

A Transdural Approach for Lower Lumbar Burst Fractures. A Novel (Kotil) Technical Note

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Abstract

The treatment of surgical procedure of lower lumbar burst fractures is challenged. The optimal method remains controversial. To assess the usefulness and safety of a novel both decompression and reconstructive procedures known as transdural approaches of lower lumbar spine burst fracture. For this reason, we presented the results of a trans-dural approach which is a new technique.

We presented the reconstruction and dural repairing results of 5 cases that were operated on between the years 1995-2011 due to lower lumbar burst fractures with a trans-dural surgical technique. Cases were chosen for this technique according to the presence of lamina fractures displayed on tomography (CT) and lumbar (MRI). Intra canal fragments, lamina fractures were determined. The postoperative opening of the spinal canal, the loss of height of the middle and anterior column and the postoperative fusion results were investigated. The surgical results of the cases were classified according to the Odom's criteria.

No instances of neurological deterioration and instrument failure occurred and no complications were noted with the use of this technique. All five patients had neurological function recovery at the most recent follow-up visit.

In conclusion, this reported new surgical approach is an efficient and safe method for the treatment of traumatic lower lumbar burst fractures.

Keywords: Transdural approach; Lower lumbar spine; Burst fractures; Decompression

Introduction

Lumbar burst fractures are due to fractures of the anterior and middle columns resulting from axial compression. In some cases the posterior column can also be affected, causing fracture of 3 columns [1-3]. In lower lumbar burst fractures (L3-5), while the treatment may be conservative or surgical in anterior and medium column fractures, there is an absolute surgical indication for fractures in the 3rd column [4]. If a posterior column fracture accompanies a lower lumbar burst fracture, there is the possibility of dural tearing along with lamina fractures [5,6]. With dural tearing there is a higher risk of neurological deficit development. These patients have a risk of CSF leakage and meningitis [2,3,5,6]. Surgery is essential for these patients. Traditional surgery is aimed at corpectomy or bilateral aggressive or severe transpedicular decompression followed by dural repair and transpedicular fixation by a posterior approach [1,5]. Preoperative MRI can determine CSF leakage in these fractures that can be either complete or in greenstick form [3]. In this technique that we are trying to define, surgery is performed with only a single session posterior approach. The lamina fracture and dural tearing are repaired by a posterior approach, where instead of extracting the bone fragments, an incision in the dura opening to the anterior dura is made and reconstruction is performed with the use of special hammers. Thus, the fractured lamina, the exposed dura and the fragments within the channel are hammered into place through a posterior approach. This is a prospective follow-up study defining a new technique.

Material and Methods

We presented the reconstruction and dural repair results of 5 lower lumbar burst fracture cases that were operated on with a new trans-dural surgical technique between the years 1995-2011. The cases were trauma patients taken in the first 24 hours from the emergency service. All cases had lamina fractures and CSF leakage diagnosed with CT and MRI. Other lower lumbar burst fractures were not included in this study and were treated with conservative or classical

surgical techniques. Direct X-rays, tomography and lumbar MRI's were obtained for all cases. With the A/P direct X-rays, the kyphotic angulation, the interpedicular distances, the sagittal index and the height losses of the middle and anterior columns were determined. With CT the areas occupied by the inter channel fragments or retro pulse fragments and the spinal stenosis ratios were calculated. Surgical results were classified according to the Odom's criteria.

Surgical technique

Patients have the classic midline lumbar bilateral paravertebral muscle opening with two sided retraction. Disruptions of lamina integrity, in the form of complete or greenstick fractures are taken out with laminectomy. Following laminectomy, open or partially torn dura is hung to the sides with hanging sutures, the exposed neural tissue in the dural sac is gathered, covered with a pad and lateralizing to one side with root retractors to provide protection during surgery. Then the anterior dura is opened with a scalpel. An average 2 cm anterior dural opening is sufficient. With special ended hammers, the retropulsed bone fragments are hammered (Figure 1). After directly observing the decompression of the spinal canal, the entrances and exits of the foramens are controlled. After suturing the anterior dura, the cauda equina fibers are washed with saline solution and the erythrocytes are removed. The dura is closed primarily or with duraplasty. Lower and

