



## A Prospective Study on the Management of Fractures of Thoracolumbar Spine With Pedicle Screw Fixation

### KEYWORDS

thoracolumbar, pedicle screw and rod instrumentation.

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**ABSTRACT** *Background: The thoracolumbar junction is the most common area of injury to the axial skeleton. Forces along the long stiff kyphotic thoracic spine switch abruptly into the mobile lordotic lumbar spine at the thoracolumbar junction. Goals of treatment are to obtain a painless, balanced, stable spine with optimum neurological function and maximum spine mobility. Our prospective study has evaluated the effectiveness of pedicle screw instrumentation in various fractures around the TL spine to overcome the complications encountered in the conservative line of management of these fractures.*

*Materials & Methods: 20 cases of fractures around the thoracolumbar spine were operated with posterior pedicle screw fixation one or two level above and below the fracture. The cases were followed up for a mean of 6 months with radiological and neurological evaluation.*

*Results: The unstable burst fractures were found to be the most common type of fracture. Radiological parameters sagittal angle and index were recorded pre and postoperatively. The neurological grading was done using the ASIA scale. Follow-up was done for a minimum of 6 months where sagittal angle reduction achieved was  $5.90 \pm 4.650$  at final follow-up from  $24.70 \pm 6.680$  pre-operative. The sagittal index achieved at final follow-up was 65% compared to the pre-operative mean of 48%. The neurological improvement was regarded to be fair enough for the type of injury sustained and fixation achieved.*

*Conclusions: We found that the application of posterior instrumentation resulted in a reasonable correction of the deformity with a significant reduction in recumbency associated complications. Neurological recovery was seen significantly when all cases with neurological deficits were clubbed together; the limiting factor being the small study group and short follow-up period.*

### Introduction:

Spinal trauma is a common and leading problem in orthopaedic practice. The working class individuals are at risk of high energy trauma in the modern era<sup>1,2</sup>. Thoracolumbar fractures are serious injuries of concern, if left untreated may result in marked morbidity and disability to the patient. The fractures to spine are reported to be around 6% approximately of the trauma patients, of which around 2.6% of the patients sustains spinal cord or nerve root level neurological injury. Such fractures are commonly associated with motor and sensory disturbance, bladder and bowel disturbances, erectile dysfunction, deformities like kyphosis, scoliosis as result of neurological injury. The patients are also prone for bed sores and pulmonary infections<sup>3</sup>.

Thoracolumbar segment is second most commonly involved segment in the spinal cord following spinal injuries followed by cervical segment. It constitutes 30 to 60% of all spinal injuries. The trauma of thoracolumbar segment is high in thoracolumbar junction to the extent up to 60% between T12 to L2<sup>4</sup>. The thoracolumbar junction T11-L2 is a common site of injury, as there is a transition from the relatively stiff and kyphotic thoracic spine above to the relatively mobile and lordotic lumbar spine below<sup>5</sup>. Only 15 – 20% of the fractures at thoracolumbar level are associated with neurological injury<sup>6</sup>. Thoracolumbar injuries classically exhibit a bimodal distribution, with peaks among males under 30 years of age and in the geriatric population<sup>7</sup>.

Historically, the thoracolumbar fractures were treated by recumbency (bed rest for a period of 8-12 weeks)<sup>8,9</sup>. This modality of treatment is often accompanied by complications. The recumbency is very much labor intensive. This method of treatment is costly since it requires care by highly skilled personnel and the number of bed day's used<sup>10</sup>. In a resource scarce country like India, the care is often neglected to the victims. So it is the need of the hour for exploring possibility of surgical stabilization, early mobilizations and rehabilitation of patients.

The goal of treatment of every spinal injury is restoration of the patient to maximum possible function with disability free life. For patients sustaining a spinal column injury, the treatment focus is protecting uninjured neural tissues, maximizing recovery of injured neural tissues and optimizing conditions for the musculoskeletal portions of the spinal column to heal in a satisfactory position. Surgical stabilization of the spinal column can prevent further mechanical injury to the damaged cord tissue. Operative intervention is intended to convey immediate stability to the spine, allow for the correction of deformities, and optimize neurologic improvement by directly or indirectly relieving any residual impingement of the neural elements.

