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Original research

Clinical efficacy of semi-laminectomy and posterior stabilization for treatment of thoracolumbar burst fracture

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ABSTRACT

Objective: The purpose of the present study was to investigate the efficacy of posterior semi-laminectomy, restoration of bony fragments and short-segment pedicle screw fixation for treatment of thoracolumbar burst fractures.

Methods: From January 2008 to April 2011, 21 patients (19 males and 2 females) who suffered single-level thoracolumbar burst fractures were enrolled in this study. Fractures at T11, T12, L1, L2 and L3 level occurred in 3, 5, 8, 4 cases and 1 case, respectively. The patients enrolled were presented with 30%–50% encroachment of spinal canal, partial neurological function deficits and intact pedicles, and underwent semi-laminectomy on the fractured thoracolumbar spine, restoration of the fractured bony fragments with special bone punch beneath dural sac, as well as pedicle screw fixation of the fractured thoracolumbar spine and the two vertical neighboring segments.

Results: All patients were followed up for 12–48 months, with a mean of 17 months. The mean kyphotic deformity was reduced from (17.3 ± 5.3)° preoperatively to (9.2 ± 4.1)° at follow-up within 12 months. The mean spinal canal diameter increased from (9.7 ± 2.7) mm before surgery to (13.3 ± 1.4) mm at follow-up. Neurological improvement occurred in all subjects after average 2.5 months (range, 1–7 months). Only postoperative wound dehiscence was observed in 1 case, which was caused by implant reaction of calcium phosphate and healed after debridement.

Conclusion: Semi-laminectomy and restoration of bony fragments is a safe and effective therapeutic measure for thoracolumbar burst factures with spinal canal encroachment of less than 50%.

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1. Introduction

Thoracolumbar burst fracture was first reported by Frank Holdsworth in 1963,[1] as an injury typically resulting from falling from a height or traffic accidents, causing a significant axial load on the spine, leading to a failure of the anterior, middle and posterior vertebral columns.[2] Most burst fractures occur at the level of the thoracolumbar junction whose vulnerability is partially explained by the anatomic and biomechanical features of this region. The radial shape of the thoracic cage and stability provided by the costotransverse ligaments in the thoracic spine give a higher resistance to load in the coronal and sagittal planes and to axial rotation. Such a protection degree and the relatively rigid shape contrast with the underlying lumbar spine – more flexible and less protected than the thoracic spine – resulting in a fragile segment that is named thoracolumbar transition (T11–L2).[3]

Non-operative and operative approaches have been proposed for treatment of thoracolumbar burst fractures.[4–6] For burst fractures without neurological injury, both of non-operative care and posterior surgery with short-segment pedicle fixation devices could provide excellent results. Although a greater residual kyphotic angle can be noted for non-operative management, this does not correlate with symptoms at follow-up.[7] Surgery is generally believed to be the appropriate treatment for thoracolumbar burst fractures associated with neurologic deficit. Anterior surgical treatment allows direct decompression of the neural elements and correction of deformity. However, it will lead to large injury, more intraoperative blood loss and longer operative time,[8] which limits its application. Nowadays, posterior short-segment pedicle screw fixation has become popular for management of thoracolumbar fractures.[9,10]

In the present study, we retrospectively reviewed the clinical and radiological outcomes of 21 patients with thoracolumbar burst

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fracture in our hospital who underwent posterior semi-laminectomy, restoration of bony fragments and short-segment pedicle screw fixation. Their preoperative characteristics, postoperative changes of kyphotic angle and neurologic recovery were assessed.

2. Subjects and methods

2.1. Subjects

The patients who met the following inclusion criteria were enrolled in this study. (1) Aged between 20 and 60 years; (2) Fractures between T11 and L4; (3) Fractures caused by obvious trauma such as fall from height and motor vehicle accidents; (4) 30%–50% encroachment of spinal canal; (5) The neurological level for spinal canal injury was grade C or D according to the American Spinal Injury Association (ASIA) modified Frankel scale[11]; (6) intact pedicles. Those who met the following criteria were excluded. (1) Aged less than 20 years or more than 60 years; (2) The cases with osteoporosis diagnosed based on the bone mineral density assessed by radiography and computed tomography (CT) scans[12]; (3) Those with pathological fractures; (4) The cases without neurological injury.

2.2. Preoperative examination

All subjects underwent lateral X-ray, CT scans and magnetic resonance imaging (MRI). The possibility of neurological functions recovery after surgery was also assessed.

