

Study of Functional and Radiological Outcome of Short-Segment Pedicle Screw Fixation for Thoracolumbar Fractures with use of Pedicle Screws in Fractured Vertebrae

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Abstract

Purpose: The treatment of fracture-dislocations and unstable fractures of the thoracic and lumbar spine has been controversial. Many authors have advised conservative treatment which was labor intensive and associated with complications, increased bed occupancy, increased cost of therapy, increased hospital stay hours, and care by trained personnel. Early surgical indirect decompression with instrumentation reduces the duration of hospital stay, facilitates early recovery, and prevents prolonged morbidity, so there is an urgent need for possibilities of surgical stabilization, early mobilization, and rehabilitation of patients. The surgical decompression can be done anteriorly, posteriorly, or anteroposteriorly. With advent of pedicle screws, more and more fractures are treated with posterior based surgeries with long-segment (LS) fixation which regains spinal alignment and provides adequate stability. Short-segment pedicle screw fixations of thoracolumbar fractures excluding screw fixation at the fractured vertebrae do not provide the necessary stability; hence, additional fixation point with screws in the fractured vertebrae is useful and a safe technique in the treatment of thoracolumbar fractures.

This prospective study aims at comparing the clinical, radiological, and neurological outcomes after surgical decompression and instrumentation by posterior and transpedicular approach in thoracolumbar spinal fractures postoperatively at 1 month, 6 months, and 1 year follow-up periods.

Materials and Methods: Adult patients with acute thoracolumbar injuries admitted to Spine Surgery unit, Father Muller Medical Hospital, Mangalore, were taken for this study after obtaining their informed, valid written consent. This is a prospective study from September 2016 to August 2018.

Results: In our study, 50% of population belong to the age group of 31–50 years, 28% belong to the age below 30 years, and 22% belong to the age above 50 years and 92% of population were male and the rest 8% were female. Twenty-nine of them sustained L1 flexion distraction injury which accounts to about 58% of the fracture, the second most common being six patients with D12 flexion distraction injury which accounts for 10% of cases. Three cases each of D11, L2, and L3 flexion distraction injury which accounts for 6% of fracture. One each case of D11 unstable burst fracture, D12 chance fracture, D12 unstable burst fracture, L1 unstable burst fracture, L1 chance fracture, and L3 unstable burst fracture which accounts for 2% of total fractures. Thirty-eight patients had no neurological deficits and categorized under the American Spine Injury Association (ASIA)-E which accounts for 76% of the cases. Seven had neurological deficits, incomplete categorized under ASIA-C which accounts for 14% of the cases. Five were categorized under ASIA-D which accounts for 10% of total cases. Preoperatively, an average of 40.09% of vertebral body height was lost which improved in immediate post-operative period to 70.25% and maintained at 70.38% at the end of 1 year. Degree of segmental kyphosis preoperatively was 15.32°, which improved to 6.62° at the end of 1 year. Percentage of canal compromise measurement preoperatively showed an average of 30.38% of spinal canal encroachment. Immediate post-operative assessment showed decompression of canal to 12.64% and 10.00% at the end of 1 year. Preoperatively, an average Oswestry Disability Index score was

44.28% which improved in immediate post-operative period to 32.52% and 15.71% at the end of 1 year which is mild level of disability. Preoperatively, average visual analog score was 7 which shows moderate-to-severe pain which improved to 2.92, indicating minimal or no pain at the end of follow-up.

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Conclusion: The technique of short-segment pedicle screw fixation with screws in fractured vertebrae is safe as our study did not show worsening of the pre-operative neurological status in any patients with ASIA-C and above. There was adequate indirect decompression of the spinal canal using smaller incision, resulting in lesser operative time, and blood loss. The vertebral body height was satisfactorily reconstructed, kyphotic angle reduced, and the spinal alignment was maintained. The final outcome in terms of improvement of ASIA impairment scale was determined by the initial injury. Incomplete injuries improved by at least one scale as per ASIA. Hence, this is an effective and safe technique which retains the biomechanical stability as compared to the LS fixation while requiring smaller incision, lesser operative time, and less blood loss.

Keywords: Short-segment pedicle screw fixation, Thoracolumbar fracture, Transpedicular instrumentation.

