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Review article

Short segment percutaneous pedicle screw fixation after direct spinal canal decompression in thoracolumbar burst fractures: An alternative option

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ABSTRACTS

Objective: To investigate the surgical results of percutaneous pedicle screw fixation (PPSF) after spinal canal decompression via a small laminectomy for the treatment of thoracolumbar burst fractures.
Method: Twenty-seven patients underwent PPSF after spinal canal decompression via small laminectomies between April 2009 and April 2015. Inclusion criteria consisted of a single-level, closed, thoracolumbar burst fracture and neurological symptoms. Decompression was performed via a small laminectomy, followed by PPSF, including at the level of the fractured vertebra. Cobb angle, vertebral wedge angle, and vertebral body index were each measured from lateral radiographs before and after surgery, and at last follow-up. Neurological assessment was made using the Frankel grading system.
Results: The average follow-up period was 26 months. The preoperative average Cobb angle was 15.8° ± 6.6°, and significantly decreased to 6.5° ± 6.2° postoperatively ($p < 0.001$). Average Cobb angle at last follow-up increased slightly to 8.9° ± 6.9°, but this was not significant ($p = 0.112$). The preoperative average vertebral wedge angle was 20.6° ± 6.3°, and decreased significantly to 12.2° ± 6.2° postoperatively ($p < 0.001$). The vertebral body index significantly decreased from 0.58 ± 0.11 to a postoperative value of 0.78 ± 0.10 ($p < 0.001$). Clinically, no patient deteriorated subsequent to surgery.
Conclusion: Percutaneous pedicle screw fixation after spinal canal decompression via small laminectomy provides significant kyphotic correction and improved neurological outcome while offering decreased surgical morbidity. This may be applied as an effective primary surgery in select patients with TLBFs with neurologic symptoms.

1. Introduction

Thoracolumbar vertebral body fractures are most common spinal injuries, and fractures of burst type account for 21 to 58% of all thoracolumbar spinal fractures [1,2]. Thoraco-lumbar burst fractures (TLBFs) are often associated with kyphotic deformity, instability and neurological decline caused by retropulsion of fractured fragments those have a significant impact on patient's physical and occupational activities without adequate treatment [3]. Many studies have proved excellent therapeutic result of TLBFs and many experts have come to the conclusion that surgical treatment is needed for symptomatic and unstable burst fractures [4–9]. Purposes of surgical management for TLBFs are not only to remake stability of the vertebral column but also to decompress the spinal canal, which is the essential of early mobilization. But, it is still controversial with usage of the best surgical approach to TLBFs. There are a number of surgical options of the management of the TLBFs, including posterior short segment or long segment pedicle screw fixation, direct anterior decompression through corpectomy, and combined methods through anterior and posterior spinal approaches [5,7,8]. Among them, anterior approach which including corpectomy with fusion was known to provides a more direct and complete decompression of the spinal canal, potentially allowing a better neurological outcome [5,7]. But it has many surgical complications and disadvantages associated with long operation time and lots of blood loss and thoraco-abdominal organic injuries. So many surgeons have been more preferable to using posterior approaches recently [3,9]. Surgical procedure used by our institution for the treatment option of TLBFs is short segment percutaneous pedicle screw fixation (SSPPSF) after direct spinal

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canal decompression via a small laminectomy. We retrospectively reviewed the clinical outcome and radiological changes in patients treated with our method and add series of cases.

2. Materials and methods

2.1. Study population

In this study we enrolled 27 patients with thoracolumbar burst fractures with symptomatic canal encroachment who were treated by SSPSF including fractured level after spinal canal decompression between January 2009 and December 2015 in our department. Inclusion criteria required the following: single-level closed burst fracture involving thoracolumbar junction (T11-L2) with neurological deficit and Magerl type A3. Patients with multiple spine fractures, previous spinal surgery, combined with malignancy, or severe osteopenia (T-score < −2.5 on bone mineral density, DXA) were excluded from this study.

2.2. Surgical procedure (Lee et al., Acta Neurochir 2013)

The conventional posterior approach was performed in all patients. Under general anesthesia, patients were positioned prone on a radiolucent spine surgery table with the chest, abdomen, and pelvis properly supported by gel pads. A small, midline skin incision limited to the level immediately superior to the fractured level was made. Subsequently, exposure of the posterior elements and a small laminectomy at the level cephalad to the fractured level was performed. After removal of the ligament flavum, surgeon can find a dura that is buldged towards to the lamina. Carefully retract the dura and root with the retractor. Root retraction must be minimal and intermittent. Proceeding to this point, operator can see the disc between the fractured vertebra and the vertebra above. The next step is to bleed control and going toward to the caudal part and check the area where the bony fragment encroach the canal. Usually the bony fragment is located at the level of pedicle of the fractured vertebra. Then place the impactor on the bony fragment, and apply pressure by pushing it down or tapping with hammer. Then, the bony fragment can be decompressed simply (Fig. 1).

