

A prospective study of the outcome of traumatic dorsolumbar fractures treated with posterior stabilisation by pedicle screw fixation

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Abstract

Background: The spinal trauma is one of the leading problems in orthopaedic practice. Thoracolumbar spinal segment is the 2nd most commonly involved segment after the cervical segment in spinal injuries, about 35 to 60% of all spinal injuries occurring between T12 and L2. The treatment options for unstable thoracolumbar spine fractures and fracture dislocations have long been controversial. Many authors, advised non-operative treatment in the past, but nowadays, posterior instrumentation gives excellent outcome. **Materials and Methods:** In all, a total of 20 cases were evaluated and assessed during the study period between August 2012 to July 2015. The study was conducted in the Department of Orthopaedics, GMKMCH, SALEM. Preoperative x-rays CT, MRI were done and neurological status recorded. The clinical outcome was measured with Denis pain scale and Denis work scale. Neurological status was assessed with ASIA scale. Radiological outcome was assessed by measuring the regional kyphotic angle and anterior vertebral height. **Results:** In our study the clinical outcome was good. Most of the patients returned to their previous job and had a considerable reduction in pain. 95% of patients had an improvement in their neurological status. There was a decrease in the regional kyphotic deformity and an increase in anterior vertebral height. 1 patient had implant failure with decrease in the neurological status. 1 patient had pedicle screw misplacement with no neurological complications and 1 patient had superficial wound infection. **Conclusion:** Pedicle screw instrumentation provides less surgical exposure, correction of deformity and better stabilization. It provides fixation and stabilization of all the three columns. So stabilization, reduction and decompression using pedicle screws and rods helps in stabilization of unstable fractures and helps in further neurologic recovery of the patient. **Keywords:** Pedicle screw and rod fixation system, Thoracolumbar spine injuries, Denis pain scale, Denis work scale, ASIA scale.

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Received Date: 19/06/2016 Revised Date: 09/07/2016 Accepted Date: 05/08/2016

Access this article online

Quick Response Code:	Website: www.statperson.com
	DOI: 14 August 2016

INTRODUCTION

The spinal trauma is one of the leading problems in orthopaedic practice, more so in modern era where the

individuals are more at risk due to high energy trauma¹. It is one of the grave injuries that cause infinite morbidity and disability to the patient. Thoracolumbar spinal segment is the 2nd most commonly involved segment after the cervical segment in spinal injuries, about 35 to 60% of all spinal injuries occurring between T12 and L2. About 15 to 20% patients with fracture at thoracolumbar level have associated neurological injury². The treatment options for unstable thoracolumbar spine fractures and fracture dislocations have long been controversial. Many authors advised non-operative treatment in the past, but nowadays, posterior instrumentation gives excellent outcome^{3,4}. Historically, thoracolumbar fractures have been treated with recumbency i.e. to bed rest for a period of 8-12 weeks⁵. This mode of treatment is accompanied with complication due to recumbency. It is very labor

intensive, cost of therapy in terms of hospital hours used, bed occupancy and care by trained personnel is very high. In a country like ours, where there is acute shortage of hospital facilities and trained manpower, conservative management more often end up as benign neglect, so there is an urgent need for exploring possibilities of surgical stabilization, early mobilization and rehabilitation of patients. Internal fixation and stabilization of spinal fractures allows early mobilization of all patients, regardless of neurological deficit, while protecting the neurological structures from further injury and enhancing their recovery⁶. Surgical treatment can be anterior, posterior or combined approach. As most orthopaedic and spinal surgeons are more experienced in posterior approach and at the same time this approach requires less operative time with less blood loss, hence a safe alternative^{7,8,9}. Historically, Harrington hook rod construct or its modifications have been extensively studied¹⁰. Their main disadvantage is that it spans 5-6 spinal segments¹¹. Hence, newer options, especially pedicle screw plate or rod constructs which provide short segment immobilization have gained popularity¹². The goals of surgery are to achieve stability, to correct deformity, early mobilization, to expedite postoperative recovery and to decrease pseudoarthrosis. The pedicle screw plate or rod construct helps to achieve all these¹³.

