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Early Clinical Results of Short Same-Segment Posterior Fixation in Thoracolumbar Burst Fractures

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SUMMARY

Background. We did a prospective study to study the efficiency of Short Segment Posterior Instrumentation using a Universal Spine System with incorporation of the fractured vertebra in post-traumatic thoracic and lumbar spine fractures.

Material and methods. 25 cases in the age group of I5-50 years with thoracic and lumbar spine fractures were included in the study. The operative decision was made on the basis of instability of spine fractures with or without neurological deficit. Patients were followed up for an average period of twelve months, reporting for assessment at 3-monthly intervals. The final result was analyzed on the basis of neurological recovery as per Frankel's Grading, spine stability as per kyphotic angle by Cobb's method, vertebral body height and complications.

Results. Post-operatively at the final follow-up visit, 36% patients had Frankel's grade E neurological status. The mean sagittal plane kyphosis pre-operatively was 31.16°, which reduced to 21.52° post-operatively, which represents 30.93% reduction. Mean anterior body compression was 38.6°, which decreased to 23.4° post-operatively, corresponding to 15% increase.

Conclusions. 1. Although conventional short segment posterior fixation (SSPF) has become an increasingly popular method of treatment of thoracolumbar burst fractures, providing the advantage of incorporating fewer motion segments in the fixation, a review of literature demonstrated that SSPF led to 9-55% incidence of implant failure and long term loss of kyphosis correction. 2. Short segment posterior fixation with pedicle fixation at the level of the fractured vertebra (short same-segment fixation) provides more biomechanical stability than traditional SSPF.

Key words: thoracolumbar burst fractures, short segment posterior fixation, short same-segment fixation

BACKGROUND

The occurrence of thoracolumbar fracture and dislocation has increased substantially due to an increase in the incidence of road traffic accidents and greater exposure to high energy blunt trauma [1]. In fact, the majority of thoracic and lumbar injuries occur within the region between T11 and L1, commonly referred to as the thoracolumbar junction [2]. Burst fractures are the most common type of fractures of the thoracolumbar spine, accounting for greater than 50% of all thoracolumbar trauma [3]. The treatment of thoracolumbar trauma continues to be one of the most controversial areas in the spine trauma care despite the high incidence of these injuries and extensive published research. Superimposed on earlier fairly consistent and substantial body of literature, there are several recent studies that provide fair evidence that for thoracolumbar fractures, although non-operative outcomes appear to be satisfactory, surgical treatment improves pain relief, function and return to work [3-5]. Treatment algorithms are based on maximizing neurological recovery and prevention of neurological decline and deformity while maximizing pain relief. Minimizing the number of vertebral levels involved in fusion of a spine fracture is a common goal of internal fixation. This is achievable by utilizing traditional short segment posterior fixation (SSPF) [6,7]. SSPF is the use of pedicle screw instrumentation one level cephalad to and one level caudad to the fractured vertebra. It has become an increasingly popular method of treatment of thoracolumbar burst fractures, providing the advantage of incorporating fewer motion segments in the fixation. However, a review of literature demonstrated that SSPF led to 9-55% incidence of implant failure and long term loss of kyphosis correction, and up to 50% of patients with implant failure had moderate to severe pain [8-11]. Failure of SSPF can be attributed to instrumentation failure (i.e., bending and/or breaking of the screws), vertebral factors (i.e., primary osseous collapse or secondary to osteoporosis), or a combination of both. Other factors include inadequate fixation points on the vertebrae and insufficient anterior column support [12]. A cadaveric study by Mahar et al. showed that short segment posterior fixation with pedicle fixation at the level of the fractured vertebra (short same-segment fixation) provides more biomechanical stability than traditional SSPF [14]. Recent studies also clinically confirmed the increased stability provided by short same-segment fixation in maintenance of kyphotic correction. The teams hypothesized that short same-segment fixation would provide successful kyphosis correction with a low rate of instrumentation failure due to increased fixation points [15-17].

MATERIAL AND METHODS

The present prospective study was conducted in the department of orthopedics, Govt. Medical College & Hospital, Jammu from May 1st 2014 till October 30th 2016.

25 cases both male and female in the age group of 15-50 years with thoracic & lumbar spine fractures were included in the study.

Operative decision was made on the basis of instability of spine fractures with or without neurological deficit.