Introduction

Spinal trauma is coming up as a common problem in today's orthopedic practice. An undiagnosed or suboptimally managed spine injury may result in neurologic deficits and can permanently impair a patient's function and quality of life, and in some cases, it may lead to death. It has been estimated that 6% of all the fractures involve the spinal column, with approximately 90% of them occurring within the thoracic or lumbar regions [1]. Majority of these injuries affect the motion segments between T11 and L2, which comprises the thoracolumbar junction. These levels connect the rigid, kyphotic thoracic spine, which is stabilized by the rib cage to the more mobile, lordotic lumbar vertebrae. As this transitional zone may experience substantial biomechanical stresses during traumatic incidents, it is generally more prone for fractures [2]. Thoracolumbar injuries classically exhibit a bimodal age distribution, with peaks among males under 30 years of age and in the geriatric population [3]. In younger patients, these fractures normally result from high-energy blunt trauma such as motor vehicle accidents, fall from height, and sports-related injuries.

The treatment of fracture-dislocations and unstable fractures of the thoracic and lumbar spine has been controversial. Many authors have advised conservative treatment which was labor intensive and associated with complications, increased bed occupancy, increased cost of therapy, increased hospital stay hours, and care by trained personnel's [3]. Early surgical

decompression with instrumentation reduces the duration of hospital stay, facilitates early recovery, and prevents prolonged morbidity, so there is an urgent need for possibilities of surgical stabilization, early mobilization, and rehabilitation of patients. With advent of pedicle screws, more and more fractures are treated with posterior based surgeries with long-segment (LS) fixation which regains spinal alignment and provides adequate stability. Short-segment pedicle screw fixations of thoracolumbar fractures excluding screw fixation at the fractured vertebrae do not provide the necessary stability; hence, additional fixation point with screws in the fractured vertebrae is useful and a safe technique in the treatment of thoracolumbar fractures.

In short-segment and long segment fusion, it was seen that the loss of correction and implant failure are certainly greater with short-segment posterior instrumentation (SSPI). However, long instrumentation compromises spinal motion and causes significant blood loss. Thus, the outcomes must be carefully balanced with the morbidity of sacrificing the motion of the segment [4,5,6].

A cadaveric study done by Mahar et al. reported an increased biomechanical stability of short-segment fixation with additional pedicle fixation at the level of fracture (short same-segment fixation) [7].

A subsequent study done by Guven et al. also showed an increased stability and long-term maintenance clinically with short same-segment fixation [8].

A comparative study done by Jonathan-James et al. showed that short same-segment fixation decreased implant failure and reoperation rate compared to traditional short-segment posterior fixation (SSPF), however, statistically significant long-term loss of kyphosis correction occurred. Despite loss of kyphosis correction, this study showed significant clinical improvement of patient disability over long-term follow-up [9].

This prospective study aims at comparing the clinical, radiological, and neurological outcomes after surgical decompression and instrumentation by posterior and transpedicular approach in thoracolumbar spinal fractures postoperatively at 1 month, 6 months, and 1 year follow-up periods.

Materials and Methods

Source of data

Adult patients with acute thoracolumbar injuries admitted to Spine Surgery unit, Father Muller Medical Hospital, Mangalore, were taken for this study after obtaining their informed, valid written consent. This is a prospective study from September 2016 to August 2018 and patient followed up at the end of 1 month, 6 months, and 1 year. All surgeries were performed by a single trained spine surgeon using standard midline posterior approach. They were assessed-

Neurologically

American Spine Injury Association (ASIA) scoring.

Radiologically**Amount of canal compromise**

Axial CT sections of fractured vertebrae at the level of pedicle were used for Anteroposterior canal dimension measurement. Anteroposterior diameters of fractured vertebrae and adjacent superior and inferior vertebra were measured and percentage canal compromise calculated using the formula $\{(a+c)/2-b\}/(a+c)/2 \times 100$



Figure 1: Computed tomographic images of fractured vertebrae demonstrating decompression

- a- Anteroposterior diameter of immediately superior vertebra
- b- Anteroposterior diameter of fractured vertebra
- c- Anteroposterior diameter of immediately inferior vertebra.

Degree of kyphosis

Cobb's angle is used to determine the degree of kyphosis. This is the angle formed between the perpendiculars to the lines corresponding to the superior endplate of cranial vertebrae and inferior endplate of the caudal vertebrae, adjacent to the site of injury.

Percentage loss of anterior vertebral body height

The amount of vertebral collapse is determined by calculating the height of the fractured body and expressing it as a percentage of the values acquired from the uninjured levels of the spine.

Functional outcome assessed using visual analog score (VAS), Oswestry Disability Index (ODI), and ASIA scoring.

Radiographic measurements were done using MicroDicom software by the same resident postgraduate in the department of orthopedics for all the cases. Collected data were analyzed by frequency, percentage, and mean and standard deviation using the SPSS version 16. Tests such as Friedman test were used to compare the parameters over different time points and post hoc analysis was carried out by Wilcoxon signed-rank test.

