and (4) early mobilization.[2–4]

Classic posterior spinal instrumentation, such as screw-plate, hook-rod and screw-rod systems, has been used successfully. It has been shown that most of these unstable injuries can be managed using these techniques without the need for additional combined or staged anterior spinal surgery.[5,6] However, recent concerns have been raised that maintenance of reduction, restored height and sagittal balance has not occurred in long-term follow-up using such systems.[7,8] As for thoracolumbar, unstable burst fractures, some have advocated that anterior decompression and anterior column reconstructions must be done to avoid delayed loss of coronal and sagittal balance,[9] but for fracture dislocations most of the literature has described a posterior approach.[10,11]

It has been our experience that the use of side-opening pedicle screws facilitates reduction to help achieve the surgical goals previously enumerated.

Technique

The patient is positioned in the standard prone fashion with appropriate bolsters. Care must be taken when rolling the patient. If the surgeon does not have access to a Jackson table, then axial traction (head to feet) should be applied to the patient when log rolling to minimize translations of the spine. A standard midline approach with elevation of paraspinal musculature is taken, exposing the spine out to the transverse processes. Cautious dissection is warranted across the fracture dislocation, so as not to inadvertently injure the possibly exposed dural elements. Dissection is done 2 levels above and 2 below the fractured/dislocated segment. Once standard bony landmarks have been identified, we then insert 2 pairs of pedicle screws above and 2 below the dislocation.

Anatomical barriers

Classically with such fracture dislocation of the thoracic spine, the facet(s) can be jumped, perched or impacted. Manual reduction of such pathology is often warranted. The facet joint can be reduced manually by introducing a large Penfield instrument underneath the inferior facet. Ideally one would prefer to leave the facet in place; however, if the reduction fails, then undertaking superior and/or inferior resection of one or both facet joints may be justified. Despite this, in some rare cases (particularly delayed cases) one may still not be able to reduce the spine.

To facilitate the reduction, we place the implants in a special configuration to generate greater reduction force, thus facilitating reduction of the spine to the precontoured rod with appropriate sagittal and coronal alignment. The complex reduction clamp, the "Persuader" from the AO Universal Spine System (USS; Synthes, Paoli, Pa.), also facilitates the reduction manoeuvre, because it is able to bring the spine to the rod simultaneously in 2 different planes (Fig. 1).

Sagittal reduction

To facilitate our spinal reduction in the sagittal plane, we purposely leave the screws slightly proud (from 5 mm to 10 mm according to the amount of dislocation/displacement and the anticipated difficulty in reduction) on the segment that is posteriorly translated (usually distal). On the other hand, we insert the screws flush to the spinal elements in the segment that is anteriorly translated (usually proximal). We purposely create an exaggerated offset of the pedicle screw height of 5–10 mm. By doing so, we

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achieve greater translational forces across the fracture dislocation when the spine is being reduced to the rods with the help of the complex reduction forceps. As this is a side-opening system, once the spine is reduced and both rods are in place, one can individually remove the locking cap and advance each screw one by one, to a normal depth as needed (Fig. 1A).

Coronal reduction

To create maximal coronal translational forces, we purposely offset the opening of the screws on the opposite side of the fracture dislocation. The side opening is directed in such a way that it faces the direction of the dislocation in the coronal plane (Fig. 1B). By doing so, one levers the translated segments across in a coronal plane with the rod as it is being fixed in the bottom 2 screws.

Axial reduction

If there is an associated locked facet, one can use the screws to apply distraction to the side where the facets may be locked.

Step-by-step reduction

The screws are inserted proud in the posteriorly (distal) translated segment, while flush in the anteriorly (proximal) translated segment. Care is taken to leave the side opening facing toward the side where the spine is coronally translated (Fig. 1), that is, if the proximal segment is translated to left, then the 4 screws proximal to the dislocation will be open to the left, while the distal 4 screws will be open to the right. The rod is cut and bent to the appropriate anatomical sagittal profile. The 2 rods are then fixed to the distal pedicle screws and cross-linked distally. Using 1 or 2 complex reduction forceps, the proximal part of the spine is reduced to the 2 rods both in the sagittal and coronal plane by pulling the proximal spine posteriorly and medially. Because of the flexibility of the metal and the elasticity of the bone, no overreduction is achieved during these correction manoeuvres. Both the coronal and sagittal offset of the screws offer strong axial, sagittal and coronal forces that enable the spine to be reduced. If there are associated locked facets, then distraction can be

