

**MANAGEMENT OF UNSTABLE THORACOLUMBAR SPINAL INJURIES BY POSTERIOR INSTRUMENTATION: A PROSPECTIVE STUDY**Shivanaik R<sup>1</sup>, Prabhanjan Kumar D<sup>2</sup>, Murahari P<sup>3</sup>**HOW TO CITE THIS ARTICLE:**

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**ABSTRACT: BACKGROUND AND OBJECTIVES:** Spinal trauma is one of the grave injuries that cause infinite morbidity and disability resulting from high energy trauma. 30-60% of all spinal injuries are concentrated in the thoracic and lumbar spine and 15-20% is associated with neurological injury. The neurological improvement is independent of treatment modality, lately consensus evolving around the world for stabilization of spine with instrumentation allowing early mobilization, prevention and limitation of neurological injury as well as restoration of spinal stability. A number of fixation systems have been advocated. The use of pedicular screws and rod system allows adequate 3 dimensional control of each motion segment and allows rigid fixation. Acceptable results have been reported in majority of patients treated with pedicle screw and rod system with good neurological recovery. The aim of the study was to access the commonest mode, level, type of fracture, efficacy of pedicle screw and rod system and the radiological, neurological and functional out come in order to recreate a stable pain free spinal column. **METHODS:** This study is a prospective clinical study of unstable thoracolumbar spinal injuries by posterior instrumentation (pedicular screw and rod fixation in thoracic, lumbar, and thoracolumbar spinal fractures). In all, a total of 21 cases were evaluated and assessed during the period from 1st June 2008 to 30th September 2010. The study was conducted in the Department of Orthopaedics, Vijayanagara Institute of Medical sciences, Bellary. Patient selection was according to the inclusion and exclusion criteria and was surgically treated with pedicle screw and rod system. **RESULTS:** In our series there were 20(94.75%) males and 1(5.25%) female patient with an average age of 28.3 years 17(82.1%) cases due to fall from height, 4(17.9%) cases following road traffic accident. 16(76.1%) cases were of AO Type A, 3 (14.2%) of AO Type B, 2(9.52%) of AO type C fractures. All patients were of ASIA grade A, B, C on admission and 9(42.8%) showed improvement to ASIA grade D, E at three months and 13(62%) showed improvement ASIA grade D, E at latest follow up. Good Functional outcome with pain relief achieved in 12(57%) of cases. Fair results in 8(38%) cases, and poor results in 1 (5%). **CONCLUSION:** Management of thoracic and lumbar spine fractures requires careful preoperative planning, patient selection, neurological evaluation and meticulous intraoperative care and post-operative rehabilitation for good functional outcome. Pedicle screw and rod 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 of one motion segment above and below the fracture. The administration of pre-operative steroids have shown to have a beneficial effect on the final neurological outcome. Early surgical intervention helped in good neurological recovery.

**KEYWORDS:** Thoracic, Lumbar, Spine, Fractures, Pedicle screw, rod, ASIA.

## ORIGINAL ARTICLE

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**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. It is one of the grave injuries that cause infinite morbidity and disability to the patient. The hopelessness and helplessness experienced by patient and doctors until the present time has been expressed by writer Edwin Smith Papyrus.

By symptoms of numbness and palsy of the arms, the urine and the excreta coming against their will and knowledge, you may for tell that death is at hand for reason that the spinal marrow is hurt. Having made such a prognostic, you may make an incision and take forth the splinters of the broken vertebra in cases where the neural arch was injured which was driven in and press the spinal marrow and nerves thereof.<sup>2</sup>

Thoracolumbar spinal segment is the 2<sup>nd</sup> most commonly involved segment after the cervical segment in spinal injuries, about 30 to 60% of all spinal injuries. Thoracolumbar injuries in trauma are concentrated at the thoracolumbar junction region, 60% occurring between T12 and L2.<sup>3</sup> 15 to 20% patients with fracture at thoracolumbar level have associated neurological injury.<sup>4</sup> The treatment options for unstable thoracolumbar spine fractures and fracture dislocations have long been controversial.

Many authors, advised non-operative treatment, but later report emphasized the advantage of Open reduction internal fixation with posterior instrumentation.<sup>5,6</sup> Most authors agree that neurological improvement is independent of treatment modality.<sup>1</sup> But the advocates of surgical decompression point at advantages of surgery in improving neurological deficits. Lately consensus is evolving around the world for stabilization of spine, with fusion and instrumentation in unstable fracture.<sup>5</sup>

Historically, thoracolumbar fractures have been treated with recumbency i.e. to bed rest for a period of 8-12 weeks.<sup>6</sup> 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 than not, end up as benign neglect, so there is an urgent need for exploring possibilities of surgical stabilization, early mobilizations and rehabilitation of patients.

