Case Report

**Novel method for stepwise reduction of traumatic thoracic spondyloptosis**

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**Abstract**

**Background:** Spondyloptosis involving complete subluxation of spinal vertebrae resulting in permanent spinal cord damage is rarely caused by high-force trauma. Rapid re-stabilization of the spine is crucial for maximizing chances of neural recovery and can significantly improve the patient’s quality of life. In this case study, we describe the challenges associated with the surgical management of traumatic thoracic spondyloptosis, and propose a novel, safe, step-wise, spinal reduction method employing an inflatable beanbag.

**Case Description:** A 17-year-old male fell 25 feet from a tree, resulting in anterior spondyloptosis at the T11/12 level. He presented with paraplegia and a T11 sensory level to pin below the umbilicus. Surgical management involved a posterior-anterior-posterior approach with initial posterior decompression, then T12 corpectomy and reconstruction and finally pedicle screw fixation. We utilized an inflatable beanbag to realign the spinal column in a stepwise fashion, thereby minimizing the risk of damage to the surrounding structures, including the thecal sac and great vessels. Postoperatively, the patient regained some sensory function below his injury level of T11 but remained plegic. X-ray imaging confirmed successful spinal fusion.

**Conclusion:** Early spinal realignment and stabilization following spondyloptosis at the T11/T12 level resulted in some improvement in sensory function without resolution of motor plegia. Here, we described how to utilize a novel beanbag reduction method to safely achieve stepwise spinal realignment.

**Key Words:** Fracture dislocation, pediatric, spine, spondyloptosis, subluxation, trauma

**INTRODUCTION**

Sagittal spondyloptosis, defined as total subluxation (≥100%) of one vertebra on another, is rare, especially in the thoracic region. The underlying mechanism of injury is typically high-energy/impact trauma (e.g., motor vehicle collisions or critical falls) causing complete cord transection, resulting in paralysis in approximately 80% of the cases. Since 1953, seven case reports and four case series have described traumatic thoracic...
spondyloptosis.\textsuperscript{[1‑10,12]} Early stabilization facilitates timely mobilization and rehabilitation.\textsuperscript{[5,12]} Here, we report a patient who sustained a critical fall resulting in spondyloptosis at the T11/12 level, resulting in paraplegia with a T11 sensory level. Surgery involved a multistage decompression and reconstruction procedure using a unique sandbag-assisted step-wise reduction technique.

**CASE DESCRIPTION**

**History and examination**

A 17-year-old male sustained a 25-foot fall from a tree, resulting in multiple posterior spinal fractures from T9-12 with sagittal, anterior spondyloptosis at the T11/12 level. He presented with a full motor/sensory paraplegia at the T11 level (ASIA A spinal cord injury). Computed tomography (CT) of the thoracic spine showed acute fracture dislocation at the T11/T12 level, suggesting complete cord transection, and an epidural hematoma from T4-T12 [Figure 1a-c]. He also had a right lung contusion accompanied by a pneumothorax and small pneumatocele.

**Operation**

The patient underwent T10-L1 laminectomies with Ponte ostomies at T11/12 to facilitate reduction of the fracture from the lateral approach. This was performed to prevent fracture fragments from injuring the spinal cord during reduction. In the lateral decubitus position on a beanbag, a thoracotomy was performed to expose T10-T12 and complete a T11 corpectomy with adjacent discectomies. To reduce the dislocation, we used a Cobb to elevate T10 superiorly while manually pushing the distal portion of the spine from the patient’s back. This was repeated multiple times for stepwise reduction of the bony elements, with deflation and re-inflation of the sandbag to maintain reduction, until adequate alignment was achieved [Figure 2a-i]. An interbody cage was then placed between T10 and T12. The patient was then turned prone again and was internally fixed from T8 to L2 with pedicle screws/rods [Figure 3a and b].

**Postoperative course**

His length of stay was 11 days. On postoperative day one, he exhibited neurogenic shock. His complete spinal cord injury with a T11 sensory level remained stable throughout to postoperative day 10. He began to regain some patchy sensation to the bilateral lower
Table 1: Summary of individual studies of traumatic thoracic spondyloptosis [1-10,12]

