CASE REPORT

Dural penetration caused by a vertebral bone fragment in a lumbar burst fracture: a case report

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INTRODUCTION: This case report describes an unusual case of lumbar burst fracture in which a bone fragment from the vertebral body penetrated into the dorsal dura through the ventral dura mater, requiring bone fragment extraction via an intradural approach.

CASE PRESENTATION: A 23-year-old male involved in a motor vehicle accident was admitted to our hospital complaining of right leg paresis and bladder-bowel disorder. Computed tomography (CT) revealed an L5 burst fracture of type B by the Denis classification scheme, with a bone fragment from the vertebral body that had perforated the ventral aspect of the dura mater and penetrated dorsally. We abandoned attempts to extract the bone fragment via an epidural approach and instead resected the fragment via an intradural approach with a dorsal dural incision. We corrected L4/5 kyphosis as possible and performed L4/5 posterolateral fusion. The patient's leg paralysis and bladder-bowel disorder were relieved, and he was discharged 2 months after the surgery with the ability to walk without crutches.

DISCUSSION: When bone fragments penetrate the dura mater, their extraction must be performed with particular care. For cases in which the dura mater cannot be pulled apart, the removal of bone fragments using an intradural approach is appropriate.

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INTRODUCTION

No prior study has reported a case of lumbar burst fracture in which vertebral bone fragments penetrated into the dorsal dura mater through the ventral dura mater. When bone fragments penetrate the dura mater, their extraction must be performed with particular care. We hereby report details regarding a successful

dural repair performed by removing bone fragments via an intradural approach.

CASE PRESENTATION

A 23-year-old male involved in a motor vehicle accident, in which he drove an automobile that collided head-on with a truck was

Figure 1. 23-year-old male was involved in a motor vehicle accident. (a, b) Computed tomography revealed an L5 burst fracture. An asymmetric, sharp pyramid-shaped bone fragment is evident in the spinal canal. (c) Magnetic resonance imaging indicated that the bone fragment had invaginated intradurally.

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Figure 2. Resection of the bone fragment via an intradural approach. (a) The tip of a bone fragment had penetrated and protruded into the dorsal dura mater. (b, c) Excavation was performed to the posterior edge of the vertebral body (asterisk in b), with a flat and thin bone fragment left behind (arrow in c).

admitted to our hospital. On physical examination, he exhibited cauda equina syndrome of L5 or lower, with particular motor weakness (MMT TA4 EHL3) and sensory disturbance in the right L5 nerve root region, and bladder-bowel disorder (urinary retention and fecal incontinence). Hepatic damage was also an observed complication. Plain radiographs and computed tomography (CT) revealed an L5 burst fracture of type B in the Denis classification scheme, with a bone fragment at the upper edge of the L5 vertebral body reaching into the dorsal spinal canal (Figures 1a and b). Magnetic resonance imaging (MRI) indicated that the bone fragment had invaginated intradurally (Figure 1c).

SURGICAL FINDINGS

After performing a partial L4 laminectomy and exposing the dura mater, we observed that the tip of a bone fragment had penetrated and protruded into the dorsal dura mater (Figure 2a). In other words, bone fragments had not only perforated the ventral dura mater but also fully penetrated the dorsal dura mater. It was impossible to pull the dura mater apart to the right and left because a pyramid-shaped bone fragment protruded into the dura mater and a large bone fragment was incarcerated in the ventral side. In addition, because of a large defect in the ventral dura mater caused by the perforating bone fragment, pulling the ventral dura mater to the dorsal side may have caused a deviation of the cauda equina to the ventral side. Therefore, we abandoned the idea of bone fragment removal using a peridural approach and made a vertical incision to develop the inside of the dural sac. The bone fragment was triangular pyramid in shape, and its apex protruded to the dorsal side; a large triangular defect had formed in the ventral dura mater. Although the bone fragment had penetrated between the right L5 nerve root and the cauda equina, neither the nerve root nor the cauda equina was disconnected.