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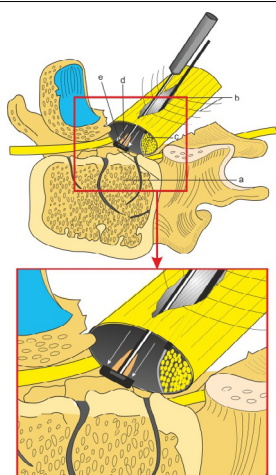


Figure 1: Intra channel bone fragments; reaching into the anterior dura entering through the posterior torn dura area, preservation of the cauda equine fibers, opening of the anterior dura and placement by special bone hammers and illustration demonstrating the provided reconstruction. The transdural approaches in the burst fracture: (a) Burst fracture and the indentation into the vertebral canal, (b) Extended the posterior dural tears and suspension of the duramater, (c) Pulled aside the rootlets, (d) The anterior dural tears, (e) Nailing of the bone fragments.

upper pedicular fixation is performed with instrumentation. With the bone fragments obtained from the laminectomy, lateral osteosynthesis is performed. A drain is placed and the surgical layers are thoroughly closed.

Sample case

A 44-year-old male patient was brought to the emergency room due to a fall from heights. On physical examination, the patient complained of lower back and leg pain, and there was swelling and edema in the lower lumbar region accompanied by a fresh echymotic area. On neurological examination, there was hypoesthesia in the perianal and L4-L5-S1 areas (L4-S4), hypoesthesia and moderate loss of strength in the anal sphincter. A L3 burst fracture was detected on spinal CT (Figure 2a). There were fragments inside the canal and a lamina fracture was also detected. On determining the degradation of posterior elements and potential CSF leakage on MRI (Figure 2b), the patient was taken to the operating room after 24 hours of falling. As the muscles were being parted, CSF leakage was observed. On noticing the CSF, muscle dissection was conducted carefully since herniation of the cauda equina fibers was possible. Cotton pads were placed on the neural tissue, the dura was opened another 1 cm and the nerve roots were placed into the dural sac. By retracting the cauda equina fibers with a root retractor, the anterior dura was opened with a scalpel. By hammering the bone fragments into the burst fracture, with a transdural approach was performed by transdural both decompression and reconstruction (Figures 2c and 2d). After, stabilization following reconstruction was obtained with upper and lower pedicle screws. The postoperative sagittal (3.mo) and axial CT (2 yr), the canal was observed to be decompressed (Figures 2e and 2f). Measurement technique for segmental kyphosis angle. Measured by Cobb's method at fractured segment. The paraparesis of the patient increased by only one point and became an ASIA grade D from a grade C. The patient was given a physical therapy and rehabilitation program and followed. Two years later, the patient had no complaints.

Results

Five cases were treated for lower lumbar burst fractures. They were followed for an average of 23 months [82-150 weeks]. The female/male

ratio was 2/3. The mean age was 39 [17-64 yr]. Three cases were due to falling from height and 2 cases were due to vehicle accidents. All the cases had neurologic deficits. All the cases were stabilized with the trans-dural technique by upper and lower pedicle screws. Greenstick lamina fractures were found in two cases and complete lamina fractures were found in 3 cases. Dura tears were complete in 3 cases and partial in 2 cases. In the cases with complete dura tearing, the cauda equine fibers were observed to be herniated extradurally. Disk integrity was preserved in all cases. Intradural hematoma or bleeding was not observed in any of the cases. Preoperative and postoperative channel diameters, fusion rates, Odom's scale values and follow up durations are demonstrated in Table 1.

Concerning change in local kyphotic angle before and after operations, an average of $18.5^\circ (\pm 9^\circ)$ kyphotic deformity was observed pre-operatively. The post-operative kyphotic angle improved to approximately $2.5^\circ (\pm 4.1^\circ)$. And at the final follow-up, it was $4.0^\circ (\pm 6.5^\circ)$ on average. As such, loss of reduction of kyphotic deformity was observed. At the final radiological examination movements on direct radiography could be observed, and on anteroposterior views, solid bone union could be confirmed. Solid union could be achieved after performing anterior and posterior fusion as showed in Figure 2f.