| Author, Year | N, gender, age | Injury Level | ASIA Score | Plane of dislocation | Procedure | Reduction Method | Outcome |
|--------------|----------------|--------------|------------|----------------------|-----------|------------------|---------|
| Mishra et al., 2015 | 20: 19 treated surgically, 17 males, 2 females, aged 12-45 | T4/5 (1) A | Sagittal | L3-5 L, T3-6 PSF | Abdominal pressure applied placing one hand below the abdomen over sterile drapes, distraction done by placing a contoured rod on one side of column, then once reduced, another rod was placed on the opposite side, followed by transpedicular corpectomy if necessary | No neurological improvement |
| | | T5/6 (2) A | Sagittal (1) Coronal (1) | T3 and T7/8 PSF; T4-7 PSF | No neurological improvement |
| | | T6/7 (1) A | Coronal | T6 L, T4-7 PSF | No neurological improvement |
| | | T8/9 (3) A | Coronal (2) Sagittal (1) | T9 C, T8-9L, T7/8 and T10/11 PSF; T8-9 C, T7-11 PSF; T9 C, T7-8 and T10-11 PSF | No neurological improvement |
| | | T11/12 (1) A | Sagittal | T11 C | Death |
| | | T12/L1 (5) A | Sagittal (5) | L2-3 L; T12-L1 L, T10-11 and L1-2 PSF; T11-L3 L, L1 partial C, T11-12 to L2-L3 PSF; Partial L1 C, L1 L, T11-L2 PSF; T11-12 and L1-2 PSF | No neurological improvement (4), Death (1) |
| | | | | L1-2 (5) A | Coronal (3) Sagittal (2) | L1-2 L, T11-12 and L1-2 PSF; L2 C with T12, L1, L3-4 PSF; T12, L1, L3-4 PSF; T11-12 and L1-2 PSF; T11-12 and L3-4 PSF | No neurological improvement (3), Death (2) |
| | | | | L4/5 (1) A | Coronal | L2-5 PSF | No neurological improvement |
| | | | | S1/2 (1) A | Sagittal | L2 fracture PSF, S1-2 listhesis treated conservatively | No neurological improvement |
| Yadla et al., 2008 | 5: 3 males, 2 females, aged 17-44 | T7/8 A | Sagittal | T3-11 PSF, anterior T7 C | Not detailed | No neurological improvement |
| | | T10-12 A | Sagittal | T3-L1 PSF | No neurological improvement |
| | | T12 A | Sagittal | T8-L1 PSF | Not detailed |
| | | T12/L1 A | Sagittal | Posterior thoracic fusion | No neurological improvement |
| | | | | T10-L3 PSF, anterior T11-L2 fusion, partial L1 C | No neurological improvement |
| | | | | T10-L4 PSF, L1-3 L, partial L1-2 C | No neurological improvement |
| | | | | L1-2 C | Coronal | T10-L4 PSF, L1-3 L, partial L1-2 C | Recovered ambulation, successful fusion |
| Chandrashekara et al., 2011 | 4: all males, aged 10-27 | T11/12 A | Sagittal | T10-12 and L2 PSF | Pedicle screw and rod fixation to realign vertebral column | No neurological improvement |
| | | T12/L1 A | Sagittal | T11 and L2 PSF | No neurological improvement |
| | | L3/4 A | Coronal | L1/2 and L4/5 PSF | No neurological improvement |
| | | L4/5 A | Sagittal | L2-5 PSF | Mild improvement |

Contd...
extremities levels starting 2 weeks after surgery, with return of sensation at the T11-T12 levels by 2 months post-operation. Although sensory function continues to improve, he remains paraplegic below T12. Three months post-operation, he started to develop a flexible scoliosis of his lumbar spine, which progressed [Figure 4a and b], which was successfully managed with bracing.

### DISCUSSION

Traumatic thoracic spondyloptosis is an uncommon injury. There have been four case series and seven case reports published involving a total of 38 patients with traumatic spondyloptosis [Table 1].

| Author, Year | N, gender, age | Injury Level | ASIA Score | Plane of dislocation | Procedure | Reduction Method | Outcome |
|--------------|----------------|--------------|------------|----------------------|-----------|-------------------|---------|
| Sekhon et al., 2007 | 2: both males, aged 22 and 36 | T6/7 | A | Sagittal | T5-9 L and PSF, rods connect T5, T7, T8 | Manual distraction, reduction with M8 spondylolisthesis reduction forceps (Medtronic) | No neurological improvement, successful fusion |
| | | T12/L1 | A | Sagittal | T11-L1 L, T12/L1 discectomy and T11-L2 PSF | TSRH pedicle screw system (Medtronic) for distraction, placement of intervertebral body spreader | No neurological improvement |
| Rahimizadeh et al., 2015 | 1: male, 29 | T2/3 | A | Sagittal | T2 C, C6-T7 PSF | Temporary rod placement, gentle distraction | No neurological improvement, successful fusion |
| Sandquist et al., 2015 | 1: male, 20 | T12/L1 | A | Sagittal | L1 C, T8-L4 PSF | Spine aligned naturally after L1 vertebrectomy | No neurological improvement, successful fusion |
| Cappuccio et al., 2014 | 1: male, 49 | T3/T4 | A | Sagittal | T4 C, T1-8 PSF | Not detailed | No neurological improvement |
| Hasturk et al., 2013 | 1: male, 20 | T5/6 | A | Sagittal | T6C, T3-8 PSF | Rod compression maneuver | No neurological improvement |
| Gitelman et al., 2009 | 1: male, 30 | T6/7 | E | Sagittal | T1-3 and T7-9 PSF, T5-7 L | Not attempted | Independent ambulation, neurologically intact, successful fusion |
| Lee et al., 2004 | 1: male, 32 | T8/9 | A | Sagittal | T5-7 and T9-10 PSF | Manual distraction with pedicle screws as lever | No neurological improvement |
| El Masri et al., 1983 | 1: male, 21 | T8/9 | C | Coronal | Treated conservatively | N/A | No neurological improvement |

C: Corpectomy, L: Laminectomy, PSF: Pedicle screw fixation

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**Figure 3:** Anterior-posterior (a) and lateral (b) radiographs of spinal construct immediately postoperatively

**Figure 4:** Anterior-posterior (a) and lateral (b) radiographs of spine six months postoperatively showing increased scoliosis
TSRH pedicle screws (Medtronic Sofamor-Danek) to reduce the dislocated vertebral body. However, our patient had comminuted fractures of the pedicles, thus precluding this technique.

Here, we utilized a new technique employing sequential sandbag deflation and reinflation to attain a stepwise correction of alignment. With multiple cycles of inflating and deflating the sandbag in lateral decubitus position, with light Cobb distraction, the dislocation could be incrementally reduced. Advantages of this technique included minimizing risk of the spinal cord injury and accidental durotomy. The 360-degree decompression, reduction, and circumferential reconstruction also increased construct stability.

CONCLUSION

Thoracic spondyloptosis is an uncommon injury. Stepwise decompression, step-wise reduction utilizing a sandbag method, and fusion allows for 360-degree correction of the deformity while reducing the risk of potential complications.

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Conflicts of interest
There are no conflicts of interest.

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