Short segment pedicle screw fixation for unstable thoracolumbar and lumber fractures: analysis of 40 cases.

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Abstract:

Introduction: *Thoracolumbar spine fractures are common injuries that can result in significant disability, deformity and neurological deficit. Controversies exist regarding the appropriate radiological investigations, the indications for surgical management and the timing, approach and type of surgery. Currently, posterior short segment pedicle screw internal fixation including the fractured vertebral body is one of the most common operative approaches to treat unstable thoracolumbar/lumbar burst fracture.This study analyzes the efficacy of short-segment pedicle screw fixation for thoracolumbar fracture/dislocation*

Methods: *Forty patients with unstable thoracolumbar spinal fractures, admitted between 1–7 days after injury (average: 2.8 days), were treated by posterior short segment spinal fixation between July 2012 and July 2016.The average age of the patients was 33.6 years (range: 20–50 years), and there were 30 male and 10 female patients. The length of the follow-up period averaged 12 months (range: 6-12). A fall from a height, usually a tree, and road traffic accident was the most common cause of injury. McAfee's [14]systemswere used to classify the fractures. There were 26 unstable burst fractures, 11 translational injuries and 3 flexion-distraction injuries.Frankel's [8] grade system was used for assessment of neurological deficit on admission and subsequently in the follow-up. Thirty patients (64%) had neurological deficit on admission.*

Result: *A sum of 40 patients (30 male and 10 female) with a ratio 3:1, were enrolled in the study. Average Age of the patient 33.6 years, range from 20 – 50 years. The affected levels were D11 level in 4, only D12 level in 14 patients, both D12 and L1 were 3, only L1 in 8, L2 in 7, L3 in 3, and L4 in 1. The majority of fractures resulted due to falls (31 cases; 75.61%). The remaining cases resulted from car accidents (9 cases; 22.5%).Neurological recovery of one or more Frankel grade was seen in 31 patients.50% of our patients had one or more complication.There were 10 cases of hardwarefailures involving 11 pedicle screws: three loose, two bent and five broken screws.*

Conclusion: *Though there is debate whether short segment or long segment fixation is appropriate for management of thoraco-lumber injury, but in our concern short segment fixation with the fracture segment is effective for preservation of motion and early mobilization of the patient. Though the hardware failure is still in debate for this.*

Key Wards: *Thoracolumber fracture, Kyphosis, Vertebral body, Spinal Fixation*

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Introduction:

Traumatic spinal cord injury is estimated to be 29 – 50 cases per million populations per year worldwide[1]. Fractures of the thoracic and lumbar region constitute a spectrum of injuries ranging from the simple undisplaced fractures to complex fracture dislocations.Anatomically and functionally, the thoracic and lumbar spine can be divided into three regions – thoracic spine (T1-T10), thoracolumbar junction (T10-L2) and the lumbar spine (L3-L5). [2,3]

Thoracolumbar spine fractures are common injuries that can result in significant disability, deformity and

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neurological deficit. Controversies exist regarding the appropriate radiological investigations, the indications for surgical management and the timing, approach and type of surgery.

There is controversy regarding the indications for operative treatment and type of stabilization procedures for the treatment of thoracolumbar burst fracture. Unstable fractures frequently require surgical correction. Progressive neurological deterioration is generally considered an absolute indication for early surgery [1,2]. Other strong indications for surgical intervention include incomplete neurological deficit, more than 25° to 30° angle of kyphotic deformity, more than 50% loss of vertebral body height, and more than 40% to 50% of canal narrowing. The two main goals of surgery for traumatic thoracolumbar burst fractures are to adequately decompress the spinal canal, maximizing neurological recovery and creating spinal stability to prevent painful deformity and potential future neurological deficit. Surgical reconstruction of the fractured vertebral body provides immediate stabilization and allows earlier mobilization, thus, it prevents or minimizes the sequelae of prolonged bed rest.

Surgical treatment in the case of thoracolumbar burst fractures is very controversial. Posterior instrumentation is most frequently used, however, but the number of levels to be instrumented still remains a matter of debate.Currently, posterior short segment pedicle screw internal fixation including the fractured vertebral body is one of the most common operative approaches to treat unstable thoracolumbar/lumbar burst fracture. Although the clinical results of this surgery are usually satisfactory, progressive kyphosis and a high rate of hardware failure remain a concern. Lack of the anterior column supporting is the main cause of hardware failure [4,5,6,7,8,9].