Internal fixation and stabilization of spinal lesion allows early mobilization of all patients, regardless of neurological deficit, while protecting the neurological structures from further injury and enhancing their recovery.<sup>7</sup> Surgical treatment can be anterior, posterior or anteroposterior. 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.<sup>8</sup>

If an incomplete neurological deficit exists, significant residual neural compression is documented and when treatment is carried out 3 weeks later anterior approach can be considered.<sup>9,10</sup> Historically, Harrington hook rod construct or its modifications have been extensively studied.<sup>11</sup> their main disadvantage is that it spans 5-6 spinal segments.<sup>12</sup> Hence, newer options, especially pedicle screw plate or rod constructs which provide short segment immobilization have gained popularity.<sup>13</sup> The goals of surgery are to achieve stability, to correct deformity, early mobilization, to expedite post-operative recovery and to decrease pseudoarthrosis. The pedicle screw plate or rod construct helps to achieve all these.<sup>14</sup>

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In Variable screw placement the fixation achieved is more rigid as the screw is passed through the “force nucleus” of the vertebrae.<sup>15</sup> This is the post through which five anatomical structures - the superior facet, the inferior facet, the lamina, the pedicle and the transverse process, channel all posterior forces that are transmitted to the body.<sup>16</sup>

In this study, we have stabilized cases of thoracic and lumbar unstable spinal lesions with pedicular screw and rod fixation. Pedicle screw system has gained much popularity in recent times. 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.

**METHODOLOGY:** This study is a prospective clinical study of unstable thoracolumbar spinal injuries by posterior instrumentation (Pedicular screw and rod fixation in thoracic, lumbar, and thoracolumbar spinal fractures). In all, a total of 21 cases were evaluated and assessed during the period from 1st June 2008 to 30th September 2010. The study was conducted in the Department of Orthopaedics, Vijayanagara Institute of Medical Sciences, Bellary. All the patients underwent treatment, as per a specific treatment plan.

All the patients were initially assessed in the out-patient department or 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. After initial investigations and haemodynamic stabilization, patients were assessed neurologically in detail. 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 CT was done, MRI was done for affordable patients. The pre-operative neurological status was graded on the basis of ASIA grading. It was also used to assess post-operative 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.

### **INCLUSION CRITERIA:**

1. Unstable fractures with neurological deficits.
2. Unstable fractures with incomplete neurological deficits to decompress the nerve tissue.
3. Unstable fractures with greater than 20 degree kyphotic deformity and 50% decrease in vertebral height collapse without neurological deficits.
4. Patients with complete spinal cord injury for the purpose of stabilization.
5. Contiguous fractures of thoracolumbar spine.
6. Thoracolumbar fractures of traumatic etiology.

### **EXCLUSION CRITERIA:**

1. Pathological fractures.
2. Those managed conservatively.
3. Patient age more than 60 years.
4. Patients not willing for surgery.
5. Medically unfit for surgery.

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### PREOPERATIVE WORK UP:

1. Plain radiograph (Static and dynamic wherever necessary)
  - i. Anteroposterior views.
  - ii. Lateral views.

To assess extent of degeneration, instability, mechanism of injury, fracture pattern and its severity and canal compromise or deformity.

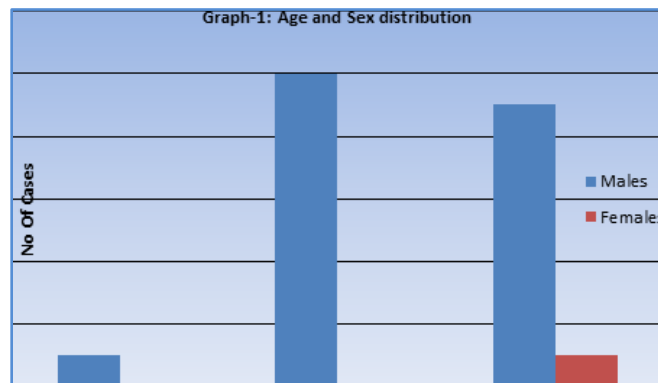
2. Magnetic resonance imaging (MRI) was useful in determining
  - i. The condition of the spinal cord following trauma.
  - ii. Any soft tissue encroachment (intervertebral disc) of the spinal Cord.
3. The following measurements were taken using plain X rays of the injured Spine:
  - a. **SAGITTAL ANGLE:** This was calculated by drawing two lines. One line joining the inferior margins of the upper vertebral body adjoining the disc space above the affected disc space on the lateral view and another line joining the disc space below the affected disc space. 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 positive in Kyphosis and negative in lordosis.
  - 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.

