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CASE REPORT

Severe old lumbar fracture and dislocation with cauda equina nerve transection: A case report

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ABSTRACT

Severe old lumbar fractures and dislocations with associated cauda equina nerve transection are rare clinical presentations which pose significant management challenges. This case report highlights a unique instance of such an injury, emphasizing novel surgical strategies for reconstruction and recovery. A 30-year-old male patient was admitted after sustaining a severe open fracture and degree IV posterior dislocation of L3 vertebra, accompanied by cauda equina nerve transection, spinal cord injury and multiple organ injuries. Following initial stabilization, the patient underwent surgical reduction and internal fixation two months after the injury. The procedure involved cauda equina nerve reconstruction using sural nerve grafts. Postoperatively, the patient showed improved bladder function and regained some mobility. However, he later developed arachnoiditis ossificans of the cauda equina, resulting in severe pain, which required additional surgical intervention. In conclusion, this case underscores the importance of timely intervention in severe thoracolumbar injuries and presents a successful approach to nerve reconstruction.

Keywords: Cauda equina nerve transection, dislocation, lumbar fracture, surgical intervention.

Among spinal fractures, thoracolumbar fractures are the most common and account for more than half of all spinal injuries.[1] Dislocation injuries account for approximately 15% of thoracolumbar fractures and usually occur following high-energy trauma. Complete fracture dislocation is rare and often presents with severe spinal deformities and significant neurological deficits. Wang and Zhu[2] reported that more than 70% of patients with complete fracture dislocation also had complete spinal cord neurological impairment. Due to severe thoracic and abdominal organ injuries, severe fracture and dislocation cases cannot be treated surgically immediately. When the patient's condition is stable, neglected fracture and soft tissue adhesion occur, increasing the difficulty of surgical reduction. After the edema of the cauda equina subsides, peripheral adhesions form. Even with spinal canal decompression, cerebrospinal fluid circulation cannot be established in a short period of time and secondary damage to the cauda equina continues to occur.[3]

Arachnoiditis ossificans of the cauda equina is a rare pathological entity typically confined

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to the thoracic and high lumbar regions and can cause progressive spinal cord and cauda equina compression, inducing severe neurological deterioration. Although clustered arachnoid cells are usually implicated in its pathogenesis, an environment induced by arachnoiditis and disturbed cerebrospinal fluid flow appears to be a more important factor.[4]

In general, bone injuries are properly treated, whereas related injuries to the cauda equina are left unattended and allowed to heal on their own. Few people have attempted to connect torn nerves through microsurgical sutures. Even if such attempts are made, they are rarely successful, as unlike the surrounding nerves, the cauda equina nerve root lacks a nerve periphery that safely connects the sutured ends together.[5] Given the poor neurological function recovery of the two methods mentioned above, particularly in cases of complete injury, we attempted to find a better matching method to improve the results. In this article, we present an effective strategy for managing severe thoracolumbar fracture and dislocation.

CASE REPORT

A 31-year-old male patient was admitted to our hospital for continuous life support and the treatment of lumbar and cauda equina injuries after undergoing emergency laparotomy for a colon fistula and lumbar debridement and suturing in a local hospital. The main diagnoses were as follows: *(i)* an open fracture of L3 vertebra and degree IV posterior dislocation; *(ii)* spinal cord injury; *(iii)* caudal nerve transection injury; *(iv)* left ureteral rupture and urinary extravasation; *(v)* intestinal rupture and fistula; and *(vi)* low back wound infection. Physical examination revealed Grade 0 lower limb muscle strength, absence of sensation in the lower half of the thighs and no physiological or pathological reflexes in either lower limb. Computed tomography (CT) findings revealed *(i)* transverse fracture of L3 vertebral body below the pedicle; *(ii)* degree IV posterior dislocation in the same vertebra; *(iii)* fractures bilaterally in the transverse processes of L1-5 vertebral bodies; *(iv)* spinous process fractures in L2-5 vertebrae, the psoas major muscle and vertical lumbar muscles; and *(v)* bilaterally and retroperitoneal multiple encapsulated effusion and hematoma (Figure 1a, b). Magnetic resonance imaging (MRI) findings were as follows: *(i)* abnormal spinal canal structure in L3-4 vertebrae; *(ii)* spinal cord conus contusion; and *(iii)* a completely broken cauda equina (Figure 1c). Following treatment in the department of critical care medicine, the vital signs of the patient were stable.