An intradural excavation of the bone fragment to minimize its size while protecting the cauda equina caused the ventral dura mater to retract from the incarcerated bone fragment; subsequently, a peridural approach was used to further excavate bone fragments. Excavation to the posterior edge of the vertebral body was performed (Figures 2b and c) because total removal of the bone fragment would have caused a defect in the posterior wall of the vertebral body and could therefore have induced the extrusion of the cauda equina to the ventral side. The excavation surface was arranged to be parallel to the posterior wall of the vertebral body, with a flat and thin bone fragment left behind. Because of the severity of the defect in the ventral side of the dura mater, we covered this defect with a fascial patch. Posterolateral fusion was performed at the L4/L5 level using a pedicle screw system (Figure 3a). On the day after the operation, the patient was placed in a hard brace that allowed for free bodily movement. Spinal drainage was performed for 7 days. Walking training was started 2 weeks after the operation. The patient's spinal canal clearance was favorable (Figure 3b), and bone union was obtained. His paralysis and bladder-bowel disorder nearly disappeared, and he was discharged 2 months after the operation with the ability to walk independently.

DISCUSSION

The incidence of dural lacerations associated with burst fractures of the spine has been reported to be between 7.7% and 25%. Luszczyk *et al.*^{1,2} have reviewed 1,615 surgically managed spinal injuries over a 7-year period, and identified traumatic dural lacerations in 9.1% of the cervical, 9.9% of the thoracic and 17.6% of the lumbosacral spinal fractures.³ Although the incidence of dural lacerations was relatively high in lower lumbar spinal fractures, there have been no previous reports of vertebral body fragments penetrating the dura mater from the ventral side to the dorsal side. Carl *et al.* reported 60 cases of surgeries for burst fractures using an anterior approach and found that six cases involved damage in the ventral dura mater, which was characterized by the presence of asymmetric, sharp-pointed bone fragments. An asymmetric, sharp, pyramid-shaped bone fragment extremely similar to those described by Carl *et al.*⁴ was found in our case.

There are two types of approaches for removing bone fragments in the dura mater: peridural approaches and intradural approaches. For cases in which the dura mater cannot be pulled apart, the removal of bone fragments using a peridural approach is impossible, and an intradural approach is appropriate. For cases

Figure 3. 2 months after the operation. (a) Postoperative lateral radiograph demonstrating L4/5 posterolateral fusion. (b) Sagittal T2 MRI indicating that the spinal canal clearance was favorable.

in which a large defect is left behind in the ventral side of the dura mater, the total removal of bone fragments may cause a defect in the posterior wall of the vertebral body and could therefore lead to the extrusion of the cauda equina to the ventral side. Therefore, it may be best to avoid performing excavation beyond the posterior edge of the vertebral body.

For cases involving a large defect in the dura mater, a fascial patch or an artificial dura mater is commonly employed.⁵ In this case report, the fascia was used as a restoration material that was inserted between the ventral dura mater and the posterior wall of the vertebral body and used for adhesion. Limiting the excavation of burst bone fragments to the posterior wall of the vertebral body improved adherence without producing a dead cavity.

A lumbar burst fracture with a failed anterior element urgently requires anterior column reconstruction. According to load sharing system,⁶ >7 points is an indication for anterior column reconstruction. A large defect in the ventral side of the dura mater is more difficult to repair through an anterior approach; therefore, a posterior approach is advantageous in this case. When anterior column reconstruction is required, a posterior approach should be used to accomplish dural repair and anterior reconstruction simultaneously. If simultaneous reconstruction cannot be performed, or its kyphosis advances to over 20 degrees,^{7,8} it would be more advisable to perform a two-stage surgery with the anterior reconstruction being accomplished at a later time.

AUTHOR CONTRIBUTIONS

KS planned and performed this surgery. CU, KS, MK and SM acquired the data for the report. MT, NI and AM are the supervisors of this report. All authors participated in the sequential medical treatment.

COMPETING INTERESTS

The authors declare no conflict of interest.

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