MATERIALS AND METHODS

In all, a total of 20 cases were evaluated and assessed during the study period between August 2012 and July 2015. The study was conducted in the Department of Orthopaedics, GKMCH, SALEM. All the above patients underwent treatment, as per a specific treatment plan. All the patients were initially assessed in the casualty according to their presentation and then they underwent a detailed evaluation of their hemodynamics spine, neurological status and other injuries if associated with trauma. The patients were interviewed; their epidemiological, historical, subjective and physical findings were noted. A neurological chart was maintained for each patient. All the patients had routine X-rays of thoracolumbar and lumbar spine in both Anteroposterior and Lateral views. In all the patients MRI with CT films was done. The pre-operative neurological status was graded on the basis of ASIA grading. It was also used to assess postoperative recovery and follow-up. The indication for the surgery was instability for which instrumentation was needed to restore spinal stability or to protect neurological elements. In this study, we stabilize the cases of the unstable thoracolumbar spine injuries with decompression and pedicular screw and rod instrumentation. We have evaluated all patients for maintenance of spinal correction and neurological

improvement after posterior instrumentation in thoracic and lumbar spinal fractures and clinical outcome in terms of spinal scoring system called as Denis work and pain scale.

Inclusion Criteria

1. Age group >14 years
2. Traumatic thoracolumbar fractures T11-L2.
3. Unstable fractures with or without neurological deficits.
4. Kyphotic angle > 30 degrees
5. Loss of vertebral body height more than 50%
6. Spinal canal compromise > 50%
7. TLICS²⁵ score >4.

Exclusion Criteria

1. Age < 14 years
2. Traumatic cervical spine fractures and sacral spinal fracture.
3. Spinal instability due to congenital spinal abnormality.
4. Patients not willing for surgery.
5. Medically unfit for surgery.
6. Multiple level fractures..

Preoperative Work Up

In thoracic and lumbar spinal lesions it is important to determine the level and extent i.e. Complete or incomplete, neurological injury. In case of trauma the most important step is to establish level of consciousness. Glasgow coma scale is universally accepted method for determining this²⁶. Spinal shock, if present it rarely lasts longer than 24 hours, but might last for days or weeks exceptionally. A positive bulbocavernous reflex or return of anal wink reflex indicates the end of spinal shock. An initial examination should include a detailed sensory examination, motor examination and reflex functions. Sacral sensory sparing is an important evidence of incomplete neurological injury. The most widely accepted classification for categorizing patients with neurological injury is the one proposed by American spinal injury association (ASIA) impairment scale.

ASIA Scale²⁷

Grade A: Absent motor (Grade 0/5) and sensory function below the injury level.

Grade B: Sensation present, motor function absent (grade 0/5).

Grade C: Sensation present, motor function active but not useful (grade 1 to 2/5).

Grade D: Sensation present, motor function active and useful (grade 3 to 4/5).

Grade E: Normal motor (Grade 5/5) and sensation function.

INVESTIGATIONS

1. Plain radiograph
 - a. Anteroposterior views.

- b. Lateral views. To assess extent of degeneration, instability, mechanism of injury, fracture pattern and its severity and canal compromise or deformity.
2. Magnetic resonance imaging (MRI) was useful in determining
 - a. The condition of the spinal cord following trauma
 - b. Any soft tissue encroachment (intervertebral disc) of the spinal cord
3. CT scan²⁹- to assess pedicle fractures, canal compromise and retropulsion of vertebral body¹⁹.
4. Blood investigations- complete blood count, blood sugar, urea, creatinine, serum electrolytes, ELISA for HIV virus and Blood grouping were done.
5. Chest X-ray and ECG were routinely taken to rule out cardiac and pulmonary pathology.
6. Adequate blood was reserved for surgery.
7. Taylor's brace was applied to immobilize the spine and patients were kept in strict bed rest.

