Total Vertebrectomy and Spine Shortening in the Management of Acute Thoracic Spine Fracture Dislocation

Technical Note and Report of 3 Cases

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Study Design: Case report of 3 thoracic spine fracture-dislocations with complete spinal cord section treated by total vertebrectomy—spine shortening through a posterior approach.

Objectives: To assess the usefulness and safety of this surgical technique in the treatment of acute thoracic spine fracture-dislocation.

Summary of Background: Total vertebrectomy can be used in different nontraumatic disorders. This surgical procedure has been used in the chronic phase of traumatic thoracolumbar dislocation. To our knowledge, the technique of total vertebrectomy and spine shortening in the acute phase of thoracic spine fracture dislocation has never been reported.

Material and Methods: Three patients who suffered thoracic spine fracture-dislocation with ASIA A paraplegia underwent complete vertebrectomy and spine shortening through a posterior approach. We report technical details, clinical, and radiologic results at 24 months minimum follow-up.

Results: Complete vertebrectomy of the fractured vertebra involved T5 in 1 patient, T7 in another, and T10 in the third. There were no perioperative complications. At latest follow-up, fusion was obtained in all 3. Overall sagittal and coronal alignment was restored.

Conclusions: Complete vertebrectomy and spinal shortening can be used in the acute phase to manage thoracic spine fracture-dislocations.

Key Words: Vertebrectomy, spine shortening, thoracic dislocation, thoracic fracture, spondylectomy, vertebral column resection

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Vertebrectomy was first described in 1922 by MacLennan[1] for the treatment of scoliosis through the posterior approach alone. This technique was subsequently used in the management of congenital,[2–5] tumoral,[6,7] infectious,[8–10] deformity,[11–15] and traumatic disorders[16,17] Sharrard[4,5] reported a technique of osteotomy-excision of the spine in the treatment of myelomeningocele. This procedure consisted of a dural dissection, excision of myelomeningocele, osteotomy-shortening of the spine, and internal instrumentation with Blount staples. Shimizu[7] reported a case of lumbar vertebrectomy and spine shortening in a patient who presented with a giant cell tumor of L6. He used a double approach to carry out this surgical procedure. Gaines[18–20] used a 2-stage technique of L5 vertebrectomy to treat high-grade spondylolisthesis.

Many authors have used posterior vertebral column resection for severe spinal deformities.[11–15] Vertebrectomy for posttuberculous kyphosis can be carried out through an anterior, posterior, or combined approach.[8–10] Barbera[16] reported the case of a young posttraumatic paraplegic patient (ASIA A), presenting with painful kyphosis owing to telescoped chronic dislocation of T12-L1. That author carried out en bloc spondylectomy with spine shortening 8 months after the accident.

In 2002, Reyes Sanchez[17] described a technique of partial vertebrectomy-shortening in the treatment of burst fractures. This technique consisted in resection of the proximal two-thirds of the vertebra. The posterior arch and upper disc were also removed. That permitted short segmental instrumentation with a high fusion rate.

To our knowledge, complete vertebrectomy and spinal column shortening in the acute phase of thoracic spine fracture-dislocation has never been reported. The purpose of our study was to assess the usefulness and safety of this surgical technique in the treatment of acute thoracic spine fracture-dislocation.

MATERIALS AND METHODS

Materials

We report the cases of 3 patients who presented with thoracic spine fracture-dislocation with ASIA A paraplegia at admission. All patients underwent one-stage posterior

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vertebrectomy of the fractured vertebra and spine shortening within a few days of their admission. The vertebrae involved were T10 (Figs. 1A, B), T7 (Figs. 2A, B), and T5 (Figs. 3A, B).

Methods

All 3 operations were carried out by the first author using the method described below. The fractured vertebra and adjacent discs above and below were completely removed. Long posterior instrumented fusion was carried out.