On arrival the patients were assessed and stabilized in terms of airway, breathing and circulation.

Immobilization on a hard board for suspected dorsal and lumbar spinal injury was done.

After admission, the patients underwent a detailed history, thorough physical examination and detailed neurological examination.

X-rays of the thoracic & lumbar spine, both anteroposterior (AP) & lateral views, were taken to know the exact level of injury, extent of injury, kyphotic angle and loss of vertebral height. CT and MRI were done to know the exact site of injury, fracture geometry and status of cord damage.

An indwelling urinary catheter was inserted initially to be replaced later by intermittent catheterization in patients with neurodeficit. Associated injuries were treated appropriately.

Appropriate physiotherapy was administered to the patients. Chest physiotherapy, care of back, care of bowel and bladder were maintained in patients with neurodeficit.

Following were the exclusion criteria for the study:

1. Pathological Fractures.
2. Multiple level/non-contiguous spine fractures.
3. Gross Osteoporosis.

Surgical Technique

For surgery, pre-anesthetic investigations for anesthetic fitness were done. Under general anesthesia, indirect decompression of the spine followed by short-segment posterior stabilization with USS (Universal Spine system) was undertaken. After administration of general anesthesia, the patients were placed prone over the bolsters on the operating table with soft cushions under the knees so that the abdomen of the patient hanged freely. This position was appropriate as in this position the intra abdominal pressure is decreased with resultant decrease in venous pressure

& bleeding in epidural plexus. A standard posterior midline incision was made after infiltration of 1:100000 adrenaline and paraspinal musculature was detached and freed up to the outer margins of the transverse processes. Hemostasis was achieved by means of electrocauterization and ribbon packing. Under direct visualization and with the help of an image intensifier, the pedicles of each vertebra were identified. A pilot hole was then drilled to he desired depth and at desired trajectory after checking the position of the probe by using the image intensifier. A depth gauge was then gently used to determine the screw length. A pedicle probe was used to feel for integrity of all the four walls of the pedicle before tapping and placing the screw. A trap was then placed down the pedicle. An appropriate length screw was then applied to the screw driver and inserted into the bone. Confirmation of the screw position was made by intraoperative fluoroscopy. The remaining screws were placed using a similar technique. Prior to rod placement, an alignment tool was used to align the saddles of the USS axial screws. The rod was then introduced with the rod holder. With the rod fully seated in the screw heads, a set screw was loaded on the tapered hex screw driver and seated into each screw head. The rod pusher assisted in seating the rod prior to introducing the set screws. Once all of the screws were placed, each set screw was tightened starting at one end of the rod and sequentially working to the other end, holding the rod in position with the rod pusher. After ensuring adequate hemostasis the wound was closed in layer. Postoperatively antibiotic cover was given for a week, The patients were allowed to turn horizontally on the second postoperative day. After suture removal, an anterior spinal hyperextension brace or a Taylor brace was applied and assisted mobilization of the patient was started. Regular physiotherapy was continued. Follow-up was carried out for an average period of twelve months, with patients reporting for assessment at 3-monthly intervals. The final result was analyzed on the basis of the following criteria:

1. Neurological recovery as per Frankel's Grading.
2. Spine stability as per.
   I. Kyphotic angle by Cobb's method.
   II. Vertebral body height (Fig. 1,2a,b).
3. Complications.

Statistical analysis

Contrast analysis was performed on Cobb's angle changes and vertebral body height. The vertebral body height was determined by the ratio of the mean of the fractured vertebral body and anterior heights of the adjacent two vertebral bodies. Cobb's angle was determined by the angle formed by the perpendiculars of the extension lines of the upper endplate of the