PROCEDURE

Prophylactic intravenous antibiotics were given preoperatively. In supine position general anaesthesia with endotracheal intubation was administered. The patient was put in prone position on a 4 poster frame encouraging more lordosis. This position avoids venous stasis and decreases intraabdominal pressure, thus reducing venous bleeding. All bony prominences were

padded. The skin, subcutaneous tissues, and paraspinal muscles down to the level of lamina were infiltrated with 1:50000 epinephrine solution to minimize bleeding. A posterior midline incision was made centering over the involved spinal unit and extending 2 levels above and below. Incision was deepened to the tips of the spinous processes. Using Cobbs elevators the paraspinal muscles were erased laterally to the tips of the transverse processes. Packing with a pad was done to reduce bleeding. The intersection technique was used to locate the entry point²¹. It is crossed by the line that connects the middle of the transverse processes and the lateral edge of the facet. In the thoracic spine, the entrance point is in line with the middle of the transverse process, which is about 2 mm below the inferior edge of the facet. C-arm was used to identify the upper level to be instrumented. The beam was adjusted until the pedicle is visualized on end just below the superior end plate. A nibbler was used to decorticate the bone over the lateral side of the pedicle. Pedicle awl was inserted into the pedicle which is the strongest part of the vertebra²⁰, and advanced through the pedicle. A probe was inserted in the path of the awl and the path of the probe was monitored with posteroanterior and lateral C-arm images. The probe was removed after the vertebral body is entered. The continuity of the pedicle wall was confirmed with a small ball-tipped probe in superior, inferior, medial and lateral walls²² and that violation into the spinal canal or inferiorly into the neural foramen has not occurred.

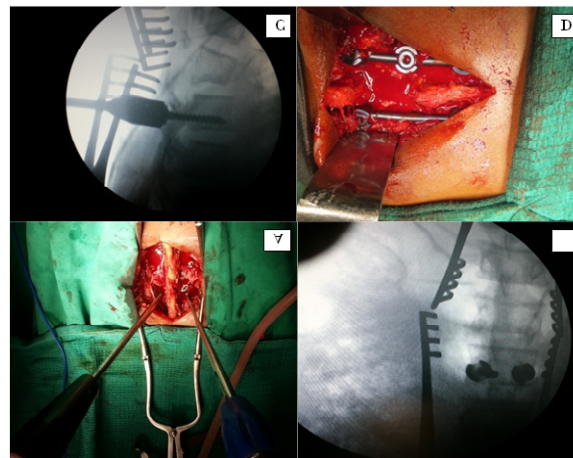


Figure 1: Pedicle Screw Fixation (A) Pedicle screw entry - Per operative, (B) C-Arm Image AP view, (C) C-Arm Image Lateral view, (D) After Posterior Stabilisation and Decompression - Per operative

The pedicle and vertebral body was tapped to at least one half of the depth of the vertebral body using a tap for a screw diameter chosen from preoperative pedicle measurements. The size of the tap was the same as the size of the pedicle screw to be inserted. 5mm screws were used for thoracic vertebrae and 6 mm screws were used for lumbar vertebrae. The direction of insertion of pedicle

screw was monitored with C-arm. Pre operative CT gives details about the intactness of pedicles. If both the pedicles of fractured vertebra are intact without fracture, then two screws are inserted in them. If one pedicle is fractured, one screw is placed in the normal pedicle. If both pedicles are damaged, then pedicle screws are placed two levels above and two levels below the fractured

vertebra. This gives good stability to the spine. When screws have been placed in all the segments to be instrumented, the titanium rod of slightly longer length than needed was chosen to accommodate distraction. The rod was bent to match the lordotic curve. The rod was first inserted on one side, and the fracture was reduced and fixed with inner screw using screw inserter. The rod was fixed in all other pedicle screws in the same manner. The prone position of the patient itself reduced the fracture in most cases. If the fracture is not reduced, then a distractor was used to reduce the fracture. Final tightening of the inner screws was done with rod stabiliser that holds the screw and rod and inner screw tightener. The reduction was confirmed with posteroanterior and lateral C-arm images. Laminectomy was done if there was a posterior laminar defect at or near

the fracture site, or if cerebrospinal fluid was visible. In patients with cord compression, decompression was performed using a nibbler and up cutter. The ligamentum flavum was removed and partial laminectomy done. Care was taken to avoid damage to the cord or nerve root by using a dural retractor. A nibbler was used to decorticate the remaining lamina and transverse processes. In selected cases, through a separate incision, the posterior iliac crest was exposed to harvest morcellized bone for grafting. The bone graft was placed over the decorticated spinal elements. Thorough saline wash was given and the paraspinal muscles were closed in two layers. The fascia was closed tightly with vicryl. The subcutaneous tissue was closed over a closed suction drain. The skin was closed with a non absorbable suture material. Sterile dressing was applied.