Surgical Technique (Fig. 4)

Incision and exposure: Under general anesthesia, the patient was placed prone on a Hall frame. Through a long midline incision, the vertebrae to be instrumented were exposed by subperiosteal dissection. Dissection was carried out laterally to the tips of the transverse processes except at the fracture level, in which exposure was extended to the costotransverse joint and first 3 centimeters of the ribs.

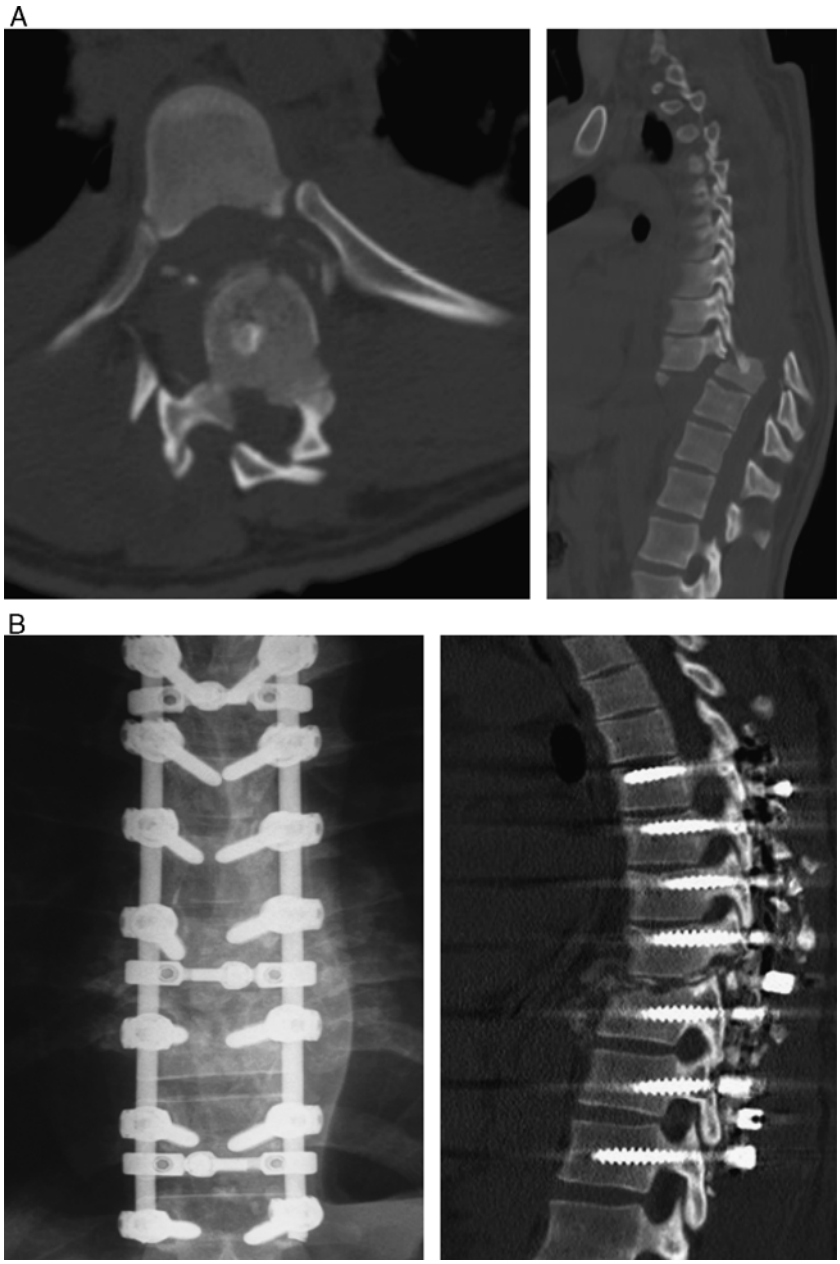

FIGURE 1. A, A 32-year-old man who presented with T10 fracture and T9-T10 dislocation after jumping from a fourth floor. Preoperative CT scan showing the fracture-dislocation and severe displacement. B, T10 vertebrectomy and spine shortening were done 28 days after trauma because of respiratory problems. Immediate postoperative radiography and CT scan showing good segmental alignment and the close apposition of the enplate of T9 on the endplate of T11. CT indicates computed tomography.

