

Original**Surgical Outcomes of Posterior Short Segment Fixation
for Thoracolumbar Burst Fractures :
A Study of Patients Treated without Vertebroplasty**

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Abstract : There is no widespread agreement regarding the treatment of thoracolumbar burst fractures. While performing posterior short segment fixation of thoracolumbar burst fractures, we evaluated therapeutic outcomes in patients treated with screw insertion into fractured vertebral bodies without vertebroplasty. We also investigated the limitations associated with the treatment of burst fractures when vertebroplasty is not performed. Twenty-one of 51 patients with thoracolumbar burst fractures who were treated surgically in Ohta Nishinouchi Hospital were evaluated in the present study. These patients underwent posterior short segment fixation with screw insertion into the fractured vertebral bodies (only pedicle screws were inserted one level above and one level below the fractured vertebral bodies) without vertebroplasty. Vertebral angles were measured before surgery, immediately after surgery, and at the final follow-up examination. Changes in vertebral angles were compared and analyzed. The mean vertebral angles before and after surgery and at the final follow-up examination were 15.4°, 6.6°, and 9.1°, respectively. The mean postoperative correction loss was 2.5°. The therapeutic outcomes of posterior short segment fixation with screw insertion into fractured vertebral bodies without vertebroplasty were generally favorable.

Key words : short segment fixation, thoracolumbar burst fracture, vertebroplasty

Introduction

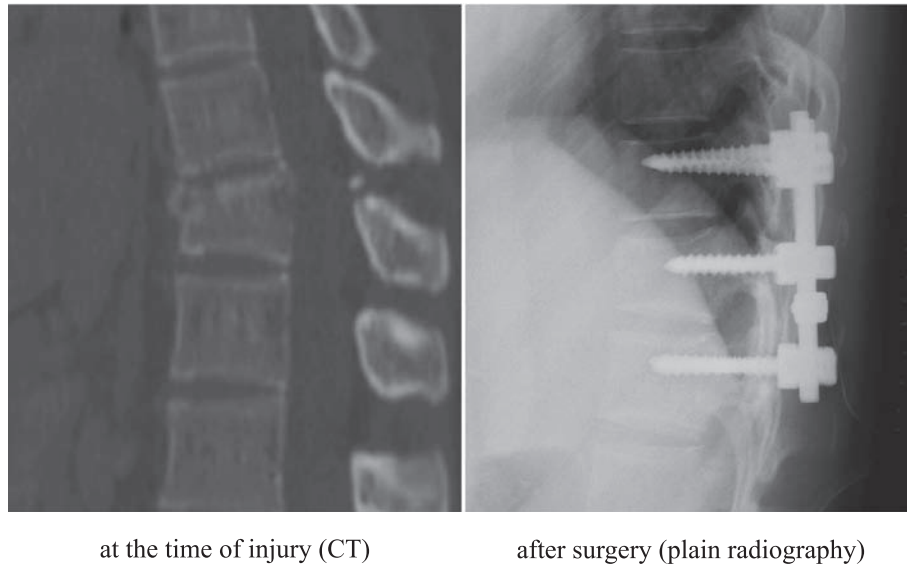
There is no widespread agreement regarding the treatment of thoracolumbar burst fractures. Treatment ranges from conservative to surgical, and there is no established therapeutic strategy. While performing posterior short segment fixation of thoracolumbar burst fractures (AO classification type A3-B2), we evaluated the therapeutic outcomes in patients treated with screw insertion into fractured vertebral bodies without vertebroplasty. We also investigated the limitations associated with the treatment of burst fractures when vertebroplasty is not performed.

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at the time of injury (CT) after surgery (plain radiography)

Fig. 1. Posterior short segment fixation at the time of injury (computed tomography) and after surgery (plain radiography).

