Complex multilevel lumbar spine fractures with transverse sacral fracture

Kshitij Chaudhary, Prabodhan Potdar, Mihir Bapat

Abstract
We report an unusual and complex case of spinal trauma in a 17-year-old boy who presented with a transverse sacral fracture associated with multiple-level lumbar fractures, paraparesis, and bladder involvement. A two-stage surgery was performed. The lumbar spine fractures were treated with posterior instrumented correction of displacements, followed by anterior instrumentation and fusion. The sacral fracture was left untreated. At 5-year followup, the patient had complete neurological recovery except for the right L5 root function. The long-segment lumbar fusion and the untreated displaced sacral fracture contributed to spinal imbalance, due to which the patient is now able to stand only in a crouched posture. Determining the optimal treatment for the case is presented due to the relative rarity of transverse sacral fracture and paucity of evidence-based treatment approaches. In patients with associated lumbar spine fractures that require extension of instrumentation to the upper lumbar spine, it is critical to restore sacropelvic alignment to achieve spinal balance. Adequate reduction of sacropelvic anatomy can be achieved with iliac screw fixation.

Key words: Lumbar spine fracture, spinal imbalance, transverse sacral fracture, dislocation lumbar spine

Introduction
Transverse sacral fractures (TSFs) are rare and a well-designed treatment protocol for these fractures does not exist.\(^1\,\|^2\) Literature abounds with reports on complex spinal fractures that confuse the available classification systems.\(^1\,\|^2\) We report an unusual case TSF associated with multiple lumbar spine fractures in a 17-year-old boy. This unusual fracture pattern has not been described previously in English literature. The surgical outcome and shortcomings of the treatment method we adopted are highlighted.

Case Report
A 17-year-old boy fell from a height of 15 meters and landed on both feet. After a delay of 6 hours, he presented with hypovolemic shock and was treated for the same. The abdomen was tender on palpation. Local examination of the spine revealed tenderness and bruising over the lower lumbosacral area. The sacrum was unusually prominent. Neurological examination revealed complete motor paralysis except for a flicker of movement in the left toe. The deep tendon reflexes were absent in the lower limbs. Sensation was reduced below the groin. Sacral sensations were preserved. Anal wink and the bulbocavernosus reflex were present. The patient had a painful distended bladder and had to be catheterized.

The following injuries were diagnosed using radiographs, CT, and MRI (Figures 1 and 2):
1. Transverse sacral fracture at S3, with 82° of kyphosis
2. Pedicle fractures of L3 to L5 (bilateral) and S1 (left)
3. Intrapelvic intrusion of spine between L3 and S2, causing a shortened vertical height of the lumbar spine, with L5-S1 and L4-L5 intact discs
4. Dislocation of L3-L4 and L2-L3, with retrolisthesis
5. Superior end-plate fracture of L3, with retropulsed fragments
6. Bilateral sacroiliac joint disruption
7. Left trimalleolar ankle fracture
8. Bilateral intra-articular calcaneum fractures
9. Splenic laceration

The patient was operated in the prone position 12 hours...
after presentation. The fractured ‘floating’ laminae (L3–L5) were excised. Bilateral roots were identified from L3 to S3. The right L5 root was discontinuous at the level of the dorsal ganglion and the cut end was severely contused and crushed underneath the fractured L5 pedicle. The distal end of the root had retracted into the muscle and could not be found. No dural leak was detected. Retropulsed fragments of the L3 fracture were excised. Distally, the broken pedicles of L5 were directly cannulated. Longer screws were used for a bicortical purchase. The right S1 was used as the distal-most fixation point. The vertebral column was reduced using contoured rods. The surgery lasted for 6 hours, with a total blood loss of 1000 ml.