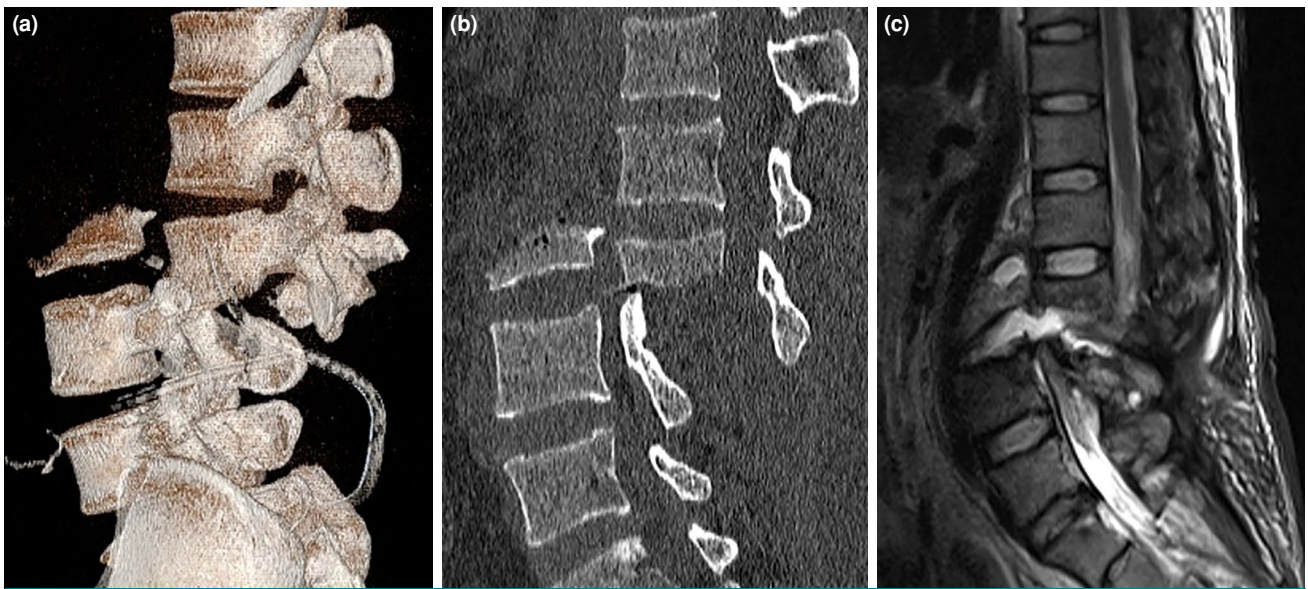

FIGURE 1. Preoperative CT and MRI scans. **(a, b)** Three-dimensional reconstruction and sagittal reconstruction of lumbar CT images. The continuity and integrity of the L3 vertebrae can be seen to be disrupted, with significant displacement between the vertebrae. **(c)** Lumbar MRI scan. Fractures and dislocations of the L3 vertebrae with disruption of the spinal canal and cauda equina continuity are seen.
CT: Computed tomography; MRI: Magnetic resonance imaging.

Two months after the injury, left renal puncture of the fistula, reduction of the fracture and dislocation of L3 vertebral body, internal fixation of L2-5 vertebrae with a vertebral pedicle screw rod system, bilateral sural nerve transplantation and cauda equina nerve anastomosis were performed.