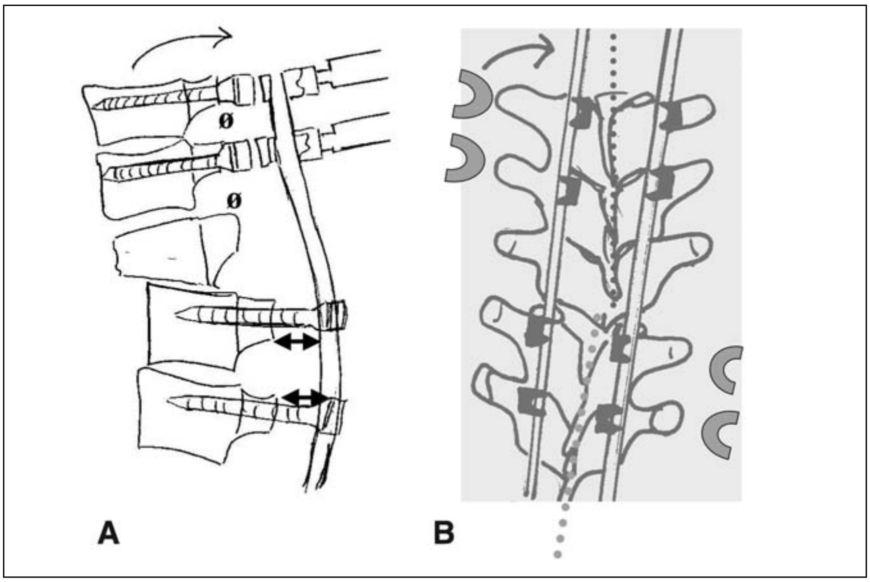

FIG. 1. Schematic representation of the screw positioning for reduction: (A) sagittal view, (B) coronal view. Steps of reduction: the screws are inserted first proud distally (↔), then flush with the lamina proximally (Ø). The side openings of the screws have to face the side of the dislocation proximally, facing opposite the direction where the spine should go, and facing the opposite side distally. Screws are inserted 2 levels above and 2 below. After achieving reduction, the distal screws may be inserted deeper to the appropriate depth. This is done after disconnecting the screws from the rods one by one and inserting them deeper. Because fracture dislocations of the thoracic spine are considered rotationally unstable, a cross-link should be applied.