Results

Of the 50 patients included in the study, 50% of population belong to the age

group of 31–50 years, 28% belong to the age below 30 years, and 22% belong to the age above 50 years and 92% of population were male and the rest 8% were female. Twenty-nine patients sustained L1 flexion distraction injury which accounts to about 58% of the fracture, which signifies that fracture of vertebrae is more common at the thoracolumbar junction, the reason being the transition between, more rigid thoracic spine, and relatively mobile lumbar spine. The second most common being six patients with D12 flexion distraction injury which accounts for 10% of cases. Three cases each of D11, L2, and L3 flexion distraction injury which accounts for 6% of fracture. One case each of D11 unstable burst fracture, D12 chance fracture, D12 unstable burst fracture, L1 unstable burst fracture, L1 chance fracture, and L3 unstable burst fracture which accounts for 2% of total fractures. Thirty-eight patients had no neurological deficits and categorized under ASIA-E which accounts for 76% of the cases. Seven had neurological deficits, incomplete categorized under ASIA-C which accounts for 14% of the cases. Five were categorized under ASIA-D which accounts for 10% of total cases. Preoperatively, an average of 40.09% of vertebral body height was lost. Immediate post-operative assessment showed restoration of vertebral body height to 70.25%. On follow-up at the end of 1 month, 6th month, and 1 year

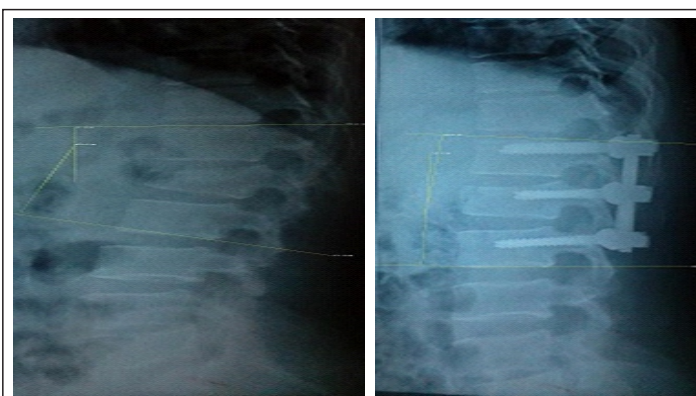


Figure 2: Radiograph images demonstrating degree of kyphosis

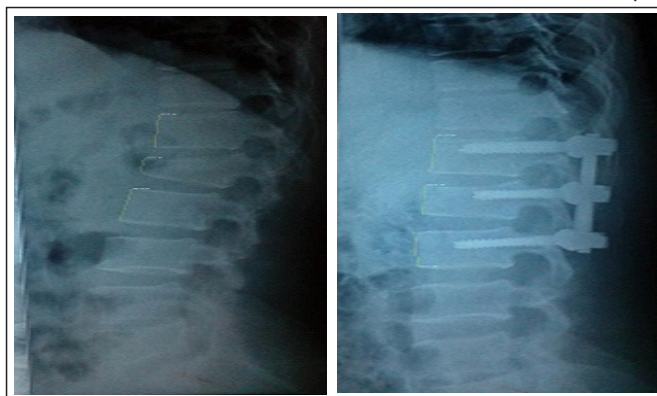


Figure 3: Radiographic imaging demonstrating measurement of anterior vertebral body height

showed the percentage of vertebral body height maintained as 68.6, 69.1, and 70.38%, respectively. An average of 15.32° of segmental kyphosis was noted preoperatively, which improved to 6.62° at the end of 1 year.

Extent of canal compromise preoperatively was 30.38%. Immediate post-operative assessment showed decompression of canal to 12.64%. Canal decompression maintained as 10.00% at the end of 1 year.

ODI score preoperatively was 44.28% which shows moderate-to-severe level of disability. Immediate post-operative assessment showed ODI score of 32.52% and 15.71% at the end of 1 year which is mild level of disability. Preoperatively, average VAS score was 7 for 50 patients included in the study, which shows moderate-to-severe pain and on follow-up showed VAS score of 5.20, 4.14, and

2.92, respectively, at the end of 1 month, 6 months, and 1 year, respectively, which is gradual decline in the pain with minimal or no pain at the end of follow-up.

Discussion

Thoracolumbar spine fractures occur normally due to high-velocity impact such as fall from height, RTA, and impact with a heavy object. Males are most commonly affected group involving mainly young, who are the breadwinners of family giving rise to economical and psychological injury.

In our study, males were the most commonly affected and mean age was 38.56 years and fall from height was the most common mechanism of injury.