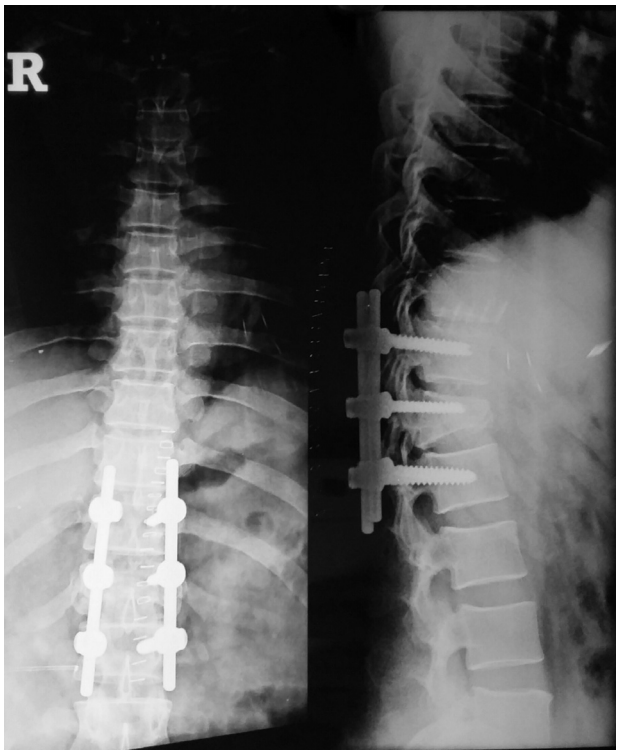

Fig. 1. Postoperative AP and Lateral views showing effects of same-segment posterior fixation on sagittal plane kyphosis and anteroposterior compression in D12 burst fracture

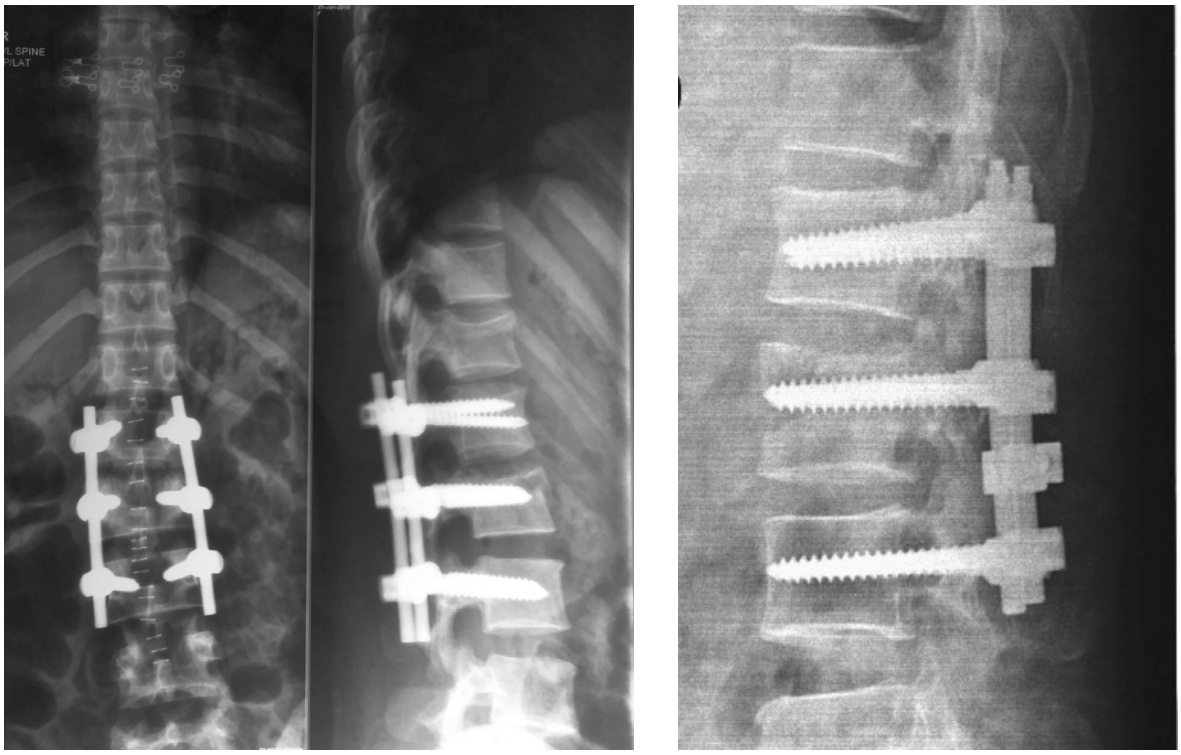

Fig. 2a. AP and Lateral views of same-segment posterior fixation in L_2 burst fracture, b. Follow-up X-ray of same patient at 9 months post fixation

upper fractured vertebra and the lower endplate of the lower fractured vertebra. The changes to the preoperative and postoperative parameters were analyzed by a t-test for independent samples with SPSS 13.0 software package (SPSS Inc., Chicago, IL, USA) and all tests were two-sided. $P<0.05$ was considered to indicate a statistically significant difference.