This study analyzes the efficacy of short-segment pedicle screw fixation for thoracolumbar fracture/dislocation

Methods

Patients

Forty patients with unstable thoracolumbar spinal fractures, admitted between 1–7 days after injury (average: 2.8 days), were treated by posterior short segment spinal system between July 2012 and July 2016. The indication for surgery were the presence of any one or more of the following: 1. presence of neurological involvement caused by the fracture or images of the affected level showed more than 50% spinal canal compromise; 2. more than 50% loss of anterior vertebral height [10,11,12,13] or local kyphosis angle exceeds 25 degree.The average age of the patients was 33.6 years (range: 20–50 years), and there were 30 male and 10 female patients. The length of the follow-up period averaged 12 months (range: 6-12). A fall from a height, usually a tree, and road traffic accident was the most common cause of injury.

The bulk of the fractures (88%) were in the thoracolumbar junction (T11–L2). Following a routine examination and X-ray of the spine, magnetic resonance (MRI) imagesand sometimes computed tomography (CT) scan of the involved vertebra and adjacent vertebrae was carried out. McAfee's [14]system was used to classify the fractures. There were 26 unstable burst fractures, 11 translational injuries and 3 flexion-distraction injuries.

Frankel's [8] grade system was used for assessment of neurological deficit on admission and subsequently in the follow-up. Thirty patients (64%) had neurological deficit on admission.

Surgical technique

The patient is placed in prone position on a radiolucent spine table. Apply manipulative reduction first if obvious kyphosis is detected. Fluoroscopy is used to locate the fractured vertebral body. A posterior midline straight incision centered on the affected level is made to expose the laminae 1 level above and below the affected level. Subperiosteal dissection is carried out with an electric cuter until the facet joints on both sides are visualized. Pedicle screws are introduced 1 level below and above the affected level and also the fractured vertebral body [18,19] if the pedicles are intact and not expected to be removed for the purpose of decompression. Spinal process and both lamina of the affected level are removed by rongeurs to decompress the posterior aspect of the thecal sac. Once posterior decompression was completed, the screws of both sides were distracted axially with contoured longitudinal rods to restore the

segmental height and realign the spinal columns, which are verified by C-arm X-ray monitoring. Then the screws of more severe damaged side are released, and the ipsilateral facet joints are resected to reveal nerve roots. Epidural veins and radicular veins are cauterized with bipolar forceps to avoid massive bleeding. Dura mater is repaired if it is lacerated. Any adhesions between the posterior longitudinal ligament and the anterior surface of the thecal sac are released, thus, the thecal sac can be easily retracted to provide better exposure of the posterior portion of the vertebral body and the intervertebral discs. Then the thecal sac and nerve root are gently retracted and protected with a nerve retractor, and the adjacent intervertebral discs are completely removed.

The retropulsed fragment of the fractured vertebral body are hammered anteriorly back into the corpus usingan 'L' angle dissector to recontour the posterior wall of the fractured vertebral body, at the same time decompressing the anterior aspect of the thecal sac. Then granulated bone graft made from removed bone tissue is packed into the intervertebral space, some of the bone graft is packed into the vertebral body through the fractured endplate.

When the decompression procedure is finished by a recheck of all the neural elements involved, a second rod is placed and tightened. A final verification of the screws positioning, alignment of the spinal columns and vertebral body height is done using postero-anterior and lateral fluoroscopy, then a drain is placed and the muscle, fascia and skin are closed in standard fashion.

Results:

Table 1 shows the summery and demographic data of the patient. A sum of 40 patients (30 male and 10 female) with a ratio 3:1, were enrolled in the study. Average Age of the patient 33.6 years, range from 20 – 50 years. The affected levels were D11 level in 4, only D12 level in 14 patients, both D12 and L1 were 3, only L1 in 8, L2 in 7, L3 in 3, and L4 in 1. The majority of fractures resulted due to falls (31 cases; 75.61%). The remaining cases resulted from car accidents (9 cases; 22.5%).