Discussion

In lower lumbar burst fractures where no neurologic deficit exists, treatment is controversial, whereas in cases presenting with neurologic

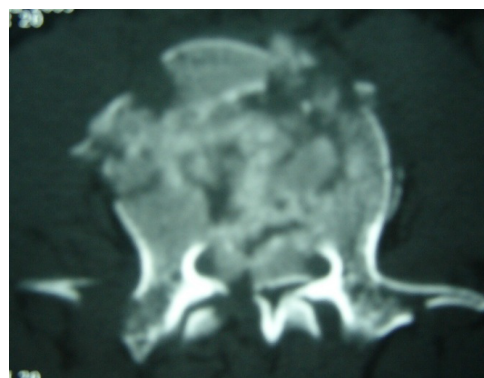


Figure 2a: Detection of burst fracture on axial CT.

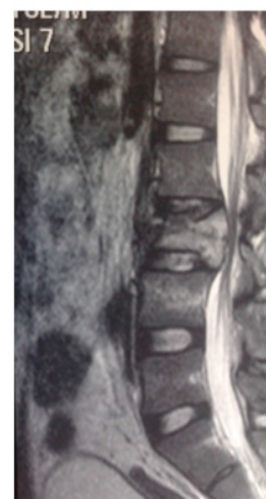


Figure 2b: Images of destructed posterior elements and CSF leakage on Lumbar MRI.

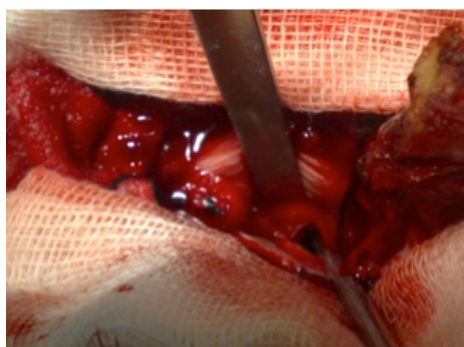


Figure 2c: Intraoperative illustration demonstrating the opening of the anterior dura following laminectomy.

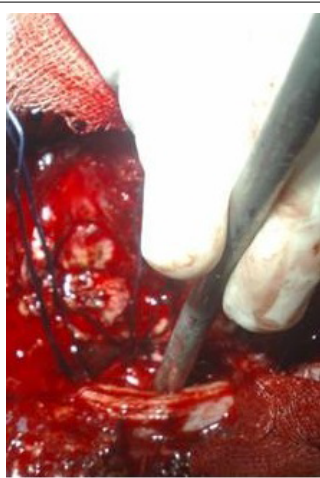


Figure 2d: Hammering of intra channel bone fragments into place with special hammers.



Figure 2e: Images of postoperative sagittal CT (3 months later).

deficit and intrachannel fragments, there is complete consensus on the requirement of surgical decompression [4-11]. Posterior column injury rates in lower lumbar burst fractures are variable. However, a large proportion of lamina fracture cases do have dura tearing [12-14].

This entities was first described by Miller et al. [14]. They mentioned that demonstrating the presence of lamina fracture on CT was associated with dura tearing in 85% of cases [14]. Denis and Burkus [8] reported that in greenstick fractures, dura or nerve roots enter into these fissures and neurologic deficit can develop. During axial pressure, the fractured corpus is also injured by its pedicles and while the lamina is fracturing, the dural sac herniates through the fracture. This leads to neurologic deficit with dura tearing [2]. In all our cases, there was lamina fracture and the dura had been affected. In this sense, the lamina in these cases should be extracted carefully, the dura should be repaired and reconstruction and stabilization should be performed.

In these types of fractures, the traditional surgical treatment approach is either anterior corpectomy or posterior-lateral transpedicular decompression [8,10,11,13]. Sometimes, the mortality, morbidity and decompression of the intracanal fragment may not be sufficient [11,12]. To be effective in this kind of transpedicular decompression fractures, it should be performed bilaterally which can cause bilateral pedicular damage [13].

