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Surgical outcomes of temporary short-segment instrumentation without augmentation for thoracolumbar burst fractures

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ABSTRACT

Background: Short-segment posterior spinal instrumentation for thoracolumbar burst fracture provides superior correction of kyphosis by an indirect reduction technique, but it has a high failure rate. We investigated the clinical and radiological results of temporary short-segment pedicle screw fixation without augmentation performed for thoracolumbar burst fractures with the goal of avoiding treatment failure by waiting to see if anterior reconstruction was necessary.

Methods: We studied 27 consecutive patients with thoracolumbar burst fracture who underwent short-segment posterior instrumentation using ligamentotaxis with Schanz screws and without augmentation. Implants were removed approximately 1 year after surgery. Neurological function, kyphotic deformity, canal compromise, fracture severity, and back pain were evaluated prospectively.

Results: After surgery, all patients with neurological deficit had improvement equivalent to at least 1 grade on the American Spinal Injury Association impairment scale and had fracture union. Kyphotic deformity was reduced significantly, and maintenance of the reduced vertebra was successful even without vertebroplasty, regardless of load-sharing classification. Therefore, no patients required additional anterior reconstruction. Postoperative correction loss occurred because of disc degeneration, especially after implant removal. Ten patients had increasing back pain, and there are some correlations between the progression of kyphosis and back pain aggravation.

Conclusion: Temporary short-segment fixation without augmentation yielded satisfactory results in reduction and maintenance of fractured vertebrae, and maintenance was independent of load-sharing classification. Kyphotic change was caused by loss of disc height mostly after implant removal. Such change might have been inevitable because adjacent endplates can be injured during the original spinal trauma. Kyphotic change after implant removal may thus be a limitation of this surgical procedure.

Introduction

Thoracolumbar burst fractures are the most common spine fracture of those that are treated surgically. These fractures are classified as anterior and midcolumn injuries according to the three-column classification proposed by Denis [1]. Proper management of these fractures remains controversial and includes nonoperative treatment, anterior surgery, posterior surgery, and a combination of anterior and posterior surgery.

Short-segment posterior spinal instrumentation (pedicle screw instrumentation one level cephalad and caudad to the fractured vertebra) without fusion has merit because it preserves segment motion, provides superior correction of kyphosis using an indirect reduction technique, and is less invasive than other procedures. However, there have been frequent reports that this procedure has failed, with or without instrumentation failure [2–4]. Recent reports suggest that additional vertebroplasty provides supplemental load-sharing through anterior reconstruction and support and that it reduces loss of kyphosis correction [5,6].

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McCormack et al. [3] proposed the load-sharing classification system in 1994 in which the parameters of comminution, fragment apposition, and reproducibility of sagittal deformation are each given 1 point (low score) to 3 points (high score), and the total of those points serves as the load-sharing score, which can range from 3 to 9. They recommend anterior reconstruction for patients with a score of $\geq$7, because patients with scores of $\leq$6 had no screw fractures; all fractures that showed evidence of screw fracture had scores of $\geq$7.

In our institution, we perform posterior reduction and fixation first to establish spinal stability and reduce surgical stress. Then if anterior reconstruction is considered to be necessary, we plan anterior reconstruction as a second procedure. Thus, we conducted a study to investigate the surgical results of temporary short-segment pedicle screw fixation without augmentation for the surgical treatment of thoracolumbar burst fractures.

Patients and methods

Our study group consisted of 27 consecutive patients in whom a single thoracolumbar burst fracture, with or without neurological impairment, was diagnosed between September 2006 and July 2012 at Osaka National Hospital. This study has been approved by institutional review board of our hospital and informed consent was obtained from all patients. There were 19 men and 8 women, with an average age of 43 years (range, 20–66 years). The injuries were caused by traffic accidents (6 patients), falls from a significant height (20 patients), and being hit by falling object (1 patients). Thus, all patients suffered high-energy injuries. Twenty-two patients had associated injuries: extremity fracture in 14 patients, stable pelvic fractures in 7, lung injury in 4, abdominal injury in 2, cerebral contusion in 2. The level of spinal involvement was T11 in 1 patient, T12 in 5 patients, L1 in 8, L2 in 10, and L3 in 3.

The neurological status of the patients was assessed using the American Spinal Injury Association (ASIA) impairment scale. We also evaluated (low) back pain before injury and at the final follow-up examination using the Denis pain scale [7] (Table 1).