The goals were clearly stated to aid selection of suitable procedures to achieve optimal results. The major aim of

the surgical treatment of the lower dorsal and lumbar spines was, restoration of neurological recovery and normal spinal anatomy. The efficiency of various surgical methods changes with the delay between injury and surgery. For old fractures which are over 6 weeks old, the mechanics of deformity correction are different, as secondary changes have already occurred [10].

Age and sex distribution

A retrospective chart study done by Jonathan-James et al. involving 25 single or two-level thoracolumbar burst fracture patients between September 2005 and April 2009, where 14 men and 11 women with an average age of 42.92 years (range 18–74 years). Mechanisms of spinal injury included motor vehicle accidents (7 patients), fall from height (16 patients), bicycle accident (1 patient), and crush injury (one patient) [9].

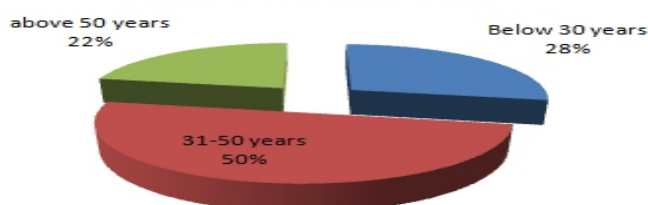
In a study done by Huang and Luo, from March 2008 to January 2010, a total of 30 patients with single thoracolumbar fractures, receiving vertical stress pedicle screw fixation of fractured vertebrae (Group A) or traditional double-plate fixation (Group B), were retrospectively reviewed. In Group A, 11 men and 3 women, aged 33–59 years (average 46.4 years), were enrolled and 12 men and 4 women, aged 34–63 years (average 47.2 years), were enrolled into Group B [11].

In a study by Wang et al., average age of the group in SS (short segment) was 47.2 years and in Group B fixation was 47.3 years ($t = 0.16$, $P = 0.987$). General information of Group short segment were 13 males and 16 female while in Group B, it was 16 males and 16 females ($t = 0.163$, $P = 0.686$). The fracture site of Group A were T11:6 T12:8 L1:8 L2:7 and Group B were T11:8 T12:8 L1:7 L2:9 ($t = 0.456$, $P = 0.928$). t-test showed that there was no statistical difference regarding age, gender, and fracture site distribution in two groups [12].

Table 1: Age distribution

Age	Frequency	Percentage
Below 30 years	14	28
31–50 years	25	50
Above 50 years	11	22
Total	50	100

AGE DISTRIBUTION

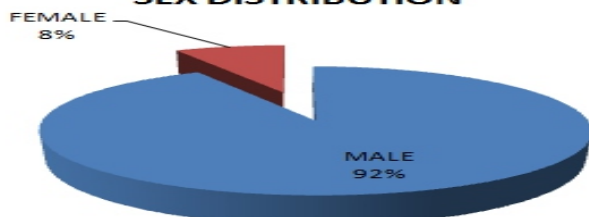


Pie chart 1: Age distribution

Table 2: Sex distribution

Sex	Frequency	Percentage
Male	46	92
Female	4	8
Total	50	100

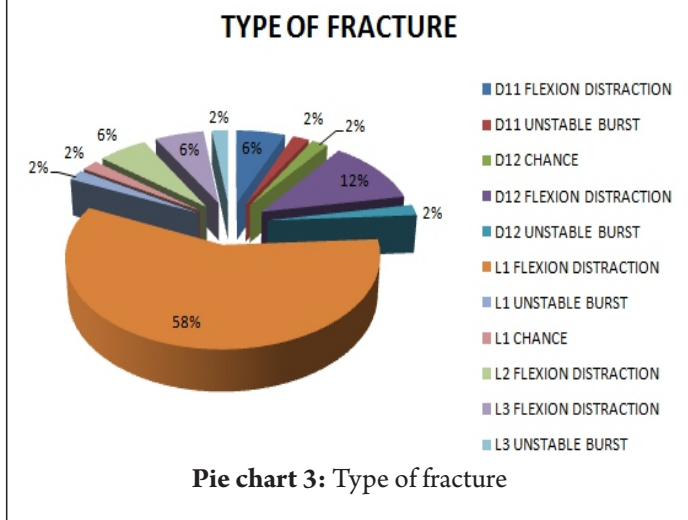
SEX DISTRIBUTION



Pie chart 2: Sex distribution

Table 3: Type of fracture

Type of fracture	Frequency	Percentage
D11 flexion distraction	3	6
D11 unstable burst	1	2
D12 chance	1	2
D12 flexion distraction	6	12
D12 unstable burst	1	2
L1 flexion distraction	29	58
L1 unstable burst	1	2
L1 chance	1	2
L2 flexion distraction	3	6
L3 flexion distraction	3	6
L3 unstable burst	1	2
Total	50	100



In our study, the inclusion criteria for age are between 18 and 60 years, of which 50% of population belong to the age group of 31–50 years, 28% belong to the age below 30 years, and 22% belong to the age above 50 years and 92% of population were male and the rest 8% were female as shown below.

