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Dr. Kushal Suthar
MS orthopedic, senior resident,
BJ medical College, Ahmedabad,
Gujarat, India

Dr. Harikrushn Ahir
MBBS, Orthopedic resident,
BJ medical College, Ahmedabad,
Gujarat, India

Dr. Kerulkumar Ninama
MBBS, Orthopedic resident,
BJ medical College, Ahmedabad,
Gujarat, India

Dr. Pratikkumar Bhabhor
MBBS, Orthopedic resident,
BJ medical College, Ahmedabad,
Gujarat, India

Dr. Saral Patel
MS orthopedic, Assistant
Professor, BJ medical College,
Ahmedabad, Gujarat, India

Correspondence
Dr. Saral Patel
MS orthopedic, Assistant
Professor, BJ medical College,
Ahmedabad, Gujarat, India

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Results of short segment posterior fixation in AO type C fracture of dorsolumbar spine

Dr. Kushal Suthar, Dr. Harikrushn Ahir, Dr. Kerulkumar Ninama, Dr. Pratikkumar Bhabhor and Dr. Saral Patel

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Abstract

Introduction: Spinal traumas are common and leading problem in orthopaedics practice. The individuals are at a risk of high energy trauma in modern era. Unstable thoraco-lumbar burst fractures are serious injuries of concern, if left untreated may result in marked morbidity and disability to the patient. Thoracolumbar is the second most common segment involved in the vertebral column following cervical segment in patients with spinal injuries. Historically, the thoracolumbar fractures were treated by recumbency (bed rest for a period of 8-12 weeks). In a resource scarce country like India, the care is often neglected to the victims. So, it is the need of the hour to explore possibility of surgical stabilization, early mobilization and rehabilitation of patients. In this study, we stabilized the patients with unstable thoracolumbar burst fractures with short segment posterior instrumentation with transpedicular screws.

Aim: To study efficacy of short segment posterior instrumentation in achieving stabilization of thoracic and lumbar fractures of spine.

Materials and Methods: This was a prospective interventional study undertaken in the Department of Orthopedics, New Civil Hospital, Ahmedabad. 32 Adult patients with acute thoracolumbar injury admitted to Civil Hospital, AHMEDABAD were included in this study after obtaining their valid, written informed consent. Plain x-rays in antero-posterior and lateral views were obtained and the instability of spine was confirmed using Thoraco-Lumbar Injury Classification and Severity Score. All patients underwent short segment posterior Fixation and were followed up in OPD every 4th week after surgery till 6 months and for each follow up, neurological, radiological and clinical examinations were done to assess the spinal stability.

Results and Discussion: All fractures were classified as Type C fractures according to the AO classification system. Intermediate screw was inserted in 21 patients out of 32. This study showed that fracture level screw fixation technique could achieve and maintain correction, regional angle and vertebral height. We have used the intermediate screw option in the fractured vertebra level as a method of augmentation in the current study. The results were comparable to other studies in the past.

Conclusion: The findings of these study show that short segment posterior instrumentation is an excellent implant system used in the treatment of vertebral fractures. There is a very high statistically significant restoration of vertebral body height, mean regional angle and mean anterior wedge angle.

Keywords: segment posterior, segment, dorsolumbar spine

Introduction

Spinal traumas are common and leading problem in orthopaedics practice. The individuals are at a risk of high energy trauma in modern era ^[1, 2, 3]. Unstable thoraco-lumbar burst 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 total trauma patients, out of which around 2.6% patients sustain spinal cord or nerve root level injuries. 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/spinal instabilities. The patients are also prone to bed sores, DVT and pulmonary infections ^[4].

Thoracolumbar is the second most common segment involved in the vertebral column following cervical segment in patients with spinal injuries. It constitutes 30-60% of all spinal injuries. Only 15-20% of thoracolumbar fractures are associated with neurological injury ^[6].

