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Thoracolumbar Spine Fracture-Dislocation without Neurological Deficit: A Case Report and Review of the Literature

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Abstract

Background: Thoracolumbar spine fracture-dislocations are very unstable and usually secondary to high energy trauma. Due to disruption of the entire vertebrae columns, the absence of neurological deficit is exceptional. **Aim:** The purpose of this work is to report our experience in the management of this entity in a context of limited resources and to make a review of the literature. **Case presentation:** A 30-year-old man was admitted with a severe low back pain after a traffic accident. Neurological functions were intact after examination. Radiological assessments revealed a complete L3-L4 fracture-dislocation. The patient underwent an open posterior reduction and internal long segment fixation. The post-operative was marked by a surgical site infection treated with surgical debridement and targeted antibiotic therapy. The neurological functions were preserved. **Conclusion:** Fracture-dislocations of the thoracolumbar spine are caused by high energy trauma and are remarkably unstable lesions. When they are associated with intact neurorological functions, reduction and stabilization of these fractures are a challenge.

Keywords

Spine Fracture-Dislocation, Thoracolumbar Spine, Spine Surgery, Trauma

1. Introduction

Fracture-dislocation of the thoracic and lumbar vertebral column comprised 3% of the injuries related to the vertebral column [1]. Common injuries resulting in fractures of the thoracolumbar spine include fall from a height, motor vehicle and pedestrian accidents, and penetrating trauma (gunshot wounds and stabbings) [2] [3]. Fracture-dislocation is defined as failure of all three columns of the spine with gross displacement [4] [5] [6]. There is a typically complete disruption of the stabilizing ligaments, facet joint capsules and the paraspinal musculature resulting in the translation of the spinal column and the transfer of shearing forces leading to disruption of the spinal cord. Considering the significant violence necessary to produce fracture-dislocations, these injuries are often associated with major neural deficit and since the spinal column is grossly unstable because of the column disruption, there are significant risks of further instability and neurological deficit during transfer, positioning on the operating table, and surgical intervention. The management is usually straightforward, the injuries are managed surgically and surgical fixation enables early mobilization and rehabilitation. Preservation of neurological function following complete fracture-dislocation is a quite rare entity. There are a few neurologically intact cases in the literature [7]-[23] (**Table 1**) and none has been reported from Senegal. Here, we report our experience in the management of this entity in a context of limited resources and we make a review of the literature.

2. Case Presentation

A 30-year-old man was admitted with severe low back pain after a traffic accident. He was a passenger on a motorcycle that collided with a truck. On examination, his vital signs were normal. His Glasgow coma scale score was 15/15, the sensation and muscle strenght were preserved, no pathological reflex was noted, bladder and bowel functions were normal. He had a severe tenderness on his lower back and pain when moving the left knee.

The X-ray and the Computed tomography (CT) of the lumbar spine revealed a rotational-dislocation of the L3 to L4 vertebrae with fractured bilateral inferior facets of L3 and corporeal split fracture and compression of L3 (**Figure 1**). The X-ray of the left knee was normal. The laboratory tests prior to surgery were normal (**Table 2**).

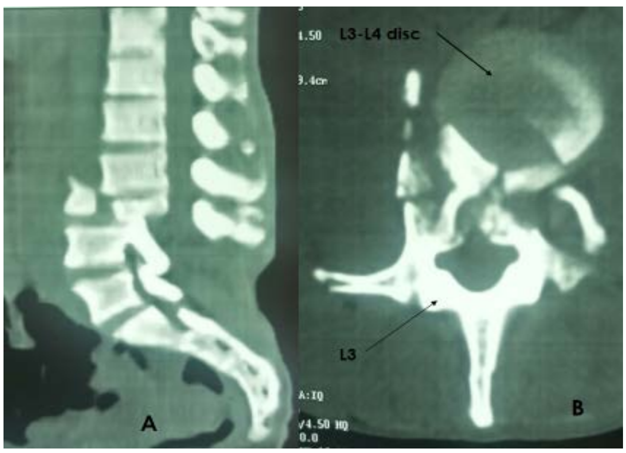

Figure 1. Sagittal (A) and axial (B) computed tomography of the complete fracture-dislocation of the L3 and L4 vertebrae.