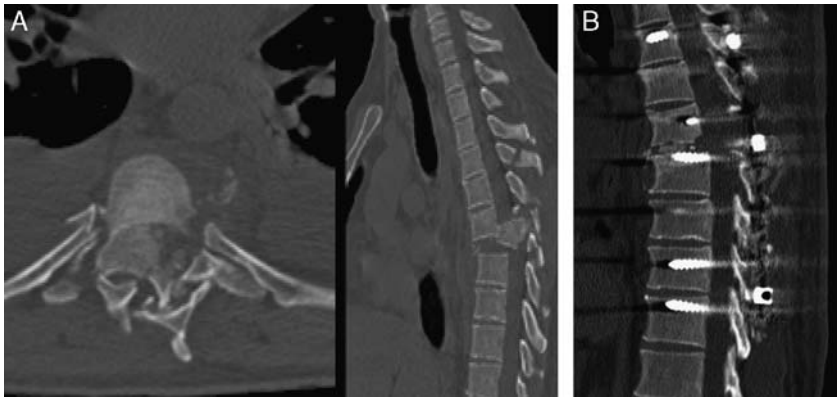

FIGURE 2. A, A 48-year-old man, who fell 6 meters while working, presented with T7 fracture and T6-T7 dislocation. Preoperative CT scan showing the fracture-dislocation and expulsion of the T7 vertebral body into the spinal canal. B, T7 vertebrectomy and spine shortening were carried out 8 days after the accident. Immediate postoperative CT scan showing good segmental alignment and close apposition of the endplates of T6 and T8. CT indicates computed tomography.

Operative findings: In all 3 cases, posterior arch fractures were present and mobile fragments were removed. The spinal cord was physically transected by the injury and the spinal canal was filled by fibrin clot and fibrous tissue. No cerebrospinal fluid leak was observed. In 2 cases, there was bilateral dislocation of the costotransverse and costovertebral joints at the level of fractured vertebra. This separation of the ribs from the spine allowed an easy approach to the lateral wall of the vertebral body. In the patient with no rib dislocation, it was necessary to resect the rib heads.

Instrumentation: In this kind of unstable fracture-dislocation, extended fixation is necessary. A minimum of 3 vertebrae below and above the fractured vertebra were instrumented. Only pedicle-screw fixation was used.

Vertebrectomy: First, we resected the posterior arch of the fractured vertebra. Pedicles and the caudal part of this vertebra were then removed in piecemeal fashion. The underlying disc was removed at that time. This stage was facilitated by the vertebral dislocation. It is essential to remove the inferior part of the vertebra and disc below to obtain good exposure of the dislocated superior part of the anteriorly displaced vertebra. The superior part of the vertebral body and the overlying disc were then carefully removed. Cautious resection must be used to remove the anterior part of the disc and vertebral body to avoid large vessel injury. These fragments have to be removed completely to obtain good reduction and bony endplate contact.

The vertebral body was then morcelized and used as bone graft. Both ends of the thecal sac were tightly ligated and closed separately. The remaining discs were excized. The inferior endplate of the overlying vertebra and superior endplate of the underlying vertebra were curetted until cancellous bone was exposed.