The patient regained ability to void and the catheter was removed on the 7th postoperative day. Two weeks later, with an anterior retroperitoneal approach, the disrupted L3-L4 and L4-L5 discs were fused using cages and autogenous iliac crest bone graft. An anterior rod–screw construct was used between L1 and L5 [Figure 3]. The surgical time was 5 hours and the blood loss was 500 ml.

The patient was nursed in bed for 6 weeks. Lower limb power recovered to grade 5/5 except for the right ankle и toe dorsiflexors, which remained grade 0. The patient started ambulating with support at 2 months and resumed college at 6 months. Followup CT scan was done after 6 months [Figure 4]. The sacral fracture had fused in a kyphotic position (77°). Standing radiographs were used to analyze sagittal and coronal alignment [Figure 5]. At 5 years, the patient has occasional pain at the sacral prominence on prolonged sitting. He stands adopting a crouched posture. He has a slight truncal shift to the right side [Figure 6]. He does not complain of bowel, bladder, or sexual dysfunction.

**DISCUSSION**

TSFs are called suicidal jumper’s fractures. Although not a suicide attempt, our patient suffered a fall from a height. The fractures in the lower limbs (calcaneal and plafond fracture) suggest that the patient landed on his feet.

The Denis classification is based on the anatomical location.
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Figure 3: (a) Anteroposterior and lateral radiographs following first-stage posterior instrumentation surgery; (b) anteroposterior and lateral radiographs shows anterior and posterior instrumentation

Figure 4: Sagittal reconstruction CT scan at 6 months followup showing (a) fusion at the sacral fracture and the (b) L2-L3 and L3-L4 level

Figure 5: Standing anteroposterior and lateral radiographs of the whole spine at 5 years' followup showing implant *in situ*

Figure 6: Clinical photographs showing crouched posturing (a) and a left-sided flank crease (b and c)

Figure 7a: Evidently, zone 3 fractures have the highest prevalence and severity of neurological compromise. TSFs are included in zone 3, but often involve all three anatomical zones [Figure 7b]. TSFs are classified into four patterns. However, this classification is incomplete and describes only fractures occurring in the upper part of the sacrum (high TSFs) [Figure 7c]. Low TSFs, which usually occur at the apex of the sacral kyphosis (S3), occur due to direct impact against the lower sacrum [Figure 7d]. In contrast, high TSFs are the result of indirect injury.

Two major forces act in opposite directions on the upper part of the sacrum (S1-S2). The ground reaction force acting upward creates a momentum of rotation that tries to rotate the pelvis and make the sacrum vertical. The weight of the patient acting downward over the superior end plate of S1 tries to force the sacrum into the horizontal position [Figure 8a]. The upper part of the sacrum (S1-S2) is the last to ossify and hence is the weakest region; this results in a high TSF. S1 and S2 articulate with the pelvis via the sacroiliac
joint. Therefore, for displacement to occur, the horizontal fracture line of a high TSF has to propagate vertically upwards through the neural foramina, resulting in lumbopelvic dissociation. The TSF in the presented case is unusual in that it has the characteristics of a high TSF but its location is typical of a low TSF; i.e., at the S3 level. Displacement of the proximal sacrum occurred due to disruption of the sacroiliac joints and not due to vertically propagating fractures through the neural foramina [Figure 8b and c]. To the best of our knowledge such a fracture pattern has not been described earlier in literature.

In such cases, the incidence of coexisting spinal injuries (usually in the thoracolumbar region) is 62%. The probable mechanism of injury can be postulated by analyzing the fracture pattern. At impact, the stiffer thoracic spine is driven into a lordotic lumbar spine, causing a retrolisthetic dislocation at the L2-L3 level. The spine is fractured in the axial plane at the S3 and the L3 level. In our patient, multiple intervening vertebrae had bilateral pedicle fractures and this allowed the middle segment to displace anteriorly, leaving behind the posterior elements, thereby averting permanent neurological damage.

