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Management of fractures of thoraco lumbar spine with pedicle screw fixation

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ABSTRACT

Background: Thoraco-lumbar fractures are serious injuries of concern, if left untreated may result in marked morbidity and disability to the patient. To study the efficacy of pedicular screw and rod fixation system (ZETA system) in achieving 'stabilization' in thoracic and lumbar fractures of the spine.
Methods: This was a prospective comparative on-randomized study of 20 patients who underwent pedicle screws and rod fixation in Goverment District headquarters hospital Nagapattinam with a follow-up ranging from September 2018 to December 2018 duration of 4 months. Patient selection was according to the inclusion and exclusion criteria and was surgically treated with pedicle screw and rod system (ZETA).
Results: In 75% of the patients, the fractures were reduced by using polyaxial implants and in 25% of the patients both monoaxial and polyaxial implants were used. The average regional angle during the pre-operative stage was 16.50±5.020 and 4.450±4.150 during the 1-year post-operative period. There was a significant difference between pre-op and post-operative regional angles.
Conclusions: There is a very high statistical significant restoration of vertebral body height, mean regional angle, and mean anterior wedge angle with this procedure in thoracolumbar fractures. Neurological recovery was seen significantly when all cases with neurological deficits were clubbed together.

Keywords: Pedicle screws and rod, Thoracolumbar spinal injury, Thoraco-lumbar fractures

INTRODUCTION

Thoracic lumbar fractures are serious injuries of concern, if left untreated may result in marked morbidity and disability to the patient. The fractures to the spine are reported to be around 6% approximately of the trauma patients, of which around 2.6% of the patients sustain spinal cord or nerve root level neurological injury.[1] Such fracture is commonly associated with motor and sensory disturbance, bladder and bowel disturbances, erectile dysfunction, deformities like kyphosis, scoliosis as a result of neurological injury. The patients are also prone to bedsores and pulmonary infections.[2] Thoracolumbar segment is the second most commonly involved segment in the spinal cord following spinal injuries followed by the cervical segment. It constitutes 30 to 60% of all spinal injuries. The trauma of the thoracolumbar segment is high in thoracolumbar junction to the extent up to 60% between T12 to L2.[3] Only 15-20% of the fractures at the thoracolumbar level are associated with neurological injury. Thoracolumbar injuries classically exhibit a bimodal distribution, with peaks among males under 30 years of age and in the geriatric population.[4] The goal of treatment of every spinal injury is the 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 the recovery of injured neural tissues, and optimizing conditions for the musculoskeletal portions of the spinal column to heal in a satisfactory position.[5] 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 neuralelements.[6] The surgical treatments for thoracolumbar fractures are by different approaches such as anterior, posterior, lateral, or anteroposterior 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 a posterior approach with many available instruments.[7] Their main disadvantage is it spans at least 5-6 spinal segments. So never options, especially pedicle screw plate or rod constructs that need shorter segment immobilization have gained popularity.[8] 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 a spinal scoring system called Denis work and pain scale.[9]

METHODS

This is a prospective comparative on-randomized study of 20 patients who underwent Pedicle Screws and rod fixation in Government District headquarters hospital Nagapattinam with a follow-up ranging from September 2018 to December 2018 duration of 4 months. A detailed history was obtained for evaluating the mode of trauma, ASIA grading, sensory level and to check for any spinal deformity. They were clinically and radiologically evaluated for ensuring the thoracolumbar fracture. Plain x-ray in antero posterior and lateral views was obtained and the instability of the spine was confirmed using White and Punjabi criteria of spinal instability. Laboratory investigations were carried out before surgery. MRI/CT scan was conducted to evaluate the relationships and instability of the spine. Those patients with an unstable spine have explained the advantages and disadvantages of the surgery. The inclusion and exclusion criteria were as follows:

Inclusion criteria

Traumatic thoracic, lumbar, or thoracolumbar fractures. Unstable fractures with or without neurological deficits. Incomplete neurological deficit. Patient with complete spinal cord injury for stabilization. Contagious fracture of the thoracolumbar spine.

