Damage Control Spine Surgery:
The Role of Minimally Invasive Spine Surgery for Complex Thoraco-Lumbar Fractures

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ABSTRACT

Orthopaedic spine trauma with or without neurologic injury can be a devastating disease. Especially in the face of multi-system trauma, an unstable spinal column can significantly compromise patient recovery during the first few days post-injury. Inability to mobilize the patient or even elevate the head of the bed can worsen pulmonary function and impede appropriate management for elevated intracranial pressures associated with a traumatic brain injury.

As an illustrative case, a patient with ankylosing spinal disease with multi-system trauma is presented, who sustained displaced T5-6 and T11-12 extension-distraction fractures. Urgent minimally invasive stabilization was performed and successful recovery resulted.

HISTORY OF PRESENT ILLNESS AND RADIOGRAPHS

This is a 61 year-old male (320lbs) with ankylosing spondylitis whom arrived at Shock Trauma Center at the University of Maryland Medical System after being struck as a pedestrian by a motor vehicle while walking his dog. Patient presented with a highly unstable spinal injury that consisted of an extension distraction injury at two independent levels in the thoracic spine. These occurred at T5-6 and T11-12. As a result, this left the entire T6 to T11 segment of the vertebral column disconnected from the upper and lower spinal column (Figure 1). The patient also presented with multiple accompanying injuries including a left humerus fracture requiring an open reduction internal fixation and hemi-arthroplasty replacement, a left tibial plateau fracture requiring open reduction internal fixation, multiple left sided rib fractures, splenic and liver lacerations, and a pulmonary contusion requiring a left-sided chest tube. Additionally, patient had an intra-cranial bleed for which 30% of the skull bone was removed to decompress the brain. The patient was spontaneously moving his bilateral upper and lower extremities.

Upon arrival to the Shock Trauma Center, the patient was intubated and sedated. Following his complete trauma evaluation, the patient was stabilized from a head, chest, abdominal, and extremity perspective. Due to the high degree of instability associated with this unique fracture pattern in the face of ankylosing spondylitis, the size of patient and his associated chest and intracranial injuries, the decision was made to urgently stabilize the spine surgically.

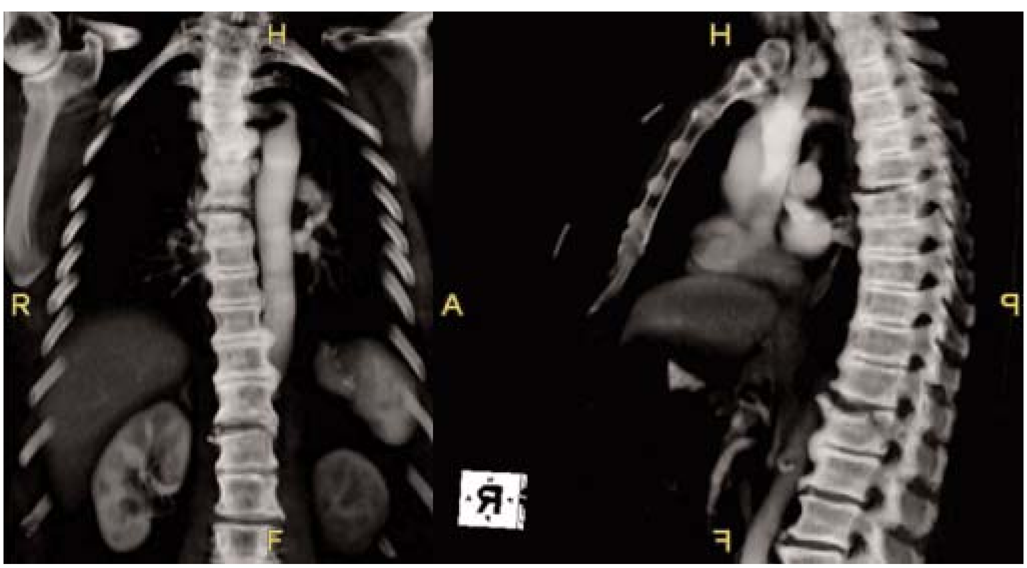

Figure 1
Sagittal and coronal reconstructions of the initial CT-scan, clearly exhibiting the T5-6 and T11-12 extension-distraction injuries in the face of ankylosing disease of the spinal column.

TREATMENT METHOD AND MATERIALS

The goals of the operation for this patient were to stabilize the spine by the least morbid approach; to enable mobilization and allow for immediate rehabilitation while preserving his neurological function and prevent against any neurological deterioration. Allowing for immediate mobilization would prevent this polytraumatized patient from suffering the morbidity associated with prolonged spinal recumbency including, but not limited to: respiratory distress, multi-system organ failure, systemic infection, elevated intracranial pressure complications, decubitus ulcers and death. All of the goals could be accomplished through a posterior approach via a standard open incision or via a minimally invasive surgical approach. Due to the concern for large intra-operative blood loss, prolonged surgical time, the increased risk for postoperative wound infection and the need for tight control of his intracranial pressure, the decision was made to stabilize the thoracic spine using a minimally invasive approach.

A careful analysis of the thoracic pedicle morphology was performed on the preoperative CT-scan. Pedicle dimensions and screw lengths were determined based on this analysis. Using isolated AP-fluoroscopy, the pedicles of T4 through L2 were cannulated in a percutaneous fashion using the standard Jamshidi needles and guidewires. The appropriately sized cannulated VIPER™ screws (DePuy Spine, Raynham, MA) were then inserted percutaneously over the guidewires using all "closed" pedicle screw extensions. Screw placement was verified using biplanar fluoroscopic images after all screws were placed. A total of 17 screws were inserted into 9 vertebral bodies. Rod length was determined by measuring the distance from the two bookend screw extensions using a template rod. Two 480 mm EXPEDIUM™ 5.5 mm Titanium-alloy rods (DePuy Spine, Raynham, MA) were then cut to size.