### RESULTS:

Age	Males	Females
<20	1(4.7)	
20-30	10(47.8)	
30-40	9(42.8)	1(4.7)

**Table 1: Age and sex Distribution**

In this series 20 (95.3%) patients were male and 1 (4.7%) were female patients. 1 (4.7%) patient was below 20 years, 10(47.8%) were in the 20-30 age group and 10 (47.8%) were in the 30-40 age group.

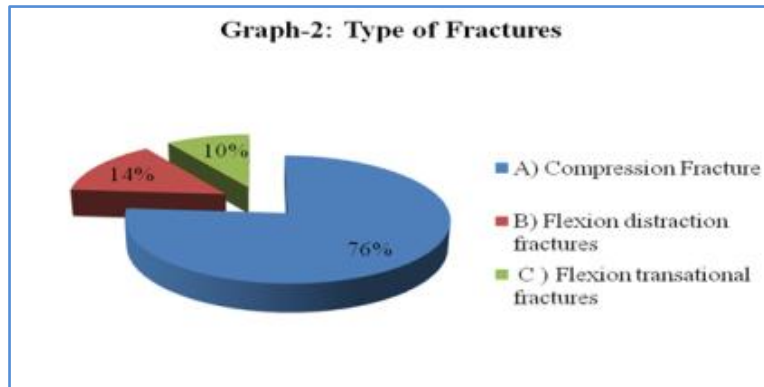


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Classification	No. of Cases	Percentage
A	16	76.1
B	3	14.2
C	2	9.7

**Table 2: Type of fractures.**

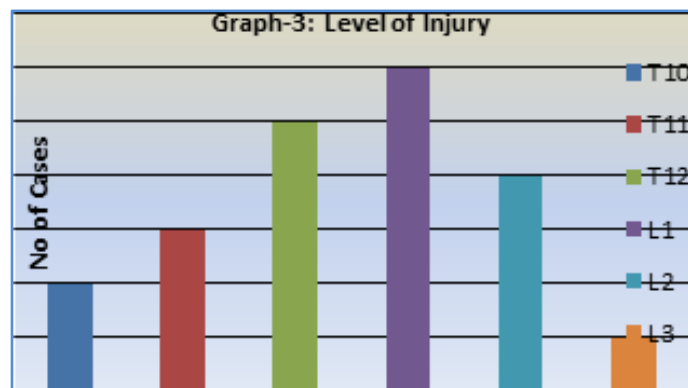
In this series there were 13 (65%) of type A fractures, 5 (25%) of type B and 2 (10%) with type C fractures.



Level	No. of cases	Percentage
T10	2	9.52
T11	3	14.29
T12	5	23.81
L1	6	28.57
L2	4	19.05
L3	1	4.76

**Table 3: Level of injury**

In this series we had 10 (47.6%) patients with fractures at the thoracic level and 11(52.4%) patients with fractures at lumbar level. The T11 - L2 fractures contributed to 18 (86%) of the cases and were the most common fractures were at T12 (23.81%), L1 (28.57%).

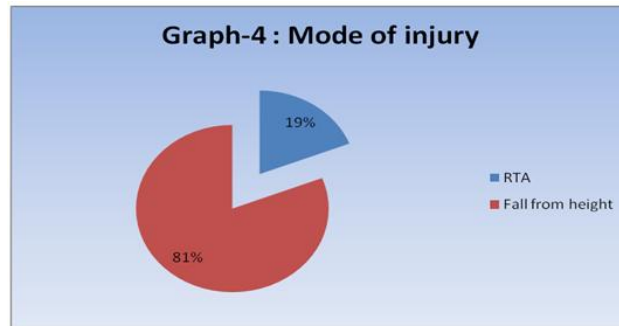


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Mode of Injury	No. of Cases	Percentage
RTA	4	19
Fall from height	17	81

**Table 4: Mode of injury**

In this series we had 12 (60%) patients having fall from height as the most common mode of injury, 5 (25%) due to road traffic accidents and in 3 (15%) of patients mode of injury was fall of a heavy object.