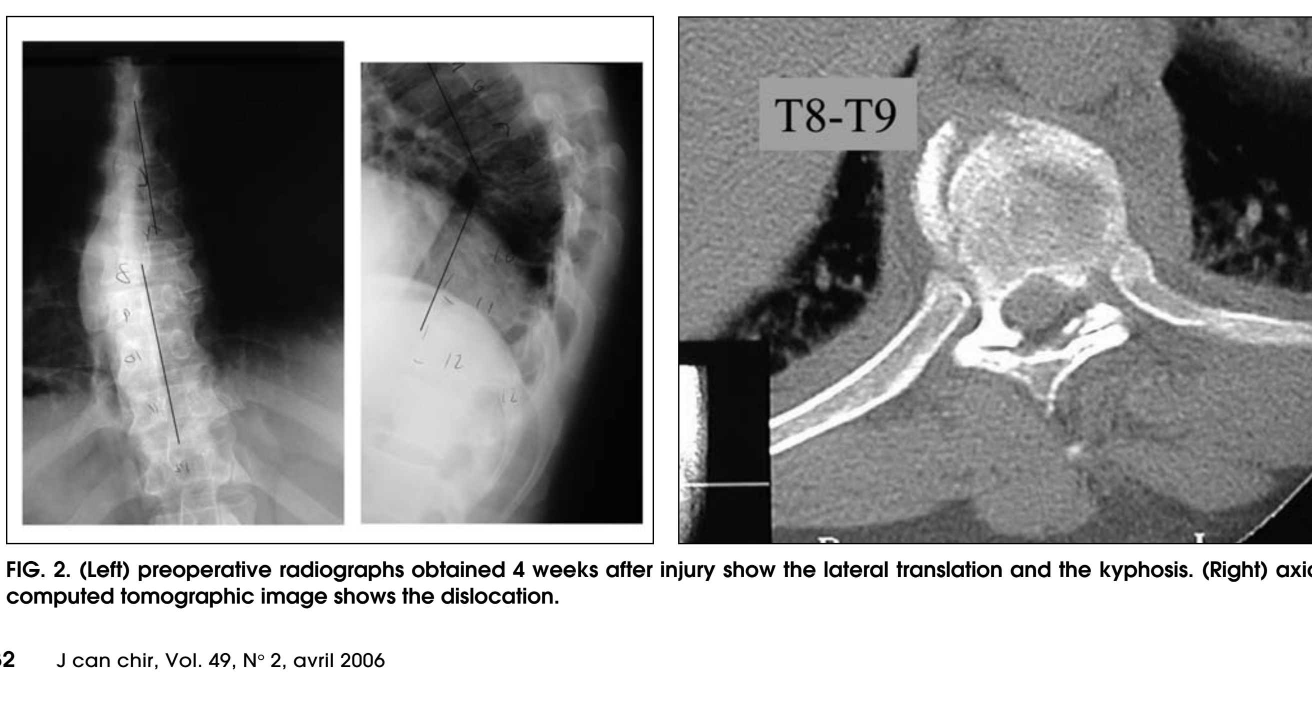

FIG. 2. (Left) preoperative radiographs obtained 4 weeks after injury show the lateral translation and the kyphosis. (Right) axial computed tomographic image shows the dislocation.

applied using the instrumentation setting. In the case of an old fracture dislocation, reduction manoeuvres are applied to both rods simultaneously with 2 complex reduction forceps to minimize the stresses

After achieving reduction in both planes, the distal screws may be inserted deeper to the appropriate depth. This is one of the advantages of side-loading screws that can be removed or modified even after the rods have been in place. Because this type of injury is rotationally unstable, then a second cross-link is applied proximally. Finally, bone grafting and fusion are performed.

Case example

A 40-year-old man who was seen initially at another hospital with back pain following a fall from a height was treated with a brace. He presented to us 5 weeks after his injury with severe back pain and progressive kyphotic deformity. Examination ruled out any neurological compromise. His radiograph and computed tomographic scan (Fig. 2) showed T8–T9 fracture dislocation. The patient was brought to the operating room to have his spine stabilized and realigned. As the dislocation was old, the reduction could only be achieved in a stepwise fashion as described above. The patient was instrumented posteriorly from T6 to T11 with posterior pedicle screws (Fig. 3). The T8 and T9 levels were not instrumented because of pedicle fractures at these levels. At the last follow-up (24 mo), the alignment was maintained with apparently good fusion.

Discussion

Management of fracture dislocation of the thoracic spine remains challenging. Compared with thoracolumbar fracture, thoracic fracture dislocations of the spine are less common and are usually associated with neurological injuries, although there have been some case reports of thoracic spine dislocations without neurological injuries.[1]

Spine fractures that produce ligamentous and bony instability are the most unstable injuries. The classic treatment has been to use a combination of distraction–compression-type hooks in the thoracic spine with lumbar pedicle screws.[12] Recently, the use of pedicle screws in the thoracic spine has gained popularity, and they appear in experienced hands to be a safe and reliable strategy in the surgical treatment of unstable thoracic spine fractures.[6,13] For fracture dislocation of the thoracic spine, we believe they are essential in facilitating and maintaining the spinal reduction. One might ask why we are not using Schanz screws in the thoracic spine. If we use them routinely for the thoracolumbar junction, it is our experience that Schanz screws in the middle of the thoracic spine are too high-profile leading to possible skin irritation, and we therefore prefer the use of USS side-opening screws in the described configuration. Naturally such a configuration can be achieved with any side-opening system and is not specific to the AO USS. Possible complications of such technique are mostly related to screw malpositioning, and anteroposterior and lateral fluoroscopy are mandatory to avoid such complications. None of our treated patients has experienced any loss of correction, and we have postulated that all our fusions had to be solid.