RESULTS

The present study included 25 cases of traumatic thoracolumbar vertebral fractures admitted in Postgraduate Department of Orthopedics, Government Medical College and Hospital, Jammu who were operated upon for short segment posterior pedicle instrumentation.

Age Distribution

Out of 25 patients, 72 % of the patients were less than 35 years of age with the majority of the patients in the age group 25-30 years (28%) and 35-40 years (24%). The youngest patient was 18 years old and the oldest patient was 48 years old. Mean age was 30.12 years.

Gender Distribution

The majority of the patients were male (72%) while 28% of the patients were female.

Mode of Trauma

Traumatic thoracolumbar fractures in the present study were occurred mainly in two scenarios, one being a fall from a height (56%) and the second being a road traffic accident (24%).

Interval Between Trauma and Fixation

No patient could be operated upon within 72 hours of injury whereas a majority (56%) of the patients were operated within 1 week of injury.

Radiological Parameters

SAGITTAL PLANE KYPHOSIS (SPK)

Mean sagittal plane kyphosis preoperatively was 31.16°, which reduced to 21.52° on postoperative day 1, which represents 30.93% reduction ($p< 0.0001$). At final follow-up, sagittal plane kyphosis was 23.08°, which indicates that 25.9% of correction was still maintained ($p=0.0024$) (Tab. 1).

Tab. 1. Sagittal plane kyphosis (SPK)

	Pre-op	Post-op D1	Final follow-up 9 mths
Mean	31.16^0	21.52^0	23.08^0

Tab. 2. Anterior body compression (ABC)

	Pre-op Percent Loss (%)	Post-op D1 Percent Loss (%)	Final follow-up 9 mths Percent Loss (%)
Mean	38.6^0	23.4	24.6

Tab. 3. Neurological Status

	Pre-op		Post-op 6 wks		Post-op 6mths		Post-op 9mths	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
A	8	32	8	32	8	32	8	32
B	7	28	3	12	2	8	2	8
C	6	24	4	16	4	16	3	12
D	2	8	4	16	5	20	3	12
E	2	8	6	24	6	24	9	36
Total	**25**	**100**	**25**	**100**	**25**	**100**	**25**	**100**

Tab. 4. Complications

Complications	Frequency	Percentage (%)
Bed Sore	5	20
Urinary Tract infection	4	16
Upper Respiratory Tract Infection	1	4
Screw Breakage	1	4
Deep Vein Thrombosis	0	0
Joint Contractures	0	0

ANTERIOR BODY COMPRESSION (ABC)

Mean anterior body compression was 38.6°, which decreased to 23.4° at postoperative day 1 ($p< 0.0001$) corresponding to approximately 15% increase in vertebral height obtained after surgery. At final follow up, mean ABC was 24.68% ($p= 0.0008$), an average loss of just 1% (Tab. 2).

Neurological Status

Preoperatively 8 (32%) patients had complete injury (grade A), 7 (28%) patients had grade B, 6 (24%) patients had grade C, and 2 (8%) patients had grade D neurological status while 2 (8%) patients had no neurological impairment. Postoperatively at final follow-up, 36% patients had grade E neurological status (Tab. 3).

Complications

One patient in our study did not strictly comply with the post-op protocol of no heavy weight lifting and had his pedicle screws broken when he lifted a heavy weight at 8 weeks post-op. He was subsequently readmitted fort repeat surgery. However, he did not consent to repeat instrumentation and was discharged after implant removal and informed consent with advice on appropriate post-op precautions (Tab. 4).

DISCUSSION

The purpose of treating vertebral fractures is to achieve rigid and stable internal fixation to promote neurological recovery and encourage early rehabilitation. The present study was undertaken with a view to assessing the clinical outcome and complications associated with same-segment pedicle screw instrumentation.

Age distribution

Seventy-two percent of the patients in the study were below 35 years of age, which confirms the fact that thoracolumbar fractures are common in the younger age group, who are the most productive members of the society. The mean age in the study was 30.12 years (range 18-48 years). This goes with the mean age in other studies [1,3].