Reduction: At this point in the procedure, complete muscle relaxation was necessary. The rods were bent to the appropriate anatomic sagittal profile. The reduction of the dislocation by translation was straightforward because of the vertebrectomy. The rods were fixed first to the inferior pedicle screws and the proximal part of the spine was reduced by introducing simultaneously the

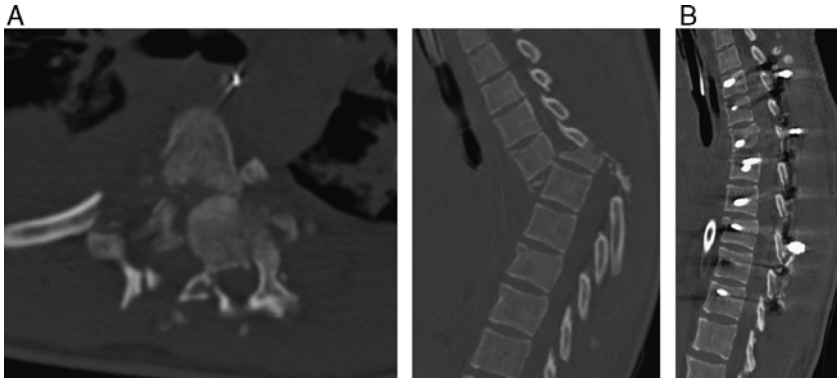

FIGURE 3. A, An 18-year-old woman who presented with T5 fracture and T4-T5 dislocation after a rock fell on her back while she was rock climbing. Preoperative CT scan showing the fracture-dislocation and severe displacement. B, T5 vertebrectomy and spine shortening were carried out 2 days after the accident. Immediate postoperative CT scan showing good segmental alignment and close apposition of the endplates of T4 and T6. CT indicates computed tomography.

