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Original Article

Two additional augmenting screws with posterior short-segment instrumentation without fusion for unstable thoracolumbar burst fracture — Comparisons with transpedicular grafting techniques

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ABSTRACT

Background: Transpedicular grafting techniques with posterior short-segment instrumentation have demonstrated to prevent high implant failure in unstable thoracolumbar burst fractures. We tested our hypothesis that short-segment instrumentation with two additional augmenting screws in the injured vertebra could provide stability and was similar to those of the transpedicular grafting technique.

Methods: Twenty patients belonged to group A; treated with short-segment pedicle screw fixation and reinforced by two augmenting screws at the fractured vertebra. Group B had thirty-one patients; the fractured vertebra was augmented with transpedicular autogenous bone graft. Group C had twenty patients; the injured vertebra was strengthened with calcium sulfate cement. Clinical outcome and radiographic parameters were compared.

Results: Group A had the least blood loss (101.7 ± 72.5 vs. 600 ± 403.1 vs. 247.5 ± 164.2 ml, $p < 0.001$) and the least operation time (142.0 ± 57.2 vs. 227.2 ± 43.6 vs. 161.6 ± 28.5 min, $p < 0.001$). However, group A had the highest collapsed rate of the body height at the 18-month follow-up (10.5 ± 7.0 vs. 4.6 ± 4.8 vs. 7.2 ± 8.5%, $p = 0.002$). The failure rate, include implant failure or loss of 10° or more of correction, group B had the lowest failure rate (10% vs. 3.2% vs. 10%, $p = 0.542$). The group A had the highest rate of return to their previous employment (50% vs. 38% vs. 35%, $p = 0.265$).

Conclusions: Compared with transpedicular grafting techniques, additional two "augmenting screws" in the fracture vertebra with short-segment instrumentation are sufficient for one-level thoracolumbar burst fracture.

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At a glance commentary

Scientific background on the subject

Unstable thoracolumbar burst fracture is usually treated by surgery. One above and one below posterior short-segment pedicle screw fixation is popular for thoracolumbar burst fracture but has possibility of early implant failure and loss of reduction. The injured vertebrae augmented by additional two screws or by transpedicular grafting are thought to be resolutions to prevent implant failure. In this study, we compared the differences between a six-screw construct and a four-screw construct with fractured body augmentation by iliac cancellous bone graft or by calcium sulfate cement.

What this study adds to the field

Compared with transpedicular grafting techniques, additional two "augmenting screws" in the fracture vertebra with short-segment instrumentation are also sufficient for most one-level thoracolumbar burst fracture. This technique is easy, spends less operation time, decreases blood loss, and obtains similar clinical result.

Burst fracture approximately accounts for 20% of thoracolumbar fractures and occurs due to an axial loading force that results in failure to support the anterior and middle column [1,2]. Surgery is usually indicated for a patient suffering from severe deformity, and/or neurologic deficit. Since the development of the pedicle screw, posterior short-segment instrumentation with fusion has been widely used for unstable thoracolumbar burst fracture. Pedicle instrumentation enables kyphosis correction, canal encroachment reduction indirectly, early mobilization, and early return to work. However, this method has been reported to have high implant failure and early loss of reduction because of loss of anterior support [3]. Liao et al. have demonstrated that posterior short-segment instrumentation and transpedicular grafting with autogenous cancellous bone could maintain better vertebral body height and local sagittal Cobb's angle, but donor-site complications could not be prevented [4]. Although injectable calcium sulfate cement is an alternative to autogenous bone for transpedicular body augmentation, the cost of this material is not covered by the National Health Insurance in Taiwan. To circumvent the difficulties we faced before in using transpedicular grafting with autogenous bone and calcium sulfate cement, we modified Wang's technique for treating thoracolumbar burst fracture [5]. In this study, we applied two more "*augmenting screws*" at both pedicles of the injured vertebra in addition to one-above one-below short-segment pedicle instrumentation. We hypothesized that these two additional pedicle screws at the fractured vertebra could augment construction of instrumentation and the spine could be maintained when the anterior and middle column achieved union, as in transpedicular grafting. In January 2010, we began to use this method in patients with a single-level thoracolumbar burst fracture. The purpose of this study was to evaluate the efficacy of all pedicle screws without fusion used in patients with thoracolumbar burst fracture and to decide whether this technique could achieve clinical and radiographic results similar to those of short-segment instrumentation with transpedicular grafting for thoracolumbar burst fracture.

Methods

From January 2010 to June 2012, twenty patients with thoracolumbar burst fracture that underwent surgical treatment using posterior short-segment pedicle instrumentation without fusion were reviewed. These patients were enrolled because they met the following inclusion criteria: (a) a single-level fracture between T11 and L3; (b) only short-segment screws (one-above and one-below) were used and the fractured vertebra were augmented with two additional screws; (c) fracture caused by high energy trauma (fall from a height, motor vehicle accident, or direct strike by a heavy object); (d) a local kyphotic angle >20°, or anterior height collapse >50%, or spinal canal encroachment >50%; (e) implants were removed after one year with union of the vertebrae proved by image; (h) follow-up radiographic and clinical data for at least 18 months were obtained.

Preoperative, immediate postoperative, and 18-month follow-up plain radiographs were analyzed. Sagittal local kyphosis was measured from the superior endplate of the cephalic intact vertebra to the inferior endplate of the caudal intact vertebra. The normal height of the fractured vertebrae on lateral radiographs was determined by averaging the heights of the adjacent cephalic and caudal vertebrae. The percentage of anterior height of the fractured vertebra was calculated as the anterior height of the injured vertebra/the estimated normal anterior height of the injured vertebra × 100%. The percentage of canal encroachment by the retropulsed fragment at the fractured level was calculated using the formula developed by Mumford et al. [6].

The American Spinal Injury Association (ASIA) impairment scale was used to evaluate patients' preoperative and final neurologic status. The final clinical results were assessed using the Denis scale, a 5-point scale that includes both work and pain scales [7]. The demographic data, including age, sex, injury level, estimated blood loss, operation time, duration of admission, time between injury and surgery, and associated injuries, were collected.

Grouping

The 20 patients that underwent posterior short-segment instrumentation with two additional "augmenting screws" were placed into Group A. The 31 patients that underwent posterior short-segment instrumentation and transpedicular grafting with autogenous cancellous bone were categorized as Group B, and the 20 patients that received posterior short-segment instrumentation and transpedicular grafting with calcium sulfate cement comprised Group C. The demographic data of Group B and Group C were the same as shown in Liao's