Following adequate decompression of the spinal canal, pedicle screws were inserted into the vertebral body one level above and below the fractured vertebra, including into the pedicles of the fractured vertebral body. Under anteroposterior (AP) fluoroscopic guidance, the initial skin incision was made approximately 1–2 cm lateral from the pedicle for screw fixation. A Jamshidi needle was positioned laterally and slightly in the cranial margin of the pedicle to guide instrumentation utilizing tactile sensation of the bone in the AP view. Under true AP view, the needle was inserted in a slightly medial direction. When the needle tip was located in the medial border of the pedicle in true AP view, fluoroscopy was then turned to see the lateral view. If the needle had been passed into the pedicle without violation of the median pedicle border, it was slowly advanced into the vertebral body. A guide wire was then inserted into the vertebral body through the needle, and the needle was carefully removed. The dilation tube was placed through the guidewire, with tapping of the tube performed to prepare for screw insertion. After tapping the junction where the pedicle meets the vertebral body, a cannulated percutaneous pedicle screw was advanced through the guidewire into the pedicle and the vertebral body (CD Horizon® Sextant® System, Medtronics, Memphis, TN USA; Apollon™, Solco, Seoul, Korea). The guidewire was then removed after adequate positioning of the screw. Under AP and lateral fluoroscopic guidance, an adequately sized rod was placed in the percutaneous pedicle screw heads through a small incision made in the thoracic region. Rod compression for spinal alignment was performed prior to the placement of locking nuts. Incisions for the spinal canal decompression and screws and rods placement were irrigated copiously and closed in meticulous fashion. All patients were braced postoperatively using thoracolumbar sacral orthosis (TLSO) for 1 month and early ambulation was encouraged.

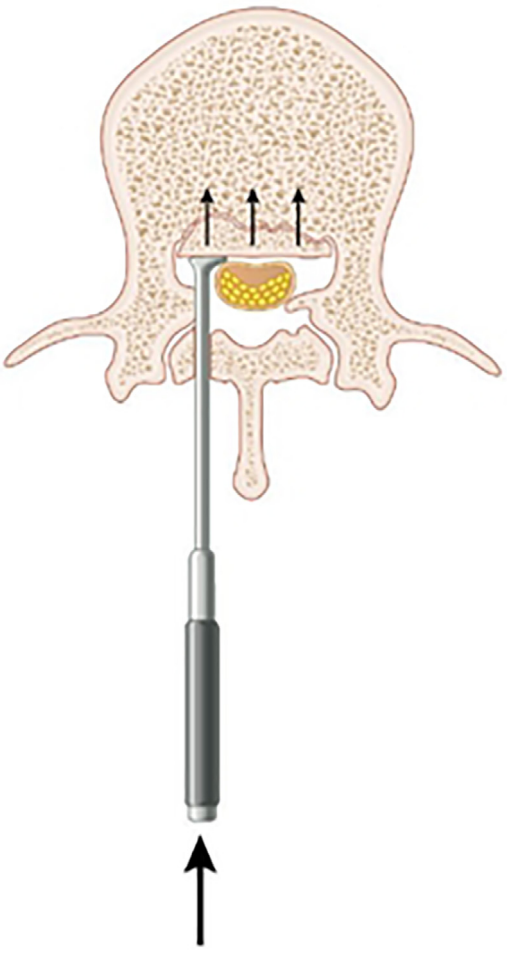

Fig. 1. Via small laminectomy, spinal canal is decompressed by tapping method.

2.3. Radiological and neurological assessment

Radiographic evaluation consisted of AP and lateral plain radiographs at the time of preoperative evaluation, immediately after surgery, and at last follow-up; CT and MRI of the thoracolumbar spine occurred preoperatively. Local kyphosis at the level of the fractured vertebral body was measured using the Cobb angle (CA), specifically from the superior endplate of the vertebra cephalad to the fractured vertebral body and the inferior endplate of the vertebra caudal to the fractured vertebral body. Additionally, the vertebral wedge angle (VWA; Cobb angle between the superior endplate and the inferior endplate of the fractured vertebra) and vertebral body index (VBI; the ratio of the fractured VB anterior vertebral wall height to the posterior vertebral wall height) were calculated (Fig. 3). Neurologic assessment was performed using the grading scale of Frankel both during preoperative workup and at last follow-up [10].

2.4. Statistical analysis

Radiographic parameters and clinical outcomes at the last follow-up were compared with preoperative and immediate post-

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