NEUROLOGICAL OUTCOMES OF TRANSPEDICULAR FIXATION IN THE MANAGEMENT OF THORACOLUMBAR BURST FRACTURES

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ABSTRACT

BACKGROUND

The injuries involving the spinal cord are generally challenging to manage. Apart from correction of the bony structures, care should also be taken to ensure optimal neurological improvement. The neurological outcomes of transpedicular fixation in thoracolumbar burst fractures were evaluated in this study.

METHODS

34 patients who underwent posterior spinal stabilization with transpedicular instrumentation and posterolateral fusion for unstable thoracolumbar burst fractures with or without neurological deficit were included in the study. Neurological evaluation was done and patients were graded according to ASIA (American Spinal Cord Injury Association) impairment scale as a part of physical examination.

RESULTS

In the short segment group four grades of improvement was found in 1 patient, three grades in 1 patient, two grades in 2 patients and one grade in 6 patients. In the long segment group, three grades of improvement were found in 3 patients, two grades in 2 patients and one grade in 2 patients. 1 of the grade D patient showed improvement within the grade and 3 patients did not show any improvement. Average ASIA motor score improved with treatment from 28.31 to 39.56 points (11.25) in short segment group and from 19.91 to 28.46 points (8.55) in long segment group.

CONCLUSION

The length of instrumentation does not seem to have any effect on the neurological outcome.

KEYWORDS

Thoracolumbar, fractures, neurological outcome.

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INTRODUCTION: Falls from height and motor vehicle accidents often lead to thoracolumbar burst fractures following substantial axial loading force that result in compression failure of anterior and middle spinal columns. Vertebral end-plate failure can result due to sudden application of supraphysiological load which can cause adjacent disc tissue to be driven into the vertebral body. Retropulsion of an osseous fragment or fragments from the superior endplate causes some degree of canal compromise.[1]

Characterisation of the fracture and any associated neurological injuries is critical in such injuries, following which, spinal stability is assessed. White and Panjabi have defined clinical instability as "the loss of ability of the spine under physiological loads to maintain its pattern of displacement so that there is no initial or additional neurological deficit, no major deformity, and no incapacitating pain".[2] Common determinants of instability include presence of neurological deficit, radiographic evidence of substantial posterior column injury, and >50% loss of vertebral body height in association with substantial kyphosis.[1]

Neurological deterioration and symptomatic kyphosis are the important complications that can result from nonoperative treatment in addition to prolonged immobilization with bed rest, long hospital stay, risks of immobilisation, and delay in rehabilitation. Overall, stability with healing cannot be predicted.[1,2]

Hence, protecting the unstable spine from all the loads that might cause displacement at the site of injury further aggravating the neurological deficit is of utmost importance. The load bearing function of the injured structure must be augmented by means of internal stabilization.[1]

Primary goals of the treatment include prevention and limitation of neurological injury as well as restoration of spinal stability. Other issues that need to be addressed

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include deformity correction, minimizing motion loss, and facilitating rapid rehabilitation. The planned management should ensure a biological and biomechanical environment conductive to osseous and soft tissue healing, in order to recreate a stable pain free spinal column.

Harrington rods, hooks and sub laminar wires were the initial fixation devices used to manage thoracolumbar burst fractures. However, complications such as loss of number of motion segments, lack of correction in the sagittal plane, and increased neurological deficit were the primary drawbacks of these devices.[3,4]

This lead to the introduction of transpedicular instrumentation systems which had various distinct advantages such as rigid segmental fixation, stabilization of the three columns, least failure at bone metal interface, early post-operative mobilization with efficient nursing care and least risk complications. Pedicle screw fixation also does not require the presence of intact lamina, facet joints or spinous processes.[5,6]

The pedicle can withstand all the transmitted stresses related to rotation, side bending, and extension of the spine. Steffee et al have thus referred the pedicle as the "force nucleus" of the vertebral body. It is an ideal structure to lock into and control with posterior instrumentation when spinal fixation is needed.[6]

Short segment instrumentation (pedicle screw fixation one level above and below the injured vertebra) aimed to preserve the number of motion segments while offering benefits such as improvement in fusion rates, ability to obtain reduction, maintain sagittal contour and ultimately leading to a lower incidence of residual back pain.[7]

We analyzed the neurological outcome following short segment and long segment transpedicular fixation of thoracolumbar burst fractures and determined whether the length of the segment had any influence on the neurological outcomes.