Exclusion criteria

Patients not willing for surgery. Patients were medically unfit for surgery. Traumatic cervical fracture with traumatic quadriplegia. Patient age of more than 60 years.

Position the patient prone on a padded spinal operating table on a 4 poster frame encouraging more lordosis. The pedicles were identified, by identifying the point of convergence of a horizontal line along the center of the transverse process and a vertical line along the center of the superior facet. Using a rongeur cortical bone was removed around the pedicle entry point. A pilot hole was made with the use of a sharp Trocar with a stopper. Centralizers or blunt kirschner wires were placed into the pedicle and their position was confirmed under image intensifier on both anteroposterior and lateral views. The pedicle probe was passed by rotating it over 30 degrees clockwise and anticlockwise so it entered the pedicle at the region of least resistance which is the center of the pedicle.

Statistical tests

The data thus obtained was entered in a spreadsheet and analyzed using the independent sample t-test for quantitative variables, paired t-test for paired observations, and chi-square test for categorical observations. A value of less than 0.05 was considered a significance level and all the values below it were considered as statistically significant. Statistics were obtained using SPSS for Windows statistical program release 21 (SPSS Inc., Chicago, IL, USA). Pearson correlation was used to find out the relationship between variables.

RESULTS

Table 1 shows the distribution of the age group and sex. The mean age of the study group was 41 years with a standard deviation of 11.5 years. The mean age of males was 40.8±11.1 years and females' age was 41.1±12.1 years. There was no significant difference between the age of males and females. Forty percent of the males and females belonged to 31-40 years, 33.3% of the males and 20% of the females belonged to 41-50 years, 13.3% of the males and 20% of the females were aged more than 50 years, 6.7% of the males and 20% of the females belonged to 21-30 years age group and 6.7% of the males belonged to less than 20 years.

Table 1: Distribution of the study group according age group and sex.

Age group (years)	Male N (%)	Female N (%)	Total
<20	1 (6.7)	0	1 (5.0)
21-30	1 (6.7)	1 (20)	2 (10.0)
31-40	6 (40)	2 (40)	8 (40.0)
41-50	5 (33.3)	1 (20)	6 (30.0)
>50	2 (13.3)	1 (20)	3 (15.0)
Total	15 (100)	5 (100)	20 (100)
Mean±SD	40.8±11.1	41.1±12.1	41±11.5
t value; p value	0.044; 0.966, NS		

The most common vertebra involved in the study group was L2 to the extent of 25% followed by T10 (20%), T11 (15%), T12 (10%), L1 (10%), and L3 (10%). In the study group, 65% of the study group had an injury due to a fall from height. About 35% of the injuries were due to road traffic accidents.About 55% of the patients had to type A

fractures, 30% had type B fractures and 15% had type C fractures (Table 2).

Table 2: Vertebra affected in the study group.

Vertebra	Frequency	Percent
T9	1	5.0
T10	4	20.0
T11	3	15.0
T12	2	10.0
L1	2	10.0
L2	5	25.0
L3	2	10.0
L4	1	5.0
Total	20	100

In 75% of the patients, the fractures were reduced by using polyaxial implants and in 25% of the patients, both monoaxial and polyaxia l implants were used (Table 3).

Table 3: Type of implant used to stabilize the spine.

Type of implants	Frequency	Percent
Polyaxial	15	75.0
Monoaxial + polyaxial	5	25.0
Total	20	100

The mean regional angle during the preoperative stage was 16.50±5.020, 12th post-operative week was 4.300±4.010, during 24th post-operative week was 4.550±4.140 and 1-year post-operative period was 4.450±4.150. The mean difference of regional angle between pre and 12th post-operative week was 12.20, between pre and 24th post-operative week was 11.950 and between pre and 1-year post-operative period was 12.050. The p values corresponding to the same was 0.0001<0.05. Since the p-value was less than 0.05, there was a significant difference between pre-op and post-operative regional angles (Table 4).

