Case Series

Radiological Outcome of Short Segment Posterior Stabilisation and Fusion in Thoracolumbar Spine Acute Fracture

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Abstract

Introduction: The optimal management of thoracolumbar spine fractures remains a matter of controversy. The current literature implies that the use of short-segment pedicle screw fixation may be inappropriate because of its high reported failure rate. The purpose of this study is to report the short-term results of thoracolumbar burst and compression fractures treated with short-segment pedicle instrumentation. Materials and Methods: From 2002 to 2007, 19 patients with thoracolumbar acute traumatic fractures were instrumented with posterior short-segment pedicle screws. The patients' case notes, operation records, preoperative and postoperative radiographs (sagittal index, anterior body compression and regional kyphosis), computed tomography scans, neurological findings (Frankel functional classification), and follow-up records up to 18 months were reviewed. Results: A statistically significant difference was found between the patients' preoperative, postoperative and follow-up sagittal index, anterior body compression and regional kyphosis measurement. One case resulted in screw pedicle screw pullout and subsequently, kyphotic deformity. The patient underwent revision surgery to long-segment posterior instrumentation and fusion. None of the patients showed an increase in neurological deficit. Conclusion: In conclusion, the short-term follow-up results suggest a favourable outcome for short-segment instrumentation. Load shearing classification is essential for the selection of patient for short-segment instrumentation. However, the long-term follow-up evaluation will be needed to verify our findings.

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Key words: Kyphoytic angle, Radiological outcome, Short segment posterior fixation, Thoracolumbar spine fractures

Introduction

The management of unstable thoracolumbar spine fractures remains controversial in spite of an improved knowledge of the morphometric, anatomic and biomechanical features of thoracolumbar vertebrae.[1-12] The transpedicular short-segment construct represents an attempt to rebuild the anterior column without the need for anterior strut graft or plate fixation, hence, avoiding extensive arthrodesis of the motion segments. Indeed, the biomechanical study conducted by Kothe R et al[13] showed that the use of pedicle screws could achieve stable construct within short-segment fixation. However, on the other hand, various unfavourable results have also been reported in the literature.[14-16]

Temporising treatments were advocated by some authors[17-20] who suggested that postures and long-term relaxations could achieve satisfactory results. Surgical treatments, on the other hand, could enhance early mobilisation, prevent subsequent complications, and thus correct any form of deformity.[14,21] Besides that, decompression and fixation could also improve neurological functions.

After temporising treatments, there were many reports on degrading neurological functions, worsening spinal stenosis, increasing pressure on the vertebral body, increasing kyphosis, and causing radiculopathy and pain.[15,22]

This study evaluated and analysed the radiological outcomes from short-segment pedicle screw fixation in 19 patients with thoracolumbar spine fractures.

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Materials and Methods

Case Materials

A retrospective review was conducted in surgically managed thoracolumbar fractures. Consecutive thoracolumbar fractures that happened from 2002 to 2007 were included with varied age, sex, causes and levels of injury. The short-segment transpedicular fixation was performed in 19 patients by a single surgeon. All the patients underwent surgical instrumentation within 1 week after their injuries. Case charts, operative records, preoperative and postoperative radiographs, CT Scans and follow-up records up to 18 months period were reviewed. Fractures were classified according to the Denis et al[15] 3-column classification. Neurological status was assessed using the Frankel score for spinal cord injury. And, the vertebral body injury was assessed by load-sharing classification.[22]

The radiological findings were measured as following methods. Sagittal index is the ratio for the anterior and posterior heights of the injuried vertebral body on lateral view[23] (Fig. 2A). Anterior body compression was measured preoperatively, postoperatively and during follow-up according to Mumford's anterior body compression (Fig. 1).[24] Regional kyphosis (Cobb angle) was measured from the inferior end plate of the intact vertebra above the fracture to the superior end plate of the intact vertebra below the fracture.[23]

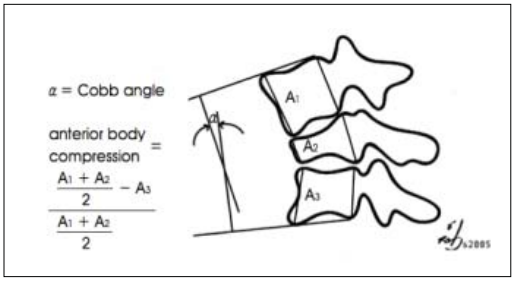

Fig. 1. Illustration of Cobb angle and anterior body compression formula by Mumford et al.[24]

Computed tomographies were done for every patient to ensure accurate diagnosis of damage to the vertebra (Fig. 2B). Patients with neurological deficit were also evaluated with MRI to assess degree of neurological compression.