General anesthesia was induced by intubation. Once the anesthesia effect was confirmed, the patient was placed in the prone position. First, left percutaneous nephrostomy of the left kidney was performed under the guidance of color Doppler ultrasound by a urologist. Then, the spine surgeon used the posterior median approach to expose the spinous process, lamina and articular process of L2-5 vertebrae. Eight pedicle long tail screws were placed on both sides of L2-5 vertebrae. Due to dislocation, the tail of the pedicle screw of L3-4 vertebrae formed obvious steps, and it was difficult to install connection rods. On prying in the intervertebral space between L3-4 vertebrae, vertebral dislocation could not be reduced. In the first step, the left side of the pedicle screw was used to install the pre-bending connecting rod (S-shaped, arc height: less than the L3-4 vertebrae, vertebral screw step heights: approximately one screw cap length) (Figure 2a). The screw caps of L2-3 vertebrae were tightened first and the screw caps of L4-5 vertebrae were pressed and tightened, when the spreader was used to open the tail of the pedicle screws of L3-4 vertebrae (open intervertebral space for reduction) (Figure 2b). The case of dislocation was preliminarily reset (Figure 2c). Following this, the pre-bending connecting rod (S-shaped, height difference: IDEM) was installed on the right side. The anterior steps on the right side were repeated while slowly loosening the left screw before the case of dislocation was significantly reduced. Subsequently, the S-rod of the left side was removed and a straight rod was installed. Finally, the right S-rod was loosened and replaced with a straight rod, and the dislocation was completely reset. A C-arm fluoroscopy examination showed complete reduction of the dislocation and a normal lumbar sequence.

After three months of bed confinement, the patient began to sit up with the help of the attendees. High-density calcification at the cauda equina nerve reconstruction area was seen on the CT scan taken at three months after the operation. Four months after the operation, the patient could move independently in a wheelchair during rehabilitation training. The patient developed severe pain in both lower limbs with an anal bulge at five months after the operation and also gradually developed pain in the lower abdomen and external urethral orifice. The Visual Analog Scale (VAS)-pain score was 8. Following a multidisciplinary consultation, the pathological pain was considered to be

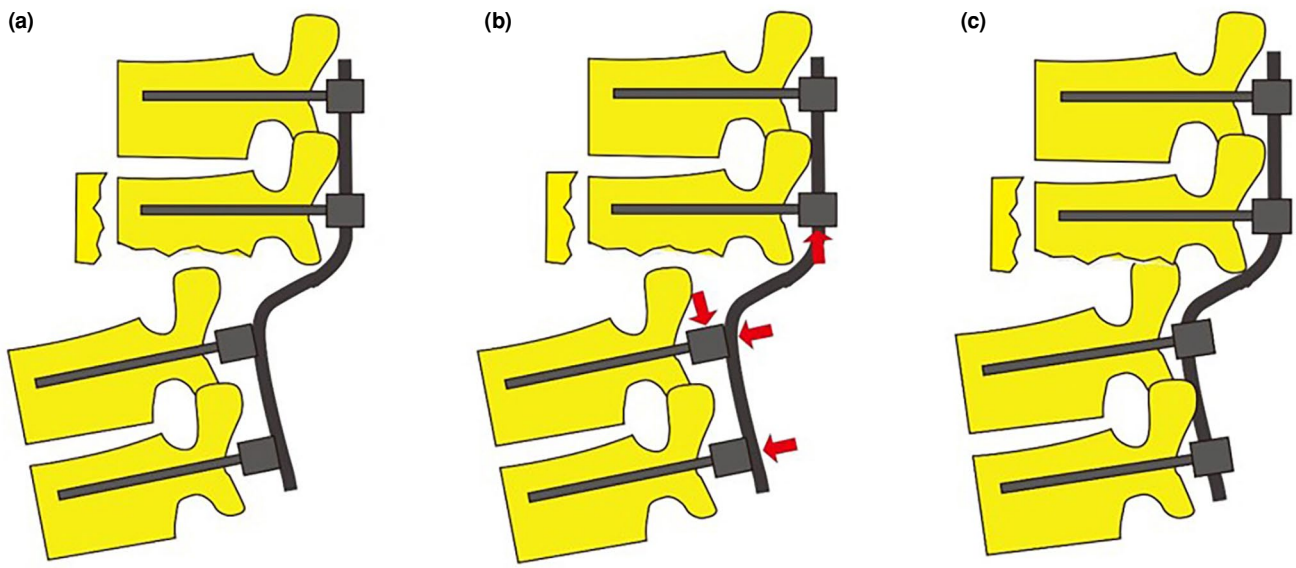

FIGURE 2. Fracture dislocation reduction schematic. **(a)** The arc height was less than the lumbar 3,4 vertebral screw steps heights, which were about one screw cap length, and the screw caps of the L2-3 vertebrae were tightened. **(b)** The screw caps of L4-5 vertebrae were pressed and tightened when the spreader was used to open the tail of the L3-4 pedicle screws. **(c)** Initial reduction of fracture dislocation.