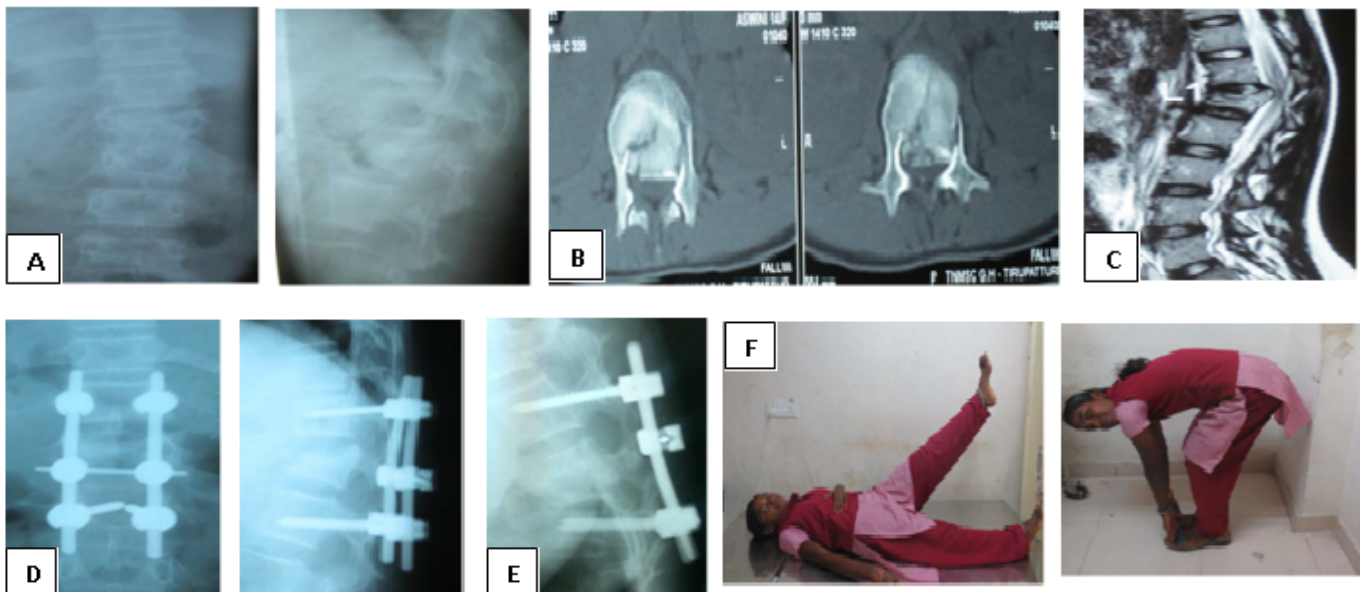


Figure 2: Case of 15 years old female with AO Type A Fracture L1 Vertebrae (A) Preoperative X-ray AP and Lateral views, (B) Preoperative CT Image, (C) Preoperative MRI Image, (D) Immediate Postoperative X-ray AP and Lateral views, (E) X-ray Lateral view 1 year Follow up, (F) Clinical images 1 year follow up

Post operative management

All the patients were given post op intravenous antibiotics for 7 days. They were switched over to oral antibiotics till suture removal. Physiotherapy was started from first day post operatively. On the second day patients were allowed to roll from side to side. They were allowed to sit up and were mobilized on a wheel chair after application of Taylor's brace on the third post operative day. A close watch was kept for any improvement or deterioration in the neurological status. A neurological examination was done daily. Patients were allowed to stand and walk with support after the lower limb power improved under the guidance of the physiotherapist. Taylor's brace was worn on all times of the day except when the patient is lying down. The brace was used for two months post

operatively. Sutures were removed on the 12th post operative day.

Follow up

All the patients were followed up at 6th week, 12th week, 3 months, 6 months and 1 year respectively. On each follow up clinical, radiological and neurological examination was done to assess spinal stability, reduction in pain, improvement in range of movements, reduction of deformity and check for any complications. Bladder training was given to patients who were affected with urinary incontinence.

1. NEUROLOGICAL ASSESSMENT:

Neurological examination was done using the ASIA scale at regular visits.