2.3. Surgical procedure

All the 21 subjects underwent the same surgical treatment by the same surgeon. The patients received general anesthesia and were placed in a prone position on a surgical bed. The abdomen was raised by a hollow pad to keep lumbar extension. The injured lumbar vertebra and the small articular processes above and below this were routinely exposed and then pedicle screws were implanted. After the operation bed was adjusted to the thoracolumbar recurvation at 15°, the vertebral body was fixed using the connecting rod on the non-compressed side and semi-laminectomy was performed on the injured lumbar vertebra at the contralateral side. The bony fragments intruding into vertebral canal were restored to the vertebral body with special bone punch beneath dural sac. If high obstruction was found on the bony fragments, the tail of the bone punch was tapped with a bone hammer. Subsequently, the connecting rod on the contralateral side was released, the angle of the operation bed was adjusted to the normal position and the bilateral pedicle screws were connected and fixed. If an ideal height was not achieved in the injured lumbar vertebra, vertebral compression and allogeneic bone grafting (purchased from Beijing Xinkangcheng Medicine Development Center, PR China) were performed via the pedicle of the injured lumbar vertebra. In addition, calcium phosphate bone cement (Zimmer, Warsaw, IN, USA) was also used to improve the strength of the injured vertebra. All operations were performed under a C-arm X-ray machine.

2.4. Postoperative management

Negative-pressure drainage was removed at 24–48 h after surgery. Antibiotics were intravenously injected for 1–3 days, and cobamamide injection was given intravenously at a dose of 1.5 mg/d for neurological nutrition for a week. The patients were rested on bed for a week after surgery, they did sit-up exercise with the protection of lumbar support after a week of surgery, and they did walking exercise with the help of two crutches at two weeks after surgery.

2.5. Therapeutic evaluation

Radiological assessment was carried out at 3, 6, and 12 months after surgery. The proportions of bony fragments in the anteroposterior diameter of spinal canal before and after surgery were measured to assess the recovery of the anteroposterior diameter of spinal canal. Local kyphosis was measured using the Cobb method described by Kuner et al.[13] The anterior vertebral body height was directly measured, and the percentage of the anterior vertebral body height was calculated using the following formula: Percentage of anterior vertebral body height (%) = anterior vertebral body height/mean height of vertically neighboring normal vertebral body × 100%.

2.6. Statistical analysis

All data were expressed as mean ± standard deviation (SD) and all statistical analyses were performed using the statistical software SPSS version 10.0 (SPSS Inc., Chicago, USA). The statistical difference of spinal canal diameter and anterior vertebral body height before and after surgery was tested using Student *t*-test. $P < 0.05$ was considered statistically significant.

3. Results

A total of 21 patients with thoracolumbar burst fractures from January 2008 to April 2011 were enrolled in this study, including 19 males and 2 females, with a mean age of 37 ± 14 years (range, 22–51 years, Table 1). All patients had single-level fractures, consisting of 3 T11 level injuries, 5 T12, 8 L1, 4 L2 and 1 L3 injury. The causes of spine injury were falling from a height (11 cases), traffic accident (8 cases) and the bruise injury caused by heavy object (2 cases).

The period from the injury to the operation ranged from one to five days, with a mean of 3.5 days. The mean operation time was 150 min (range, 120–210 min) and the mean blood loss was 400 ml (range, 300–600 ml). The patients were discharged after an average hospital stay of 8.5 days (range, 7–10). All patients were followed up for 12–48 months postoperatively, with a mean of 17 months. The mean kyphotic deformity was reduced from (17.3 ± 5.3)° preoperatively to (9.2 ± 4.1)° at follow-up within 12

Table 1
Clinical characteristic of 21 patients with thoracolumbar burst fracture.

Variable	Number of patients
Sex (*n*)	
Male	19
Female	2
Age (years)	37 ± 14
Injury cause (*n*)	
Fall from a height	11
Traffic accident	8
Bruise caused by heavy object	2
Injury area (*n*)	
T11	3
T12	5
L1	8
L2	4
L3	1
Preoperative Frankel grade (*n*)	
C	6
D	15
Postoperative Frankel grade (*n*)	
D	5
E	16
Preoperative kyphosis Cobb (°)	17.3 ± 5.3
Postoperative kyphosis Cobb (°)	9.2 ± 4.1
Preoperative vertebral canal diameter (mm)	9.7 ± 2.7
Postoperative vertebral canal diameter (mm)	13.3 ± 1.4

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