Posterior Instrumentation Surgery for Thoracolumbar Junction Injury Causing Neurologic Deficit

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Abstract

Thoracolumbar junction (TLJ) injury is one of the most common spine injuries. TLJ injury manifesting as neurologic deficit usually requires surgery because of the underlying spinal instability and/or neural compression. The objectives of surgical treatment are to restore biomechanical stability of the spine and/or to achieve neural decompression. The short-term outcomes were evaluated of 32 patients with symptomatic TLJ (T11–L2) injury who underwent posterior instrumentation surgery in the acute stage between 2000 and 2004. Seventeen patients had unstable burst fracture and 15 patients had either flexion-distraction or fracture-dislocation injury of the TLJ. Fifteen patients had American Spinal Injury Association (ASIA) classification Grade-A, eight had Grade-B, seven had Grade-C, and two had Grade-D preoperative neurologic deficits. All patients underwent posterior instrumentation surgery using pedicle screws and connecting rods, fixed to two vertebral levels above and below the injured segment. No patient experienced neurologic deterioration perioperatively. Postoperative recovery evaluated 3 months after discharge heavily depended on the preoperative neurologic status: patients with ASIA Grade-A deficits usually had limited neurologic recovery, whereas some with Grade-C or D became ambulatory. Complications occurred in five patients, but none suffered death or permanent morbidity. Posterior instrumentation surgery is a safe and efficacious treatment for patients with symptomatic TLJ injury. Long-term efficacy of the posterior instrumentation surgery is less clear, because of the limited duration of the follow-up period.

Key words: burst fracture, flexion-distraction injury, fracture-dislocation injury, neurologic deficit, posterior instrumentation surgery, thoracolumbar junction

Introduction

Thoracolumbar junction (TLJ) injury is one of the most common spine injuries. Accidental fall and motor vehicle accident are the two most common causes of TLJ injury. Treatment of TLJ injury depends on several clinical factors, including age of the patient, mechanism of injury, degree of spinal canal compromise by bony fragments, degree of integrity of the posterior spinal elements, and presence of neurologic deficit. Patients with TLJ injury manifesting as neurologic deficit generally require surgical treatment, because they almost invariably have underlying spinal instability and/or neural compression. Therefore, the objectives of surgical treatment are to restore biomechanical stability of the spine and/or to achieve neural decompression.

Several surgical approaches are available for patients with TLJ injury, including the anterior (antero-lateral) approach, posterior approach, and combination of both. The present study evaluated the outcomes of posterior instrumentation surgery for patients with TLJ injury manifesting as neurologic deficit.

Materials and Methods

I. Patients

Eighty-three patients with major TLJ (T11–L2) injury underwent surgical treatment at the Tampa General Hospital, a regional Level I trauma center, after sustaining high-energy trauma between January 2000 and March 2004. Osteoporotic TLJ fractures in the elderly and TLJ gunshot wounds were
excluded. Thirty-six of the 83 patients presented with neurologic deficit to the emergency room. Four of these 36 patients were treated by anterior surgery (thoracotomy followed by corpectomy of the fractured segment) because their neurologic deficits were rapidly progressive and urgent decompression of the spinal cord was considered necessary. The remaining 32 patients had stable neurologic status after initial resuscitation and admission, and underwent posterior instrumentation surgery within 7 days of admission. High-dose methylprednisolone, according to the National Acute Spinal Cord Injury Study II protocol, was not administered routinely. The clinical characteristics and outcomes of the 32 patients were investigated retrospectively by meticulous review of medical charts, operation records, and radiographic images.

II. Surgical treatment
Patients were positioned prone on a Jackson table under general anesthesia. The four or five vertebrae of the TLJ were exposed periosteally with a standard midline approach. The Universal Spine System (Synthes® Spine; Paoli, Pa., U.S.A.) was used as an internal fixator. The Schanz screws (Synthes® Spine) were placed through the pedicles into the four vertebrae bilaterally, under fluoroscopic guidance. In patients with burst fracture, the screws were placed two levels above and below the fractured vertebra, excluding the fractured one. If decompression was considered necessary, the lamina over the fractured vertebra was removed, and bony fragments within the spinal canal were pushed back to the vertebral body with a special pusher, after gentle retraction of the dural sac to the side. Bony fragments could be further expelled from the canal by properly distracting the Schanz screws as long as the posterior longitudinal ligament was intact (ligamentotaxis). In patients with flexion-distraction or fracture-dislocation injury, the Schanz screws were placed two levels above and below the translated segment. Dislocation was reduced by manipulating the Schanz screws under fluoroscopic guidance. Regardless of the underlying injuries, the Schanz screws were cut to the appropriate length and connected to the titanium rods bilaterally. Maximal effort was made to achieve optimal alignment of the TLJ by manipulating the Schanz screws and rods. The rods were then connected with a cross-link. The facet joints within the fixated segments were partially drilled, and morcelized bone graft was placed over the joints to promote bony fusion. Postoperatively, all patients underwent a rigorous rehabilitation program, and were mobilized in a thoraco-lumbar-sacral orthosis in a neutral position for a period of 3 months. The constructs are left in situ even after solid fusion was achieved, and explantation surgery was not performed unless requested by the patients.