Thoracolumbar injuries classically exhibit a bimodal distribution, with peaks among males under 30 years of age and in the geriatric population [7].

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

The goal of treatment of any 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 the injured neural tissues and optimizing conditions for the musculoskeletal portions of the spinal cord 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 correction of deformities and optimize neurological improvement by directly or indirectly relieving any residual impingement of the neural elements.

The surgery for the treatment of thoracolumbar fractures can be performed by different approaches such as anterior, posterior, lateral or antero-posterior approaches. The posterior approach is a safe option since most of the specialists are familiar with this approach. The added advantage being the spine can be stabilized by the posterior approach by many available instruments [11].

Historically, Harrington hook-rod construct or its modifications have been studied extensively [4]. Their major disadvantage is it spans at least 5-6 spinal segments. So newer options like short segment posterior instrumentation have gained popularity [12].

In Transpedicular Screw Placement system, the fixation achieved is more rigid as the screw is passed through the 'force nucleus' of the vertebrae and through all the three columns. This is the point through which 5 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.

In this study, we stabilized the patients with unstable thoracolumbar burst fractures with short segment posterior instrumentation with transpedicular screws. We have evaluated all patients for maintenance of spinal correction and neurological improvement after short segment posterior instrumentation in unstable thoraco-lumbar burst fractures.

Aim: To study efficacy of short segment posterior instrumentation in achieving stabilization of thoracic and lumbar fractures of spine.

Materials and Methods

This was a prospective interventional study undertaken in the Department of Orthopaedics, New Civil Hospital, Ahmedabad. Adult patients with acute thoracolumbar injury admitted to Civil Hospital, Ahmedabad were included in this study after obtaining their valid, written informed consent. Clearance from institutional ethics committee was taken before initiating the study.

Method of collection of data

Sample size: Thirty two adult patients with acute thoracolumbar injuries who gave the consent for surgery admitted during the study period were included as the study sample. 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-rays in antero-posterior and lateral views were obtained and the instability of spine was confirmed using ThoracoLumbar Injury Classification and Severity Score. Laboratory injections were carried out before surgery. MRI/CT scan were conducted to confirm the about the advantages and disadvantages of the surgery. All fractures were classified as Type C according to the AO classification system.

The inclusion and exclusion criterias were as follows:

Inclusion criterias: Traumatic thoraco-lumbar fracture from T10 to L5, Age > 18 years, Duration of injury < 2 weeks

Exclusion criterias: Patients not willing for surgery, patients medically unfit for surgery, age < 18 years, fracture anywhere in spine other than thoracolumbar region, associated head injury, traumatic thoracolumbar fractures treated with other methods, pathological thoracolumbar fractures, duration of injury > 2 weeks.

Pre-operative work-up

- Plain radiograph (static and dynamic wherever necessary) with antero-posterior views and lateral views were carried out to access the extent of degeneration, instability, mechanism of injury, fracture pattern and its severity and canal compromise or deformity.
- Magnetic Resonance imaging was useful in determining the condition of spinal cord following trauma and any soft tissue encroachment (intervertebral disc) of the spinal cord.

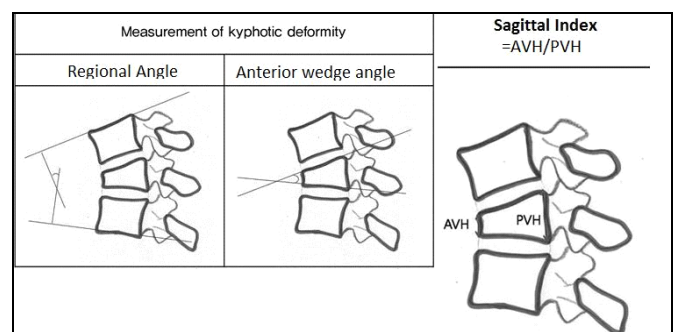
The following measures were taken using plain x-rays of the injured spinal cord:

• Sagittal angle

This was calculated by drawing two lines, one line joining the inferior margins of the upper vertebral body adjoining the disc space over the affected disc space on the lateral view and another line joining the disc space below the affected disc space. Perpendiculars are dropped over these two lines equidistant from the posterior borders of the respective vertebrae. The angle between these two perpendiculars gives the sagittal angle positive for kyphosis and negative for lordosis.