Materials and methods

The present study was performed on 21 of 51 patients with thoracolumbar burst fractures who were treated surgically in Ohta Nishinouchi Hospital between 2008 and December 2012. These 21 patients underwent a posterior short segment fixation with screw insertion into the fractured vertebral bodies (only pedicle screws were inserted one level above and one level below the fractured vertebral bodies) without vertebroplasty (Fig. 1). Patients in whom posterior long segment fixation (more than two levels above and one below) was conducted for the treatment of thoracolumbar burst fractures were excluded from the study. To be included in the study, patients had to have been followed up for at least 1 year. The age of the 21 patients (10 men, 11 women) at the time of injury ranged from 23 to 69 years (mean 48.7 years). The causes of injury were falling from a height ($n = 12$; six patients jumped), traffic accidents ($n = 6$), a fall on level ground ($n = 2$), and being kicked by a cow ($n = 1$). The level of the fractured vertebrae was T10 in one patient, T11 in three, T12 in five, L1 in six, L2 in four, L3 in one, and L4 in one. The fracture types according to the AO classification were A3.1 in one patient, A3.2 in nine, A3.3 in three, B1.2 in one, and B2.3 in seven. The scores on the McCormack Load Sharing Classification (LSC)¹⁾ were 4 in four patients, 5 in five, 6 in four, 7 in six, and 8 in two, with a mean LSC score of 5.9. Radiographs were analyzed to determine vertebral angles. Vertebral angles were measured before surgery, immediately after surgery, and at the final follow-up examination. Vertebral angles were measured from the upper to the lower endplate of the fractured vertebral body (Fig. 2). Changes in vertebral angles were compared and analyzed according to sex, age, AO classification, and LSC score. All analyses were performed using JSTAT for windows. Statistical analyses were performed with the Mann-Whitney *U*-test. $P < 0.05$ was considered significant.

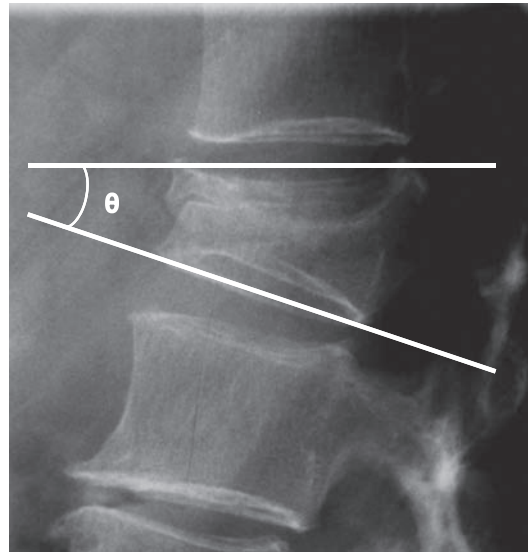


Fig. 2. Measurement of the vertebral angle. Vertebral angles were measured from the upper endplate to the lower endplate of the fractured vertebral body.

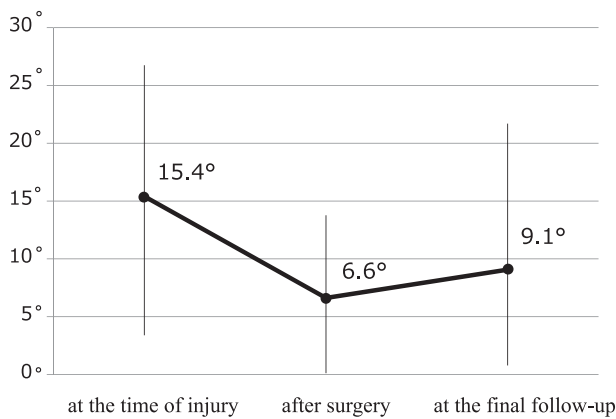


Fig. 3. Mean (high-low lines) vertebral angle at the time of injury, after surgery, and at the final follow-up. (n = 21)

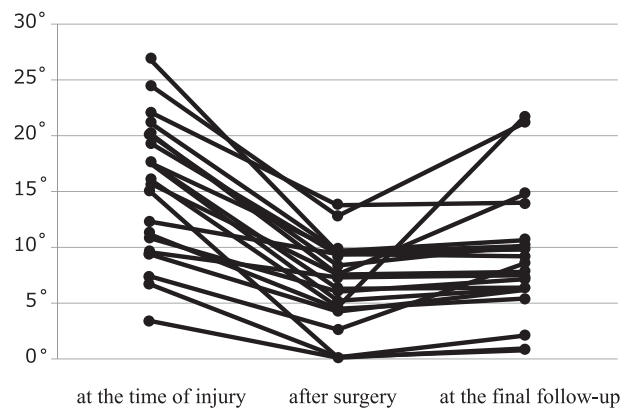


Fig. 4. Vertebral angles in individual patients at the time of injury, after surgery, and at the final follow-up.

