Short Segment Screw Fixation without Fusion for Low Lumbar Burst Fracture: Severe Canal Compromise but Neurologically Intact Cases

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**Objective:** The purpose of this study was to determine whether screw fixation without bone fusion in patients with a low lumbar burst fracture has satisfactory outcomes.

**Methods:** Twelve patients that underwent screw fixation without bone fusion for a low lumbar burst fracture (L3–5) between 2006 and 2009, were included in this study. Motor power was intact despite severe canal compromise in all. Surgical procedures included postural reduction for 2 days and screw fixation without bone fusion. Imaging and clinical findings, including level of the involved vertebra, vertebral height, canal compromise, clinical outcomes, and related complications were analyzed.

**Results:** Mean follow-up was 23.1±11.0 months. Mean pain score (visual analogue scale) prior to surgery was 7.8±2.0 and this decreased to 1.8±1.0 at final follow-up. In 5 patients, open screw fixation by midline skin incision was performed and 7 patients underwent percutaneous screw fixation at one level above, one level below the fractured vertebra and fractured level itself. The proportion of canal compromise at the fractured level improved significantly from 60% to 30% at final follow-up (p<0.001). Mean preoperative vertebral height loss was 31.0%, and improved to 20.5% at final follow-up, though this improvement was not statistically significant (p<0.001). No neurological aggravation related to neural injury was observed.

**Conclusion:** Short segment pedicle screw fixation without bone fusion can be an effective and safe operative technique for the management of selected low lumbar burst fractures.

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**KEY WORDS:** Lumbar vertebrae · Burst fracture · Pedicle screw.

**Introduction**

Burst fractures of the low lumbar spine (L3–5) represent a small percentage of all spinal fractures. Due to their rarity, most of the literature regarding the best treatment for burst fractures concerns the thoracolumbar junction, rather than the low lumbar region.3 Fractures of these vertebrae have biomechanical and anatomic characteristics that distinguish them from thoracolumbar burst fractures.11 In particular, the iliolumbar ligaments and a location below the pelvic brim with major muscle support are two stabilizing factors that are unique to these fractures. Furthermore the spinal canal is widest in the low lumbar region.3 As a result, neurologic deficits are rare in low lumbar burst fracture compared with thoracolumbar burst fracture. The relative and absolute indications for surgery or conservative treatment for the management of low lumbar burst fractures remain controversial, especially in neurologically intact patients with severe canal compromise. Conservative treatment, including prolonged bed rest with subsequent bracing, has proven to be an effective means of treating low lumbar burst fractures.3 On the other hand, surgical treatment provides immediate spinal stability and more reliably restores sagittal alignment and canal dimensions. However, despite the advantages of earlier ambulation and anatomic reduction, due to major muscle support and forceful retraction for lateral to medial direction to insert screws, long segment fusion should be avoided in patients with a low lumbar...
bar burst fracture.\(^\text{1,2}\) Recently, good clinical results have been reported for short segment fixation without bone fusion in thoracolumbar spine.\(^\text{1,2}\) However, no report addressed the clinical outcomes of short segment fixation without bone fusion for low lumbar burst fractures. Accordingly, the purpose of this study was to evaluate the clinical and radiological results of low lumbar burst fractures treated by short segment fixation without bone fusion.

**Materials and Methods**

This study included 12 patients (5 males, 7 females) with a low lumbar burst fracture. Patients that met the following criteria were included: 1) neurologically intact patients with a single level low lumbar burst fracture (L3–5); 2) canal encroachment more than 50%, that is surgical indication suggested by National Health Insurance Corporation of Korea; 3) intact bilateral pedicles (enabling the insertion of screws at the fractured vertebra); 4) follow-up period more than 12 months; and 5) non-osteoporotic spine (T-score by bone mineral densitometry > -1.0). Patients with conditions requiring anterior decompression for neurologic deficits, and those with conditions preventing screw insertion at the fracture level were excluded. However, posterior column fracture was not viewed as an exclusion criterion.

In five patients, a standard posterior midline approach with a short-segment transpedicular fixation to adjacent above and below the injured segment including fractured level was performed. In the other seven patients, percutaneous screw fixation was confined to adjacent levels one above and below the injured vertebra, including the fractured vertebra. All patients were allowed to ambulate in a brace on postoperative day 2 or 3. A brace was used for 3 months after screw fixation. Lateral plain radiographs and computed tomography (CT) scans taken at preoperatively and final follow-up were used to analyze vertebral height and canal compromise. Vertebral height loss was quantified using vertebral heights at the anterior collapse on lateral radiographs or sagittal CT scans. Vertebral heights were reported as fractions of anterior heights between fractured vertebrae and normal adjacent vertebrae heights on lateral radiographs or sagittal CT scans. Axial CT scans showing greatest canal encroachment by retropulsed bone fragments were selected to determine the degree of canal compromise.