2. RADIOLOGICAL ASSESSMENT:

Radiological assessment was done by measuring

- Regional kyphotic angle
- Anterior vertebral body height. Regional kyphosis was measured from the inferior end plate of the intact vertebra above the fracture to the superior end plate of the intact vertebra below the fracture. Anterior vertebral body height was measured with standard lateral view of spine.

- CLINICAL ASSESSMENT:** Clinical assessment was done using the Denis pain scale and Denis work scale.

RESULTS

In this series 15 (75%) patients were male and 5 (25%) were female patients. 4 (20%) patients were below 20 years, 3 (15%) were in the 21-30 age group, 6 (30%) were in the 31-40 age group, 3 (15%) were in the 41-50 age group and 4 (20%) in the 51 and above age group, with an average age of 36.6 years.

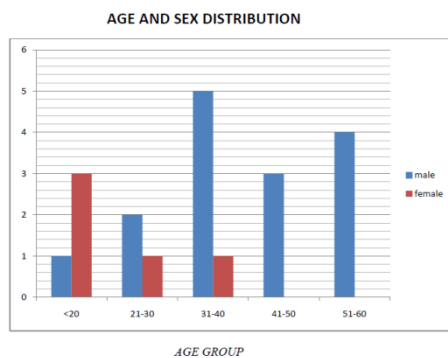


Figure 3: Diagram showing Age and Sex distribution in our study

In this series there were 16 (80%) of type A fractures, 03 (15%) of type B fractures, and 01 (5%) of type C fractures according to AO classification²⁴. 14 (70%) patients had accidental fall as most common mode of injury and 06 (30%) were having road traffic accident as mode of injury. 1 (5%) patient had fracture at D11 level, 4 (20%) patients had fracture at D12 level, 13 (65%) patients had fracture at L1 level and 02 (10%) patients had fracture at L2 level. In our study, 5 (25%) patients had associated head injury, 1 (5%) patient had fracture radial head with elbow dislocation, 1 (5%) patient had calcaneus fracture and 1 (5%) patient had fracture of fibula. 12 (60%) patients had no other injury. In this series, 2 patients (10%) had TLICS score of 4, and 18 (90%) patients had a score of 5 and above.

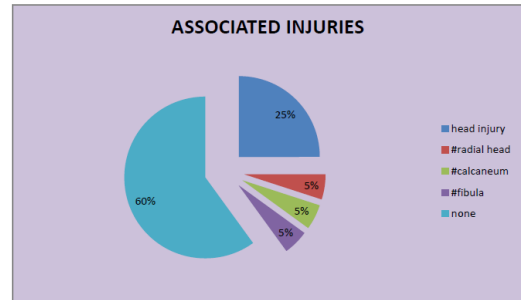


Figure 4: Diagram showing associated injuries in our study

In our study, 10 (50%) patients underwent surgery within 10 days of admission and 10 (50%) patients had surgery within 20 days of surgery. The average duration of the surgical procedure was 1 hour and 41 minutes. The average blood loss during surgery was 328 ml. In our series, 10 (50%) patients presented with ASIA scale C, 7 (35%) patients with D, and 3 (15%) patients with ASIA scale E. At the end of 1 year, 1 patient (5%) had ASIA scale D, and 18 patients (90%) had a scale of E. 1 (5%) patient had a decrease in the neurological status from scale E to D.

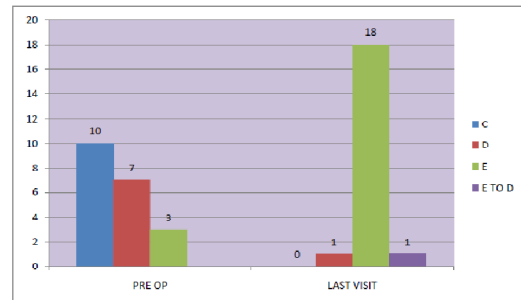


Figure 5: Comparison of Neurological outcome according to ASIA scale – Pre op and Final Follow up

In our series, average regional angle of 20 patients is 22.5 degree, whereas postoperative angle was 8 degree and average angle at the last visit was 12.2 degree. The average anterior vertebral height among 20 patients is 13.5mm whereas height in postoperative height was 21.3mm and in last visit was 20.4 mm. In our series, out of 20 patients, 11 (55%) were having Denis pain scale of P1, 06 (30%) were having scale of P2, 2 (10%) patients were having scale of P3 and 1 (5%) patient was having a scale of P4 and 09 (45%) were having Denis work scale W1, 08 (40%) were having work scale of W2, 01 (5%) patient was having W3 and 2 (10%) patients were having work scale W4. In our study, 16 (80%) patients had no complications. 1 (5%) patient had rod displacement, 1 (5%) patient had screw misplacement and 1 (5%) patient had dural puncture and 1 (5%) patient had superficial wound infection.