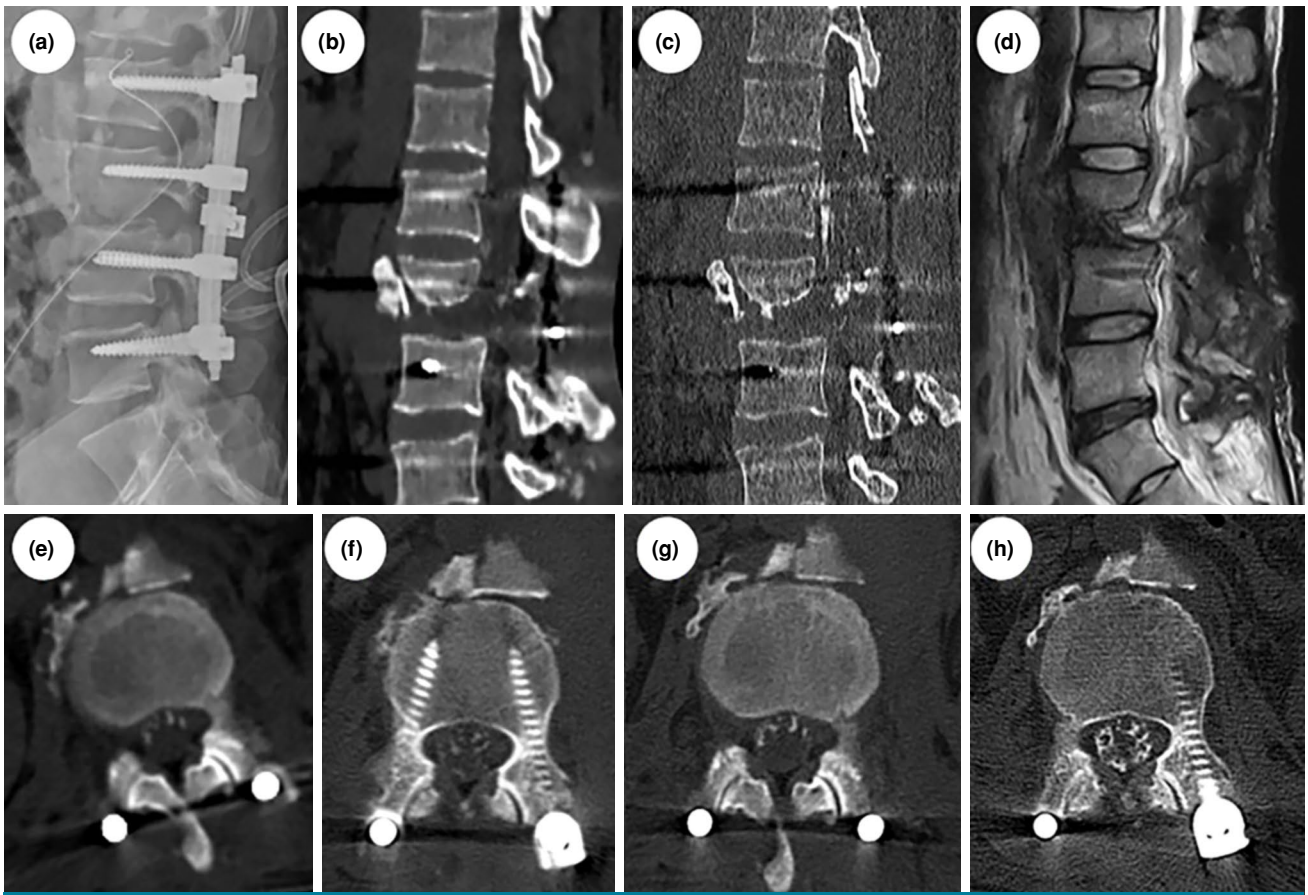

FIGURE 3. Postoperative follow-up images. **(a)** In the postoperative one-week lumbar X lateral radiograph, the fracture dislocation had been completely reset. **(b, c)** Sagittal reconstruction, spinal sequence stability, and reliable internal fixation were observed at five months and one year after the operation. **(d)** In the lumbar MRI scan at one year after the operation, spinal canal reconstruction was observed. **(e-h)** The CT scans in the transverse position of L3 vertebra were taken at three, five, and seven months and one year after the operation. The degree of ossification of cauda equina have gradually increased in the follow-up CT scan.
CT: Computed tomography.