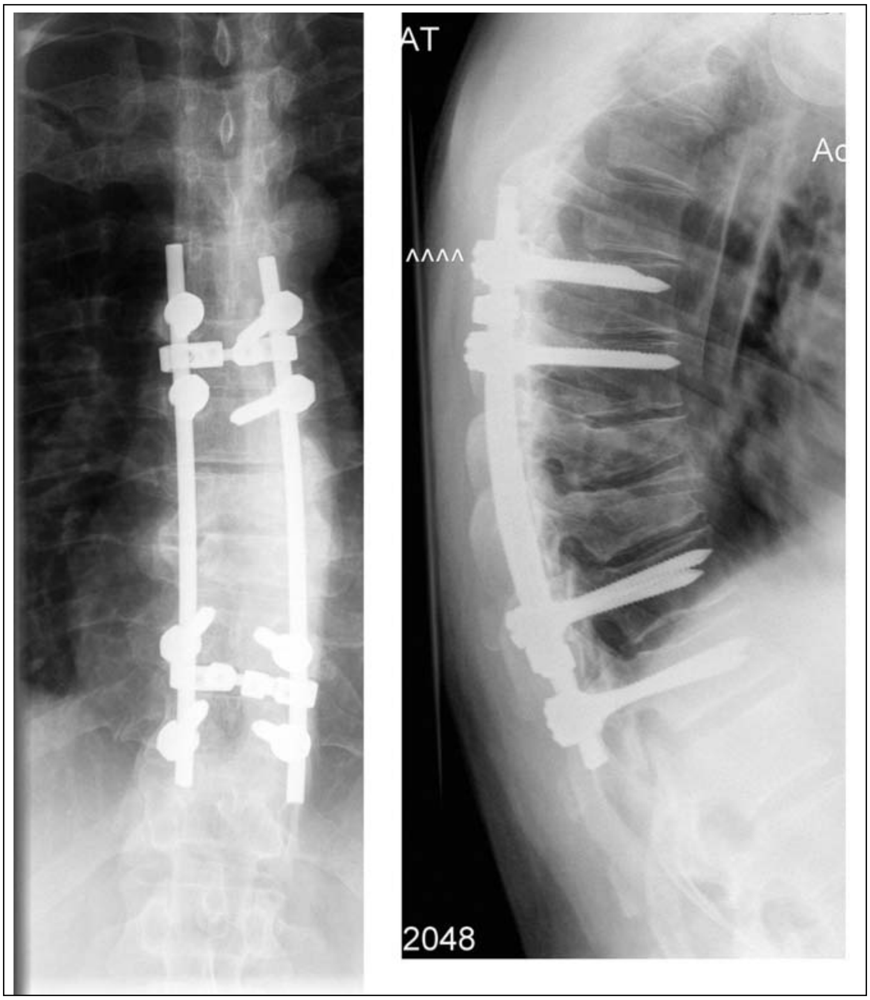

FIG. 3. Postoperative radiographs show the perfect reduction of the fracture. Note that T8 and T9 were not instrumented because of the existence of pedicle fractures at these levels.

Conclusion

The use of thoracic pedicle screws with the configuration and surgical technique described here facilitates intraoperative reduction and restoration of spinal alignment in the management of unstable thoracic spinal fracture dislocation.

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References

1. Weber SC, Sutherland GH. An unusual rotational fracture-dislocation of the

thoracic spine without neurologic sequelae internally fixed with a combined anterior and posterior approach. *J Trauma* 1986;26:474-9.

2. Carl AL, Tromanhauser SG, Roger DJ. Pedicle screw instrumentation for thoracolumbar burst fractures and fracture dislocation. *Spine* 1992;17(8 Suppl): 317-24.
3. Dickson JH, Harrington PR, Erwin WD. Results of reduction and stabilization of the severely fractured thoracic and lumbar spine. *J Bone Joint Surg Am* 1978;60:799-805.
4. Lindsey RW, Dick W. The fixateur interne in the reduction and stabilization of thoracolumbar spine fractures in patients with neurologic deficit. *Spine* 1991;16(3 Suppl):140-5.
5. Stambough JL. Posterior instrumentation for thoracolumbar trauma. *Clin Orthop Relat Res* 1997;335:73-88.
6. Francaviglia N, Bragazzi R, Maiello M, et al. Surgical treatment of fractures of the thoracic and lumbar spine via the transpedicular route. *Br J Neurosurg* 1995;9:511-8.
7. Sasso RC, Cotler HB. Posterior instrumentation and fusion for unstable fractures and fracture-dislocations of the thoracic and lumbar spine: a comparative study of three fixation devices in 70 patients. *Spine* 1993;18:450-60.
8. Moon MS, Choi WT, Moon YW, et al. Stabilization of fractured thoracic and lumbar spine with Cotrel-Dubousset instrument. *J Orthop Surg (Hong Kong)* 2003;11:59-66.
9. Kirkpatrick JS. Thoracolumbar fracture management: anterior approach. *J Am Acad Orthop Surg* 2003;11:355-63.
10. Sapkas GS, Papagelopoulos PJ, Papadakis SA, et al. Thoracic spinal injuries, operative treatments and neurologic outcomes. *Am J Orthop* 2003;32:85-8.
11. Liljenqvist U, Halm H, Castro WH, et al. Thoracic fracture-dislocations without spinal cord injury, a case report and literature review. *Eur Spine J* 1995;4:252-6.
12. Cotler JM. Introduction to thoracolumbar fractures. AAOS instructional course lectures. *Instr Course Lect* 1999; 48:427-8.
13. Yue JJ, Sossan A, Selgrath C, et al. The treatment of unstable thoracic spine fractures with transpedicular screw instrumentation: a 3-year consecutive series. *Spine* 2002;27:2782-7.

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