Table-I

Summary of demographic and clinical data distribution

Characteristics	
Average age	33.6 years (Range 20-59 years)
Mechanism of injury	
Fall	31 (75.61%)
Accidents	9 (22.5%)
Neurological deficit	
Frankel A	13 (32.5%)
Frankel B	3 (7.5%)
Frankel C	6 (15%)
Frankel D	4 (10%)
Frankel E	14 (35%)
Fracture level	
D11	4 (10%)
D12	14 (35%)
L1	8 (20%)
Both D12 and L1	3 (7.5%)
L2	7 (17.5%)
L3	3 (7.5%)
L4	1 (2.5%)
McAfee type of injury	
Unstable burst	21 (52.5%)
Translational injury	12 (30%)
Flexion distraction	6 (15%)
Chance	1 (2.5%)

Neurological recovery of one or more Frankel grade was seen in 31 patients. Of the 26 patients with partial neurological deficit, two grades of improvement were observed in seven patients and one grade of improvement was found in ten patients. Of the 14 patients with complete paraplegia on admission, one- and two-grade improvements were observed in five and two patients, respectively.Most of the patients with partial neurological deficit (i.e. grade C and D) were unable to return to their previous activity.

Table-II

Complications which appeared in some of the patients who underwent surgical treatment

Complication	Number
Hardware failure	10 (25%)
Screw loosening	3 (7.5%)
Bent Screw	2 (5%)
Broken Screw	5 (12.5%)
Superficial wound infection	2 (5%)
Deep wound infection	1 (2.5%)
Urinary tract infection	7 (17.5%)

50% of our patients had one or more complication (Table 2). There were 10 cases of hardwarefailures involving 11 pedicle screws: three loose, two bent and five broken screws. Only onepatient agreed to revision surgery in which four screw failures were involved. No neurological complication due to instrumentation was observed in any patient. Seven patients with pre-operative neurological deficit had urinary tract infections and required prophylactic antibiotics. Two patients with superficial wound infections responded to antibiotics and antiseptic dressings. One patient had a deep wound infection due to Pseudomonas aeurogenosa; this infection responded to parenteral ceftizidime and the wound healed with granulation. One patient with decubitus ulcer required plastic surgery.