Level of fracture

In a comparative study done by Patil and Joshi et al. of 50 patients (38 males and 12 females), age group of 18–50 years (mean 30.36 ± 9.15 years) with TLICS score of >4 (5.2 ± 0.6), they underwent posterior spinal instrumentation. Fall from height was the most common mechanism of injury in 34 (68%) patients followed by road traffic accidents in 10 (20%) patients. Forty-eight (70%) of patients sustained injury at a level of

thoracolumbar junction (T12-L1 level), and L1 was the most common vertebra involved [13].

From a study done by Huang and Luo, a total of 30 patients with single thoracolumbar fracture, receiving vertical stress pedicle screw fixation of fractured vertebrae (Group A) or traditional double-plate fixation (Group B), were retrospectively studied. The injured segments were T12 in three patients, L1 in six patients, L2 in three patients, and L3 in two patients in Group A and T12 in three patients, L1 in four patients, and L3

in two patients in Group B [11,14]. Harrington, in his study, found that thoracolumbar fractures most commonly occurred at T12 and L1 levels [15].

In our study, 29 of them sustained L1 flexion distraction injury which accounts to about 58% of the fracture, which signifies that fracture of vertebrae is more common at the thoracolumbar junction, the reason being the transition between, more rigid thoracic spine and relatively mobile lumbar spine. The second most common being six patients with D12 flexion distraction injury which accounts for 12% of cases. Three cases each of D11, L2, and L3 flexion distraction injury which accounts for 6% of fracture. One each case of D11 unstable burst fracture, D12 chance fracture, D12 unstable burst fracture, L1 unstable burst fracture, L1

chance fracture, and L3 unstable burst fracture which accounts for 2% of total fractures.

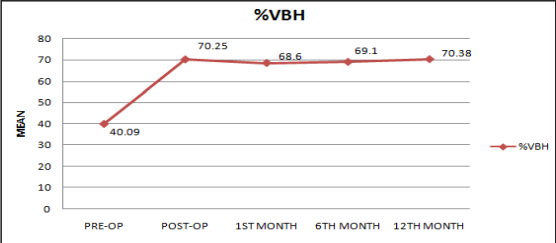
Percentage of vertebral body height reconstruction

In a prospective study done by Yang et al., the posterior fixation with screw in fracture vertebra (PFFV) group, the pre-operative vertebral body height improved from 62.69 ± 10.83% to 93.72 ± 6.75% postoperatively, there was significant difference (P = 0.016). In the traditional short-segment fixation (TSSF) group, the pre-operative vertebral body height significantly improved from 60.57 ± 10.12% to 91.97 ± 8.26% postoperatively (P = 0.029). During the last follow-up of after 1 year, the loss of correction of vertebral body height in the PFFV group (3.78 ± 2.28%) was significantly less than in the TSSF group (8.31 ± 5.33%) (P = 0.038). Up to 12 months post-surgery, no loose screws were found in the PFFV group, but screw breakage was found in two patients in the TSSF group [16].

In a study by Wang et al., the anterior height compression rate T1 and T4 were not significantly different (P = 0.152 and P = 0.17), but T2 and T3 in three fixations were significantly better (P = 0.046 and P = 0.003). Statistic indicated that the middle compression rate T1 and T4 were not significantly different (P = 0.81 and P = 0.763); however, T2 and T3 in short segment were significantly better (P = 0.047 and P = 0.044). The posterior compression rate T1, T2, T3, and T4 were the same (P = 0.071, P = 0.122, P = 0.118, and P = 0.17). There was satisfactory post-operative recovery of vertebral body height in the triplane fixation group and dual-plane fixation group, with 92.9 and 90.9% recovery, respectively [17].