The surgical treatments for thoracolumbar fractures are by different approaches such as anterior, posterior, lateral or antero-posterior approaches. The posterior approach is a safe alternative for the surgery as most of the specialists are more experienced. Also the spine can be stabilized by posterior approach with many available instruments<sup>11</sup>.

The development of reliable and biomechanically stable implants for stabilization has evolved over many years beginning from Harrington rod system, interspinous process wiring, serrated spinous process plates, short compression rods, springs, laminar wiring and to the recent addition of pedicle screw implantation<sup>12</sup>.

The advantages of surgical treatment with pedicle screw and rod fixation systems in spine injuries are shorter hospital stay, more complete rehabilitation, fewer complications of prolonged immobilization and reduced morbidity and mortality. Hence there is a need for study to delineate the benefits of this procedure on the functional outcome of the patients. Twenty cases of thoracolumbar fractures stabilized with pedicle screw and rod fixation system have been performed in our institution to prove how cost effective these fixations are to the patients. Our objectives were also to evaluate the restoration of the alignment of the thoraco lumbar spine and spinal canal and thereby aid in early mobilization of the patient. We aimed to evaluate the improvement of neurological deficit if any, following the procedure.

**Materials and Methods:** Twenty patients with acute thoraco-lumbar injuries were included in this study after obtaining their informed and written consent from the period of October 2012 to March 2013. Clearance from institutional ethical committee was obtained before initiating the study. Patient selection included those who sustained traumatic thoracic, lumbar or thoracolumbar fractures, unstable fractures with or without neurological deficits and posterior ligamentous complex injuries. Patients with injuries involving other spinal segments other than thoracolumbar segment were excluded along with osteoporotic fractures, pathological fractures due to malignancy and secondary deposits and Pott's spine. A detailed history pertaining to mode of injury and time of injury were taken, clinical examination which included general examination for head, cervical spine, chest, abdominal injury is completed. After the patient is stabilized, examination of the spine with neurological evaluation for motor power, sensory, reflexes and bowel-bladder is done to evaluate the level of spine injury and extent of cord damage. This follows the American Spinal Injury Association of neurological evaluation. Methylprednisolone is administered in cases who presented within 6 hours from injury. A radiograph of the injured spine in two views is done to classify the fracture type using the McAfee's system of classification. In cases with associated injuries additional radiographs were included to rule out fractures. MRI scan or CT Scan was reserved for affordable patients.

**The following measurements were taken using plain X rays of the injured Spine.**

**a. Sagittal Angle :** This was calculated by drawing two lines. One line joining the superior endplate and inferior endplate of the adjacent uninjured segment.. Perpendiculars are dropped on these two lines equidistant from the posterior borders of the respective vertebrae. The angle between the two perpendicular lines gives the sagittal angle.

**b. Sagittal Index :** This is also calculated from the lateral x ray film. This is a ratio between anterior and posterior heights of the fractured vertebra.

Patients were operated between 2 to 11 days of injury surgical interval with a mean of  $3.5 \pm 2.32$  days. For all cases posterior approach was used primarily. Stabilization

was done using pedicle screw-rod system and followed by decompression of the cord with laminectomy of the injured segment and if required of adjacent segments also. The pedicle entry was established using the intersection method and confirmed by image intensifier. Bone grafts were placed in the postero-lateral aspect in all selected cases. The mean surgical interval was  $2.9 \pm 0.55$  hrs, ranging from 2 to 4 hrs. Postoperatively patients were administered intravenous antibiotics for 5-7 days, and oral preparations were continued for another five days. Drainage tubes were removed within 48 hrs of surgery. Check radiographs were taken for evaluation of fracture reduction; implant position, kyphotic angle and correction of vertebral height. All patients were started on a rehabilitation program with the passive mobilization of lower limb joints and to teach the patient attender regarding bed care and strengthening of muscles. Thoraco-lumbo-sacral orthosis were prepared for adequate bracing. Patients were made to sit on the third - fifth day with his braces on. Bladder training was begun on the 7th day and if patients obtained control, catheter was removed and discharged; if not patients were taught self catheterization. Bowel evacuation was taught by tickling the perianal region or by digital evacuation.

