Original Article

Short segment screw fixation without fusion in treatment for unstable thoracolumbar burst fracture

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Abstract: This study aims to evaluate clinical efficacy of short segment pedicle screw fixation without bone fusion for unstable thoracolumbar burst fracture. Nineteen patients younger than 40 years old with unstable thoracolumbar burst fractures were included. The surgical procedure included postural reduction for 3 days and screw fixations at one level above, one level below and at the fractured level itself. The implants were removed 12 months after initial operation. Imaging and clinical findings were analyzed at preoperative, 12 months after surgery, just before implant removal, and at six months after implant removal. Results indicated that difference was statistically significant between preoperative period or postoperative 1 year follow-up, just before implant removal and 6 months after implant removal (P < 0.05). Results at postoperative 1 year follow-up, just before implant removal and 6 months after implant removal were better than preoperative period. There were no significant complications or neurological deterioration after screws insert and removal in any patient. The rate of clinical outcome with excellent and good was 94.7%. In conclusion, short segment pedicle screw fixation without bone fusion can be an effective and safe operative strategy in the management of young patients suffering from unstable burst fracture.

Keywords: Pedicle screw fixation, short segment, burst fracture, bone fusion

Introduction

Despite the general agreement on the goals of surgical treatment, the treatment of unstable burst fractures of the thoracolumbar and lumbar spine without neurologic deficits still remains controversial. Some authors believed that conservative treatment for burst fractures without neurological deficit has been reported to have good results [1]. On the other hand, surgical methods provide immediate spinal stability and more reliably restore the sagittal alignment, as well as vertebral and canal dimensions [1, 2]. Regardless of the approach used, one important goal of internal fixation is to minimize the number of fused levels by using short segment fixation [3]. Nowadays, some good clinical outcomes were also reported with short segment fixation without bone fusion [2, 4, 5]. However, there are few reports for burst fracture investigating the stability of the spine after removal for screws short segment fixation without bone fusion. We conducted a clinical study to evaluate the clinical outcome of short segment fixation without bone fusion of unstable burst fractures of the thoracolumbar and lumbar spine and studied whether implant removal would lead to increased loss of vertebral height and poor clinical outcome.

Methods and methods

Subjects

The inclusion criteria were limited to neurologically intact patients in spite of severe canal compromise (more than 50%) or more than 40% height loss from original height, intact bilateral pedicles, which enabled surgeons to insert the screws at the fractured vertebra, and no osteoporotic spine (T-score on bone mineral densitometry > 1.0) in patients younger than 40 years old. Patients with conditions requiring anterior decompression for neurologic deficits, and conditions when screws could not be inserted at the fractured level were excluded.
However, posterior column injuries including lamina or spinous process fractures and ligamentous injury were not an exclusion criterion in this study. We did not perform aggressive decompressed laminectomy because there were neurological deficits identified.

Finally, this study included 19 patients (15 male, 4 female) with unstable thoracolumbar or lumbar burst fractures from January 2006 to December 2010. The involved level was T11 (n=3), T12 (n=4), L9 (n=9), and L2 (n=3). The mean age of the participants at the time of injury was 23.2 years (range 16-38 years) (Table 1).

### Surgical technique

After postural reduction for 3 days using a soft roll under the collapsed vertebra in the supine position, standard posterior midline approach was undertaken in all patients. This included short segment transpedicular fixation with one level above and one level below the injured segment, thus including the fractured level itself. The facets and spinal processes were not exposed as widely as in fusion surgery. Intraoperative instrumental reduction was performed to provide anterior force by insertion of the rod to push the injured vertebra ventrally and simultaneously correct the kyphosis to lordosis. On postoperative day 3, after removal of the suction drain, the patients were allowed to ambulate in a thoracolumbosacral orthosis (TLSO) brace. The TLSO brace was used for 3 months after operation.

### Assessment methods

Lateral radiographs and computed tomography (CT) scans were taken and analyzed at three different time points: at preoperative, at 12 months after surgery, just before implant removal, and at six months after implant removal.

The vertebral height loss was quantified using the vertebral heights at the anterior collapse on lateral radiographs or sagittal CT scan. The vertebral heights were reported as fractions of anterior height between fractured vertebra and normal height of adjacent one level below the fractured vertebra. The axial CT scan showing the largest canal encroachment by the retro-pulsed bone fragment was selected for the measurement of canal compromise.

The pain score using VAS was evaluated at three different time points. At six months after implant removal, the patients were evaluated according to a modified version of MacNab’s criteria for characterizing the clinical outcome after spinal surgery.

### Statistical analysis

All data were presented as mean and standard deviations, and analyzed by using SPSS software (SPSS, Chicago, IL). Comparison between preoperative and postoperative data was done by paired t-test. \( P < 0.05 \) was considered statistical significance.

### Results

#### Preoperative data

The average operative time was 93 minutes (range 70 to 128 min). The average intraoperative blood loss was 92 mL (80-175 mL) (Table 1). Pedicle screws were accurately placed for all cases. Intraoperative complications of neurovascular injury were not found for all patients. No case required blood transfusion. All incisions were healed by first intention after surgeries. All patients were postoperatively followed up for 18 months. And implants were removed at 12 months after thoracolumbar fixation.