• Sagittal index

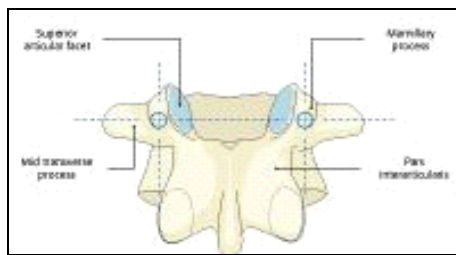
This is also calculated from the lateral x-ray view. This is a ratio between the anterior and posterior heights of fractured vertebra.



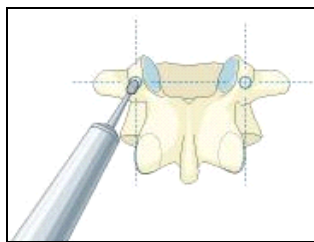
Procedure: short segment pedicle screw spinal instrumentation

The patient was positioned prone on a 4 post spinal frame encouraging lordosis. Care was taken that the nipples in females and scrotum in males along with all bony prominences were free from pressure. This position avoids venous stasis and decreases intra-abdominal pressure, thus reducing venous bleeding. A posterior midline incision was made centering over the involved spinal unit and extending 2 levels above and below. The incision was deepened to expose the posterior elements of the vertebrae one level above and one level below the injury. The dissection was carried out laterally to the tips of the transverse processes, maintaining meticulous homeostasis.

Pedicle screw entry points

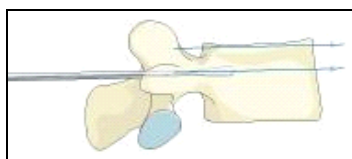


Screw insertion



Opening of the cortex

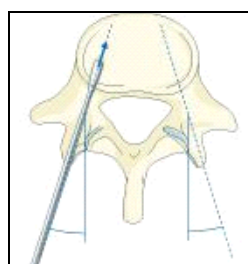
Open the superficial cortex of the entry point with a burr or a rongeur.



Cranial-caudal angulation

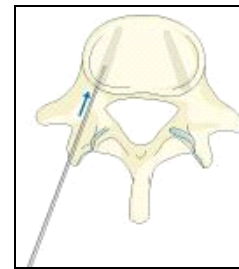
A pedicle probe is used to navigate down the isthmus of the pedicle into the vertebral body. The appropriate trajectory of the pedicle probe in the cranial caudal direction occurs by aiming for the contralateral transverse process.

Thereby paralleling the screws to the superior endplate.



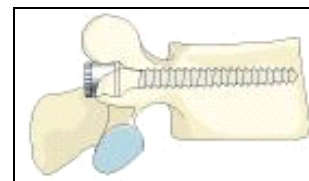
Medio-lateral inclination

The medio-lateral inclination will depend on the rotation of the vertebra. The main goal is to avoid medial penetration of the spinal canal superficially and lateral or anterior penetration of the vertebral body cortex at the depth of insertion. Ideally, the two screws should converge but stay entirely within the cortex of the pedicles and body.



Crew insertion

Once the pedicle track has been created, it is important to confirm a complete intraosseous trajectory by pedicle and body palpation using a pedicle sounding device. At any point in the process, radiographic confirmation can be obtained.



An appropriate diameter and length screw is carefully inserted into the same trajectory created one level above and one level below the fractured vertebra. An intermediate screw was inserted in the fractured vertebrae on both sides whenever possible by the same technique. All the screws were inserted and after giving appropriate curvature to the rod, assembly was constructed. Using a distracter, distraction was applied for correction of the deformity and indirect decompression and the construct was tightened. A thorough homeostasis was achieved and the wound was closed in layers over drain. Clean dressing was applied.