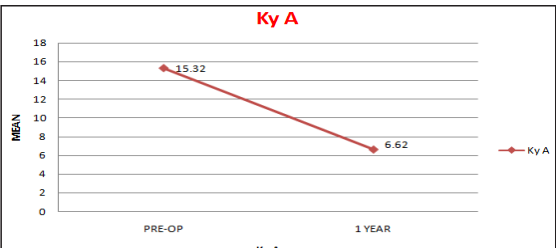
In our study, percentage of vertebral body height lost preoperatively was 40.08%. Immediate post-operative assessment showed restoration of vertebral body

Table 4: Percentage of vertebral body height reconstruction (%VBH)						
	n	Mean	Standard deviation	Median	Friedman test value	P-value
Pre-operative	50	40.09	8.03	40	31.656	0
Post-operative	50	70.25	13.8	70		HS
1 st month	50	68.6	15.49	64		
6 th month	50	69.1	11.68	60		
12 th month	50	70.38	11.25	70		



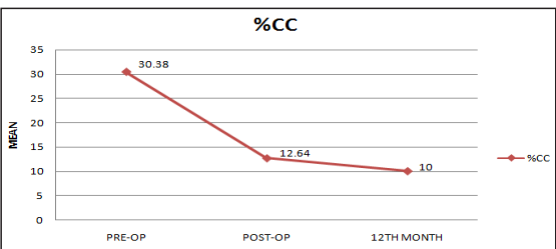
Graph 1: Vertebral body height correction

Table 5: Correction of segmental kyphosis (Ky A)						
	n	Mean	Standard deviation	Median	Friedman test value	P-value
Pre-operative	50	15.32	5.27	15	21.724	0
1 year	50	6.62	2.57	6		HS



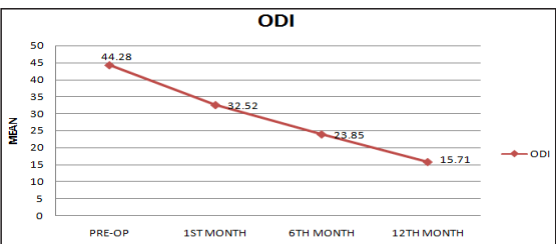
Graph 2: Correction of segmental kyphosis (Ky A)

Table 6: Percentage of vertebral canal compromise (%CC)						
	N	Mean	Standard deviation	Median	Friedman test value	P-value
%CC pre-operative	50	30.38	10.12	33	26	0
%CC post-operative	50	12.64	4.3	12		HS
%CC 12 th month	50	10	5.1	8		



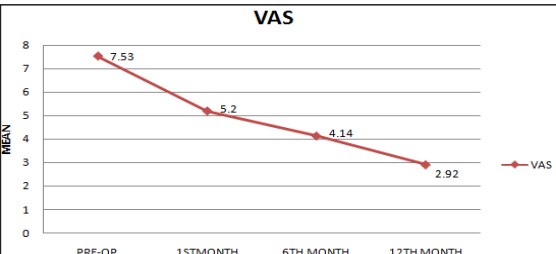
Graph 3: Percentage of canal compromise (%CC)

Table 7: Oswestry Disability Index (ODI)						
	N	Mean	Standard deviation	Median	Friedman test value	P-value
Pre-operative	50	44.28	6.223	45	40.59	0
1 st month	50	32.52	4.603	30		HS
6 th month	50	23.85	6.679	25		
12 th month	50	15.71	4.746	15		



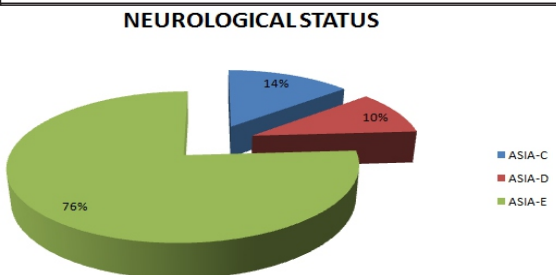
Graph 4: Oswestry Disability Index

Table 8: Visual analog score						
	N	Mean	Standard deviation	Median	Friedman test value	P-value
Pre-operative	50	7.53	0.507	8	35.175	0
1 st month	50	5.2	1.118	5		HS
6 th month	50	4.14	1.108	4		
12 th month	50	2.92	0.862	3		



Graph 5: Visual analog score

Table 9: Neurological status		
Neurological status	Frequency	Percentage
ASIA-C	7	14
ASIA-D	5	10
ASIA-E	38	76
Total	50	100



Pie chart 4: Neurological status

height to 70.25%. On follow-up at interval of 1 month, 6th month, and end of 1 year showed the percentage of vertebral body height maintained as 68.6, 69.1, and 70.38%, respectively. The post hoc analysis and the Wilcoxon signed-ranked test, P value was found to be highly significant ($P = 0.002$) at the end of 6th month and 1 year follow-up for restoration of vertebral body height.

Correction of segmental kyphosis (KyA):

A study conducted by Myung et al. states that in all patients, trauma-induced deformity (initial kyphosis average = 33°) in the sagittal plane was corrected on surgery (residual kyphosis average = 2°) and maintained (residual kyphosis average = 3°) until the final follow-up concluding that there was no clinically significant residual spinal deformities in any patient [18].