DISCUSSION

In our study we had 75% males and 25% female patients. The average age was 36.6 years and more common in the third and fourth decade. Gregory F. Alvine *et al* in their study found that average age was 31 years, with a male predominance. Rick C. Sasso²⁸ *et al*, in their study had 77% males and 23% females with a mean age of 34 years. Razak M, *et al* in their study found that average was 30 with a male predominance. In our study we noted fall from a height in 70% patients as the most common mode of injury and was mainly the result of work injury. Road traffic accident was the second commonest cause 30% of patients. Nasser M.G, *et al* in his study noted that the main cause of injury was fall from a height and road traffic accident was the second commonest. Gregory F. Alvine, *et al* noted that in 52% of patients injuries resulted from fall from a height, in 39% patients due to road traffic accidents and 9% due to fall of heavy objective. Razak M, *et al* in his study noted that 69% of injuries were caused from fall from height, 31% due to road traffic accident. In our series we found 80% of patients with AO Type-A fractures, 15% with AO Type-B fractures and 5% with AO Type-C fractures. Nasser M.G. *et al*, in their study noted 76% of patients with Type-A, 8% with Type-B and 16% with Type-C. Rick C.Sasso²⁸ *et al*, noted that 62.5% had AO Type-B and 37.5% had AO Type-A fractures. Gregory F. Alvine *et al* noted that Type-B fractures were seen in 57.5% of patients Type-A in 22.5% and 20% with Type-C. The most common vertebrae involved in this series were between T11 – L2 to the extent up to 100%. While Alvine noted to the extent of 70%, Sasso²⁸ *et al* noted up to 80% and Razak *et al* noted to the extent of 92% of the fractures were at the level of T11 – L2. In our study, 5 (25%) patients had associated head injury, 1 (5%) patient had fracture radial head with elbow dislocation, 1 (5%) patient had calcaneum fracture and 1 (5%) patient had fracture of fibula. 12 (60%) patients had no other injury. CT brain was taken for patients with head injury and neurosurgeon fitness for surgery was obtained. 1 patient with elbow dislocation and fracture radial head was managed with closed manual reduction immediately and excision of radial head later. Patients with fracture calcaneum and fibula were managed conservatively. In our study, 10 (50%) patients underwent surgery within 10 days of injury and 10 (50%) patients had surgery within 20 days of surgery. Sasso²⁸ *et al* noted that the average time interval between injuries to surgery was 4 days and mean hospital stay was 16 days. While Razak *et al* noted the average time duration to surgery was 5.6 days. The average duration of the surgical procedure was 1 hour and 41 minutes. This avoided other complications due to general anaesthesia. The average blood loss during