Table 1. Summary of thoracolumbar fracture-dislocations with neural sparing.

References	Age/Sex	Location	Fractured facet/pedicle	Aetiology	Time of surgery	Surgery	Outcome
Weber *et al.* [7]	19, M	T6-T7	Right tranverse pedicle process of T4-5 with fracture of body and pedicle T7-10	Motor cycle accident	6 Days	Reduced anteriorly using Harrington distraction rod and fixed with an AO broad plate then augmented posteriorly with segmental spinal instrumentation	Good
Korovessis *et al.* [8]	24, M	T5-6		Motor cycle accident	6 Week	Two Luque L-rods with sublaminar wires from T4-11 Good	Good
Akay *et al.* [9]	21, M	T12-L1	Right inferior facet of T12 and left superior facet and pedicle of L1	Car accident	NA	T12-L1 Posterior screws, rod fixation (T11, T12, L2, L3) and posterolateralfusion (T12-L1)	Good
Kiymaz *et al.* [10]	35, F	L2-L3		Car accident		Reduction, T12L1-L2L3 transpedicular screws	
Phadnis *et al.* [11]	21, M	L1-L2	Right pedicle of L1 and left pedicle of L2	Road traffic accident	48 Hours	Posterior screws, rod fixation (T12, L1, L3, L4) and interbody fusion (L1-L2)	Good
Hsieh *et al.* [12]	50, M	T12-L1	Right pedicle of L1 and bilateral facet joints between T12 and L1	Fall from bicycle	3 Hours	Posterior screws, rod fixation (T10, T11, L2, L3) and posterolateral fusion (T12-L1)	Good
Hidalgo-Ovejero *et al.* [13]	40, F	L3-L4		Airplane accident	72 Hours	Laminectomy, facetectomy, corporectomy, reduction, fixation and fusion	
Solera *et al.* [14]	51, M	T8-T9		Fall from 10 m	< 6 Hours	Open reduction and posterior instrumentation	Good
Solera *et al.* [14]	29, M	T10		Road traffic accident		Open reduction and fixation with pedicle screws at T8-T12	Good
Sugiura *et al.* [15]	18, M	T12-L1				Anterior only fusion instrumentation	Good
Zeng *et al.* [16]	38, M	L1-L2	Bilateral pedicles of L2 and bilateral facet joints between L1 and L2	100 kg rebar fell on his back	72 Hours	Laminectomy (L1, L2), posterior screws, rod fixation and posterolateral fusion (T12, L1, L2, L3, L4)	Good
Evans *et al.* [17]	44, M	T12-L1	NA	Gym accident, 200 kg bar fell on his lower back	<24 Hours	Open reduction and internal fixation of the vertebral bodies (T12-L1)	Good
Enishi *et al.* [18]	35, F	L1-L2	No	Motor vehicle accident	5 days	Laminectomy followed by subtotal corpectomy (L2) and anterior fixation (L1-L3)	Good
Rahimizadh *et al.* [19]	19, F	L1-L2	No	Fall from a height	14 Days	Posterior screws, rod fixation (T11, T12, L1, L3, L4, L5) and anterior corpectomy (L2)	Good
Zhang *et al.* [20]	35, F	T6-T7	Left pedicle of T4; spinous process, vertebral laminae, and bilateral pedicles of T5 and T6; spinous process of T7 and both pedicles of T8	A 80-Kg heavy giant rubber tire with metal whell hub fell on her back from about 10 m high	6 days	Laminectomy T5-T8, transpedicular screws (T3, T4, T5, T8, T9) and rods fixation, posterolateral fusion T3-T9	Good