A cadaveric study done by Jonathan-James et al. of SSPF with pedicle fixation at the level of the fracture (short same-segment fixation) showed that short same-segment fixation provides more biomechanical stability than traditional SSPF. It also clinically confirmed the increased stability provided by short same-segment fixation in maintenance of kyphosis correction [9,19,20].

A study by Jonathan-James et al. showed average duration of the most recent follow-up was 21.64 months (range 3–42 months). Mean pre-operative kyphosis was 14.49° (range 6.25° – 24.40°). Average post-operative kyphosis was -0.74° (lordosis) (range 6.97° – -18.40°). Average follow-up kyphosis of all cases was 10.78° (range 0.85° – 35.00°), excluding failures, average follow-up kyphosis was 8.67° (range 0.85° – 25.00°). A mean of 15.23° of kyphosis correction was attained from pre-operative to post-operative ($P < 0.0001$). Average loss of kyphosis correction from immediate post-operative to most recent follow-up was -11.51° and -9.51 excluding the two failures ($P < 0.0001$). Average pre-operative to most recent follow-up

kyphosis correction was 3.72° ($P = 0.067$) and 5.51° excluding failures ($P = 0.0024$) [9].

In a study done by Machino et al., where long segment fixation was done sparing the fractured vertebra, kyphotic angle (KA) was 12.2 ± 10.51 kyphotic preoperatively, 3.5 ± 11.51 lordotic postoperatively, and 0.8 ± 10.81 lordotic at the final observation. For all fractures in this series, the operative correction angle for sagittal kyphosis was 15.7 ± 9.21 . A slight correction loss (loss of kyphosis correction; 2.6 ± 3.31) was observed because of sinking of the grafts [21].

In a prospective study by Yang et al. on surgical outcome of posterior fixation, including fractured vertebra, the pre-operative Cobb's angle improved from $19.78 \pm 7.31^\circ$ to $7.06 \pm 3.26^\circ$ after surgery, and there was a significant difference ($P = 0.026$). In the TSSF group, the pre-operative Cobb's angle improved from $20.51 \pm 6.06^\circ$ to $8.03 \pm 3.61^\circ$ after surgery, and there was also a significant difference ($P = 0.039$). At the last follow-up of after 1 year, the loss of correction of the Cobb's angle in the PFFV group ($2.63 \pm 1.95^\circ$) was significantly less than the TSSF group [16].

In our study, the pre-operative average segmental kyphosis was 15.32° and showed restoration of segmental kyphosis to 6.62° at the end of 1 year.

Restoration of canal dimension

In a study done retrospectively by Canbek and Karapinar [22], the diameter of spinal canal measured preoperatively was compared to post-operative measurements in the long-term period, the diameter of the spinal canal in the long-term post-operative period increased by 48.56% in Group 1 and by 47.01% in Group 2 patients compared to pre-operative measurements. The difference between the intermediate segment (IS) and long segment groups was not statistically satisfactory ($P = 0.839$).

In a study by Zou et al., spinal canal compromise was restored from $26.1 \pm 4.2\%$ preoperatively to $25.8 \pm 4.0\%$ postoperatively. The improvement in this group was significant ($P < 0.05$). At final follow-up, loss of vertebra height was detected to some extent. Remodeling of the spinal canal compromise was also detected in this group [23].

SSPI provides better restoration of spinal canal compromise. SSPI makes the partially displaced fragment return toward the vertebral column. This minimizes the possibility of deterioration in spinal canal compromise. However, some authors have reported spontaneous remodeling of the spinal canal in thoracolumbar burst fractures. Wilcox et al. concluded that there is no correlation between bony or canal disruption and the degree of neurological compromise [23,24,25].

Average pre-operative spinal canal encroachment was 30.38% and immediate post-operative assessment showed decompression of canal to 12.64% and at the end of 1 year, it showed the percentage of canal decompression maintained as 10.00%.

Oswestry Disability Index

A retrospective study by Jonathan-James et al. on short-segment fixation of thoracolumbar burst fractures, on initial 1-month follow-up, average Oswestry Disability score was severe at 52.63% (range 16–84%). At most recent follow-up, average Oswestry Disability score was minimal at 5.5% (range 0–16%). One patient was lost to long-term follow-up. Mean difference from 1-month follow-up to most recent follow-up (excluding failures) was 47.27% ($P < 0.0001$) [9,26].