MATERIALS AND METHODS: Thirty-four patients who underwent posterior spinal stabilization with transpedicular instrumentation and posterolateral fusion for unstable thoracolumbar burst fractures with or without neurological deficit, in the department of orthopaedics, SRMC and RI, from April 2002 to October 2004 were included in the study.

The primary inclusion criterion was the presence of unstable thoracolumbar burst fractures with or without neurological deficit.

The criteria for instability were:

- Kyphosis angle >11 degrees.
- Loss of anterior vertebral body height by at least 30%.
- 2 or 3 column involvement.
- Presence of neurological deficit.

Exclusion criteria for this study were as following:

- All pathological fractures.
- Patients who underwent global fusion (anterior & posterior).
- Patients who underwent anterior-only surgery.

The assessment of the included patients included detailed history, physical examination, plain AP and lateral radiographs, CT scans and / or MRI scans.

Following primary evaluation, injuries in relation to spine were assessed. Presence of abrasions/lacerations, swelling, deformity, tenderness, step off, gaps/malalignment were checked for by log rolling the patient. Neurological evaluation was carried out and the patients were graded according to ASIA (American Spinal Cord Injury Association) impairment Scale as a part of physical examination.

A=Complete: No motor or sensory function is preserved in the sacral segments S4-S5.
B=Incomplete: Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-S5.
C=Incomplete: Motor function is preserved below the neurological level, and more than half of key muscles below the neurological level have a muscle grade less than 3.
D=Incomplete: Motor function is preserved below the neurological level, and at least half of key muscles below the neurological level have a muscle grade of 3 or more.
E=Normal: Motor and sensory function is normal.

Neurological assessment also included assessment of the extent of motor and sensory deficit using ASIA motor and sensory score for a total of 50 and 56 points, respectively.
Initial radiographic assessment included interpedicular distance on an AP view, loss of vertebral body height (anterior & posterior), Kyphus angle and wedge angle on a lateral view.

Kyphus angle was measured from superior end plate of the intact vertebra just above to the inferior end plate of intact vertebra just below the fracture. Wedge angle was measured from the superior end plate to the inferior end plate of the fractured vertebral body. CT imaging was done to evaluate the amount of comminution, apposition of fragments and retropulsion of fragments into the canal. MRI was recommended for patients with a neurological deficit to identity possible spinal cord or cauda equina injury, haemorrhage, or epidural haematoma.

Load sharing classification (Gaines scoring) was used retrospectively to correlate fracture comminution and displacement with progression of the deformity and implant failure.

Operative Procedure: Surgery was performed at the earliest after assessing fitness for surgery and obtaining relevant consents. The standard protocols related to asepsis, antibiotic usage, general anaesthesia and other relevant procedures were followed during the surgery.

Standard posterior midline approach was followed to expose the spinous processes two level above and below the fractured site for a short segment fixation, while it was exposed 3 levels above and below, for long segment fixation. Sub periosteal erasure of para spinal muscles was done up to the facets of the respective segments. Capsulotomy of the

facets with dissection up to the tips of the transverse processes was done bilaterally.

Levels were confirmed under image intensifier control and pedicle screws were inserted bilaterally. This procedure was repeated as necessary depending on short segment or long segment construct. Laminectomy was done at the fracture level to achieve posterior decompression wherever necessary. Decortication of the spinous process, transverse processes, and lamina was done along with facetectomy.

Adequate quantity of corticocancellous bone graft harvested from iliac crest was used to augment fusion. Care was taken to ensure that all the slots of the screws were aligned. The rod was contoured depending on the sagittal contour of the zone of fixation and was loaded into the universal top loading connecting post of the screws. Rod pusher was used whenever required to facilitate correct seating, and the screws were secured in that position by tightening inner and outer nuts. Rods were inserted bilaterally over the screws. Connecting blocks were placed over the rods.