Radiographic assessment was performed using supine anteroposterior and lateral roentgenograms, computed tomography (CT) scans (GE Discovery CT750 HD; slice thickness 0.625 mm), and magnetic resonance imaging ([MRI] Philips 1.5T NT- Intera) before surgery. All patients were monitored radiographically after surgery using standing anteroposterior and lateral roentgenograms and CT scans just after surgery, 6 months later, 1 year later (around the time of implant removal), and 2 years later (approximately 1 year after removal). MRI was performed 1 year after surgery and 1 year after implant removal.

Three independent observers evaluated all radiographs and CT scans. The sagittal plane contour was assessed by measuring (1) the vertebral body angle (VBA), which was measured between the superior and inferior endplates of the injured vertebra, and (2) the superoinferior endplate angle (SIEA), which was measured between the superior endplate of the intact vertebra cephalad to the fracture and the inferior endplate of the vertebra caudad to the fracture with using the Cobb method (Fig. 1).

Table 1
Denis pain scale.

Pain	P1: no pain
	P2: occasional minimal pain; no need for medication
	P3: moderate pain, occasionally medications; no interruption of work or activities of daily living
	P4: moderate to severe pain, occasionally absent from work; significant changes in activities of daily living
	P5: constant, severe pain; chronic pain medications

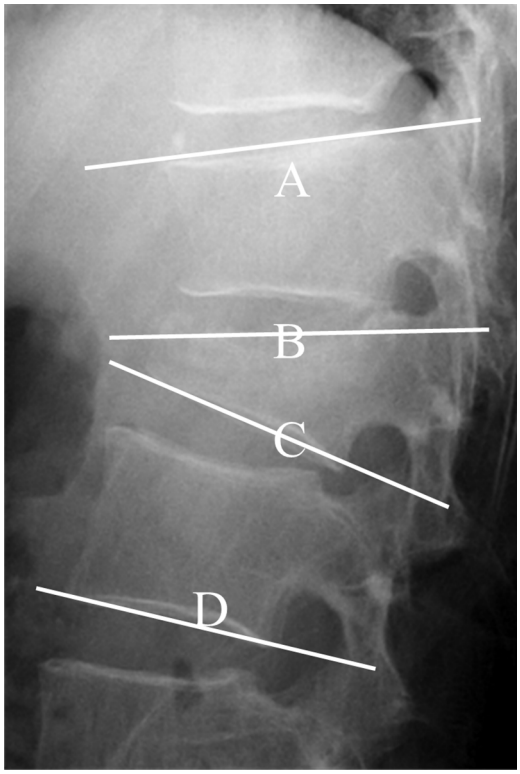

Fig. 1. Radiographic measurement of the sagittal plane contour. The vertebral body angle is the angle between B and C. The superoinferior endplate angle in the angle between A and D.

Canal compromise was determined using CT scanning by directly measuring the anteroposterior canal dimension at the maximum area of the retropulsed osseous fragment or fragments and was recorded in millimetres. This value was then compared with the average of similar dimensions measured at the levels above and below the injury. The result of this comparison was recorded as the percentage of anteroposterior canal compromise at the injured vertebra.

The extent of intervertebral disc degeneration was evaluated on midsagittal T_2-weighted MRI according to the criteria of Borenstein et al. [8] as follows: normal (score = 0); mild, with slight dehydration of the disc on T_2-weighted images (score = 1); moderate, with disc dehydration and mild loss of disc height (score = 2); and severe, with total disc dehydration and nearly complete loss of disc height (score = 3). Discs above and below the fractured vertebra were graded.

Fracture severity was calculated using the load-sharing classification [3], the AO classification [9], and the Denis classification [1].

Patients were allowed to sit up as soon after surgery as a custom-moulded thoracolumbosacral brace was fabricated. Nine patients had delay to sitting up because of an associated injury. However, they could sit up by 1 week, and no patient was required to remain lying in bed for a long period. The brace was used for at least 3 months after surgery. During this period, physical activity was restricted, and if kyphotic deformity due to vertebral collapse was observed, we planned to perform anterior reconstruction. Sports activities and strenuous labour were prohibited for 6 months after surgery. Removal of implants was performed approximately 1 year after initial surgery after confirming union of the fracture by CT scan and MRI, because of the preservation of segment motion and the possibility of implant failure, which was explained before initial surgery. Therefore, the pedicle screw implants were only temporary. All patients were monitored