caused by arachnoiditis ossificans of the cauda equina and spinal cord conus injury, which were non-responsive to intrathecal morphine injection and oral medication. The VAS score decreased to 2 points following spinal cord posterior rhizotomy from thoracic vertebra 12 to L2 vertebra, as performed by the neurosurgeon. After six months, the patient could urinate independently after the catheter was removed and partial systolic function of the anal sphincter was regained. During the one-year follow-up after the operation, X-ray and CT scans showed that the spine maintained a normal sequence, and the internal fixation device was stable without loosening (Figure 3). On the MRI scan, complete spinal canal decompression was observed (Figure 3). Considering cauda equina ossification arachnoiditis, the degree of ossification of the patient had gradually increased in the final follow-up CT scan (Figure 3e–h). A written informed consent was obtained from the patient.

DISCUSSION

For patients with lumbar spine fracture and dislocation, the main goal of surgical treatment is to reconstruct the spinal sequence, restore spinal stability and relieve nerve compression. Even in the case of complete spinal cord injury, early surgery is still necessary to restore biomechanical stability of the spine and prevent aggravation of the spinal cord injury.[6] Currently, the commonly used surgical methods include anterior, posterior and combined anterior and posterior approaches. Posterior surgery can effectively treat fractures and dislocations, and damaged nerves can be explored or repaired under direct vision, which is a relatively

simple and safe procedure. Furthermore, the pedicle screw internal fixation system can stabilize and reliably fix the three columns.[2] However, bone graft fusion cannot be performed on the anterior column. A 360° circumferential bone graft fusion can be performed using the anterior-posterior combined approach, and anterior column reconstruction and posterior column fixation can be performed simultaneously.[7] In cases of severe injury, circular fusion is an ideal surgical method for restoring spinal stability; however, it is associated with large trauma, prolonged operation time, and a considerable volume of intraoperative bleeding, meaning some patients with chest and abdominal injuries cannot tolerate it.

Currently, there is no consensus on the optimal surgical strategy for reducing thoracolumbar fractures and dislocation, and the method should be selected according to the specific case of dislocation and the experience of the surgeon. In addition, these cases are often reset by trunk traction, intervertebral space prying, pulling with towel pliers on the spinous process and a spinous process intervertebral disc stretcher.[8] In this case, due to the severe injury, the operation time was controlled to reduce the surgical risks. Also, the case was complicated with an abdominal injury, and it was not feasible to use the anterior approach. Therefore, we performed only the posterior operation. The fracture of the lower edge of L3 vertebra did not affect the bilateral pedicles and we, therefore, also performed pedicle screw fixation for L3 vertebra. Considering that the lumbar pedicle is thick and the pedicle screw is fixed firmly, we used an S-rod alternately fixed on the pedicle screw to reset the fracture and dislocated bones. We performed bone grafting on the articular process and intervertebral disc of lumbar vertebrae 3 and 4 and did not treat the free fracture block in front of the spine. During the follow-up period, the patient exhibited stable internal fixation and a normal spinal sequence; however, there was no sign of intervertebral fusion, and additional follow-ups were needed to determine whether intervertebral fusion was achieved after the operation.