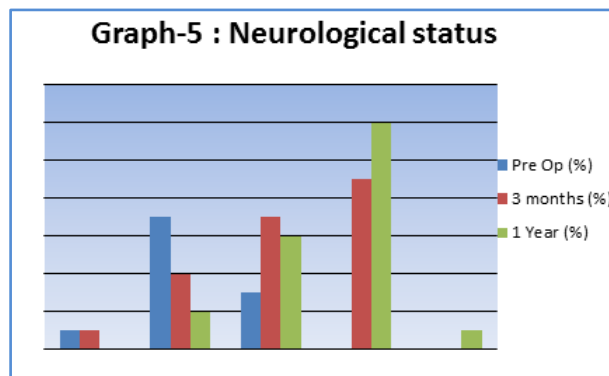


Neurological status	Pre Op (%)	3 months (%)	1 Year (%)
A	11	1	0
B	7	4	2
C	3	7	6
D	0	9	12
E	0	0	1

**Table 5: Neurological status**

$X^2 = 20.3$   $P < 0.001$  HS

In this study 11 (52.38%) of patients were of grade A, 7 (33.33%) were grade B, 3 (14.4%) were grade C at admission. All patients showed at least one ASIA grade improvement at latest follow-up. At 3 months follow up 9 (42.85%) were of grade D & E, at 1 year 13 (62%) of patients were of grade D and E. This shows that the posterior spinal stabilization with indirect decompression with pedicle screw and rod system was directly related to the neurological recovery.

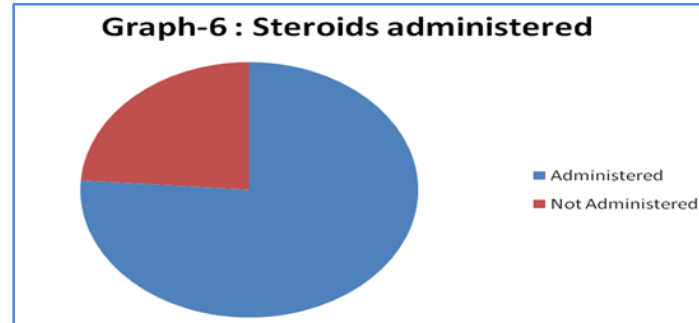


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Steroids Administered	No. of Cases	Percentage
Administered	16	76
Not Administered	5	24

**Table 6: Steroids administered**

In our series 16 (76%) patients were administered pre-operative steroids and in 5 (24%) of cases preoperative steroid was not administered.



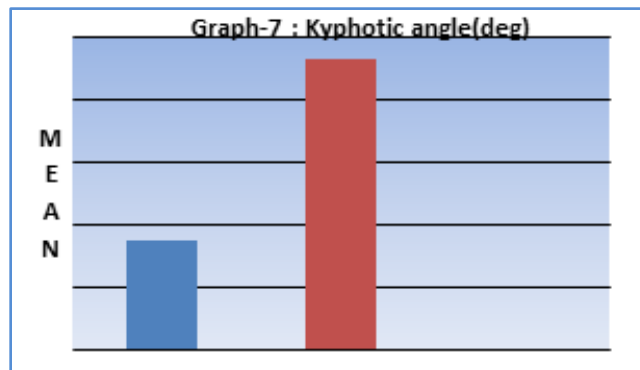
Kyphotic angle (deg) Mean	Pre Op 21	3 Months 8.38	1 Year 7.38	P* Value	Significant Pairs**
SD	3.68	2.40	1.91	P<0.001 HS	1&2, 1&3

**Table 9: Radiological parameters**

\* Repeated measures ANOVA test

\*\* Tukey's test

In our series the mean kyphotic angle was 20.9° at admission, 6.9° at 3 months follow up and 7.30° at 1 year follow up with a standard deviation of 3.63 at admission, 1.83 at 3 months of follow up, and 2.39 at 1 year follow up. ANOVA test gave significant difference of the pairs. Tukey's pair wise analysis test was applied to compare the variables and significant pairs were 1 and 2, 1 and 3. A significant correction in kyphotic deformity after posterior spinal stabilization with pedicle screws and rod system was observed.