Post-operative treatment

All patients were given post op intravenous antibiotics (third generation cephalosporin + aminoglycoside) for 3 days. Physiotherapy was started form 1st day post operatively. Sutures were removed on 11th day. On the 2nd day, patients were allowed to roll on side to side. They were allowed to sit up and mobilized on a wheel chair after applying a thoracolumbar belt on 3rd or 4th day postoperatively. A close watch was kept on the improvement or deterioration of neurological status.

Patients wore TLSO braces for about 6 weeks. Those with incomplete neurological deficits were given physiotherapy and gradually ambulated. Patients with complete neurological injury were given physiotherapy and ambulated on wheel chair. Routine post-operative x rays were taken prior to discharge. The neurological grading and radiological parameters were recorded daily.

Follow up

All patients were followed up in OPD every 4th week after surgery till 6 months and for each follow up, neurological, radiological and clinical examinations were done to assess the spinal stability.

At the end of 6 months follow up, patients were evaluated clinically.

Evaluation of neurological status with ASIA grading and radiological assessment of deformity was done at the time of admission, 6th week, 12th week and 24th week.

Instruments and implants:

- General spinal instruments
- Mastoid retractor
- Cobb’s elevator
- Pedicle centralizers
- Pedicle probe
- Tap 4.5 and 5.5 mm
- Pedicle sound
- Rod bender
- Rod cutter
- Rod holder, rod pusher
- Screw driver
- Rod stabilizer
- Distractor, self-holding
- Hex screw driver

Statistical tests

The data thus obtained was entered in a spread sheet and analysed using Independent t test for quantitative variables, paired t test for paired observation and chi-square test for categorical observations. Value of 0.05 was considered as statistical significance level and all the values below that level were considered statistically significant.

Results

This was a prospective interventional study undertaken in the Department of Orthopedics. Adult patients with acute thoracolumbar injury admitted to Civil Hospital, Ahmedabad were included in this study after obtaining their valid, written informed consent. Clearance from institutional ethics committee was taken before initiating the study.

Table: Distribution of the study group according to age, group and sex

Age group	Male	Female	Total
Less than 20 years	2	1	3
21-30 years	9	2	11
31-40 years	4	4	8
41-50 years	5	1	6
More than 50 years	3	1	4
Total	23	9	32
Mean ±SD	35.6 ± 11.62	33.56 ± 11.2	
p value	0.82, NS		

Table shows distribution of study subjects according to age group and sex. The mean age for males was 35.57 ± 11.62 years. The mean age for females was 33.56 ± 11.2 years. There was no statistically significant difference between the age of males and females. Highest number of males belonged to the age-group of 21-30 years; whereas for females it was 41-50 years. Ratio of males was higher than females in the study.

Table: Mode of injury

Mode of injury	Frequency	Percent
Fall from height	21	65.62
RTA	11	34.38
Total	32	100

Table: Mean and SD of Duration of injury to admission, injury to surgery and stay

Parameter	Mean	SD
Duration of injury to admission	2.44	1.22
Duration of injury to surgery	4.1	1.3
Duration of stay	10.8	2.77

The mean duration of injury to admission was 2.44 days with a standard deviation of 1.22 days. The mean duration of injury to surgery was 4.1 days with a standard deviation of 1.3 days. The mean duration of hospital stays was 10.8 ± 2.77 days.