Continued

Junfeng *et al.* [21]	38, M	L1-L2	Bilateral pedicles of L2 and bilateral facet joints between L1 and L2	100 kg rebar fell on his back and he fell from a scaffold of 3 m in height	72 Hours	Laminectomy (L1, L2), posterior screws, rod fixation and posterolateral fusion (T12, L1, L2, L3, L4)	Good
Kumar *et al.* [22]	25, F	T10-T11	Posterior elements of T10 involving the bilateral lamina, with pedicle	Road traffic accident	5 Days	Laminectomy (T10, T11), posterior screws, rod fixation and posterolateral fusion	Good
Kumar *et al.* [22]	26, F	T12-L1	fracture dislocation at the T12-L1 managed with short fixation followed by implant failure and removal	Road traffic a accident		Laminectomy of T12-L1 levels, factectomy and discectomy T12-L1, deformity correction followed by 9 × 25 mm bullet cage and bilateral transpedicular screws, rod fixation.	Good
Xu F *et al.* [23]	42, M	L3-L4	Pedicles L4 to S1, spondyloptosis	Fall	7 Days	Reduction, intervertebral fusion, internal fixation	
Present case	30, M	L3-L4	Bilateral inferior facets of L3	Road traffic accident	7 Days	Laminectomy of L4, Lamino-arthrectomy of L3, Transpedicular screws (L1, L2, L4, L5) and rods fixation	Good

M: Male F: Female NA: Not available.

Table 2. Laboratory investigations of the case before surgery.

Parameters	Results
White blood cells (WBC) count, $\times 10^9$ /L	9.35 (4.0 - 10)
Red blood cells count, $\times 10^9$ /L	4.45 (4.0 - 5.5)
Hemoglobin g/dL	12.8 (12 - 16)
Hematocrit%	37.5 (39 - 45)
Platlets count, $\times 10^9$/L	245 (150 - 450
Prothrombin Time (PT) %	86.1 (70 - 100)
International Normalized Ratio (INR)	1.12
Blood Group and Rhesus	A^+

Surgery was performed 7 days after initial injury. The patient was placed in the prone position under general anesthesia on a non X-ray transparent operating table. Sensory evoked potential responses (SSEP) monitoring was not available. A posterior middle incision was made from T12 to L5 revealing a contusion of paravertebral muscles, rupture of the supraspinous and interspinous ligaments at the L3-L4 level and a fracture of both inferior facets of L3. Laminectomy of L3-L4 and inferior facetectomy of L3 were performed. Bilateral transpedicular 45mm screws were inserted in the L1, L2, L4 and L5 vertebrae under intraoperative lateral fluoroscopic imaging. The realignment was made with reduction forceps applied on spinous process of L2 and L4; stabilization was achieved with rods and tightened nuts. Posterolateral grafting was performed with autologous bone harvest from the resected posterior arc. The operating site was then irrigated with 0.9% saline solution and a drain was placed and secured with a suture before wound closure.

On day 1 after surgery, neurological functions were intact. On day 2, the drain was removed and the lumbar spine control x-ray showed good spinal alignment (**Figure 2**). The patient was allowed to walk with a brace on day 3 after surgery (**Figure 3**). The patient presented, 6 days after surgery, fever, wound dehiscence and purulent drainage from the wound. An open surgical debridement was done the same day and the exploration of the wound established a superficial infection. Cultures of the surgical site were obtained and broad spectrum antibiotics were initiated and then the antibiotics were tailored to culture's results 4 days after (**Table 3**). The evolution was satisfactory and the patient was discharged on day 29 after surgery with preserved neurological functions. The brace was removed 3 months later and the patient remained neurologically asymptomatic at 2 years follow-up. Due to his financial limitation neither a CT nor an X-ray could be done to assess the bony fusion.

Figure 2. Postoperative lateral X-rays showing good realignment of the the lumbar spine.

Figure 3. The patient walking with a brace on day 3 after surgery.

Table 3. Laboratory investigations for infection and antibiotics protocols.