Table 4: Paired T test of regional angle in the study group.

The regional angle in degree	Mean difference	t value	P value	Significance
Pre-operative- 12th post op week	12.2	10.64	0.0001	Sig
Pre-operative- 24th post-op week	11.95	10.03	0.0001	Sig
Pre-operative- 1 year	12.05	9.97	0.0001	Sig

The mean anterior wedge angle during the pre-operative stage was 19.050±6.70, 12th post-operative week was 5.00±4.60, during 24th post-operative week was 5.60±4.60 and 1-year post-operative period was 5.40±4.60. The mean difference of anterior wedge angle between pre and 12th post-operative week was 14.050, between pre and 24th post-operative week was 13.450 and between pre and 1 year post-operative period was 13.60. The p values corresponding to the same was 0.0001<0.05. Since the p value was less than 0.05, there was a significant difference between pre and post-operative anterior wedge angles (Table 5).

Table 5: Anterior wedge angle in degree in the study group.

Anterior wedge angle	Mean±SD	Minimum	Maximum
Pre-operative	19.05±6.7	2	30
12th post-operative week	5.0±4.6	0	12
24th post-operative week	5.6±4.6	0	14
1 year	5.4±4.6	0	14

The mean vertebral height was 15.2±3.2 MMS during the pre-operative stage. The mean vertebral height at the 12th post-operative week was 24±5 MMS, during the 24th post-operative week was 23.1±4.6 and during the 1-year post-operative period was 23.1±4.7 MMS. The mean difference of vertebral height between pre and 12th post-operative week was 8.8 MMS, pre and 24th post-operative week was 7.95, and pre and 1-year post-operative period were 7.95. These differences were statistically significant (Table 6).

Table 6: Vertebral height in mm in the study group.

Anterior wedge angle	Mean±SD	Minimum	Maximum
Pre-operative	15.2	3.2	10
12th post-operative week	24.0	5.0	16
24th post-operative week	23.1	4.6	16
1 year	23.1	4.7	16

Table 7 shows the ASIA grading of the study group during pre-operative, at 12th post-operative week, 24th post-operative week, and 1-year post-operative period. During the pre-operative period 40% were graded as grade A, 5% as grade B, 15% as C, 30% as D, and 10% as Grade E. During 12th post-operative week, the Frankel grade A was 35%, B was 10%, C was 10% and E was 45%. During 24th post-operative week grade was 30%, B was 2%, C was 10%, D was 5% and E was 50%. During 1 year post-operative period, grade A was 25%, grade B was 5%, C was 5%, D was 10% and E was 55%. There was a statistically significant difference between the ASIA

grading of pre-operative and 12th post-operative week and 1-year post-operative period. But there was no statistically significant difference between the pre-operative and 24th post-operative week ASIA grading.

Table 7: ASIA grading for neurological status in the study group.

ASIA grade	Pre-operative n (%)	12th postoperative week n (%)	24th postoperative week n (%)	1-year n (%)
A	8 (40.0)	7 (35.0)	6 (30.0)	5 (25.0)
B	1 (5.0)	2 (10.0)	1 (5.0)	1 (5.0)
C	3 (15.0)	0	2 (10.0)	1 (5.0)
D	6 (30.0)	2 (10.0)	1 (5.0)	2 (10.0)
E	2 (10.0)	9 (45.0)	10 (50.0)	11 (55.0)

Table 8 shows the complications in the study group. Eighty-five percent of the study group had shown no complications, pressure sore, screw fracture, and screw misplacement were observed in 5% of the study group.

Table 8: Complications in the study group.

Complications	Frequency	Percent
Nil	17	85.0
Pressure sore	1	5.0
Screw fracture	1	5.0
Screw misplacement	1	5.0

Among all the subjects 20% of the patients returned to their previous work or physically challenging job, 35% were able to return to previous employment to heavy labour with some restriction, 30% of the patients were unable to return to their previous employment but worked for full time in their new employment and 25% of the patients were unable to return to their full-timework (Table 9).