Table: Regional angle (degree) in study group

Regional angle (degree)	Mean	SD	Minimum	Maximum
Pre-Operative	16.0	5.1	4	24
6 th post-operative week	3.9	4.0	0	10
12 th post-operative week	4.2	4.18	0	10
24 th post-operative week	4.1	4.2	0	10

Table: Paired t test of regional angle in the study group

Regional angle (degree)	Mean difference	t value	p value	Significance
Pre op- 6 th post op week	12.2	10.64	0.0001	Sig
Pre op – 12 th post op week	11.95	10.03	0.0001	Sig
Pre op-24 th post op week	12.05	9.97	0.0001	Sig

Table: Anterior Wedge angle (degree) in study group

Anterior Wedge angle (degree)	Mean	SD	Minimum	Maximum
Pre-Operative	18	6.9	2	30
6 th post operative week	4.5	4.6	0	12
12 th post operative week	5.19	4.78	0	14
24 th post operative week	5.1	4.8	0	14

Table: Paired t test of anterior wedge angle in degree in study group

Anterior wedge Angle (degree)	Mean difference	t value	p value	Significance
Pre op- 6 th post op week	14.05	8.8	0.0001	Sig
Pre op – 12 th post op week	13.45	8.1	0.0001	Sig
Pre op-24 th post op week	13.6	8.1	0.0001	Sig

Table: vertebral height in mm in the study group

Vertebral height(mm)	Mean	SD	Minimum	Maximum
Pre-Operative	15.2	3.2	10	24
6 th post-operative week	23.84	4.95	16	32
12 th post-operative week	23.1	4.6	16	31
24 th post-operative week	23.2	4.81	16	31

Table: Paired t test of vertebral height (mm) in study group

Vertebral height (mm)	Mean difference	t value	p value	Significance
Pre op- 6 th post op week	-8.8	-8.7	0.0001	Sig
Pre op – 12 th post op week	7.95	-8.7	0.0001	Sig
Pre op-24 th post op week	-7.95	-8.3	0.0001	Sig

Table: Complications in the study group

Complications	Frequency	Percent
Nil	25	78.13
Patient related		
Pressure sore	4	12.5
Discharging sinus	1	3.13
DVT	0	0
Surgery related		
Screw impingement	2	6.25
Screw failure/breakage	0	0

Discussion

In a resource scare country like India, care is often neglected to the victims. So it is the need of the hour for exploring the possibility of surgical stabilization, early mobilization and rehabilitation of the patients. The goal of treatment of every

spinal injury is restoration of the patient to maximal possible function with disability free life. Operative intervention is intended to convey immediate stability to spine, allow for correction of deformities and optimize neurologic improvement by directly or indirectly relieving any residual impingement of the neural elements. In transpedicular screw system the fixation achieved is more rigid as screw is passed through the force nucleus of the vertebrae. This is the point through which 5 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.

Acute fracture of the thoracolumbar spine is a major cause of disability in adult population. Posterior transpedicular fixation has been the preferred method for stabilizing acute unstable thoracolumbar fractures [13].

Short segment fixation of the fracture level has replaced the traditional long segment instrumentation to decrease the number of motion segments sacrificed in the fixation process. However, when there is significant disruption of the load-sharing anterior column, the simple one level above and one level below short segment fixation does not ensure adequate stability, resulting in poor reduction in the kyphotic deformity and occurrence of instrument failure. This necessitates more extensive approaches, such as anterior reconstruction via an anterior approach or posteriorly using balloon-assisted vertebroplasty [13].

This study used stabilization of the cases of the unstable thoracolumbar spine injuries with short segment posterior instrumentation.

Prospective interventional study was undertaken in the department of orthopaedics, new civil hospital Ahmedabad in order to achieve the study objective. 32 adult patients with acute thoracolumbar injuries who gave written informed consent for surgery admitted during the study period were included in the study. All fractures were classified as Type C fractures according to the AO classification system.

Age and sex distribution: The mean age of the study group was 35 and SD was 11 years. The mean age of males was 35.6 years with a SD of 11.6 years and females' age was 33.6 years and a SD of 11.2 years in this study. These results were almost comparable to a study by Uzumcugil *et al* [16]. Alvine *et al* in their study found that average age was 31 years with a male predominance. Sasso RC *et al* in their study had 77% males and 23% females with a mean age of 34 years. The mean age of the present study is almost comparable to these studies.