Laboratory investigations	
WBC count, $\times 10^9$/L	23.67 (4.0 - 10)
C- Reactive Protein (CRP) mg/dL	236.2
Cultures	Streptococcus spp
Antimicrobial treatments for the infection	
Prior to culture's results	Intravenous (IV) treatment Ciprofloxacin 2 × 200 mg + Metronidazole 3 × 500 mg for 4 days
After culture's results	Ceftriaxone 2 × 2 g for 2 weeks + Gentamycin 1 × 240 mg for 5 days. This IV treatment was followed by a 3 weeks oral treatment with Amoxicillin/Clavulanic Acid 3 × 1.2 g

3. Discussion

Fracture-dislocation of the thoracolumbar spine is rare. It requires a very high energy trauma and a direct application to the spine, most often, of shearing forces [24]. This injury mechanism shows the importance of displacement and the highly unstable nature of this injury due to the rupture of the three columns. The neurological prognosis is usually severe resulting in permanent paraplegia. Neurological trauma is very often related to the rupture of nerve structures during the translational displacement of the spine or the sudden and extreme tension of these structures without rupture [20].

Rare cases of fracture-dislocations without neurological disorder have however been described. The crucial element in preserving neurological functions in these cases is spontaneous decompression of the spinal canal [20] [25]. Thus, the fracture of the pedicles or the facet joints, at the involved vertebrae, contributes to significantly widen the vertebral canal, protecting its contents [7] [9] [11] [12] [16] [20] [21] [22] [23]. Junfeng *et al.* [21] reported a case of complete fracture-dislocation of the L1 to L2 vertebrae with a normal neurological examination. He claimed that the mechanism of neural preservation was spontaneous decompression from fractured bilateral pedicles of L2 and bilateral facet joints between L1 and L2. Rahimizadeh *et al.* [19] also reported such a case and speculated about the possibility of the existence of a preservation mechanism for the functional integrity of the cord despite gross spinal fracture-dislocation. They reproduced the injury on a plastic model and simulated a corresponding model using 3D Slicer software with the help of CT data, along with a detailed description of the pathomechanism of neurologic sparing. It was interpreted that a mechanism other than saving fractures could have protected the cord in spite of the near-complete dislocation. They demonstrated that violent hyperflexion in combination with shearing rotational stress affected the intervertebral L1-L2 disc. Continued shearing forces, accompanied by rotational forces with the spinal cord as a hinge, led to the corresponding facet joints getting engaged and locked, with the spinal canal still remaining aligned. Tetsuya *et al.* [26] presented two cases with significant fracture-dislocation of the thoracic or lumbar spine without neurologic deficits. In each case, certain factors were considered crucial to neuropreservation. In the first case, bilateral pedicle fractures at the involved levels preserved the relationship between the spinal canal and the posterior elements; in the second case, rotational displacement and collapse of the broken vertebrae decompressed the dura and widened the spinal canal. In our case, we had rotational dislocation-fractures with fractured bilateral inferior facets of L3 joints between L3-L4 and a corporeal split fracture and compression of the L3 vertebrae. Furthermore, in fracture-dislocations of the lumbar region, two anatomical facts can help preserve neurological damage in patients, when compared with trauma in the cervical or thoracic region. Firstly, the spinal cord in adults extends only to the lower edge of the first lumbar vertebra, and secondly, the large vertebral space in this region gives ample space for the roots of the cauda equine. As a result, the nerve injury may be minimal, because the nerve roots in this region are accommodated in a larger area, with less content [27].

Due to high energy trauma, fracture-dislocations of the thoracolumbar spine may be associated with various organ injuries which can delay the diagnosis [19]. Having an accurate and early diagnosis is critically important before any improper maneuver can be applied to patients. Some authors have recommended a spinal computed tomography for patients involved in severe high velocity trauma [9] [12].

