Surgical Management of High Thoracic Spine Injuries Resulting in Instability or Spinal Cord Injury

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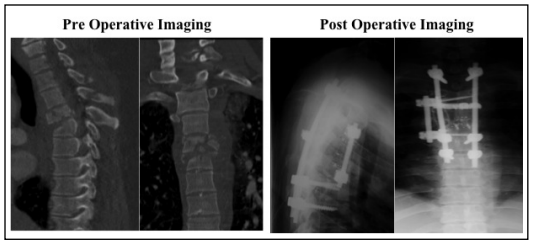
INTRODUCTION

Fractures of the upper thoracic spine, T1-T5, provide a challenging surgical environment, even for the most skilled spinal surgeons. These fractures are difficult to access because of the surrounding structures unique to this location such as the heart, the great vessels, and the apices of the lungs. Currently, these high thoracic fractures can be approached in a variety of ways - Anterior thoracotomy, Lateral extracavitary, Posterolateral, or a combination of each of these. Herein, the authors present a series of 9 patients who presented with T1--T5 pathology resulting in spinal cord compression or unstable fractures that were managed surgically through these various approaches.

ANTERIOR THORACOTOMY

History: 28yo M with neck, back and leg pain after high speed MVC. +EtOH.
Physical Exam: Grossly Intact
Radiology: Comminuted T4 fracture dislocation with T5 superior vertebral body fracture with spinal instability and increased kyphotic angulation with multiple spinous process fractures.

STAGED SURGICAL APPROACH:
Access Surgeon: Right anterior lateral thoracotomy for thoracic spine exposure, resection of 5th right rib. **Stage 1:** T4 corpectomy, placement of expandable PEEK cage, T3 to T5 arthrodesis with autograft. **Stage 2:** T2 to T7 posterolateral arthrodesis, T2 to T7 posterior segmental fixation with pedicle screws at T2, T6, and T7.



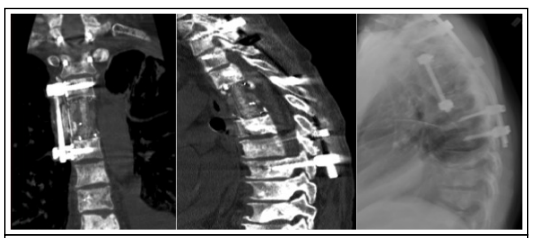
OUTCOME
5/5 strength and sensation in BUE and BLE. Ambulating without diffculty Post-operative imaging demonstrating solid fusion.

ANTERIOR THORACOTOMY with ICM

History: 53yo F h/o metastatic breast CA with mets to the spine on XRT & chemo presents with progressively worsening back pain with acute weakness in the lower extremities x3 days with inability to ambulate.
Physical Exam: 5/5 strength BUE in all groups. dense paraparesis, hyper-reflexia, inability to ambulate and a sensory level at T5-T6,+ Babinski.
Radiology: Pathologic fracture at the T4 level resulting in kyphosis and subluxation of T3 on T5

STAGED SURGICAL APPROACH:
Access Surgeon: Right anterior lateral thoracotomy for thoracic spine exposure, partial resection of 4th right rib. **Stage 1:** T4-T5 corpectomy, placement of expandable PEEK cage, T3 to T6 arthrodesis with autograft. Intercostal flap to the graft. **Stage 2:** Posterior decompression T4, T5. Posterior fusion T1-8 with pedicle screws.

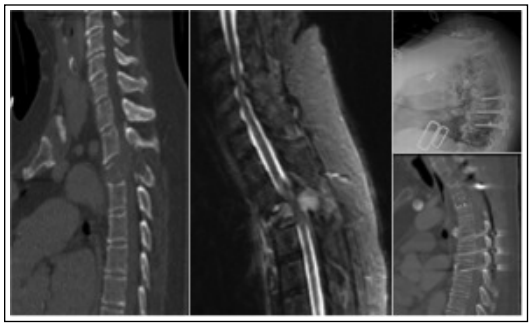
OUTCOME: Post-operatively, the patient had a significant return of motor/sensory function and regained the ability to easily ambulate with a cane. Panel immediately above shows the two-year follow-up imaging demonstrating solid fusion of the vertebral column and restoration of height following two-level corpectomy, radiation, and several rounds of chemotherapy.



ADVANTAGES	DISADVANTAGES
• Decompression of ventral spinal cord under direct visualization. • Anterior/Middle column reconstruction & stabilization • No disruption of the posterior column. • More thorough corpectomy • More secure cage placement • More bone can be packed • More points of fixation • Shorter posterior fusion construct	• An access surgeon is needed. • Some patients will not tolerate single-lung ventilation. • Approach morbidity includes possibility of: great vessel injury, pulmonary structure injury requiring the need for a chest tube, and intercostal neuralgia.