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Time duration of injury	Mean	SD
To admission	1.76	1.52
To surgery	4.66	1.90

**Table 7: Time duration of injury**

Duration of injury to admission	No. of Cases	Percentage
< 72 Hours	15	71
> 72 Hours	6	29

**Table 8: Duration of injury to admission**

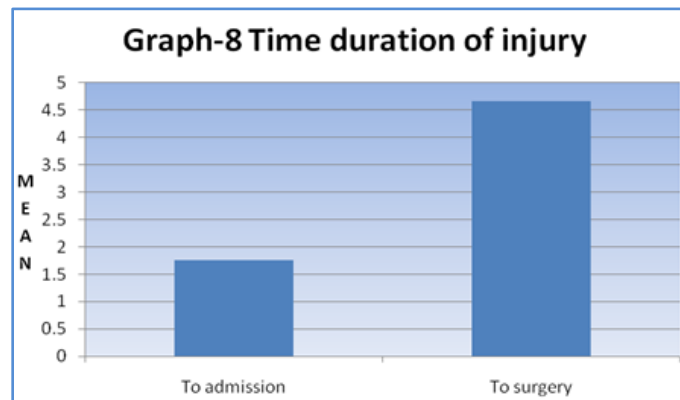
Duration of injury to surgery	No. of Cases	Percentage
<= 4 Days	13	62
> 4 Days	8	38

**Table 9: Duration of injury to surgery**

Total Stay	No. of Cases	Percentage
20-40 days	19	90
> 40 days	2	10

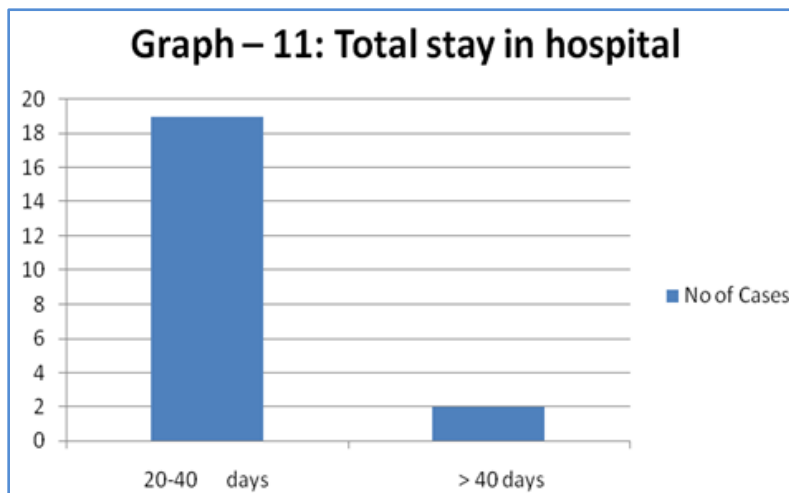
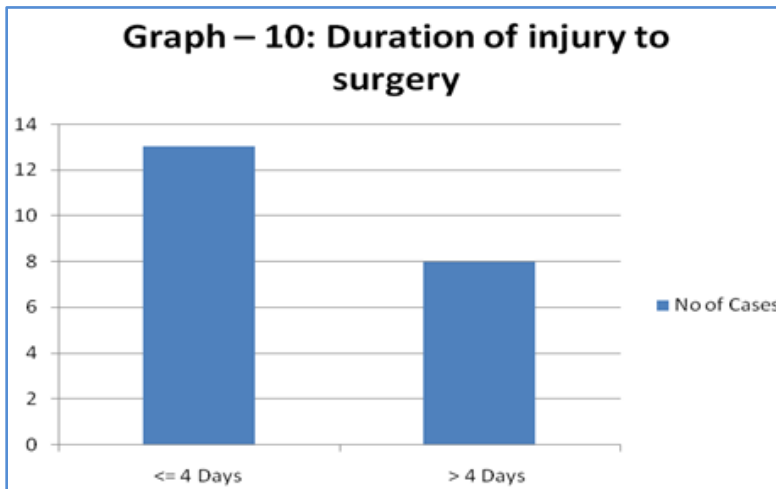
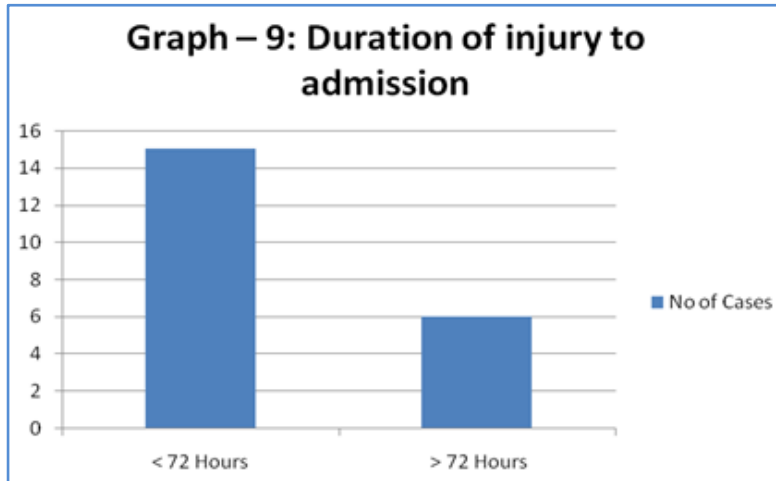
**Table 10: Total stay in hospital**