Results

The mean operative time was 97 min (range 56–137 min), which included three patients who were simultaneously undergoing surgery for other trauma. The mean vertebral angles before and immediately after surgery and at the final follow-up were 15.4°, 6.6°, and 9.1°, respectively, and the mean postoperative correction loss was 2.5° (Fig. 3). In four patients, the postoperative correction loss of the vertebral angle was $\geq 5^\circ$ (Fig. 4). The mean local kyphotic angles before and immediately after surgery and at the final follow-up were 12.7°, 2.6°, and 7.1°, respectively. Differences in correction angle (the change in vertebral angles from before to immediately after surgery) and the correction loss angle (the change in vertebral angles from immediately after

Table 1. Changes in vertebral angles according to sex, age, AO classification, and LSC

	before surgery	after surgery	final follow-up
Male (n = 9)	15.2°	5.3°	9°
Female (n = 12)	15.6°	7.8°	9.1°
< 50 years (n = 9)	15°	6.6°	7.4°
≥ 50 years (n = 9)	15.7°	6.6°	10.4°
AO Type : A (n = 13)	13.2°	5.8°	8.7°
AO Type : B (n = 8)	19°	7.9°	9.7°
LSC ≤ 6 (n = 13)	13.1°	6.2°	7.2°
LSC ≥ 7 (n = 8)	19.1°	7.4°	12.1°
< 50 years or LSC ≤ 6 (n = 17)	14.4°	6.4°	7.4°
≥ 50 years and LSC ≥ 7 (n = 4)*	19.5°	7.6°	16°

* p < 0.05

surgery to the final follow-up examination) according to sex, age, AO classification, and LSC score are summarized in Table 1 and detailed below.

Sex

In male patients, vertebral angles before and immediately after surgery and at the final follow-up were 13.0°, 5.9°, and 7.0°, respectively; in female patients these angles were 18.1°, 7.5°, and 11.4°, respectively. There were no significant differences in either correction angle or correction loss angle between male and female patients.

Age

Vertebral angles in patients < 50 years of age before and immediately after surgery and at the final follow-up were 15.0°, 6.6°, and 7.4°, respectively; in patients ≥ 50 years of age, these angles were 15.7°, 6.6°, and 10.4°, respectively. There were no significant differences in either correction angle or correction loss angle between these two age groups.

AO classification

Vertebral angles in patients with type A fractures before and immediately after surgery and at the final follow-up were 13.2°, 5.8°, and 8.7°, respectively. In patients with type B fractures, these angles were 19.0°, 7.9°, and 9.7°, respectively. The correction angle was significantly greater in patients with type B fractures, whereas there was no significant difference in the correction loss angle between these two groups.

LSC score

Vertebral angles in patients with an LSC score of ≤ 6 before and immediately after surgery and at the final follow-up were 13.1°, 6.2°, and 7.2°, respectively. In patients with an LSC score