LATERAL EXTRACAVITARY

History: 74yo F h/o fungating breast mass presents with BLE weakness with associated numbness below nipple line to feet for 2 days.
Physical Exam: 5/5 strength & sensation in BUE. RLE: psoas 3/5, hamstring 2/5, quad 2/5, DF 2/5, PF 2/5. LLE: 0/5. Sensation decreased or negative sensation below bilateral breasts. Patchy areas of "tingling" to touch in areas inferior to umbilicus. Unable to discern sharp vs dull in BLE. Diminished rectal tone and unable to bear down. Tenderness to palpation of thoracic spine
Radiology: Pathological fracture T3 secondary to metastatic disease. Spinal cord compression from anterior and left lateral and posterior tumor compression. Probable breast cancer. T2 on T4 anterior spondylolisthesis



SURGICAL APPROACH: T3-T5 laminectomy with epidural tumor resection. Left T3-T4 costovertebral approach with paraspinal tumor resection involving the proximal rib and the T3 pedicle. Lateral extracavitary approach to T3 vertebral corpectomy. Placement of interbody expandable cage between T2 and T4 vertebral bodies (T2-4 anterior arthrodesis). Pedicle screw fixation T1-T2 and T6, T7, and T8. Posterolateral arthrodesis T1-8.

OUTCOME: Sensation: 5/5 in BUE & BLE. Motor: 5/5 Bilateral deltoid, biceps, triceps. 3/5 RT quadriceps. 4/5 RT hamstring. 3/5 LT quadriceps. 4/5 LT hamstring. Thoracic spine xray shows stable hardware and cage with good reduction of T3 pathologic fracture.

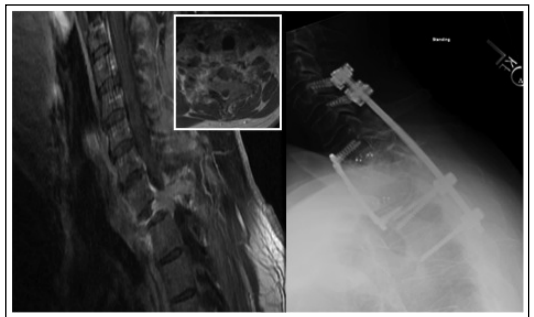
ADVANTAGES	DISADVANTAGES
• NO ACCESS SURGEON • Exposure of both the ventrolateral & dorsal aspects of the spine in ONE APPROACH • Allows maximal protection of the neural structures by mobilizing abnormal tissue away from neural elements, rather than toward them • Initial anterior decompression, which is followed by posterior reduction of the deformity → posterior fusion can be accomplished if necessary	• Not as clean – may still have some vertebral body left behind on contralateral side • No additional security of lateral vertebral body screws • Need longer posterior fusion construct, maybe 3-4 levels above and below, to prevent possibility of perijunctional kyphosis

MANUBRIUM SPARING

History: 44yo M h/o progressive neck pain with radiation down his right arm and weakness.
Physical Exam: : Motor: 5/5 BLE & LUE, 5/5 RUE except 4/5 grip. Sensory: Sensation intact except RUE ulnar distribution.
Radiology: Metastatic disease with T1 pathological fracture with complete collapse of the vertebral body, kyphotic deformity, subluxation, and compression on the spinal cord.

STAGED SURGICAL APPROACH:
Stage 1: Anterior T1, T2 corpectomy, with tumor resection. Placement of an expandable intervertebral PEEK cage C7 –T3 arthrodesis with correction of subluxation. **Stage 2:** Posterior segmental fixation with lateral mass screws at C5, C6, and pedicle screw fixation at T3 and T4. Posterolateral arthrodesis at C5-T4.

OUTCOME: 5/5 strength in BUE and BLE, with exception of 4/5 RT grip strength. Sensation intact in BUE and BLE. Normal gait. No swallowing difficulty. Post operative imaging showed decompression of spinal cord with stable hardware placement.



MANUBRIUM SPARING

- May be able to access T1-T3 anteriorly without splitting the sternum (aka manubrium sparing) but this is dependent on patient anatomy – able to utilize this with patients with long thin necks.
- Make sure to take a LT sided approach to avoid injury to recurrent laryngeal nerve.
- Use a longitudinal incision so you have more stretch up and down (ie intraoperative view can be expanded)

RESULTS & CONCLUSIONS

Treatment Algorithm