Surgical Indications

Surgical instrumentation indications in this study series included any one or more of the following: neurological involvement caused by the fracture, 20 degree more kyphosis, >50% loss of the vertebral body's height, compromised spinal canals, or any other instability based on the criteria of unstable thoracolumbar fractures by McAfee et al.[25] In severe comminuted fractures and severely midline retropulsed fragments (canal compromise ratio >0.7) with anticipated load sharing, operations were performed by the ventral approach. Multiple fractures and severe pedicle fractures were excluded in this study.

Surgical Method

Patients were under general anaesthesia on prone-position,and the skin of the midline was incised to expose 1 to 2 levels above and below the fractured vertebrae. Pedicle screws fixation and posterior-lateral synostosis were performed with bone fragment with autologous bone graft. Correction of kyphotic angle was attempted by distraction of connecting rods. If bone fragment remained in the spinal canal, decompression followed by posterior pedicle fixation was done (Fig. 2C). Rehabilitation programme was started once the patients' postoperative status stabilised. Orthosis were prescribed to patients for 6 months.

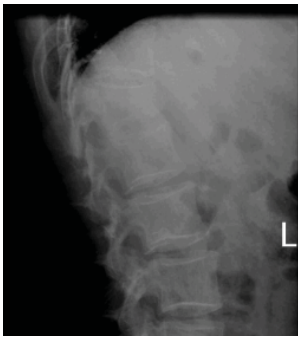

Fig. 2A. An X-ray showing T12 spine Chance fracture.

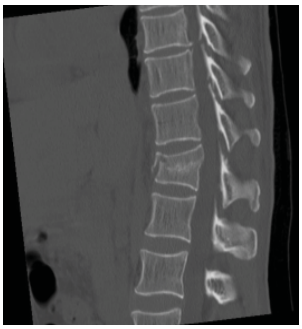

Fig. 2B. A CT image to assess the degree of vertebral comminution.

Fig. 2C. An X-ray showing posterior short segment instrumentation.

Table 1. Summary of study results.

	Preoperation	Postoperation	At 18 months follow-up	*P* value
Sagittal index	0.682 ± 0.155	0.792 ± 0.123	0.790 ± 0.142	0.016
Anterior body compression	0.42 ± 0.22	0.24 ± 0.16	0.23 ± 0.3	0.04
Regional kyphosis	10.9 ± 11.2	3.2 ± 10.0	3.68 ± 10.2	0.049

Analysis

The degrees of correction of vertebral transformation were compared and analysed by sagittal index, sagittal plane kyphosis, anterior body compression, vertebral kyphosis and regional kyphosis preoperatively, postoperatively and 18 months after surgery by periodic simple radiography (Table 1). ANOVA (Analysis of Variance) method was used by SPSS 13.

Results

A total of 19 patients (15 male, 4 female) were included in this study. The mean age was 36.8 years (range, 28 to 49) and the follow-up period was 18 months. Ten cases were burst fractures and 9 cases were Chance fractures. The commonest level of injury was L2 (Fig. 3).

During the preoperative assessment, there were 5 Frankel grade D and 14 Frankel grade E neurological injuries. None of the patients suffered from deterioration of neurological deficit and 2 of the Frankel grade D improved to be Frankel grade E in 12 months to 18 months follow-up assessment.

One case resulted with screw pullout and progressive kyphotic angulation. This patient subsequently underwent revision fixation with long-segment instrumentation and fusion. No deterioration of neurological deficit was found.