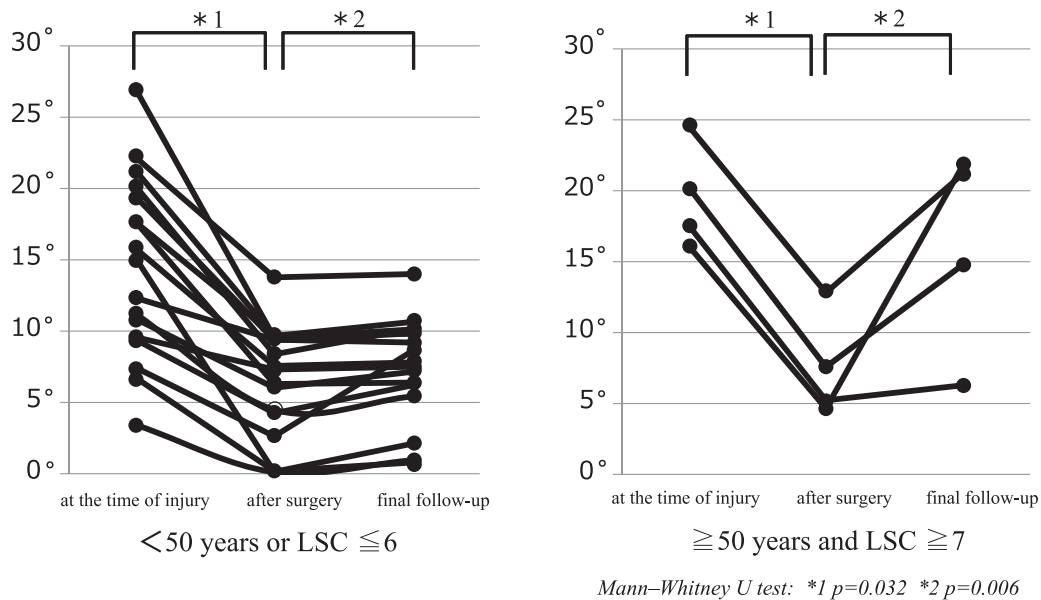


Fig. 5. Therapeutic outcomes in individual patients according to age and the McCormack Load Sharing Classification (LSC) score.

≥ 7 these angles were 19.1° , 74° , and 12.1° , respectively. The correction angle was significantly greater in patients with an LSC score of ≥ 7 , but there was no significant difference in the correction loss angle between these two groups.

LSC score and age

Vertebral angles before and immediately after surgery and at the final follow-up in patients who had an LSC score of ≤ 6 or were < 50 years of age were 14.4° , 6.4° , and 7.4° , respectively. These angles in patients who had an LSC score of ≥ 7 and were ≥ 50 years of age were 19.5° , 76° , and 16.0° , respectively. Both correction angle and correction loss angle were significantly greater in the latter group (Fig. 5).

Discussion

McLain *et al*²⁾ performed short segment fixation for thoracolumbar burst fractures in 19 patients, and reported that implant breakage was observed in 10. However, neither vertebroplasty nor screw insertion into the fractured vertebral bodies was performed on these patients; that is, fixation was performed at one level above and one level below the fractured vertebral bodies, and thus the fixation force, stiffness, and correction force were insufficient. Later, Toyone *et al*³⁾ reported that favorable outcomes were achieved in 15 patients with thoracolumbar burst fractures who underwent vertebroplasty using hydroxyapatite blocks, including no incidence of implant breakage and a correction loss of 2° . Those authors demonstrated that even short segment fixation could achieve favorable outcomes when performed in combination with vertebroplasty.

Meanwhile, Mahar *et al*⁴⁾, in a cadaveric biomechanical study, reported that construct stiffness

during axial torsion was significantly higher in patients who underwent short segment fixation with insertion of pedicle screws into the fractured vertebral bodies compared with those treated without the insertion of pedicle screws. Moreover, Guven *et al*⁵⁾ reported that the effectiveness for maintaining the correction of kyphotic deformity in patients with thoracolumbar burst fractures did not differ significantly between fixation with pedicle screws inserted two levels above and below the fracture and fixation with screws inserted one level above and below the fractured vertebral bodies. Furthermore, Gelb *et al*⁶⁾ reported that the insertion of pedicle screws into the fractured vertebral bodies was useful for short segment fixation. In addition, Inokuchi *et al*⁷⁾ found that a combination of vertebroplasty and screw insertion into the fractured vertebral bodies may prevent the progression of defects of the vertebral body endplate. In the present study, we have shown that short segment fixation with insertion of pedicle screws into the fractured vertebral bodies is useful in preventing correction loss even without vertebroplasty. However, Jimbo *et al*⁸⁾ reported a correction loss of $\geq 5^\circ$ in elderly patients at high risk based on the LSC score. These findings are similar to those in the present study in patients with an LSC score of ≥ 7 who were ≥ 50 years of age; in these patients, the postoperative correction loss was significantly greater and a need for anterior spinal column reconstruction, including vertebroplasty, was recognized. However, in patients with an LSC score of ≤ 6 or < 50 years of age, the mean correction loss was only 1° , and short segment fixation with insertion of pedicle screws into the fractured vertebral bodies was useful in preventing correction loss of the vertebral angle even without anterior spinal column reconstruction, including vertebroplasty.

In conclusion, when presented with vertebral burst fractures classified as AO type A3–B2 fractures, the therapeutic outcomes of posterior short segment fixation with screw insertion into the fractured vertebral bodies without vertebroplasty are generally favorable. In patients aged ≥ 50 years who have an LSC score of ≥ 7 , vertebroplasty and other procedures need to be performed simultaneously because correction loss may occur in this group.

Conflict of interest

The authors have no conflict of interest to declare.

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