**Safety and outcome evaluations**

Patients were evaluated at final follow-up, according to visual analogue scale (VAS) and a modified version of MacNab’s criteria for characterizing clinical outcomes after spinal surgery. Radiographs were used to evaluate the radiological findings including vertebral height loss and canal compromise at the levels of affected segments.

**Statistics**

Statistical analyses, including the determinations of mean values and standard deviations, were performed using SAS 6.12 (SAS Institute, Inc., Cary, NC). Comparisons between different time points were performed using the paired \(t\)-test. Differences were considered statistically significant when \(p\) values were <0.05.

**Results**

With respect to the anatomic distribution of fractures, L3 was affected in 4 patients, L4 in 5, and L5 in 3. Mean follow-up was 23.1±11.0 months, and mean operation time

<table>
<thead>
<tr>
<th>Case</th>
<th>Age/Sex</th>
<th>Level</th>
<th>Combined injury</th>
<th>Height loss (%)</th>
<th>Canal compromise (%)</th>
<th>Screw fixation</th>
<th>Implant removal</th>
<th>Final F/U (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16/M</td>
<td>L4</td>
<td>Lamina Fx.</td>
<td>30</td>
<td>85</td>
<td>Open</td>
<td>Yes</td>
<td>27</td>
</tr>
<tr>
<td>2</td>
<td>17/F</td>
<td>L5</td>
<td>–</td>
<td>30</td>
<td>55</td>
<td>Percutaneous</td>
<td>No</td>
<td>28</td>
</tr>
<tr>
<td>3</td>
<td>15/F</td>
<td>L3</td>
<td>Lamina Fx.</td>
<td>20</td>
<td>50</td>
<td>Percutaneous</td>
<td>No</td>
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</tr>
<tr>
<td>4</td>
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<td>L4</td>
<td>–</td>
<td>30</td>
<td>55</td>
<td>Percutaneous</td>
<td>Yes</td>
<td>24</td>
</tr>
<tr>
<td>5</td>
<td>41/F</td>
<td>L3</td>
<td>Lamina Fx.</td>
<td>40</td>
<td>60</td>
<td>Open</td>
<td>Yes</td>
<td>27</td>
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<tr>
<td>6</td>
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<td>L3</td>
<td>–</td>
<td>40</td>
<td>55</td>
<td>Open</td>
<td>Yes</td>
<td>13</td>
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<tr>
<td>7</td>
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<td>30</td>
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<tr>
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<td>55</td>
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<td>No</td>
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<tr>
<td>9</td>
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<td>55</td>
<td>Open</td>
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<tr>
<td>10</td>
<td>37/M</td>
<td>L5</td>
<td>Lamina Fx.</td>
<td>30</td>
<td>65</td>
<td>Percutaneous</td>
<td>No</td>
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<tr>
<td>11</td>
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<tr>
<td>12</td>
<td>25/F</td>
<td>L4</td>
<td>–</td>
<td>25</td>
<td>65</td>
<td>Percutaneous</td>
<td>No</td>
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</tbody>
</table>

Fx: fracture, F/U: follow-up
was 66.5±30.5 minutes. In 5 patients, open screw fixation by midline skin incision was performed and 7 patients underwent percutaneous screw fixation at one level above, one level below the fractured vertebra and fractured level itself (Table 1). No patient required a blood transfusion. The 7 patients who underwent percutaneous screw fixation did not need suction drainage. Implant removal was suggested at 1 year postoperatively due to the possibility of implant failure; this was explained fully before surgery. Implants were removed in 7 patients, and the other 5 patients refused screw removal due to the absence of any discomfort during the follow-up period (Figures 1, 2).

Clinical outcome
The mean pain score (VAS) prior to surgery was 7.8±2.0 and this decreased to 1.8±1.0 at final follow-up. All patients were graded as having achieved an excellent or good outcome according to MacNab’s criteria at final follow-up. No neurological deterioration or significant complication was encountered during follow-up period.

Proportion of canal compromise
Mean preoperative canal encroachment, due to retropulsed bony fragments, was 60%, and CT scans at final follow-up revealed a statistically significant improvement to 30% (p <0.001).