Connecting rod was used to augment torsional rigidity and prestressing was done to prevent the parallelogram effect. Wherever posterior longitudinal ligament was intact on MRI, indirect reduction technique by distraction was done. Haemostasis was achieved, following which wound closed in layers with a suction drain in situ.

The implants used were: Transpedicular screw fixation with rod-screw system (Moss Miami). Size of the pedicle screws most commonly used were 4.5 and 5.5 mm.

Postoperative Protocol and Rehabilitation: Antibiotics and analgesics were administered postoperatively as per schedule. Suction drain was removed after 48 hrs. Vital signs input and output, abdominal charts were maintained in the immediate postoperative period as a routine.

Patients were log rolled in the bed for the first 2 days along with passive stretching exercises of both lower limbs and active exercises of both upper limbs.

Neurological assessment was carried out after pain had subsided and the patients were able to move the lower limbs without distress. Hourly clamping was done if bladder sensation was regained. Otherwise, patients were taught clean intermittent self-catheterization. Suppository was provided for bowel clearance wherever possible.

Sutures were removed on 12th post-operative day. Patients were kept in the hospital considering their response to the treatment instituted, progress in rehabilitation programme, complications if any, socioeconomic conditions and were discharged when considered fit enough to sustain themselves independently at least at house environment. Patients were mobilized postoperatively with supporting brace (TLSO brace) from the time they were pain free and this was continued for 6 months. Rehabilitation training continued for other normal daily activities.

Standard AP and lateral films were taken to assess position of the implant and degree of correction achieved in the early post-operative period. Later follow-ups included assessment of progression of deformity, loss of correction, final gain and implant failure.

Neurological assessment was done at each follow up and the most recent follow-up using ASIA impairment scale. Patients were followed up at 3 weeks, 6 weeks, 3 months, 6 months, 1 year and then every 6 months. Each patient was assessed clinically and radiologically at each follow-up.

RESULTS: Of the total 34 patients enrolled in the study 5 patients were lost for follow-up, leaving 29 patients for final evaluation. Among these, 22 were male (76%) and 7 were female (24%). Short segment stabilization was carried out in 16 patients (56%) while long segment stabilization was carried out in the rest 13 patients (44%). The mean age of the patients who were treated with short segment was 28.5 years and 28 years in the long segment group.

The injury levels were D11 in 4 patients (13.8%), D12 in 5 patients (17.2%), L1 in19 patients (65.5%), and L2 in 1 patient (3.4%). The vertebral level most commonly involved was D12-L1 (82.7%). Calcaneal fracture (22.2%) was the most commonly associated skeletal injury.

The average length of hospital stay for these patients was 28.6 days (range, 12 to 58 days). Average follow-up period was 13.81 months and 18.15 months, for short and long segments, respectively.

Neurological Outcome: Asia Impairment Scale: Overall, there were 7 patients with ASIA grade A, of whom 1 improved to E, 4 improved to D and 2 showed no improvement. Of the 4 patients with ASIA grade B, 2 improved to grade D, 1 improved grade C and 1 remained in grade B. 2 of the 7 grade C patients improved to grade E, 3 to grade D and 2 remained in the same grade. Of the 7 patients with grade D, 4 improved to E, 2 improved within the grade and 1 did not show any improvement. 4 grade E patients had no neurological deficit.