The patients were followed up at every month interval for 3 months and every 2 months for total of 6 months. At every follow-up symptomatic history pertaining to pain relief, his level of activities and bowel-bladder function is taken. Clinical examination for deformity and neurological grading using the ASIA criteria is done. Radiographs are taken for evaluation of the fixation, sagittal angle and index calculation.

The cases with incomplete injuries were strictly restricted of activities for 4 weeks and all patients advised to continue Thoraco-Lumbo-Sacral Orthosis brace for over 10 wks. Patients with complete injuries were confined to bed to prevent early re-collapse and mobilized depending on the radiographic evidence of fracture consolidation. They were mobilized using wheelchair mobilization. Follow-up ranged from 6 to 12 months with mean follow up of  $7.4 \pm 2.23$  months.

**Observation & Results:** A total of 20 cases were included of which 1 cases below 20 years of age, 9 were in the age group of 21 to 30, 5 of them in the group of 31 to 40 and 5 cases above 40 and The mean age calculated for the study was  $32.7 \pm 9.55$  yrs (Table 1). Out of the 20 cases 18 were males and only 2 were females. The most common mode of injury in the study group was fall from a height in 14 cases & followed by road traffic accident in six cases (Graph 1). We observed one case with fracture at T-10 level followed by five cases at T-12 level & ten cases at L-1 level, three cases at L-2 level and one case at L-3 level with sum total of 75% of fractures at T-12 and L-1 junction. Four cases were at L-2 & L-3 level which constitutes the remaining 20%. One case at T-10 level which constitutes 5% (Table 2). The commonest type of fracture observed in the study was unstable burst fracture with 17 cases followed by 3 cases with wedge compression fracture (Table 3). The radiological evaluation of Sagittal angle and Sagittal index was done preoperatively, post operatively and at final follow-up. The results obtained are as shown in Tables 4 and 5.

Neurological evaluation was done according to American Spinal Injury Association scale in the pre-operative period and at all follow-ups. Here 45% cases showed improvement by one grade, 35% showed improvement by

two grades, 20% showed no neurological improvement (Graph 2). The Mean injury surgical interval obtained was  $3.5 \pm 2.32$  days (Table 6). Mean duration of surgical procedure was  $2.9 \pm 0.55$  hrs (Graph 3). Associated injuries encountered were two cases of unilateral distal end of radius fractures and one case of right calcaneal fracture (Table 7). The common complication associated in the study was bed sores and urinary tract infections & wound infection (40%) (Table 8).

**Discussion:** In our study of 20 cases the highest percentage of patients were males and were in the age group of 20 to 50 yrs. These numbers when compared with studies done in developed countries and in developing countries showed consistent results. These results show that males in the working age group are predisposed to trauma. The mean age of the study group was  $32.7 \pm 9.55$  years. These results were almost comparable to a study by Roy Camille et al<sup>13</sup> with a mean age of 30 years.

In our study males (90%) are predominant than females (10%). In a similar study by Yaser M Behairy<sup>14</sup> statistics showed 64.7% males & 35.2% females.

The mode of injury comparison with studies done in India also shows 70% of the patients had injury due to fall from height & 30% of the patients due to road traffic accidents. Whereas studies done in western countries show road traffic accidents to be the most common mode of injury. In study by Dipanker sen<sup>15</sup> shows 64.7% Of patients due to fall from height & 35.2% due to road traffic accidents, Yaser M Behairy<sup>14</sup> noted 47% due to fall from height & 52.9% due to road traffic accidents.