The rods were lightly pre-contoured to mimic the curvature of the kyphotic and lordotic spine from T4 to L2. Confirmation of the sagittal plane contour was performed by placing the rod on the patients skin in line with the screw extensions. Using a heavy rod holder, the two rods were inserted subfascially through the most apical screw extension and subsequently advanced into the slots of the distal screws using light manual pressure, ending inside the most caudal extension at L2 bilaterally. Both rods were placed percutaneously in all screw leads by this method. The rod was "directed" when necessary by manipulating the extensions and the rod position/rotation. Rod placement was verified by using fluoroscopic imaging (Figure 2a). Once in final position, the rods were locked down with set the "innie" screws (Figure 2b).

Figure 2a
Hand-feeding the rod (patient head to the right) from the most cranial screw extension to distal. The rod was directed in 'upside-down' (lordotic) fashion and turned 180 degrees as soon as the before-last screw head was reached with the tip of the rod in the lumbar spine.

Figure 2b
Lateral intra-operative picture showing all screw extensions and the normal sagittal curvature of the spine (head to the right).

The entire bilateral procedure was completed in approximately 90 minutes. Total fluoroscopy time was nearly 3 minutes. The total blood loss associated with the procedure was approximately 200 ml from the skin incisions for all screw extensions (Figure 3). Comparatively, if this case was performed in an open fashion, the estimated operative time would have approached 3.5 hours with similar fluoroscopic time and blood loss approaching a potential of multiple liters.

FOLLOW-UP RESULTS

Immediately post-op, the patient was allowed to be mobilized out of bed to chair. Follow-up wound healing is shown in Figure 4. After four months of rehabilitation form his multi-organ system involvement and brain injury, the patient has had an excellent recovery with no complications or neurologic symptoms related to his spinal injury. He presently has no complaints of thoracic pain. AP and lateral radiographs obtained 4-month postoperatively demonstrated evidence of healing with maintenance of alignment of the thoracic spine (Figure 5). The patient had no complaints of incisional or muscle pain and the incisions were observed to have healed completely with minimally scarring. (Figure6).

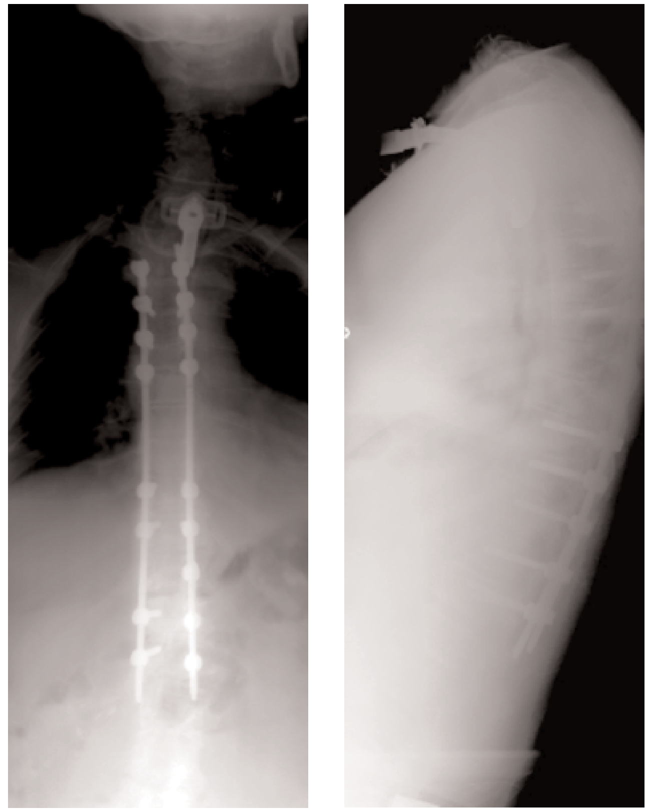

Figure 4
Final post-op radiograph.

Figure 3

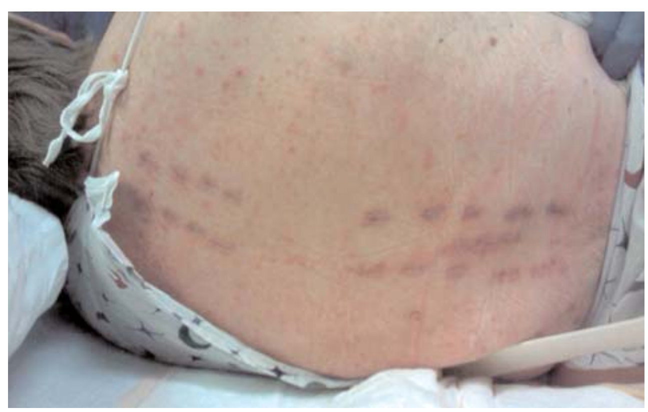

Figure 5
Image of the patient's back 3 months post-op.
Note the minimal scarring.

CONCLUSION

This case demonstrates the successful use of damage control spine surgery using minimally invasive techniques for complex thoracic spinal trauma. Due to the extent of the accompanying multi-system organ injuries, achieving spinal stability in the least morbid fashion was of the utmost importance. The flexibility and tactile feedback of the percutaneous VIPER system proved to be an optimal solution in this situation where few other reasonable options existed.

Figure 6

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