surgery was 328 ml. This loss was compensated with one unit of blood transfusion intra operatively. In our study 18 (90%) patients had a score of 5 and above, which is an indication for surgery. 2 (10%) patients had a score of 4. One patient had a regional angle of 30 degrees and a loss of anterior vertebral height of 60%. Other patient had a regional kyphotic angle of 32 degrees and loss of anterior vertebral height of 69%. So these two patients were considered for surgery. In our series, 10 (50%) patients presented with ASIA scale C, 7 (35%) patients with D, and 3 (15%) patients with ASIA scale E. At the end of 1 year, 1 patient (5%) had ASIA scale D, and 18 patients (90%) had a scale of E. 1 (5%) patient had a decrease in the neurological status from scale E to D. This was due to implant failure. Titanium rod got displaced and resulted in increase in kyphotic angle, cord compression. All other patients had at least 1 grade improvement in neurological status (95%). Nasser M.G. *et al*, noted that patients who had neurological deficits showed at least 1 grade improvement at latest follow up. Gregory F Alvine *et al*, noted that neurological improvement was seen in 50% of cases with 40% improving with 1 grade and 20% with 2 grades and none had decrease in neurological level. Rick C.Sasso²⁸ *et al*, in their study noted that all patients with incomplete neurological deterioration improved at least by 1 grade. Razak M *et al*, noted that 64.4% of those with incomplete lesions showed an improvement of at least 1 grade. Khan I *et al*, noted that 2 grade improvement in 18 patients (1.1 Grade improvement). In our series the mean Regional angle by Cobb's method was 22.5° on admission, 8° post operatively and 12.2° at latest follow up. Nasser M.G *et al*, noted the kyphotic angle was 23.6° on admission, 7° post – operatively and 11.5° at latest follow up. Rick C.Sasso²⁸ *et al*, noted that the kyphotic angle was 17.6° pre operatively, 3.5° post operatively and 11.6° at latest follow up. Razak M. *et al*, noted that the average kyphotic angle was 20° pre operatively, 7° post operatively and 9° at latest follow up. A Study of Rex AWM involving vertebral body height improved from a mean of 42% preoperatively to 64% at the time of the latest follow-up. In a study by Yaser MB involving 70 patients with thoracolumbar fractures treated with pedicle screw instrumentation with mean follow up of 10 months, there was a significant improvement in anterior vertebral body height. Our study also shows improvement of vertebral height from a preoperative value of 13.5 mm to a value of 20.4 mm during the last follow up, i.e., an improvement from 45% to 68% of vertebral height. In our study, 55% of patients had no pain (P1) at follow up and 30% patients had occasional mild pain (P2). Around 45% patients returned to their previous employment with heavy labour (W1) and 40% of patients returned to their

previous heavy labour with lifting restrictions.(W2) These results are comparable to a study conducted by Tae-Sob Shin *et al* of the Korean neurosurgical society in 2007, and the results were P1-57.9%,P2-36.8% and W1-52.6%,W2-20.5%. Curtis AD in their metaanalysis of surgical treatment alternatives for fixation of unstable fractures of thoracic and lumbar spine, they analysed 15 articles including 614 patients and noted loss of fixation by disconnection of rod in 21patients (3.4%). Screw rod interface loosening and disconnection of rod with failure of construct was seen in 1 patient (3.1%). Razak M *et al*, noted 2 instances of hardware loosening and 3 misplaced pedicle screw in their study. Our study of 20 patients had 1 (5%) patient with rod displacement from the pedicle screw, which is comparable to the above study. The patient developed kyphotic deformity and paraparesis. Since she was on 5 months amenorrhoea she was kept on regular follow up. She is planned for resurgery after delivery. The cause of rod pullout may be due to improper inner screw placement. In highly unstable fractures or in fractures where both pedicles are disrupted, stabilization should be done two segments above and two segments below the fractured vertebra. If one pedicle is intact, then one pedicle screw can be inserted in the intact pedicle. 1 (5%) patient had pedicle screw misplacement. On follow up, he did not have any neurological symptoms or pain. So, the screw was left as such. Razak M *et al*, noted 3 cases of misplaced pedicle screw in their study, which is comparable to our study. 1(5%) patient had superficial wound infection, which was treated with higher antibiotics. Khan. I *et al.*, in their study noted that there was 1 patient with superficial wound infection. 1 (5%) patient had dural puncture per operatively which was repaired with 6-0 prolene.

CONCLUSION

This study was conducted to assess the Radiological, Neurological and Clinical outcome of surgical management of thoracolumbar fracture spine with pedicle screws and rod system. We conclude:

- Thoracolumbar spine fractures are more common in the 3rd and 4th decade of life with male predominance due to outdoor activities.
- The commonest mode of injury was fall from a height.
- The posterior midline approach provides adequate exposure and direct visualization. Blood loss is minimal and operating time is less.
- Pedicle screw fixation should be done as early as possible in order to facilitate neurological recovery, help in good nursing care and early mobilization of the patient and to prevent deterioration of the neurological status.
- Pedicle screw instrumentation provides less surgical exposure, correction of deformity and better stabilization. It provides fixation and stabilization of all the three columns.
- So pedicle screws and rods help in stabilization of unstable thoraco-lumbar fractures and gives good neurologic recovery to the patient.

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Source of Support: None Declared
Conflict of Interest: None Declared