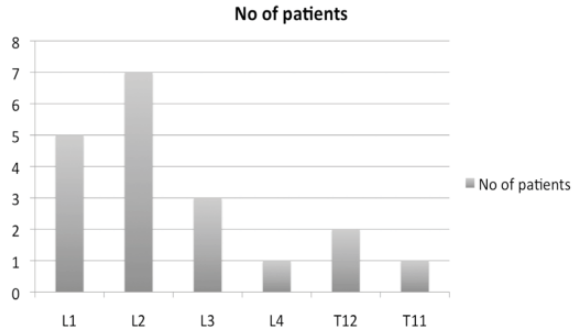

Fig. 3. The level of spine injuries.

Sagittal index, anterior body compression, regional kyphosis were measured by serial follow-up for 18 months. The sagittal index improved by operation and maintained at 18 months follow-up (P = 0.016). The anterior body compression decreased after surgery and maintained at 19 months follow-up (P = 0.04). The regional kyphosis preoperative was 10.9 and postoperative was 3.2. At 18 months follow-up assessment, the kypotic angle was 3.68 (P = 0.049).

Discussion

The aims of treating vertebral fractures are early recovery of neurological deficit, overcome damaged spinal segments anatomically and accomplish firm and stable fixation for early rehabilitation.[26]

In 1944, King et al[27] first reported the use of vertebral body screw fixation through transfacet approach to the lumbar spine. Boucher[28] introduced a way to pierce screws into the vertebral body through the pedicle in 1958. After it was described and advocated by Roy-Camille and colleague[29] in 1963, the pedicle screws fixation have been widely used in lumbar spine surgery.[30] The clinical study by Sasso and Cotler[31] compared the spine pedicle screw fixation with other instruments like Harrington rods, hooks, Luque rods and sublaminar wires. It was found that the pedicle screw fixation was a posterior fixation which could be applied as shorter segment fixation compared to other fixation tools.

The pedicle screw system does have its limitations. In theory, the pedicle screws fixation can resist both bending and axial loading, and can be used to correct angular deformity and restore the height as a cantilever beam fixation system. However, when the vertebral body is significantly compromised and associated with considerable loss of height or abnormal angulation, the biomechanical stability of the system would be altered significantly. The instantaneous axial rotation (IAR) is shifted posteriorly away from the injury and kyphotic angulation is inevitable.[32,33] Hence, load-sharing classification[22] is a good guide to decide the suitability of short-segment posterior instrumentation for the spine fracture.

In various studies,[22,34,35] the loss of degree correction or implant failure appeared around 6 months to 12 months after the surgery. Lee et al[36] reported 6 cases of implantation failure out of 48 patients who underwent dorsal short-segment fixation in thoracolumbar fracture. In our study on the latest assessment, there was a case of loss of kyphotic correction among the 20 patients. The patient was an osteoportic lady. In the study by Lee et al,[36] 2 out of 6 failure cases were osteoportic patients. Therefore, we should consider long-segment fixation and avoidance ending instrumentation

within kyphotic segment[37] for osteoportic patients.

Finkelstein et al[38] conducted a 21-patient cohort study of thoracolumbar Chance fractures which were managed surgically with a single level short-segment posterior stabilisation and posterolateral autograft fusion. A 20-month follow-up assessment showed that significant correction of kyphosis from 10.1° to 0.9°. Eighty-eight percent of the patients had minimal disability and the mean Oswertry score was 11.5.

Dai et al[39] studied the randomised prospective design for short-segment posterior instrumentation along with fusion and without fusion. Their follow-up results at 5 to 7 years postoperation found no clinical or radiological difference between with and without fusion, provided that thoracolumbar fracture scored less than 6 in the loading sharing system. They also showed good results in terms of radiological finding of kyphotic angle correction and clinical outcome in the overall short-segment posterior instrumentation with or without fusion.

In a cadaveric biomechanical study by Mahar et al,[40] they found that segmental screw fixation i.e. pedicle screws at the level of burst fracture could improve axial torsion force at short segment posterior fixation (one level up and down). The insertion of pedicles at the level of fracture can act as reinforcement in terms of improvement in axial torsion stability. This can be advocated to improve short-segment pedicle screw construction.

Conclusion

This study showed significant radiological corrections in 19 cases and stable constructs in 18 patients. With adequate assessment with load sharing classification, short-segment posterior instrumentation seems to be comparable to any other fixation methods. This study was, however, limited by its short duration follow-up and small study population. A larger scale case control study will be necessary to verify our results.

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