In this series the duration from time of injury to time of admission showed a mean of 1.76 days, duration from time of injury to time of surgery showed mean of 4.66 days. The number of patients admitted <72 hours were 15 (71.42%) and >72 hours were 6 (28.57%) of the cases. 13 (61.9%) of patients underwent surgery <= 4 days and 8(38.09%) of patients underwent surgery >4 days. 19 (90.47%) of patients had hospital stay ranging from 20-40 days and 2 (9.52%) patient >40 days.





# ORIGINAL ARTICLE

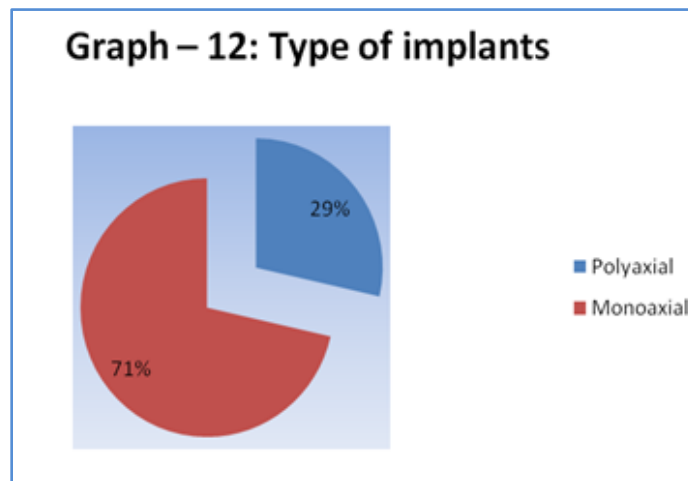


## ORIGINAL ARTICLE

Type of implants	No. of Cases	Percentage
Polyaxial	6	28.57
Monoaxial	15	71.42

**Table 11: Type of implants**

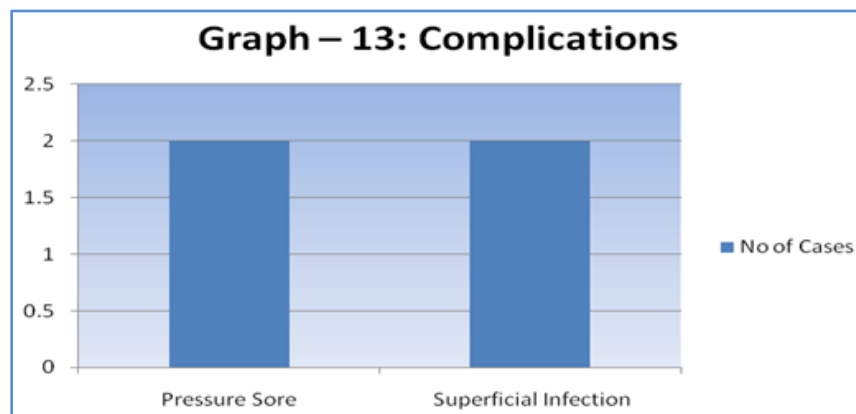
In this series 6 (28.57%) patients polyaxial pedicle screws were used with transverse connector in 2 (9.52%) patients and in 15 patients (71.42%) patients monoaxial pedicle screws were used.



Complications	No. of Cases	Percentage
Pressure Sore	2	9.52
Superficial Infection	2	9.52

**Table 12: Complications**

In our series 2 (9.52%) patients had pressure sores and were treated accordingly. 2(9.52%) patient had superficial wound infection which subsided on appropriate antibiotic cover.