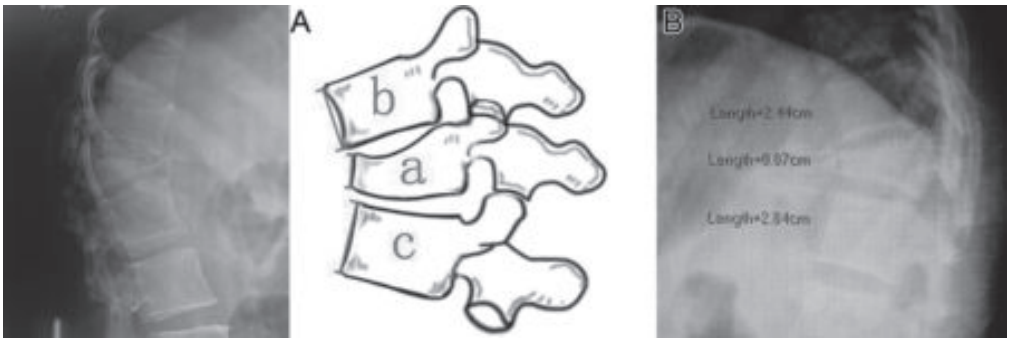

Fig.-1: *Reduction of veretebral body height*

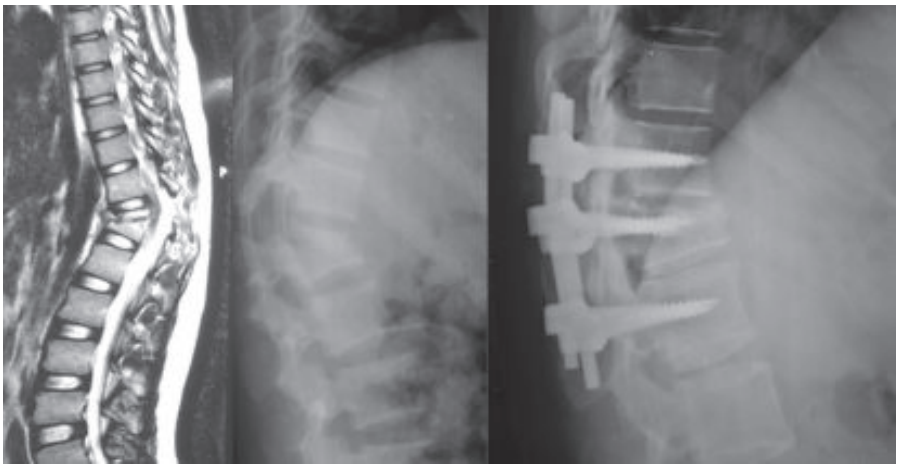

Fig.-2: *D12 burst fracure*

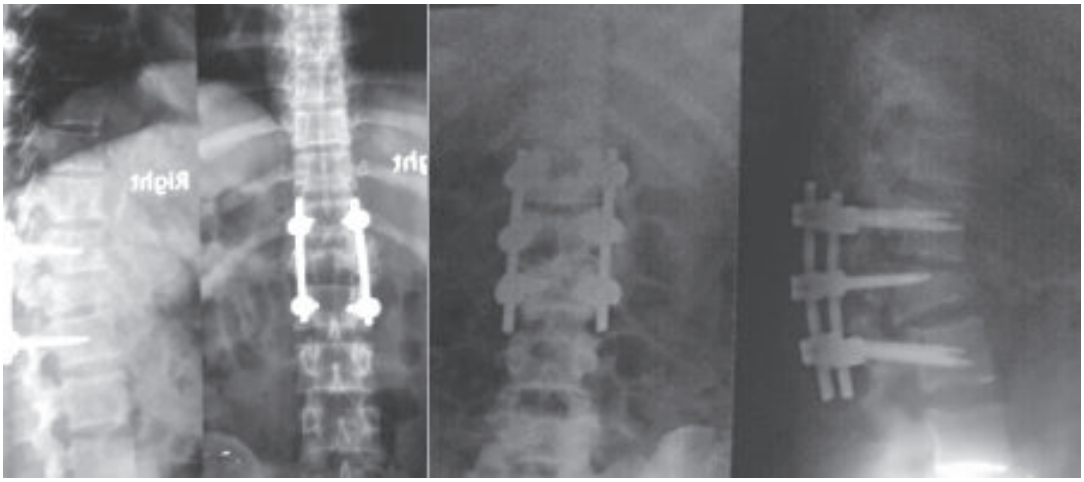

Fig.-3: *Short segment posterior fixation with fracture segment and without fracture segment*

Discussion:

Fracture and fracture dislocations of the thoracolumbar spine are the most commonly occurring types of osseous spine injury. In developed countries such injuries mainly occur in association with motor vehicle accidents and falls [5,9], while in the developing world they are primarily the result of a fall from a height [4,16].The advantage of an operative procedure for treating these injuries is the immediate stabilisation of the injured spine and an indirect or direct decompression of the neural structures. Operative stablisation enables early mobilisation without a heavy and uncomfortable cast and clearly shortens the hospital stay[4,5,7,9].

The indication for an operative stablisation in patients with unstable spine injuries and complete paraplegia is the prospect of early rehabilitation and a reduced burden to the care-giver.Biomechanical and clinical studies have shown that when there is loss of more than 50% of the vertebral body height or more than 25° angulation deformity of the injured segment, acute spinal instability results, and the spinal segment will eventually fail with weight-bearing [19]. Here we present a consecutive series of 40 patients with acute traumatic thoracolumbar/lumbar unstable burst fractures who need to be operated on according to the above criteria.

Evolution in spine hardware and surgical technique has offered an ample variety of instrumentation and surgical approaches. Common surgical options include anterior approach decompression and reconstruction, posterior pedicle screw fixation, and combined anterior-posterior approach [20,21,22].

Each technique has advantages and disadvantages [4]. No ideal surgical approach exists at present. By anteriorapproach we can decompress nerves sufficiently and provide reliable anterior column support. However, this approach requires longer operation duration and the rate of approach related complication and the death rate is significantly higher than posterior approach. Although the combination of anterior and posterior approach can provide the most stable biomechanical repair, the operation time, complication and morbidity rate might be apparently higher than that of the single approach. Traditionally the standalone posterior approach is relatively an easy procedure but can only indirectly reduce a fractured vertebral body, and the means of augmenting the anterior column are limited [21,22]. Reported loss of reduction caused by insufficient anterior column support with or without hardware failure is not uncommon [29].