Study	Mean age in years	Predominant sex
Alvine GE <i>et al</i>	31	Male
Uzumcugil <i>et al</i>	39.3	Male
Sasso RC <i>et al</i>	34	Male
Current study	34.95	Male
Mode of injury		

Alvine *et al* noted that 52% patients had injury due to fall from height. Uzumcugil *et al* noted it as 60%. These results are comparable to the present study in which 65% of the patients had injury due to fall from height.

Level of injury

The most common vertebra involved in this study was T12. Alvine [14] noted that 70% of patients had injury between T11 to L2. Sasso [15] noted it up to 80%.

Time duration

In this study the mean duration of injury to admission to hospital was 2.4 days, duration of injury to surgery was 4.1 days and mean duration of stay in hospital was 10.8 days. Sasso noted that average time interval between injury to surgery was 4 days and the hospital stay was 17 days. Uzumcugil noted that average time duration of injury to surgery was 5.6 days and mean duration of hospital stay was 24 days. In this study about 25% of the patients were operated within 4 days of injury and about 75% were operated after 4 days of injury.

Radiological parameters

The average regional angle during the preoperative stage was $16.0^\circ \pm 5.1^\circ$ and $4.2^\circ \pm 4.1^\circ$ during the 24th post-operative week.

Nasser MG *et al* noted that the kyphotic angle was 23.6° on admission, 7° post operatively and 11.5° at last follow up. Alvine *et al* noted that sagittal plane angulation was 12° preoperatively 1° postoperatively and 6° at follow up. Sasso *et al* noted that kyphotic angle was 17.6° preoperatively, 3.5° post operatively and 11.6° at latest follow up.

Study	On admission	Post-operative	Follow up
Nasser MG <i>et al</i>	23.6°	7°	11.5°
Alvine <i>et al</i>	12°	1°	6°
Sasso <i>et al</i>	17.6°	3.5°	11.6°
This study	16.5°	4.55°	4.45°

Complications

78% of the study group had shown no complications. Pressure sores were observed in 12.5% and screw impingement was observed in 6.25% of the study group. 3% patients also showed a discharging sinus. Uzumcugil *et al* noted two instances of hardware loosening and 3 misplaced pedicle screws.

Intermediate screw

Intermediate screw was inserted in 21 patients out of 32. This study showed that fracture level screw fixation technique could achieve and maintain correction, regional angle and vertebral height. First of all, this technique provides the correction of deformity through vertebral endplate augmentation with its buttress effect (bending force) like in the rod-sleeve method, which was used in spinal instrumentation at recent past [15].

The large bone defect created inside the fractured vertebra after height restoration has been speculated to be an important cause for implant failure, which is mostly seen in short-segment fixation. Therefore, augmentation techniques were designed and used for preventing failure. Transpedicular grafting of the injured anterior vertebral body in addition to short-segment fixation has been offered as a possible solution by Knop *et al* [17] and Alanay *et al*. Cementing of the injured vertebra beside the short-segment fixation is another option which was previously mentioned by Cho *et al* [5, 11].

We have used the intermediate screw option in the fractured vertebra level as a method of augmentation in the current study. The screw at the fracture level may provide a mass effect and prevent the vertebra from collapsing. It may also help to support anterior column, which is vital for the stability of the construct. The intermediate screws insertion leads to a stronger 3-point posterior support (instead of a 2-point fixation in the "conventional" method) for the failed anterior column in eligible cases. Insertion of additional screws

[intermediate] would only marginally increase the operative time, blood loss and surgical cost as rest of the procedure would remain the same.

Conclusion

The findings of these study show that short segment posterior instrumentation is an excellent implant system used in the treatment of vertebral fractures. There is a very high statistically significant restoration of vertebral body height, mean regional angle and mean anterior wedge angle. However in patients who presented with 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 patients.

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