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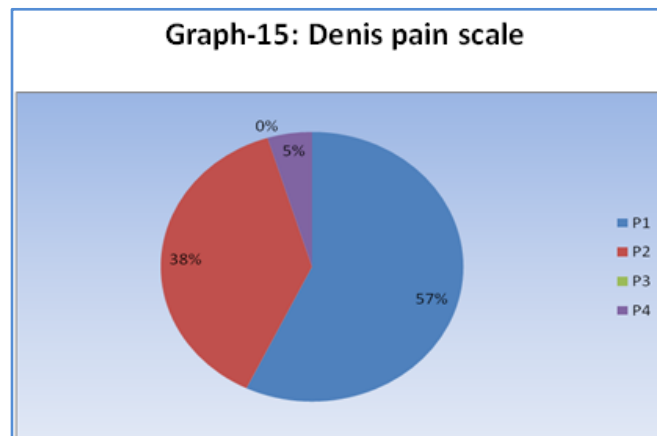
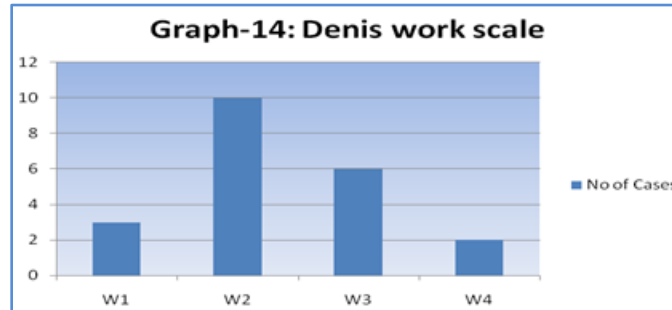
Denis work scale	No. of Cases	Percentage
W1	3	14.5
W2	10	47.5
W3	6	28.5
W4	2	9.5

**Table 13a: Functional outcome**

Denis Pain scale	No. of Cases	Percentage
P1	12	57
P2	8	38.25
P3	0	0
P4	1	4.75

**Table 13b: Functional outcome**

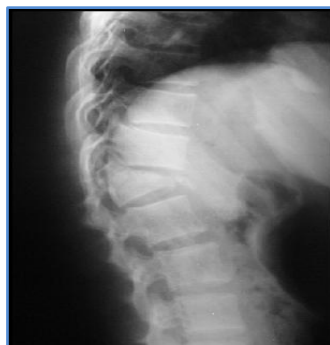
In our series 3 (14.5%) patients returned to previous employment or physically demanding activities. 10 (47.5%) were able to return to previous employment to heavy labour with some restriction. 6 (28.5%) were unable to return to previous employment but worked full time at new jobs. 2 (9.5%) were unable to return to full time work. 12 (57%) had no pain, 8 (38.25%) patients had occasional minimal pain with no need for medication. 1(4.75%) had moderate to severe pain, occasional absence from work and change in activities of daily living.



# ORIGINAL ARTICLE

## CLINICAL & RADIOLOGICAL PHOTOGRAPHS:

CASE NO: 1



**Pre-operative Radiography**



**Immediate post-operative x-ray  
Post operative assessment a 3 months**



**Post-operative X-ray at 1 year**



**Healed Scar**



**Standing without support**

## ORIGINAL ARTICLE



**Movements**

**1) AGE AND SEX DISTRIBUTION:** In our study we had 95% males and 5% female patients. The average age was 28.3 years and more common in the second and third decade. Gregory F. Alvine et al in their study found that average age was 31 years, with a male predominance. Nasser M.G, et al in their study found that average age was 28.8 years with a male predominance. Rick C. Sasso 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 years with a male predominance.

Authors	Mean Age (years)	Sex distribution
Gregory E. Alvine et al	31	Male
Nasser M.G, et al	28	Male
Rick C. Sasso et al	34	Male
Razak M, et al	30	Male
Present study	28.3	Male

Table 14

**2) MODE OF INJURY:** In our study we noted fall from a height in 81% patients as the most common mode of injury and was mainly the result of work injury. Road traffic accident was the second commonest cause 19% 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. Raza k M, et al in his study noted that 69% of injuries were caused from fall from height, 31% due to road traffic accident.

Authors	Fall from height	RTA
Nasser M.G, et al	67%	24%
Gregory F. Alvine, et al	52%	39%
Razak M, et al	69%	31%
Present study	81%	19%

Table 15

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**3) CLASSIFICATION TYPE:** In our series we found 76.1% of patients with AO Type-A fractures, 14.2% with AO Type-B fractures and 9.7% 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. Sasso 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% Type-C.

Authors	A	B	C
Gregory E. Alvine et al	57%	13%	30%
Nasser M.G, et al	76%	8%	16%
Rick C. Sasso et al	62.5%	37.5%	-
Present study	76.1%	14.2%	9.7%

Table 16

**4) LEVEL OF INJURY:** In our series we had 86.1% of patients with fractures between T11-L2 levels. 9.52% with fractures between T1-T10, 4.5% with fractures between L3-L5 levels. Nasser M.G. et al., in their study noted that the commonest vertebra to be fractured was L1 comparable to our study. Gregory F Alvine et al, noted that in 72.5% of cases the injury was at level of T11-L2. Rick C. Sasso et al, noted that in 80% of cases the injuries were at T11-L2 levels. Razak M et al, noted that in 92% of cases the injuries were at the L1 and L2 vertebral levels.