Posterior approach instrumentation can be devided into long-segment fixation (involving more than two upper and lower neighboring levels), short-segment fixation (involving one level above and one below the fractured level) and mono-segment fixation. Nowadays short-segment pedicle screw instrumentation is a well described and popular technique to reduce and stabilize thoracic and lumbar spine fractures [5]. Short-segment fixation offers the advantage of saving motion segments when compared with longer instrumentations. On the contrary, investigators in recent studies have reported earlier implant failure and correction loss as the most important disadvantages of this method [5,7]. Controversy still exists about whether short-segment pedicle screw instrumentation is a suitable method for unstable thoracolumbar/lumbar burst fracture.

We used McAfee's system to classify the fractures after radiological evaluation. The most common fracturepattern in our study was unstable burst fracture, as revealed in the x ray and sometimes CT scan by subluxation of one or more facet joints, fracture of one or more neural arches or gross displacement of the neural elements [14]. The second most common pattern was translational injuries, usually involving the thoracolumbar junction. There were two vertebral body outlines at one level, referred to as the double margin sign [15]. Flexion distraction injury was another pattern of fracture which showed a characteristic, so-called naked facet sign on the CT scan [23]. Unstable burst fractures and, in particular, translational injuries were associated with severe neurological involvement. Nam-Hyun et al. [17] also reported a high degree of neurological involvement in patients with posterior element involvement – i.e. burst fractures and rotational injuries.

Most of our patients with severe neurological involvement had a fall from tall trees while felling branches for firewood or collecting walnuts from tall walnut trees with slippery surfaces and relatively weak strength. The improvements observed in the radiological parameters (vertebral body height, kyphotic deformity) measured in the immediate post-operative period and at the final follow-up are, with a few exceptions, comparable with those reported elsewhere [4,5,9]. After an initial substantial correction, there was a gradual partial loss of correction, leaving

an overall loss of kyphosis of 3.46° at the final follow-up. The loss of initial correction after pedicle screw fixation has been reported by many authors. Although a good correction of kyphosis and restoration of vertebral body height is achieved by surgery, most is lost during the long-term follow-up period. This loss of correction and the failure of the implant are more common in spine fractures repaired with pedicle screws [2,5] than in those in which anterior grafting and instrumentation are used [7,12,13], reportedly due to the failure of posterior instrumentation to support the anterior column.

Neurological recovery has been reported with early stablisation of thoracolumbar spinal fractures [9].The highestrecovery rates have been reported for patient's operateon within 8 h of the initial trauma, while high remission rates have been reported for patients operated on within 48 h of the initial trauma. After this time there is no significant difference in the neurological outcome with respect to the timing of operation after the trauma. The earliest we were able to stabilise a spine was 15 days after the initial trauma – primarily because of the non-availability of facilities for operation. The pattern of neurological recovery in our patients, however, is not discouraging despite this delay.Of the 26 patients with partial neurological deficit, two grades of improvement were observed in seven patients and one grade of improvement was found in ten patients. Of the 14 patients with complete paraplegia on admission, one- and two-grade improvements were observed in five and two patients. As with all surgical implants, failure of the instrumentation with subsequent loss of reduction is of utmost concern. We had a significant number of implant failures in the form of loose, bent and broken screws. Almost all of the implant failures in our study occurred at the thoracolumbar junction. Krag[15] has suggested segmental pedicle fixation two levels above the kyphosis to avoid such implant failures. We believe that this technique should be used at the thoracolumbar junction where compression forces act more anteriorly. Another pedicle-related concern, which has been reported to occur in between 10 and 28.8% of cases [13], is screw misplacement. Four of our screws, as evident from post-operative radiographs, were misplaced, and all of these eventually failed. Whereas early (within hours of the initial trauma) orimmediate (within 48 h) stablisation and indirect or direct decompression is a distant dream in our surgical set-up (and, we believe, in most of the developing countries),even delayed stablisation of the unstable spine has benefits. However, the number of complications remains worrisome; this is particularly true with respect to hardware failure.

Conclusion:

Though there is debate whether short segment or long segment fixation is appropriate for management of thoraco-lumber injury, but in our concern short segment fixation with the fracture segment is effective for preservation of motion and early mobilization of the patient. Though the hardware failure is still in debate for this.

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