In the short segment group four grades of improvement was found in 1 patient, three grades in 1 patient, two grades in 2 patients and one grade in 6 patients. 3 of the patients showed improvement within the grade and 1 grade D patient did not show any improvement. (Table 1)

Before treatment	Last followup				
	A	B	C	D	E
A = 2	0	0	0	1	1
B = 2		0	1	1	0
C = 4			2	1	1
D = 6				2	4
E = 2					2

Table 1: ASIA impairment scale in short segment group

In the long segment group, three grades of improvement were found in 3 patients, two grades in 2 patients and one grade in 2 patients. 1 of the grade D patient showed improvement within the grade and 3 patients did not show any improvement. (Table 2)

Before treatment	Last followup				
	A	B	C	D	E
A = 5	2	0	0	3	0
B = 2		1	0	1	0
C = 3			0	2	1
D = 1				1	0
E = 2					2

Table 2: ASIA impairment scale in long segment group

Ten of the patients (62.5%) in short segment group had improved at least by one grade and 7 of the patients (53.8%) in long segment group had improved by at least one grade. Average ASIA motor score improved with treatment from 28.31 to 39.56 points (11.25) in short segment group and from 19.91 to 28.46 points (8.55) in long segment group. Similarly, average ASIA sensory score improved with treatment from 44.75 to 53.18 points (8.43) in short segment group and from 36.42 to 42.38 points (5.96) in long segment group.

DISCUSSION: The D12-L1 junction is the commonest site of injuries as this area represents the transition from normal thoracic kyphosis to lumbar lordosis; therefore, maximum stress concentration on weight bearing occurs here.[8] In our study 82.7% of the injuries were around this region. Further, a clear correlation with level of fracture and Frankel's grade is suggested; accordingly, neurological injury at the spinal cord tends to be more severe than the injuries in the cauda equine.[9]

The primary goal in the management of patients with thoracolumbar burst fractures the absolute goal should be to stabilize an unstable injury. Other goals include decompression of a compromised spinal canal and correction of deformity.[10]

Decompression is particularly important in those cases associated with neurological deficit. Although some authors have shown no relationship between spinal canal narrowing and neurological deficit, there is an increasing body of literature that suggests otherwise.[1]

McEvoy and Bradford[11] have shown that patients presenting with neurological injury have a better chance of improvement when treated surgically. Crutcher and Anderson along with Fredrickson and Mann[10,12,13] suggested that posterior spinal instrumentation and fusion alone without any direct decompression of the spinal canal is a reasonable surgical technique allowing adequate realignment and favourable neurological outcome, despite persistent encroachment of the canal.

Gertzbein et al[9] studied over 104 patients to assess neurological recovery with and without decompression and proposed that the recovery occurred independently of the treatment. Anderson, Durnmond, Lynn and Wagner have illustrated that major determinants of the neurological outcome is the initial insult at the time of the injury, but the role of decompression could not be underestimated.

In our study, all the patients underwent stabilization with decompression and bone grafting, except for 4 patients without neurological deficit. Therefore, the role of decompression in determining the neurological outcome could not be assessed.

In our study, 62.5% and 53.8% patients, in the short and long segment groups, respectively, showed improvement to the next ASIA grade. Complete neurological recovery in patients with incomplete injury was observed in 41.6% of patients in the short segment group and 16.6% patients in the long segment group. In a similar study, Louis et al reported 66% complete recovery in patients with incomplete injury.[14] None of the patients in our series had a neurological decline, during the course of the treatment.

Mean average ASIA motor score and ASIA sensory score improved by 11.25 and 8.43 points, respectively in the short segment group in comparison with 8.55 and 5.96 points, respectively in the long segment group. In the Louis et al study the mean average Asia motor score improved by 14.6 points and mean average sensory score improved by 10.3 points.[14]

Neurological outcome was better in short segment group in terms of improvement in ASIA grade as well as ASIA motor and sensory indices. The probable cause for the better neurological outcome, in the short segment group could be due to the presence of less number of patients with ASIA grade A (complete injury) and more number of patients with ASIA grade D (incomplete injury).

There were almost equal number of patients with ASIA grade B and grade C in both the groups.

CONCLUSION: Based on the outcomes noted it can be said that transpedicular fixation is a stable, reliable and less surgically extensive construct. However, it requires a thorough understanding of fracture pattern and pedicle morphometry along with proper intraoperative technique. There was no significant difference in neurological recovery between short and long segments. Therefore, it can be concluded that the length of instrumentation does not seem to have any effect on the neurological outcome.

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