Technical Notes

Transdural reduction of a bone fragment protruding into the spinal canal during surgical treatment of lumbar burst fracture: A case report

Wakiko Saruta1, Toshiyuki Takahashi2, Toshihiro Kumabe2, Manabu Minami1, Ryo Kanematsu1, Hiroya Shimauchi Ohtaki1, Ryotaro Otsuka1, Junya Hanakita1

1Spinal Disorders Center, Fujieda Heisei Memorial Hospital, Fujieda, Shizuoka, 2Department of Neurosurgery, Kitasato University School of Medicine, Sagamihara, Kanagawa, Japan.

E-mail: Wakiko Saruta - wakiko.saruta@gmail.com; Toshiyuki Takahashi - heisei.t-taka@ny.tokai.or.jp; Toshihiro Kumabe - toshihirokumabe@hotmail.co.jp; Manabu Minami - minami@mac.com; Ryo Kanematsu - dragon14_k@yahoo.co.jp; Hiroya Shimauchi Ohtaki - h.ohtaki126@gmail.com; Ryotaro Otsuka - ryotaro1990.711@gmail.com; Junya Hanakita - heisei.spine-jh@ny.tokai.or.jp

INTRODUCTION

Lumbar burst fractures caused by high-energy trauma, can result in vertebral body bone fragments protruding into the spinal canal, resulting in significant cauda equina/root injuries. Here, the authors showed that posterior transdural impaction of ventrally extruded lumbar vertebral bone fragments could be safely/effectively accomplished utilizing a L3-L4 laminectomy followed by a pedicle/screw/rod instrumented fusion.
MATERIALS AND METHODS

History and examination

An 18-year-old male fell from a height of 10 m resulting in an L3-level paraparesis (i.e., complete motor loss, partial sensory loss, and sphincter dysfunction: American Spinal Injury Association Impairment Scale B) [Table 1]. The magnetic resonance/computed tomography (MR/CT) studies showed the L3 vertebral body burst fracture fragments protruding into the spinal canal resulting in marked cauda equina compression [Figure 1a and b].

Operative procedure

Performing a L3-L4 laminectomy, revealed his dorsal dura was lacerated, with several damaged nerve rootlets herniating through the traumatic durotomy [Figure 2a]. Through the dorsal durotomy, the ventrally extruded L3 body bone fragments were impacted back into the fractured vertebral body [Figures 2b, 3a and b]. This was followed by a primary dorsal dural repair about 5 cm in length by stitch suture to the watertight. This was followed by percutaneous pedicle screw fixation from L1 to L5.

RESULTS

One month postoperatively, the patient’s proximal (3/5) and distal (2/5) motor strength improved along with bladder and bowel dysfunction completely. Further, the postoperative CT and MRI studies confirmed adequate canal decompression with just a slight residual ventral shift in the protruded bone fragments [Figure 4a and b].

DISCUSSION

Several studies have reported the removal of bone fragments protruding into the spinal canal in patients who have sustained lumbar burst fractures with resultant cauda equina syndromes.\[1,2,6,8,9\] Typically this was achieved utilizing either an anterior or posterior microscope-assisted approach, rather than through a traumatic dorsal durotomy [Table 2].

Table 1: The neurological findings before and after the surgery were revealed. At 1 month after the surgery, all the symptoms were mild and the ASIA Scale improved to C.

| Neurological examination | Preoperative | Postoperative; on month later |
|-------------------------|-------------|-------------------------------|
| Strength                | Loss below L3 | Recovered to 3/5 at proximal muscles, 2/5 at distal one |
| Sensory                 | Loss below L3 including perineal, slight residual touch, and pain in the right toe | Slight recovered to the lower limbs and perineal region |
| Deep tendon reflexes    | Absent       | excessive                     |
| Bowel and bladder       | loss         | recovery                      |
| ASIA Impairment Scale   | B            | C                             |

Figure 2: Intraoperative photographs. (a) The dorsal dura mater was found to be lacerated and several damaged rootlets herniated from the point of the ruptured dura mater. (b) The protruded bone fragment was pushed back into the ventral side by transdural tapping using an impactor, while protecting the cauda equina.

Figure 3: Illustrations demonstrating the transdural tapping approach. (a) The dural sac was elevated due to the bone fragment from the ventral side. The dorsal dural sac was injured and the rootlets was deviated (arrow head). (b) Transdural tapping, which involves pushing the bone fragment back into the vertebral body.
Advantages of posterior versus anterior approach

There are pros and cons for posterior versus anterior approaches to lumbar burst fractures with ventrally extruded/fractured bone fragments contributing to cauda equina syndrome. The posterior approach allows for ventral fragment removal (i.e., tamping down into the fractured vertebral body) while also facilitating direct dorsal dural repair.[5] Although the anterior approach allows for direct bone fragment removal/decompression, the major disadvantage is the difficulty in repairing the ventral dural defect.[6,7]

Dural injury due to lumbar vertebral burst fractures

Yoshiwa et al. found that the cauda equina notch sign was a predictable MR finding of cauda equina entrapment (i.e., due to greenstick lamina fractures), but in many cases this is just found intraoperatively.[10] Here, the patient clearly had a greenstick laminar L3 fracture responsible for the dorsal dural injury.