Results

I. Clinical presentation
The demographic data for the 32 patients are summarized in Table 1. The 23 males were aged 15 to 59 years (mean 33.4 years) and the nine females were aged 13 to 46 years (mean 32.4 years). Causes of TLJ injury were: motor vehicle accident in 17 patients, accidental fall in nine, motorcycle accident in three, and other causes in three. Associated injury was present in 12 patients, including pelvic fracture in six, rib fracture in four, facial injury in two, femur fracture in one, brain contusion in one, and cervical spine fracture in one. The length of hospital stay ranged from 5 to 68 days (mean 12.7 days).

II. Type and anatomical level of TLJ injury
The distribution of the type and anatomical level of TLJ injury is illustrated in Fig. 1. TLJ injuries were classified according to the AO fracture classification. Seventeen of the 32 patients had unstable burst fracture (type A injury), two had flexion-distraction injury (type B injury), and the remaining 13 had fracture-dislocation injury (type C injury).

III. Preoperative neurologic status
The neurologic deficit in each patient was evalu-
ed with the American Spinal Injury Association (ASIA) classification (Table 2). Preoperatively, 15 patients had ASIA Grade-A deficits, eight had Grade-B, seven had Grade-C, and two had Grade-D. Neurologic status of the 32 patients remained unchanged between admission and surgery.

IV. Surgical treatment

Surgery was performed within 7 days of admission in all but one patient, in whom surgery was delayed 20 days after admission because of the associated injuries. The time from admission to surgery was 1 to 20 days (mean 3.9 days). Representative case of unstable L1 burst fracture (Case 1) and fracture-dislocation injury (Case 2) are presented below.

Case 1: A 21-year-old man was brought to the emergency room after sustaining a fall from the third floor. He had ASIA Grade-A deficit at the time of admission. Sagittal and axial reconstituted computed tomography (CT) scans showed L1 burst fracture with the spinal canal narrowed significantly due to bony fragments (Fig. 2A, B). Spinal alignment of the TLJ was markedly kyphotic. He underwent posterior instrumentation surgery extending from T11 to L3, combined with L1 laminectomy and ligamentotaxis procedure, 2 days after the injury. Postoperative CT scans showed that the canal was adequately decompressed and spinal alignment was restored (Fig. 2C, D). Despite uneventful postopera-

Table 2  American Spinal Injury Association classification

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<thead>
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<th>Grade</th>
<th>Neurologic deficit</th>
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<tr>
<td>A</td>
<td>No sensory or motor function is preserved in sacral segments S4–S5</td>
</tr>
<tr>
<td>B</td>
<td>Sensory, but not motor, function is preserved below the neurologic level and extends through sacral segments S4–S5</td>
</tr>
<tr>
<td>C</td>
<td>Motor function is preserved below the neurologic level, and most key muscles below the neurologic level have muscle grade less than 3</td>
</tr>
<tr>
<td>D</td>
<td>Motor function is preserved below the neurologic level, and most key muscles below the neurologic level have muscle grade greater than or equal to 3</td>
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<tr>
<td>E</td>
<td>Sensory and motor functions are normal</td>
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Fig. 2  Representative case of unstable L1 burst fracture (Case 1). Sagittal (A) and axial (B) reconstituted computed tomography (CT) scans before surgery showing that the spinal canal is narrowed significantly due to bony fragments. Postoperative CT scans (C, D) showing that the canal is decompressed and spinal alignment is restored.
tive course, the patient remained in ASIA Grade-A 6 months after discharge.

Case 2: A 25-year-old man was brought to the emergency room after sustaining high velocity motor vehicle accident. He had ASIA Grade-A deficit at the time of admission. A reconstituted CT scan showed the presence of dislocation together with fractures at T12-L1 intervertebral level (Fig. 3A). He underwent posterior instrumented fixation from T11 to L2 4 days after the injury. Postoperative radiography showed that the dislocation was reduced and spinal alignment was restored (Fig. 3B). The patient had uneventful postoperative course, but remained in ASIA Grade-A 3 months after discharge.