Gender distribution

The majority of the patients were males (72%) similar to the pattern observed in other studies. Males are more prone to injury probably as a result of more time spent outdoors.

Mode of trauma

The commonest mode of injury in our study was a fall from a height (56%), followed by a road traffic accident (24%), which is similar to the data from other studies. However, Wood et al. found motor vehicle accidents the most common etiology [4].

Interval between trauma and fixation

Fifty-six percent of the patients were operated within 1 week of sustaining injury and 44% were operated within 2 weeks of sustaining injury.

No patient could be operated upon within 72 hrs of injury due to patient presenting late to the hospital.

The mean trauma-to-fixation interval was of 7.96 days with earliest surgery within 4 days and delayed surgery within 14 days.

Dai et al. operated their patients with a mean of 3.24 days while Geib et al. had a mean trauma-to-fixation interval of 2.78 days (range 0-7 days) [7,8]. It is recommended that surgery should be performed as early as possible as the condition of the patient allows.

Vertebral level of injury

The majority of the patients (72%) sustained injury at L_1-L_2 level, which is a part of the thoracolumbar junction (T_{11} to L_1). The same pattern was observed in other studies [1-8].

Associated injuries

One patient in our study had fracture of the right calcaneum, two had sustained blunt trauma to the abdomen and one patient had fractures of both bones in the left leg. Thoracolumbar fractures are known to occur following high energy trauma, so a detailed clinical examination of the patient is an integral part at the time of primary assessment as injuries to other organ systems may be life threatening.

Radiological parameters

1. *Sagjttal plane kyphosis:*

The mean sagittal plane kyphosis was 31.16° preoperatively, which reduced to 21.52° postoperatively. At the 6-month follow-up, mean sagittal plane kyphosis was 23.08° (p=0.0024).

Shin et al. demonstrated correction of approximately 70 in sagittal plane kyphosis in their study [11].

2. *Anterior body compression:*

Mean restoration of vertebral height was 15% in this study ($p< 0.0001$). Mean anterior body compression was 38.6% preoperatively and mean anterior body compression was 23.4% on postoperative day 1.

Shin et al. demonstrated a 17% increase in vertebral height obtained after surgery, which was comparable to our study [11].

Neurological status

All patients who underwent short segment posterior pedicle instrumentation were thoroughly assessed preoperatively and at regular intervals postoperatively. The neurological function of each patient was graded using the ASIA classification.

Preoperatively, 8% of patients had grade E function while postoperatively 36% of the patients had grade E function.

No patient with complete injury (grade A) showed recovery while there was neurological deterioration in one patient postoperatively at the 2-month follow-up owing to screw breakage consequent upon lifting of heavy weight by the patient at 8 weeks post-op. We did not include this patient in the final assessment of results.

Neurological recovery can be attributed to the decompression of the neural elements indirectly by restoration of the anatomy of spinal canal.

In study of Dai et al., 17.6% patients had grade E neurological status on admission while at final follow-up 64.8% patients had grade E status (Frankel grade) [7].

Knop et al. in their study studied factors influencing neurological recovery in thoracolumbar fractures and concluded that the improvement of paralysis was associated with restoration of sagittal spine alignment [13]. With reduction of the fracture and correction of the kyphotic deformity, the spinal cord, roots and their vessels become lax, and the chances for neurological recovery increase significantly.

CONCLUSIONS

1. Indirect decompression and short same-segment posterior stabilization without bone grafting fulfils all the aims of surgical treatment of fractures and fracture dislocations of thoracolumbar spine. This can furnish a near anatomical restoration of the vertebral column and spinal canal and is an effective method to adequately decompress the neural elements and provide the best milieu for neurological recovery.
2. Surgery never compromised the neurological status. Early mobilization and ambulation is one of the major advantages of this procedure, which shortens the hospitalization and rehabilitation period.
3. The limited surgical dissection with consequent decrease in perioperative morbidity is another notable advantage seen with indirect decompression and short same-segment posterior instrumentation. It is, however, advisable to use thoracolumbar orthoses for a period of 12-18 weeks post-operatively while the patient is ambulatory, to prevent any unforeseen complications vis-à-vis implant failure and re-collapse.
4. One of the limitations of the study is its short duration. We therefore recommend a longer follow-up to assess the degree of loss of correction of kyphosis and re-collapse of vertebral body height with short same-segment fixation.

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