Restoration of vertebral height
Average preoperative percentage of vertebral body height loss was 31.0%, which improved to 20.5% at final follow-up. However, this difference was not statistically significant (p>0.05).

Discussion
Low lumbar burst fractures are relatively infrequent as compared with thoracolumbar burst fractures, and have different characteristics due to their anatomical and biome-
Mechanical features. The management of low lumbar burst fractures also differs from that of thoracolumbar fractures and requires an understanding of factors that do not affect more proximal spine injuries. In comparison to the thoracolumbar junction, the low lumbar spine is protected by the pelvis and strong ligamentous and muscular attachment. As noted, flexion-extension injuries and neurologic deficits are rare.\(^6,9\) Treatments for low lumbar burst fractures are conservative or surgical, that is, by posterior stabilization or by applying an anterior approach.\(^9,10\) However, no accepted guidelines or consensus exists regarding the optimal approach for such lesions, and no universally accepted criterion is available for evaluating stability of the low lumbar spine. In neurologically intact patients, conservative care, including prolonged bed rest with postural reduction and the subsequent wearing of a brace and ambulation, has provided an effective treatment for low lumbar burst fractures despite some loss of lordosis and vertebral height.\(^3\) However, it seems highly unlikely that bed rest or postural reduction might result in significant vertebral height reconstitution or any improvement in lumbar lordosis after a low lumbar burst fracture. Conservative treatment may lead to ongoing neurogenic pain, neurologic deficits, and progressive spinal deformity. Furthermore, surgical treatment more reliably restores sagittal alignment, translational deformities, and canal dimensions. Kostuik\(^8\) suggested that stabilization of thoracolumbar or lumbar burst fractures without neurologic deficit should be performed in cases with more than 50% canal compromise, in conjunction with loss of height and local kyphosis, because of potential bony fragment displacement and spinal stenosis due to degeneration related to disc and endplate injury. The main advantage of short-segment fixation is that it better preserves motion segments than long level fixation. In 2006, Wang et al.\(^12\) reported satisfactory results for short-segment fixation without fusion in surgically treated thoracolumbar burst fractures. They found for patients with a burst fracture treated surgically that low back outcome scores were no different for those with or without bone fusion. The advantages of instrumentation without fusion are the elimination of donor site complications, the preservation of motion segments, a reduction in blood loss, and a shorter operation time. However, it is not known whether these results are maintained over time and whether they also apply to lower lumbar burst fractures. However, from a biomechanical perspective, this extrapolation to lower lumbar fractures seems valid, because the pattern of collapse after fracture in this region is less likely to result in significant kyphosis leading to implant failure. Therefore, screw fixation without formal bone fusion is probably an appropriate treatment approach for low lumbar burst fractures. More recently, some investigators have reported suc-

**FIGURE 2.** A neurologically intact 15-year-old female patient fell down and sustained an L3 burst fracture. **A, B:** Preoperative computed tomography scans showing severe canal compromise (about 50%) and lamina fracture. **C, D:** Simple lateral radiograph and computed tomography scan taken at 12 months after screw fixation demonstrating well-maintained alignment and improved canal compromise.
successful surgical results for percutaneous screw fixation.4,5) Percutaneous screw fixation appears to be ideally suited for the lower lumbar spine in cases requiring stabilization but not fusion, where temporary stabilization without fusion may prove to be an effective way of maintaining motion. The present study demonstrates the efficacy of short segment fixation without fusion in patients with a low lumbar burst fracture without neurologic deficits. Furthermore, screw removal at 12 months postoperatively did not affect stability in 7 patients and it could be maintained when natural bone healing and solid union have been achieved. However, this does not mean that all patients with a low lumbar burst fracture should be treated using this technique, for example, patients with more unstable fractures and possibly more severe neurologic injuries should be excluded. In such cases, treatment should include decompression, spinal realignment with maintenance of lumbar lordosis, rigid posterior instrumentation over minimal segments, and a period of bed rest and/or bracing to allow bony union and fusion maturation. Randomized, comparative, clinical trials in a larger population are required.

Conclusion

For the management of selected patients with a single level low lumbar burst fracture without neurologic deficits, short segment screw fixation without bone fusion provides an alternative to traditional long level fusion.

The authors have no financial conflicts of interest.

REFERENCES

4) Gahr RH, Strasser S, Strasser E, Schmidt OI. Percutaneous internal fixation of thoracolumbar spine fractures. Top Spinal Cord Inj Rehabil 12:45-54, 2006