V. Postoperative neurologic status

No patient experienced neurologic deterioration in the immediate postoperative period. The follow-up period after discharge ranged from 3 to 48 months (mean 18 months). Patients underwent routine neurologic examination 3 months after discharge. The overall results are summarized in Fig. 4. None of the 15 patients with Grade-A deficits became ambulatory after surgery. Two of the eight patients with Grade-B deficits, all of the seven patients with Grade-C deficits, and both patients with Grade-D deficits became ambulatory after surgery.

VI. Complications

A total of five complications that occurred in our series are summarized in Table 3. Intraoperative complications occurred in two patients, who both had misplacement of a pedicle screw which violated the medial pedicle wall and partially protruded into the spinal canal. The misplaced pedicle screw did not cause any clinical symptoms in one patient, and repositioning of the screw was not attempted. The misplaced screw caused painful nerve root irritation, and the screw had to be repositioned in the other patient. Postoperative complications occurred in three patients. One patient developed *Klebsiella* pneumonia and adult respiratory distress syndrome several days after surgery, and intensive respiratory care was temporarily necessary. One patient developed deep wound infection 3 weeks after surgery, which required explantation of the construct and administration of intravenous antibiotics for a prolonged period. The patient underwent second posterior instrumentation surgery 1 month after the explantation surgery. The other patient suffered instrumentation failure with breakage of a connecting rod 1 year after surgery. The patient had developed solid bony fusion, and the construct was removed surgically without sequelae.
Discussion

Recently, treatment of TLJ injury has undergone significant paradigm shift. Particularly, the role of surgical treatment for burst TLJ fractures has become more obscure. Conservative management may be sufficient for patients with stable burst TLJ fracture who present without neurologic deficit, as shown in a prospective, randomized study in which surgical treatment had no major long-term advantage compared with non-operative treatment. In contrast, surgery is generally warranted for patients presenting with neurologic deficit, because they almost invariably have underlying biomechanical instability and/or neural compression. Therefore, the main objectives of surgical treatment for patients with symptomatic TLJ injury are restoration of the biomechanical stability/physiological alignment and/or neural decompression. The degree of neurologic recovery after surgery largely depended on preoperative neurologic status in the present study: patients with ASIA Grade-A deficits usually had limited neurologic recovery, whereas some with Grade-C or D became ambulatory. The trend has previously been reported by many authors.

There have been lengthy debates on whether the anterior or posterior approach should be used for unstable burst fractures of the TLJ. The choice of surgical approaches has mostly been anecdotal, influenced heavily by the surgeon’s preference and education. In our institution, symptomatic burst TLJ fractures are approached from the posterior direction, unless patients show progressive worsening of paraparesis resulting from severe canal stenosis and neural compression by bony fragments. Our series included four such patients who were not included in the present study. Seventeen patients with burst TLJ fracture who were symptomatic but remained neurologically unchanged were treated with the posterior approach. The short-term outcomes were generally satisfactory with low rates of serious complications, which have made us convinced that the stand-alone posterior approach may be sufficient for most patients with TLJ burst fracture who present with non-progressive neurologic deficit. Although there has been concern whether the stand-alone posterior surgery can adequately stabilize the two- or three-column TLJ injury, a recent biomechanical study found no significant difference in biomechanical properties between the anterior vs. posterior TLJ fixation, as long as the long-segment posterior instrumentation was used. The advocates of anterior surgery have also reported satisfactory results for symptomatic patients operated on from the anterior approach only. Although randomized, controlled studies would clarify which approach is more suited for each individual, such studies to compare the efficacy of the two approaches for patients with symptomatic burst TLJ fracture have never been conducted. In that context, a spine surgeon may be allowed to adopt the approach with which he or she feels more comfortable in many circumstances. Generally, the posterior approach is thought to be less effective in neural decompression compared with the anterior approach. In experienced hands, adequate spinal canal decompression can be achieved with a combination of laminectomy and ligamentotaxis (Fig. 2C, D). On the other hand, the posterior approach was essential because of the presence of posterior ligamentous disruption in the 15 patients with flexion-distraction or fracture-dislocation injury.