The results of our study showed majority of fractures (75%) around T-12 and L-1 level which are consistent and comparable with the results of other studies which also shows T-12 – L-1 to be the most common level of fracture. In a study by Roy Camille<sup>13</sup> shows 42%, study by Dipanker Sen<sup>15</sup> shows 82% & Mohammad F. Butt<sup>16</sup> shows 88% at that level.

The type of fracture being the unstable burst fracture (85%) being the commonest in our study was also comparable with other studies showing similar results as the likes of Dipanker Sen<sup>15</sup> shows 58.8%. This correlates with the mode of injury and the fracture type sustained by patients included in the study.

The mean sagittal angle in the present study during pre operative stage was  $24.7^\circ \pm 6.68^\circ$ ,  $11.8^\circ \pm 4.67^\circ$  post operatively and  $5^\circ \pm 4.65^\circ$  at final follow up. Roy Camille et al et al<sup>12</sup> noted the sagittal angle was  $18^\circ$  pre -op,  $5^\circ$  post – operatively and  $8^\circ$  at final follow-up. Dipanker Sen<sup>15</sup> noted that sagittal angle was  $16^\circ$  pre operatively,  $3.8^\circ$  post operatively and  $5.8^\circ$  at final followup. Mohammad F. Butt<sup>16</sup> noted that the sagittal angle was  $21.4^\circ$  pre operatively,  $12.8^\circ$  post operatively and  $16.2^\circ$  at final follow up.

The mean sagittal index in our study during pre operatively was 48%, post operatively 67% & at final follow up was 65% as compared to study by Yaser M Behairy<sup>14</sup> noted that sagittal Index was 51% pre-operatively, 85% post operatively and 84% at final followup. Mohammad F. Butt<sup>16</sup> noted that the sagittal index was 44% pre operatively, 72% post operatively & 98% at final follow up.

The neurological evaluation was done according to ASIA scale in our study which showed significant improvement

of one grade which is comparable with other studies showing 60 to 70% improvement at the final follow-up. Out of 20 cases studied 7 cases were with complete neurological injury and 13 cases with incomplete injury (B, C, D). 53.9% of these incomplete injuries showed one grade improvements, and 46.1% of them showed two grade of improvement. Of the complete neurological injury cases about 28% (2 case) showed one grade improvement & 14% (1 case) showed two grade improvement. The limiting factor in the assessment was the mean of follow-up of 7.4 months compared to a long term follow-up of up to 2 years in various other studies.

Associated injuries in various other studies were pelvic injuries, abdominal injuries and long bone fractures. In our study the associated injury encountered was distal end radius fracture in two patients & calcaneal fracture in one patient.

Bed sores and urinary tract infection were most common postoperative complications encountered in this study.

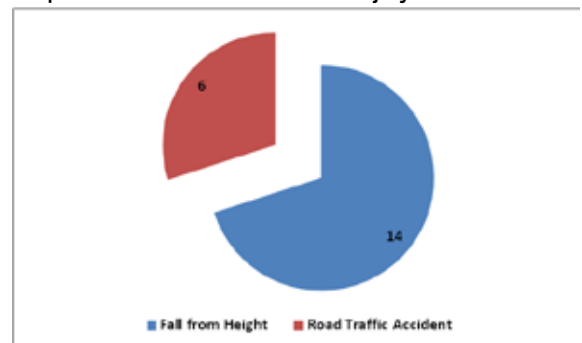
**Conclusion:** In this study group mean age was 32.7 years with a standard deviation of 9.55 years and the males in the working age group are predisposed to trauma. The common mode of injury encountered was fall from height. Unstable burst fractures were the most common fracture type encountered which leads to deformity and neurological compromise. There is significant restoration of alignment of thoracolumbar spine and spinal canal vis., mean sagittal angle and mean sagittal index with this procedure. Neurological recovery was seen significantly when all cases with neurological deficits were clubbed together. However, in patients who presented with ASIA type A neurological deficits, this procedure did not improve neurological status statistically but it helped to stabilize and helped in good nursing care and early mobilization of patient.