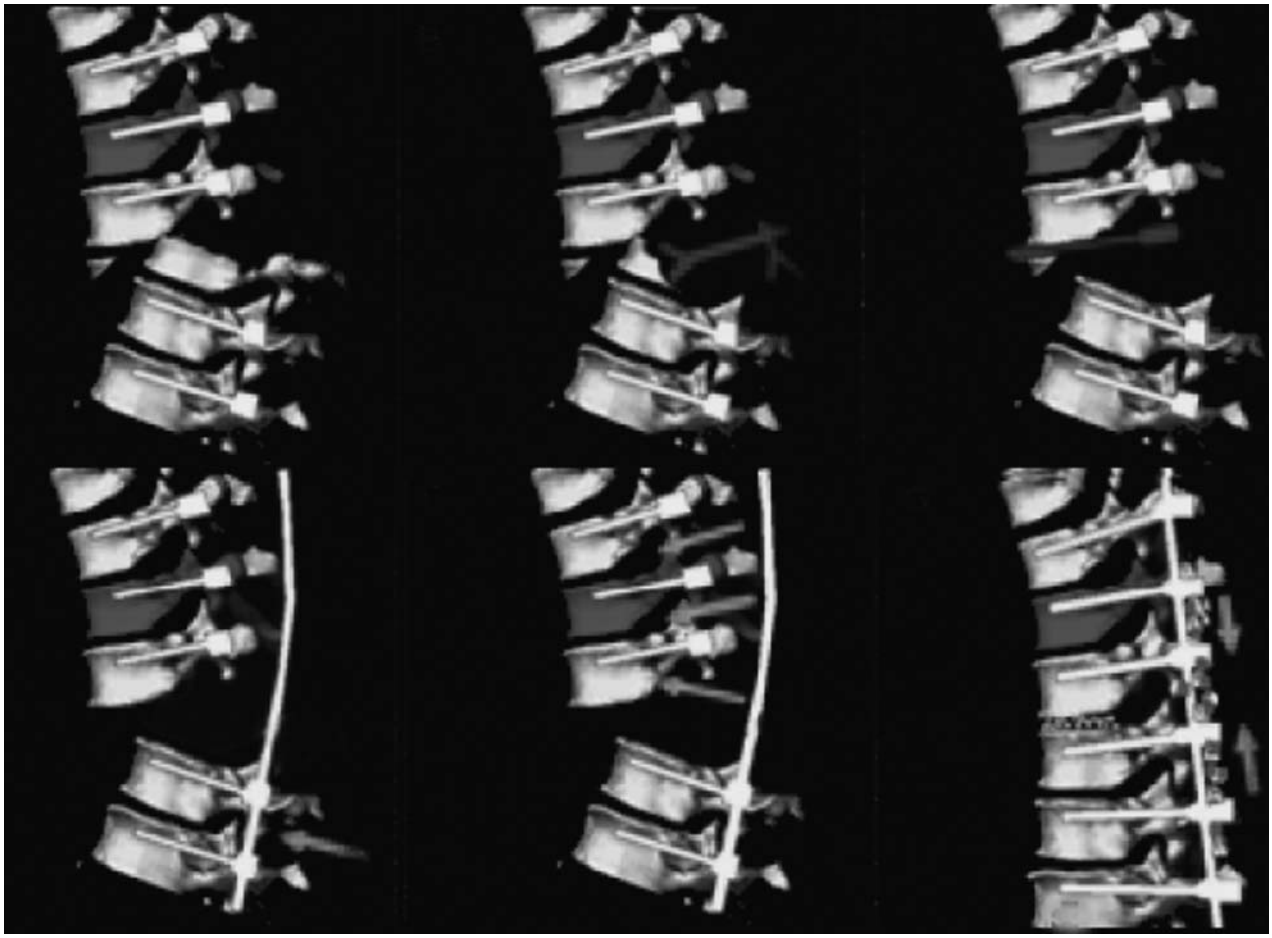

FIGURE 4. Steps of the surgical technique: Pedicle screw placement—resection of the posterior arch, of the inferior part of the vertebral body and underlying disk—resection of the anterior and superior dislocated part of the fractured vertebra and the disc above—complete disc resection and curettage of the endplates—fixation of the rods to the distal pedicle screws—reduction by translation—compression applied between the curetted endplates and posterolateral onlay of bone graft.

2 rods into the superior screw heads. Before tightening the fusion rod to the screws, the construct was submitted to axial compression to obtain firm contact between the exposed vertebral body endplates of the adjacent vertebrae. Cancellous bone graft was used to fill persistent anterior bone defects. Finally, cancellous bone from the vertebrectomy was used for posterolateral bone graft.

Wound closure: The wound was closed layer by layer and 1 closed suction drain was left at the resection level for 48 hours. The patients received prophylactic antibiotherapy for 48 hours. Immediate mobilization of the patients was authorized. None of them required an external orthosis and they began rehabilitation soon after the operation. Clinical and radiologic examinations were done at 3, 6, 12, and 24 months after surgery.

RESULTS

The characteristics of the 3 cases are presented in Table 1. Total vertebrectomy of the fractured vertebra were carried out at T5, T7, and T10, respectively. The mean operative time was 160 minutes (range, 120 to 210 min). The mean operative blood loss was 567 mL (range, 400 to 800 mL). The postoperative period was uneventful. The patients were able to sit on the third day without external immobilization, starting their early rehabilitation program.

TABLE 1. Patients Data

Case	Age	Sex	Follow-up (mo)	Fracture Level	Surgical Delay After Trauma (d)	Fusion Levels	Operative Time (min)	Operative Blood Loss (mL)
1	32	M	25	T10	28	T6-L1	210	800
2	48	M	25	T7	8	T4-T11	120	400
3	19	F	24	T5	2	T2-T10	150	500

The immediate postoperative x-rays showed an excellent reduction with good contact between the vertebras adjacent to the vertebrectomy. There were no perioperative local or general complications.

At latest follow-up, all the patients were autonomous and independent. There were no local or general complications and, at 24 months follow-up, all 3 patients were completely pain-free (VAS = 0). Follow up x-rays (Fig. 5) and CT-scans showed an excellent reduction and fusion in all cases without loss of correction. All patients had a harmonious thoracic kyphosis. There was no implant failure. Global sagittal and coronal alignments were restored.