Table 9: Functional outcome- Denis work scale.

Denis work scale	Frequency	Percent
W1	2	20.0
W2	7	35.0
W3	6	30.0
W4	5	25.0
Total	20	100

Table 10: Functional outcome- Denis pain scale.

Denis pain scale	Frequency	Percent
P1	9	45.0
P2	6	30.0
P3	4	20.0
P4	1	5.0
Total	20	100

In this case series 45% of the patients had no pain, 30% had occasional minimal pain with no need for medication, 20% had moderate pain with an occasional need for medication and 5% had moderate to severe pain with occasional absence from work and change in activities of daily living (Table 10).

DISCUSSION

Spinal traumas are the common and leading problem in orthopedic practice. The fractures to the spine are reported to be around 6% approximately of the trauma patients, of which around 2.6% of the patients sustain 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 a result of neurological injury.[10] 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.[11] In a variable screw placement system (VSP) the fixation achieved is more rigid as the screw is passed through the "force nucleus" of the vertebrae. This is the point 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. This study used stabilization of the cases of the unstable thoracolumbar spine injuries with decompression and pedicular screw and rod instrumentation. The mean age of the study group was 41 years with a standard deviation of 11.5 years. The mean age of males as 40.8±11.1 years and the female's age was 41.1±12.1 years in this study. These results were almost comparable to a study by Guttman et al in their study found that the average age was 31 years, with a male predominance. 77% of males and 23% of females with a mean age of 34 years. In this study group, 65% of the patients had an injury due to a fall from height. About 55% of the patients had to type A fractures, 30% had type B fractures and 15% had type C fractures in this study.[12] Jacobs stated the most common vertebrae involved in this series were between T11-L2 to the extent up to 50%. In this study, the mean duration of injury to admission to hospital was 2.6 days, duration of injury to surgery was 5.55 days, and mean duration of stay in hospital was 29.5±6.5 days.[13] Jens et al noted that the average time interval between injuries to surgery was 4 days and mean hospital stay was 16 days. In this study,

about 25% of the patients were operated on within 4 days of the injury and about 75% were operated on after 4 days of the injury. In 75% of the patients, the fractures were reduced by using polyaxial implants and in 25% of the patients, both monoaxial and polyaxial implants were used. The average regional angle during the pre-operative stage was 16.5°±5.02° and 4.45°±4.15° during the 24th post-operative week.[14] Kelly et al noted that the average kyphotic angle was 20° preoperatively, 7° postoperatively, and 9° at the latest follow-up. The ASIA grading for the neurological state during the preoperative period, 40% were graded as grade A, 5% as grade B, 15% as C, 30% as D, and 10% as Grade E. During the last follow up, grade A was 25%, grade B was 5%, C was 5%, D was 10% and E was 55%.[15] Olerud et al, noted that patients who had neurological deficits showed at least 1-grade improvement at the latest follows up.[16] Leventhal 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 a decrease in neurological level. Eighty-five percent of the study group had shown no complications, Pressure sore, screw fracture, and screw misplacement were observed in 5% of the study group.[17] In this case, series, 20% of the patients were able to return to their previous work or physically challenging job, 35% were able to return to previous employment to heavy labour with some restriction, 30% of the patients were unable to return to their previous employment but worked for full time in their new employment and 25% of the patients were unable to return to their full-timework.[18] About 45% of the patients had no pain, 30% had occasional minimal pain with no need for medication, 20% had moderate pain with an occasional need for medication and 5% had moderate to severe pain with occasional absence from work and change in activities of dailyliving.[19,20]

CONCLUSION

The findings of this study show that pedicle screw-rod instrumentation is an excellent implant system used in the treatment of vertebral fractures. There is a very high statistical significant restoration of vertebral body height, mean regional angle, and mean anterior wedge angle with this procedure in thoracolumbar fractures. 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 the patient. A standard sample size and sampling technique has not been used. However the study adds for the current knowledge base of thoracolumbar fractures and its treatment.

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