While neurologic injury is reported as being 30-60% in thoracic lumbar burst fractures, in the evaluation of lumbar fractures, there are publications that report no neurologic deficit even with intra channel fragments that can create sufficient stenosis [1]. However, there are several publications that report a high frequency of neurological deficits associated with dural tearing [1,5,14,16]. For this reason, surgical indication is essential and leads to an indication of the posterior approach.

All our cases had neurologic deficits and the laminae were affected by the fractures. In these cases the severity of the neurologic deficit was directly proportional to intrachannel obliteration and the number of nerve fibers passing through the lamina fracture. In our study, while the 3 cases with complete lamina fractures had major deficits, the 2 cases with greenstick fractures had isolated root damage which supports this thesis

For this reason, trying to perform anterior decompression may lead to the worsening of or the irreversible loss of neurological functions because the nerve roots are intertwined with the lamina. Denis and Burkus [8] emphasized this topic and stressed the disadvantages of anterior decompression in their study. This suggestion emphasized or mandated the necessity to go over the lamina in our cases. Yet, Karaikovic et al. [11] used Kaneda instrumentation with the anterior approach in minor lamina fractures, but did not observe any neurologic deficits. They explained the absence of neurologic deficits in minor lamina fractures with the absence of nerve root pressure. But the interesting aspect of their study was that the neurologic deficit in 15.5% of cases did not change and the lost bladder function was not recovered in 33% of cases.

Yet, the justifications of advocates for posterior decompression of minor or major lamina fractures are obvious. A posterior approach not only provides decompression of the herniated nerve root but also provides the opportunity for duraplasty. With this discussion, both dura repair and restoration of the intrachannel(retropulsed) bone fragments can be provided with the trans-dural approach. The reasons for the applicability of this method include; absence of posterior dura tearing, wide enough dural space at the lower lumbar area and the presence of a sufficient working area. Additionally, in these cases it is interesting that disk rupture does not occur, thus the disadvantages of two distance discectomy performed in anterior corpectomy are not present with this technique. One other advantage is that this technique does not require a donor graft area thus donor site complications are

| Case No | Sex Age | ASIA (P/P) | SCD (P/P) | Fusion Grade | Odom's criteria | FT(mo) |
|---------|---------|------------|-----------|--------------|-----------------|--------|
| 1 | F/34 | D/D | 17-Sep | Grade 4 | good | 24 |
| 2 | F/17 | D/D | 21-Oct | Grade 4 | good | 37 |
| 3 | M/44 | C/D | 17-May | Grade 4 | excellent | 22 |
| 4 | M/50 | E/E | 18-Jun | Grade 3 | good | 24 |
| 5 | F/64 | D/D | 19-Oct | Grade 4 | good | 26 |

SCD: Spinal Channel Diameter; P/P: Preoperatuar/Postoperatuar; FT: Following Time, ASIA: American Spinal Cord Injury Association

Table 1: Preoperative and postoperative channel diameters, fusion rates, Odom's scale values and follow up durations are demonstrated.



Figure 2f: Axial CT image following decompression and fixation after the 2 years later.

avoided. All these surgical procedures can be performed successfully by the posterior approach in a single session. With this technique, in our cases, we found that the preoperative neurologic deficits recovered. With this approach, the cauda equine fibers that have herniated to the posterior extradural area can be placed inside the dural tube and repositioning of the nerve roots can be achieved.

The other subject is kyphotic correction angle. In this study, this technique is restorative, the pulse osseous fragments can be used by direct anterior support that can be achieved by impaction of bony fragments, the retropulsed bone fragments are hammered. After directly observing the decompression of the spinal canal, the entrances and exits of the foramina are controlled. We hadn't detected of relapse of kyphotic deformity and breakage of instrumentation. In addition, for the fractured vertebra, we tried to restoration in all cases. As seen in the results, the post-operative correction of kyphotic deformity was well maintained.

In conclusion, with this new trans-dural single surgical approach for lower lumbar burst fractures, vertebral osseous reconstruction and neural decompression can be achieved and the dura can be repaired. This intervention eliminates the need for grafts by nerve root decompression and duraplasty. It shows that nerve root decompression can be done more securely. For this reason, it is an alternative approach to the anterior and posterior classical decompression operations for all fractures. We believe that high value evidence based studies are required on this subject.

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