Ninety-seven percent of patients with TSFs present with some neurological deficit. In the acute setting, a Foley catheter and other confounding variables can mask voiding problems, resulting in delayed diagnosis of neural injury. In our patient, the extent of sacral root injury (urinary retention with preserved sacral sensations) was difficult to establish due to a significant proximal lumbar spine injury. Postoperatively the rapidity of neurological recovery suggested neuropraxia of the nerve roots. Electrophysiological assessment (perineal somatosensory evoked potential and anal sphincter electromyography) can be useful in such situations and help in intraoperative decision making.

Neurological recovery correlates poorly with fracture reduction and depends on the type of nerve injury. Our review of literature suggests that the patients with higher chances of achieving good neurological recovery were those who were treated with surgery and, intraoperatively, had sacral roots that were compressed but intact. Unfortunately no preoperative investigation can establish the extent of root damage. Hence, several authors now recommend surgical treatment for displaced TSFs with neurological deficits.

Inadequate distal fixation was a shortcoming of our procedure. Inexperience in treating sacral fractures and poor skin condition contributed to our decision to not treat the sacral displacement. Iliac screw fixation would have been ideal in this scenario. It was indicated for two reasons. Firstly, it would have corrected the malalignment of the sacroiliac joints and thus maintained the sacral slope. While the use of iliac screw fixation would have corrected the sacral deformity in a typical high TSF [Figure 7c], it would not have been useful to correct the sacral deformity resulting from a low TSF [Figure 8] as the fracture line in the latter is caudal to the sacroiliac joints. Secondly, iliac screw fixation would have protected the lone S1 screw. Long constructs extending to the S1, tend to put great pull-out stresses on the S1 screw. However, in our patient the distal fixation survived, probably because we used bicortical L5 screws, with additional anterior fixation. Also, the L5-S1 segment was sacralized, which worked like the surgical L5-S1 fusion that is commonly used to protect the S1 screw.

The patient assumed a crouched posture on standing due to sagittal imbalance. Such an imbalance has not been reported in conservatively treated TSFs. This is due to the fact that increased sacral slope in isolated high TSFs is
compensated by a hyperlordotic lumbar spine and pelvic rotation. In low TSFs, the pelvic ring is not disrupted and hence pelvic morphometry remains unaltered. In our patient, the disruption of the sacroiliac joints, in addition to the low TSF, increased the sacral slope [Figure 8]. The pelvic tilt increased as compensation, thus increasing the pelvic incidence [Table 1]. As the lumbar spine was fused in lordosis, further compensation could not occur and thus resulted in spinal imbalance.

We conclude that it is crucial to restore the sacropelvic alignment to achieve spinal balance, especially when the fusion extends into the lumbar spine.

**REFERENCES**

1. Roy-Camille R, Saillant G, Gagna G, Mazel C. Transverse fracture of the upper sacrum. Suicidal jumper’s fracture. Spine (Phila Pa 1976) 1985;10:838-45.
2. Robles LA. Transverse sacral fractures. Spine J 2009;9:60-9.
3. Denis F, Davis S, Comfort T. Sacral fractures: An important problem. Retrospective analysis of 236 cases. Clin Orthop Relat Res 1988;227:67-81.
4. Strange-Vognsen HH, Lebech A. An unusual type of fracture in the upper sacrum. J Orthop Trauma 1991;5:200-3.
5. Schmidek HH, Smith DA, Kristiansen TK. Sacral fractures. Neurosurgery 1984;15:735-46.
6. Hak DJ, Baran S, Stahel P. Sacral fractures: current strategies in diagnosis and management. Orthopedics 2009;32:10.
7. Vaccaro AR, Kim DH, Brodke DS, Harris M, Chapman JR, Schildhauer T, et al. Diagnosis and management of sacral spine fractures. Instr Course Lect 2004;53:375-85.
8. Santos ER, Rosner MK, Perra JH, Pollyjr DW Jr. Spinopelvic fixation in deformity: A review. Neurosurg Clin N Am 2007;18:373-84.

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