Table 2: The advantages and disadvantages of each approach.

| Approach                  | Advantage                                      | Disadvantage                                      |
|---------------------------|------------------------------------------------|---------------------------------------------------|
| Anterior approach         | Bone fragments can be removed under direct     | Highly invasive                                   |
|                           | vision                                        | Dural repair is difficult                         |
|                           | Improving vertebral height                    |                                                   |
| Posterior approach        | Bone fragments can be removed in a full circle | Resection of remaining normal support structures  |
|                           | Dural repair is easy.                         |                                                   |
| Minimally Invasive Surgical approach | Preserve the facet                            | Risk of inadequate decompression                  |
|                           |                                               | Dural repair is difficult                         |
|                           |                                               | Risk of spinal fluid leakage and cauda equina injury |
| Transdural approach       | Minimally invasive to supportive structures   |                                                   |

Surgery

Minimally Invasive Surgical (MIS) Approaches: MIS surgical approaches are ineffective when dealing with dorsal dural injuries attributed to lumbar burst fractures. Chen et al. reported ventral packing of fractured fragments under endoscopy with vertebroplasty.[1] However, this risked inadequate decompression and neural damage when bilateral bone fragments extended in the spinal canal, while also making dorsal dural repair extremely more difficult.[14]

Transdural Approach to Impaction Vertebral Body Burst Fracture Fragments Contributing to Cauda Equina Compression.

One study discussed impaction of ventral vertebral body bone fragments utilizing a transdural approach in a case in which there was a traumatic dorsal durotomy.[7]

CONCLUSION

Transdural reduction of protruded lumbar bone fragments through a posterior traumatic durotomy following a L3 burst fracture was safely/effectively accomplished.

Ethical approval

This study was approved by the Medical Ethnic Board of Fujieda Heisei Memorial Hospital (approved number FHR2020-6).

Declaration of patient consent

Institutional Review Board (IRB) permission obtained for the study

Financial support and sponsorship

Nil

Conflict of Interest

The authors declare that they have no conflict of interest.

REFERENCES

1. Chen L, Liu H, Hong Y, Yang Y, Hu L. Minimally invasive decompression and intracorporeal bone grafting combined with temporary percutaneous short-segment pedicle screw fixation for treatment of thoracolumbar burst fracture with neurological deficits. World Neurosurg 2020;135:e209-20.
2. Daisuke I. Bone fragment removal by posterior approach for delayed paralysis due to vertebral body rupture fracture. Orthop Traumatol 2019;68:601-5.
3. Deqing L, Kejian L, Teng L, Weitao Z, Dasheng L. Does the fracture fragment at the anterior column in thoracolumbar...
burst fractures get enough attention? Medicine (Baltimore) 2017;96:e5936.
4. Haiyun Y, Rui G, Shucai D, Zhanhua J, Xiaolin Z, Xin L, et al. Three-column reconstruction through single posterior approach for the treatment of unstable thoracolumbar fracture. Spine (Phila Pa 1976) 2010;35:295-302.
5. Lenehan B, Street J, Kwon BK, Noonan V, Zhang H, Fisher CG, et al. The epidemiology of traumatic spinal cord injury in British Columbia, Canada. Spine (Phila Pa 1976) 2012;37:321-9.
6. Qian Y, Jin C, He L, Zhu GQ, Xu GJ. Anterior reconstruction via a relatively noninvasive retroperitoneal approach for lumbar burst fracture. Orthop Surg 2015;7:185-6.
7. Ushiku C, Suda K, Matsumoto S, Komatsu M, Takahata M, Iwasaki N, et al. Dural penetration caused by a vertebral bone fragment in a lumbar burst fracture: A case report. Spinal Cord Ser Cases 2017;3:2016-8.
8. Wang Y, Ning C, Yao L, Huang X, Zhao C, Chen B, et al. Transforaminal endoscopy in lumbar burst fracture: A case report. Medicine (Baltimore) 2017;96:e8640.
9. Xu JG, Zeng BF, Zhou W, Kong WQ, Fu YS, Zhao BZ, et al. Anterior Z-plate and titanic mesh fixation for acute burst thoracolumbar fracture. Spine (Phila Pa 1976) 2011;36:e498-504.
10. Yoshiwa T, Miyazaki M, Kodera R, Kawano M, Tsumura H. Predictable imaging signs of cauda equina entrapment in thoracolumbar and lumbar burst fractures with greenstick lamina fractures. Asian Spine J 2014;8:339-45.

How to cite this article: Saruta W, Takahashi T, Kumabe T, Minami M, Kanematsu R, Ohtaki HS, et al. Transdural reduction of a bone fragment protruding into the spinal canal during surgical treatment of lumbar burst fracture: A case report. Surg Neurol Int 2021;12:406.