Authors	T1-T10	T11-L2	L3-L5
Gregory E. Alvine, et al	-	70%	30%
Rick C. Sasso, et al	11%	80%	9%
Razak M, et al	3%	92%	5%
Present study	9.52%	86.17%	4.56%

Table 17

**5) NEUROLOGICAL STATUS:** In our study we had of patients with 52.3% ASIA Grade-A, 33.3 % with Grade B, and 14.4 % with Grade-C at admission and at latest follow up showed at least 1 ASIA Grade improvement. 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. Sasso 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 20 grade improvement in 18 patients (1.1 Grade improvement).

Authors	Neurological Improvement
Nasser MG et al	At least 1 Grade
Gregory F. Alvine et al.	1.2 Grade
Rick C. Sasso et al	At least 1 Grade
Razak M, et al	At least 1 Grade

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Khan I et al.	1.1 Grade
Present Study	At least 1 Grade

**Table 18**

**6) RADIOLOGICAL PARAMETERS:** In our series the mean kyphotic angle by Cobb's method was 21° on admission, 8.3° post operatively and 7.3° 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. Gregory F. Alvine et al., noted that sagittal plane angulation was 12° pre operatively, 1° post operatively and 6° at follow up Rick C. Sasso et al., noted that the kyphotic angle was 17.6° pre operatively, 3.5° postoperatively 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.

Authors	On Admission	Post Operatively	Follow Up
Nasser M.G. et al	23.6°	7°	11.5°
Gegory F. Alvine et al	12°	1°	6°
Rick C. Sasso et al	17.6°	3.5°	11.6°
Razak M, et al	20°	7°	9°
Present study	21°	8.38°	7.38°

**Table 19**

**7) TIME DURATION:** In our series the duration from injury to a admission was a mean of 1.76 days, from injury to surgery was 4.66 days and average hospital stay was 28.4 days. Rick C.Sasso et al, noted in their study that average time interval between time of injury to time of surgery was 4 days and mean hospital stay was 16 days. Razak M et al, noted that average time duration to surgery was 5.6 days and average hospital stay was 24 days.

Authors	Injury to Surgery (Days)	Total Stay (Days)
Rick. C Sasso et al	4	16
Razak. M. et al.	5.6	24
Present Study	4.66	28.4

**Table 20**

**8) COMPLICATIONS:** In our study we had 2 patients with pressure sores and 2 patients with superficial wound infection. No case of hardware loosening and no misplacement of pedicle screws were noted. Khan. I et al., in their study noted that there was 1 patient with superficial wound infection, and 1 patient with deep vein thrombosis. Razak M et al, noted 2 instances of hardware loosening and 3 misplaced pedicle screws.

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Complications	Present	Khan. I et al.,	Razak. M et al.
Superficial wound infection	9.52%	6%	-
Hardware Loosening	-	-	8%
Misplacement of Screws	-	-	12%
Pressure sores	9.52%	-	-
Deep vein thrombosis	-	6%	-

Table 21

**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:

- Thoracic and lumbar spine fractures are more common in the 2<sup>nd</sup> and 3<sup>rd</sup> decade of life with male predominance due to outdoor activities.
- The commonest mode of injury was fall from a height.
- Management of thoracic and lumbar spine fractures requires careful pre- operative planning, patient selection, neurological evaluation and meticulous intra-operative care and post-operative rehabilitation including counselling for good functional outcome.
- Still, neurological recovery after dorso-lumbar spinal injuries poses a great challenge to orthopaedic surgeons.
- Severity of the primary cord damage at the time of accident is a major factor in the neurological recovery of the patients. Earlier the intervention and less number of transfer of patients from place to place (less secondary neurological damage) gives good prognosis.
- The posterior midline approach provides adequate exposure and direct visualization.
- Pedicle screw fixation should be done as early as possible in order to facilitate neurological recovery, help in good nursing care and mobilization of the patient and to prevent deterioration of the neurological status.
- The administration of pre-operative steroids have shown to have a beneficial effect on the final neurological outcome.
- Pedicle screw instrumentation provides less surgical exposure, correction of deformity and better stabilization, of one motion segment above and below fracture.
- Early surgical intervention helped in good neurological recovery.

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