Surgery is recommended for fracture-dislocations of the thoracolumbar spine and should be performed at the earliest possible opportunity for neurologic protection [6] [21] [28] [29] [30]. The physical condition of the patient, as well as the potential existence of associated lesions, should always be taken into account before attempting the procedure. It is also important for patients to be stabilized before surgery, and for the right personnel to be available at the time of decompression and reduction of these injuries [13]. The objectives of the surgery are reduction of dislocated vertebrae, decompression of nerve structures, spinal stabilization and an early mobilization and rehabilitation [28] [31]. In our case, through a posterior approach, we performed laminectomy and facetectomy at the involved level of compression; a long transpedicular fixation and posterolateral fusion were performed. The optimal surgical approach for decompression and stabilization is controversial. A posterior approach with long instrumentation (2 levels above and 2 levels below) is recommended due to the severe instability of the injured spine. In addition, short bony fusion, that is, posterolateral or interbody fusion, should be applied [9] [11] [12] [29]. Junfeng Z *et al.* [21], for a complete fracture-dislocation in 38-year-old patient, performed a long instrumentation and long posterolateral fusion for fixation to avoid implant failure. He obtained a solid fusion and a satisfactory outcome at the 23-month follow-up.

Anterior approach for fracture-dislocation injury may not be applicable as the reduction of the fracture through an anterior approach alone is very difficult and in some cases impossible. Realignment and fixation are best accomplished through a posterior approach with reduction, multilevel instrumentation and fusion [32]. Circumferential anterior and posterior fusion often plays a role in these severely injured cases. Xia *et al.* [33] advocated this combined surgery for thoracolumbar fracture-dislocations and he conclued that simultaneously combined anterior and posterior surgery was a reliable method that can achieve a sufficient decompression, reduction and reconstruction. Xiao-Bin W *et al.* [32] performed a posterior TLIF approach with a single stage pedicle screw fixation and interbody bone graft to achieve reduction, decompression and reconstruction for the treatment of thoracic and lumbar fracture-dislocations. He claimed that it is a safe procedure because working zone can be acquired without retraction on the spinal cord. He believed that the advantages of one stage posterior approach are multiples: less invasive, anatomical reduction and kyphotic correction, sufficient neural decompression, anterior column fusion and long term correction maintenance.

Reduction, whether open or closed, should be performed with great care and with the aid of pre-operative and post-operative imagings. Hidalgo-Ovejero AM *et al.* [13] applied a halo-bifemoral treatment, on a patient with a L3-L4 dislocation without neurological lesions, before surgery. This system is used for the reduction of spine deformities and fracture-dislocations [34] [35] [36]. However, it has been less used since the recent developpment of powerfull new surgical techniques and instrumentations. Meticulous care should be taken during the surgical reduction of the injuries to avoid iatrogenic vascular and neurological lesions. Sapan Kumar *et al.* [37] have summerised the published literature papers on the surgical management of thoracolumbar fracture-dislocations and described the reduction maneuvers used in detail. In our case, the realignment was made with reduction forceps applied on spinous process of L2 and L4. This technique is among the five different techniques described by the AO Spine group. Advantage of this technique is the relative simplicity of the maneuvers. As only spinous processes are manually distracted, theoretically lesser risk of neurological insult is there. Disadvantages are higher risk of cut-out of the towel clips through spinous processes, particularly in osteoporosis cases, and hence failure to achieve reduction [37]. Rishi MK *et al.* [38] insisted on critical steps to ensure safe surgical reduction of the spine: Unilateral exposure and temporary fixation, use of high-speed burr and drill to create screw track, avoid torque forces while inserting the screws, perform a laminectomy before reducing the dislocation, use of gentle reduction maneuvers with persuaders and rod rotation under direct visualization of the spinal cord. Overall, experience and expertise of the operating surgeon is also important, as unintended neural injury can happen if appropriate care is not taken.

4. Conclusion

Fracture-dislocations of the thoracolumbar spine are caused by high energy trauma and are remarkably unstable lesions. When they are associated with intact neurorological functions, reduction and stabilization of these fractures are a challenge for spine surgeons, especially in a context of limited resources. In view of our results and the literature, early diagnosis and surgical treatment ensure a good prognosis.

Informed Consent

Informed consent was obtained from the patient for publication of this manuscript and any accompanying images.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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