#### Radiological and clinical outcome

The radiological outcomes were indicated in Figure 1. The improved vertebral height and canal compromise were maintained at 6 months after implant removal. There were no significant complications or neurological deterioration after screws insert and removal in any patient. Based on canal encroachment (Table 2), percentage of vertebral body height loss (Table 2) and visual analogue scale (VAS) pain score

### Table 1. Demographic and characteristics of involved level

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Unstable Thoracolumbar Burst Fracture</th>
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<tbody>
<tr>
<td>Age (y), mean (range)</td>
<td>23.2 (16.38)</td>
</tr>
<tr>
<td>Male (n, %)</td>
<td>15 (78.9)</td>
</tr>
<tr>
<td>Involved level</td>
<td></td>
</tr>
<tr>
<td>T11 (n, %)</td>
<td>3 (15.8)</td>
</tr>
<tr>
<td>T12 (n, %)</td>
<td>4 (21.1)</td>
</tr>
<tr>
<td>L9 (n, %)</td>
<td>9 (47.4)</td>
</tr>
<tr>
<td>L2 (n, %)</td>
<td>3 (15.8)</td>
</tr>
</tbody>
</table>
Table 2), the difference was statistically significant between preoperative period or postoperative 1 year follow-up, just before implant removal and 6 months after implant removal (P < 0.05). Results at postoperative 1 year follow-up, just before implant removal and 6 months after implant removal were better than preoperative period. The improved vertebral height and canal compromise were maintained at 6 months after implant removal (P > 0.05).

According to a modified version of MacNab’s criteria for characterizing the clinical outcome at final follow-up, the rate of excellent and good was 94.7% (Excellent: 15 patients, Good: 3 patients and Fair: 1 patients). There were no significant complications or neurological deterioration after screws insert. Neurologically, Frankel 1 or 2 grades were improved for all cases after surgery (Table 3).

Discussion

According to the “three-column” concept of Denis [3], burst fracture is a 2 or 3 column injury that may lead to unstable spinal column when presenting with severe canal compromise, greater than 50% loss of vertebral height, angu-
Treatment for unstable thoracolumbar burst fracture

Table 2. Radiological and clinical outcome at three different time points (n=19)

<table>
<thead>
<tr>
<th></th>
<th>Preoperative period</th>
<th>postoperative 1 year</th>
<th>6 months after implant removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canal compromise (%)</td>
<td>55.4±3.8</td>
<td>35.6±4.1*</td>
<td>35.6±4.1*</td>
</tr>
<tr>
<td>Vertebral body height loss (%)</td>
<td>45.3±3.4</td>
<td>16.9±2.9*</td>
<td>18.1±3.1*</td>
</tr>
<tr>
<td>VAS pain score (points)</td>
<td>8.2±1.8</td>
<td>2.2±1.3*</td>
<td>2.1±1.1*</td>
</tr>
</tbody>
</table>

*Compared with preoperative period, P < 0.05.

Table 3. Neurological function outcomes (n=19, Frankel grade)

<table>
<thead>
<tr>
<th>Preoperative period</th>
<th>One year follow-up</th>
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<tbody>
<tr>
<td></td>
<td>A</td>
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<tr>
<td>A</td>
<td>-</td>
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<tr>
<td>B</td>
<td>-</td>
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<tr>
<td>C</td>
<td>-</td>
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<tr>
<td>D</td>
<td>-</td>
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Theoretically, ligamentotaxis allows posterior instrumentation to provide distractive forces, leading to fracture reduction and canal decompression. The annulus fibrosus attaching to the endplate is thought to play a critical role during the reduction of fragments near endplate [2, 4, 5, 11]. On the basis of fracture reduction theory, in this study, short segment pedicle screw instrumentation was designed and applied in clinical practice. Initially, there were concerns that the insertion of pedicle screws into the fractured body might negatively affect canal restoration, because the increased pressure in the vertebra during screw insertion could push the fracture fragments backwards. However, after postural reduction, the intervertebral pressure has already been reduced to some degree, which, to a large extent, could allow the increased pressure caused by screw insertion. Insertion of pedicle screws at the level of the fracture resulting in a segmental construct that can improve the biomechanical stability by protecting to the fractured vertebral body and supporting the anterior column indirectly.

Spontaneous remodeling of the spinal canal after burst fractures was shown to occur, regardless of the way of treatment. Scapinelli [12] insisted that the loss of mechanical loading and rhythmic respiratory oscillations in cerebrospinal fluid pressure would be important factors in the mechanism of bone remodeling. de Klerk et al [13] reported that the process of remodeling mainly takes place during the first year after injury; after this period, there is little further remodeling. For this reason, we removed implants at 1 year after screw fixation. With short segment fixation without bone fusion, early ambulation was possible and we could preserve motion segments by removal of screws, compared with long level instrumentation and fusion.

In terms of the limitations of the study, all patient’s surgeries were carried out by a single...
surgeon, which may lead to the biased interpretations of the data. Therefore, the study group is only small sized limiting the statistical power. Timing of surgery for all patients was also not uniform. Furthermore, this study is the lack of randomization leading to an inhomogeneous distribution of fracture patterns and individual treatment strategy. The differences of clinical effects between fusion and non-fusion technique in the patients with thoracolumbar burst fractures need further studies.

In conclusion, short segment fixation without bone fusion is an effective and reliable operative technique for the treatment of unstable burst fractures when properly indicated, especially in young patients without osteoporosis. The improved canal compromise and vertebral height were maintained during the follow-up period after removal of screws.

Disclosure of conflict of interest

None.

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References