The number of thoracolumbar vertebral segments to be incorporated into the posterior instrumental fixation also remains controversial. In our institution, a total of five vertebrae (two above and two below the injured vertebra) are routinely incorporated into the fixation. Although the range of motion may be diminished after a long-segment posterior fixation, the risk of hardware failure is smaller compared with a short-segment posterior fixation, i.e., fixation incorporating two vertebrae (one above and one below the fractured segment). Laboratory as well as clinical studies revealed that short-segment posterior fixation may be biomechanically incompetent to support the destroyed or weakened anterior vertebral column in patients with unstable burst TLJ fracture. However, short-segment posterior fixation is superior to long-segment fixation in that the range of motion is less compromised and the risk of pedicle-screw related complications is smaller, because short-segment fixation uses half the number of pedicle screws. The injection of polymethyl methacrylate into the fractured vertebral body to strengthen the anterior column in combination with a short-segment posterior fixation has been improvised to overcome the shortcomings of conventional short-segment fixation. The technique may be beneficial in selected patients.

There are several limitations in the present study. Firstly, this is a retrospective case series, without different treatment methods for comparison. Although we are convinced that posterior instrumentation surgery is a safe and efficacious treatment, it cannot be determined whether the posterior approach is superior to the anterior approach, or vice versa. Secondly, because of the limited duration of the follow-up period, the long-term outcomes, including the quality-of-life parameters, of the patients could not be evaluated. Patients who showed no

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neurologic improvement 3 months postoperatively may have achieved delayed recovery. Continued clinical and radiographic follow up, which often reveals progression of kyphosis of the TLJ or delayed instrumentation failure, is often difficult to conduct in a vast country like the United States, where patients are usually sent back to the referring physicians shortly after discharge and not to the spine surgeon for follow-up examination. Such long-term follow-up studies may rather be easier to conduct in Japan, where patients tend to be seen continuously by the same surgeons.

References


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Commentary

The authors have to be acknowledged for providing a retrospective study on a series of 32 patients with thoracolumbar junction injury causing neurological deficit and treated with posterior instrumentation for reduction and stabilization, together with decompressive laminectomy when necessary.

The authors, who used the classical ASIA grading of the neurological status and the AO classification of fractures of the TL junction, have written a concise and precise report stressing neurological improvement in a significant number of patients. Results seem worthwhile in terms of spinal alignment after a mean 18-month follow up. Malposition of pedicle screwing occurred in 2 cases, without neurological aggravation.

However, the authors are wise to point out the fact that, due to the lack of long-term follow up in their series, a number of patients might well have secondary kyphosis deformity. The experience in our institution is that a delayed kyphosis frequently happens in those TL-junction fractures, especially ones of the burst-type, which justifies a complementary anterior operation for stabilization. Our policy is the following: Posterior approach on emergency for reduction, decompression, and immediate stabilization, completed with an anterior approach in the early phase if there are important bone corporeal defects, or (eventually) in a second stage if a delayed kyphosis deformity develops.

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Inamasu et al. present a retrospective review of 32 patients with thoracolumbar fractures who underwent posterior stabilization alone. Demographic data, type and anatomic level of thoracolumbar injury, preoperative neurological status, postoperative neurological status (including a 3 month follow-up assessment) and complications are described.

There are approximately 79,000 spinal fractures in the United States each year, with the majority involving the thoracic and lumbar spine (72.5%). The thoracolumbar junction (T11-L1) represents a mechanical transition zone between the rigid kyphotic thoracic and more mobile lordotic lumbar spine and is the most common site of injury. The formulation of a treatment plan for patients with injuries to the thoracolumbar spine depends upon the presence and extent of neurological injury and deformity and an estimate concerning spinal stability. Both nonsurgical and surgical treatment options are available to achieve the goals of preservation of neurological function and restoration of spinal stability. Our experience is similar to the authors’, in that patients who present with ASIA A neurological deficits rarely had significant neurological recovery and those with ASIA C or D neurological deficits made some recovery.

The authors utilize the AO classification of fractures. We have adopted the thoracolumbar injury severity score (TLISS) described by Vaccaro et al. to determine which patients should be treated surgically. TLISS is based on three objective variables: 1) the mechanism of injury as evidenced by imaging studies; 2) the integrity of the posterior ligamentous complex (PLC); and 3) the neurological status of the patient. If the total score is <3, a nonoperative treatment is recommended, a total score = 4, a nonoperative vs. operative treatment is proposed and if the score is >4, operative treatment is pursued. Like the authors, we approach the majority of thoracolumbar fractures posteriorly and we favor a longer construct (i.e. 2 levels above and 2 levels below the fracture) with pedicle screws and ligamentotaxis to decompress the neural elements and re-establish sagittal balance.

Although the follow-up period is limited in the current study, we look forward to further updates regarding the patient’s neurological recovery and the durability of the thoracolumbar alignment and construct at longer time points. Additionally, we echo the authors’ sentiment regarding the need for a randomized trial looking at posterior vs. anterior approached and early vs. delayed surgery. We encourage the authors to pursue such studies.

References


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