Adequate stabilization and fair neurological recovery was noted in our patients with this procedure. Therefore application of posterior instrumentation resulted in a reasonable correction of the deformity with a significant reduction in recumbency associated complications.

**TABLE 1. Distribution of cases according to age**

Age group	No. of cases	Percentage
Less than 20	1	5
21-30	9	45
31-40	5	25
40	5	25
Total	20	100

**Graph 1. Distribution of mode of injury**



**TABLE 2. Distribution of level of injury**

Level of injury	No. of Cases	Percentage
T10	1	5.00%
T12	5	25.00%
L1	10	50.00%
L2	3	15.00%
L3	1	5.00%
Total	20	100.00%

**Table 3. Type of Fracture Distribution**

Type of injury	No. of cases	Percentage
Wedge Compression	3	15.00%
Unstable Burst Fracture	17	85.00%
Total	20	100.00%

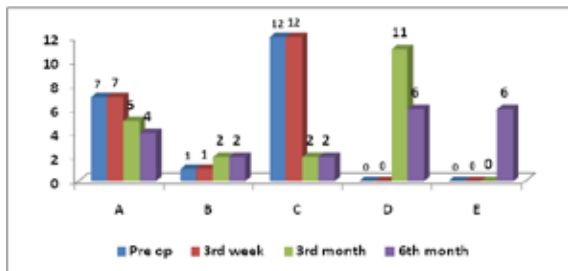
**Table 4. Distribution of sagittal angle (ANOVA Analysis)**  
**F value: 62.83 p value: 0.0000 Interpretation: Highly significant**

Sagittal angle (degrees)	Mean ± SD
Pre- op	24.7 ± 6.68
Post- op	11.8 ± 4.67
6th month- follow up	5.9± 4.65

**Table 5. Distribution of Sagittal Index (ANOVA Analysis)**  
**F value: 12.22 p value: 0.0000 Interpretation: Highly significant**

Sagittal index	Mean ± SD
Pre- op	0.48 ± 0.11
Post -op	0.67 ± 0.15
6th month-follow up	0.65 ± 0.13

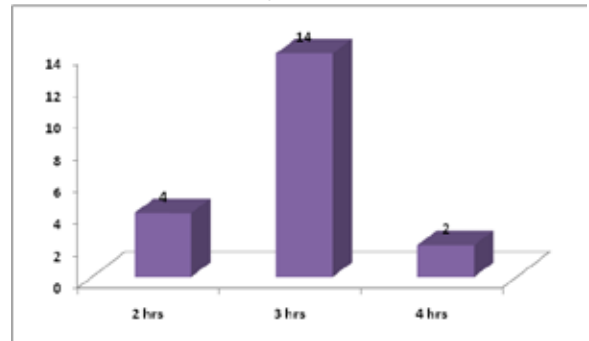
**Graph 2. ASIA (American Spinal Injury Association) grading for neurological status in the study group**  
**NS: Not significant HS: Highly significant**  
**Pre - operative - 3rdPost op week:  $\chi^2$  value= 0.00df=2p value= 1.000, NS**  
**Pre - operative - 3<sup>rd</sup>Post op month:  $\chi^2$  value= 18.81df=3p value= 0.0002, HS**  
**Pre - operative - 6<sup>th</sup> Post op month:  $\chi^2$  value= 20.29 df=4 p value= 0.0004, HS**



**Table 6. Mean distribution of injury surgery interval**

Injury surgical interval	Frequency	Percentage
< 5 days	17	85%
> 5 days	3	15%
Total	20	100%

**Graph 3. Duration of Surgical Procedure**



**Table 7. Distribution of Associated injuries**

Associated injuries	No. of cases	Percentage
Distal end radius #	2	10.00%
R.calcaeneal #	1	5.00%
No injury	17	85.00%
Total	20	100.00%

**Table 8. Distribution of complications**

Complications	No. of cases	Percentage
Bed sore	3	15%
UTI	4	20%
Wound infection	1	5%
No complication	12	60%
Total	20	100%

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