Thoracolumbar fractures and dislocations are often accompanied by complete or incomplete injury of the cauda equina nerve, which can lead to lower limb paralysis, sensory disorders and urinary and fecal incontinence, among other complications. With regard to the repair of cauda equina injuries, although there is some evidence

TABLE I
A summary table of cauda equina nerve transection in the literature

Authors	Year	Number of patients	Diagnosis/cause of injury	Treatment	Outcome
Tedesco-Marchese et al.[12]	2014	4	A penetrating traumatic injury in the lumbosacral area	The microsurgical reconstruction of the cauda equina nerve roots (MRCER)	A marked improvement in motor function in two patients, but no sensory recovery
Sun et al.[15]	2010	8	L2 or L3 fracture and/or dislocation complicated with complete cauda equina injury	Repair the motor cauda equina fibres with fibrin glue after open reduction and internal fixation	Recovery of the strength of thigh muscles was observed in all acute cases but not in the chronic one
Miekisiak et al.[16]	2015	1	A flexion-distraction injury at the L3-L4 level and completely severed from the spinal cord	A fusion procedure and a good recovery	Walk with a knee-ankle-foot orthosis, but no motor function below knees, no sensation below L2, and no voluntary bladder control.
Tubbs et al.[17]	2006	1	L4 Chance-type fracture and ligamentous disruption at the L4-L5 interval	A spinal fusion procedure	No volitional motor control inferior to his costal margin at six months after his initial injury

of regeneration in animal models,[9,10] there are only few clinical studies on direct reconstruction, particularly for completely transected cauda equina. Jiang noted that repairing cauda equine fibers with multi-segmental and revascularized nerve grafts can restore the patient's partial sensory and fecal function, urinary function and a small amount of motor function.[11] Tedesco-Marchese et al.[12] performed cauda equina anastomosis in four patients with cauda equina injury. The sensory, fecal and urinary functions of three patients improved to varying degrees, whereas one patient did not show significant improvement. In this case, the cauda equina nerve was completely transected, and there was urination disorder and lower limb paralysis. When a nerve root is sectioned and sutured directly to the cord, the regenerating fibers end up at the spinal cord, without functional reinnervation, although some authors have demonstrated some degree of reinnervation while reinserting avulsed roots.[13] Experimental studies have also shown that the surgical replantation of avulsed roots following brachial plexus and cauda equina injuries can restore not only motor, but also autonomic pathways, thereby facilitating the recovery of neurological function.[14] Sun et al.[15] used fibrin glue to repair seven acute cases and one chronic case of L2 or L3 fracture and/or dislocation complicated with complete cauda equina injury. The authors observed recovery of the strength of thigh muscles in all seven acutely injured patients, but not in the chronic case. Others have used fusion surgery to manage unstable fractures, but have not described in detail the repair of the cauda equina (Table I).[16,17] In the presented case, we reconstructed the cauda equina nerve two months after injury. Six months after the operation, the patient exhibited normal bladder function and could urinate spontaneously. The anal sphincter also recovered partial contraction function.

In our case, three months after the operation, the lumbar CT scan showed calcification around the cauda equina. Anal pain, external genital pain, and lower limb pain occurred after five months. We believe that these symptoms may be caused by arachnoiditis ossificans of the cauda equina. However, pathological pain following medullary cone injury cannot be excluded, as the patient also experienced hypogastrium pain. Following comprehensive analysis, our patient's pain may have been caused by arachnoiditis ossificans of the cauda equina arachnoid and pathological pain after medullary cone injury. The area of calcification was closely wrapped around the cauda equina, and the CT images showed a type 3 case, which is difficult to remove by operation. Following treatment with drugs such as baclofen, pregabalin and intrathecal morphine injection, the severity of pain in the patient did not significantly improve. Finally, we performed dorsal root nerve transection according to the patient's pain plane, and the pain significantly decreased in severity postoperatively.[18]

In conclusion, this case report presents an effective strategy for managing severe thoracolumbar fracture and dislocation, demonstrating that timely surgical intervention can lead to significant functional recovery in patients with cauda equina injuries. We emphasize the need for early recognition and treatment of cauda equina arachnoiditis ossificans.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Managed patient care, collected imaging data, conducted follow-up evaluations, and drafted the manuscript: Y.Z.; Organized imaging materials, identified key radiological features, and co-wrote the manuscript: L.F.; Designed the S-rod reduction technique and performed internal fixation: J.A.; Analyzed cauda equina repair strategies and technical innovations: Y.Z.; Wrote the ossifying arachnoiditis discussion section: W.Z.; Validated clinical data accuracy: K.F., J.L.; Supervised the study, finalized data verification, revised the manuscript, and handled submission: X.Z.

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