DISCUSSION

Fracture dislocation of the thoracic spine is a rare spinal injury and is usually associated with paraplegia.[21,22] The major characteristics of thoracolumbar injuries that influence the surgical decision are injury morphology, neurologic status, and posterior ligament integrity.[23] In case of vertebral fracture dislocation, some authors recommend a posterior approach, or a combined approach.[23–25] An isolated anterior approach is probably not indicated in this situation.[23] The primary goals of surgical treatment of thoracic fracture dislocation with complete spinal cord transection are reduction of the deformity, rigid spine stabilization with fusion, and achievement of overall status permitting early rehabilitation.[24]

Posterior reduction and stabilization without consolidation of the anterior gap increases the risk of loss of reduction, failure of instrumentation, and pseudarthrosis.[25–27] If a combined approach is used, the patient is exposed to potential complications of posterior surgery, but, above all, to possible anterior complications, including pulmonary failure, persistent pleural effusion, hemothorax, chylothorax, dural-pleural fistula, damage to internal organs, vessel injury, postoperative ileus, infection, incisional herniation, intercostal neuralgia, and postthoracotomy pain.[28–30]

FIGURE 5. Patient 2—postoperative radiography 25 months after surgery.

Vertebral resection with spinal shortening has primarily been reported for the treatment of demanding cases of nontraumatic disorders and severe deformities.[2–16] To our knowledge, there are no earlier reports in the literature of total vertebrectomy-spine shortening for acute trauma.

There are several advantages to using the technique of total vertebrectomy-spine shortening for patients with acute fracture dislocation of the thoracic spine with large displacement. The fracture is treated through an isolated posterior approach. The direct contact between 2 healthy endplates permits an excellent reconstruction of the anterior spinal column. This apposition of the vertebral endplates under compression allows an excellent interbody fusion rate. The associated posterior segmental fixation provides a solid and strong construct with immediate stability allowing early mobilization and the sitting position.[2] An additional anterior approach is not necessary, because there is no anterior defect to fill. Moreover, this surgery can be carried out in the acute phase of the traumatism without additional delay. Bleeding loss and perioperative complications are acceptable.

Complete cord transection and traumatic dislocation of the rib heads facilitated spondylectomy. We think that one should always excise the entire proximal portion of the vertebra, particularly the anterior aspect of the superior endplate, to obtain good reduction and bony surface contact. Overall, however, the technique is quite straightforward. Total vertebrectomy facilitated reduction and shortening of the column avoided traction on adjacent vascular elements and seemed to be less traumatic for the adjacent structures. This procedure requires strong posterior segmental fixation.

Thoracic spine dislocation creates the most difficult biomechanical conditions for internal fixation. An application of an anterior spinal column support substantially decreases the transpedicular fixation load bearing and implant related complications.[31–34] Further, this anterior support allows the maintenance of physiological spine alignment.[35] Posterior interbody fusion through a total excision of intervertebral disc and bone grafting can be used in this case.[36] It can be achieved either by an anterior, posterolateral, or transforaminal approach. This technique represents a less invasive surgical option compared with spine shortening.

In our experience, the reduction of the dislocation was not possible for the first patient even after disc resection and it was necessary to resect the fractured vertebra to obtain good reduction. We have applied this technique to other patients who showed the same type of fracture and presented a major bone defect of the anterior column.

In our spine unit, we treated approximately 207 spine fractures in this timeframe and thoracic spine dislocation is a rare situation. This surgical technique was used only in 1.45% of patients treated in this period.

In case of incomplete cord injury, we use more conventional methods to obtain reduction and fusion, in most cases a double approach. However, in patients with complete cord injury, this technique is a straightforward means of restoring harmonious thoracic kyphosis and overall sagittal and coronal balance.

CONCLUSIONS

Total vertebrectomy and spinal shortening can be considered as an option in the management of thoracic spine fracture-dislocations in the acute phase. We recommend this technique when the spinal cord is physically transected. Through a posterior approach, it allows nontraumatic reduction, solid fixation, and rapid fusion of the vertebral column.

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