In a retrospective study done by Canbek and Karapinar on posterior fixation of thoracolumbar burst fractures, the mean Oswestry Disability score among the 10 patients who underwent Intermediate segment instrumentation was 14.4% (12–24%), and the mean Oswestry

Disability score of the 15 patients who underwent Long segment instrumentation was 29.2% (12–58%). In the Intermediate segment instrumentation group, 8 cases (80%) reported low disability, 2 cases (20%) reported moderate disability, and there were no reports on severe disability. In the long segment instrumentation group, 6 cases (40%) reported low disability, 4 cases (27%) reported moderate disability, and 5 (33%) reported severe disability [22].

In a prospective study done by Zou et al. in the SSPI group, the ODI score changed from $66.1 \pm 9\%$ preoperatively to $58.2 \pm 5.9\%$ postoperatively ($P < 0.05$) and decreased to $34 \pm 4\%$ at the final follow-up ($P < 0.05$) [27,28].

In our study, pre-operative ODI score was 44.28 which indicates moderate-to-severe level of disability. Assessment at the end of 1 month showed ODI score of 32.5. ODI score at the end of 6 months and 1 year was 23.85 and 15.71, respectively, which indicates mild level of disability.

VAS

In a prospective study done by Zou et al. in the SSPI group, pre-operative VAS improved from 7.8 ± 0.9 to 5.8 ± 1.2 after surgery and at 2 ± 0.7 within the 2-year period of follow-up ($P < 0.05$) [27].

In our study, pre-operative average VAS score was 7.53 which shows moderate-to-severe pain and at the end of 1 and 6 months and 1 year was 5.20, 4.14, and 2.92, respectively, which is gradual decline in the pain with minimal or no pain at the end of follow-up.

Neurological status

A prospective study done by Singh et al. on functional outcomes of neurological recovery following monosegmental fixations of vertebral fractures, there was an improvement of average 1.03 grades in neurological status as per the ASIA impairment scale from the pre-operative to final follow-up at 1 year. The neurological recovery was highly significant ($P = 0.000$ using Chi-square

test with Yates' correction). Eighteen (27%) patients did not improve, 34 patients (51%) improved by one grade, 8 patients (12%) improved by two grades, and 6 patients (9%) improved by three grades. Twelve patients (18.2%) improved fully to Grade E. A total of 41% of patients of the pre-operative Grade A improved by one or more grades. All patients who did not improve had complete paraplegia (ASIA-A) at the time of injury [29,30].

Chadha et al. had also reported a fair neurological recovery in delayed surgery cases. In another study, the patients of early surgery group showed more improvement of the average ASIA score (1.2 grade) than the patient of late surgery group (0.95 grade), but the difference was not statistically significant ($P = 0.966$). It was also seen that there was neurological improvement in patients even when they were operated as late as 4 weeks. In the present study, the patients having incomplete lesions of the spinal cord showed more neurological improvement (average, 1.5 grade) than the complete lesion of the spinal cord (average, 0.53 grade). Similar observations were seen in other studies. Patients who did not improve were those with complete paraplegia (ASIA-A) at the time of injury [31].

In our study, 38 patients had no neurological deficits and categorized under ASIA-E which accounts for 76% of the cases. Seven had neurological deficits, incomplete categorized under ASIA-C which accounts for 14% of the cases. Five were categorized under ASIA-D which accounts for 10% of total cases. Of these 12 cases with neurological deficits [ASIA-C (268) and ASIA-D (286)], 5 patients showed improvement in neurology to ASIA-D (298) and ASIA-D (304), respectively, at the end of 1 year follow-up and are mobilizing with walking aid.

None of the patients in our study had any complications such as immediate post-operative surgical site infection,

worsening of the neurological status, and implant failure.

Five patients had urinary tract infection due to prolonged indwelling catheter, which resolved after a course of antibiotic as per culture sensitivity.

Summary

The technique of short-segment pedicle screw fixation with screws in fractured vertebrae was safe as our study did not show worsening of the pre-operative neurological status in any patients with ASIA-C and above. SSPI provides better restoration of spinal canal compromise and makes the partially displaced fragment return toward the vertebral column. This minimizes the possibility of deterioration in spinal canal compromise. We could achieve adequate and significant indirect decompression of the spinal canal.

The procedure resulted in smaller incision, lesser operative time, and blood loss. The vertebral body height was satisfactorily reconstructed, Kyphotic Angle reduced, and the spinal alignment was maintained.

The final outcome in terms of improvement of ASIA impairment scale was determined by the initial injury. Incomplete injuries improved by at least one scale as per ASIA and there was no deterioration of neurological status till the final follow-up.

Complication is a very important factor for assessing surgical safety. Being a posterior short-segment fixation, the surgical time and cost incurred in this technique will be much less than a long segment technique or a combined anterior and posterior fixation.

Hence, this is a practical, biomechanically advantageous, effective, and safe technique which retains the biomechanical stability as compared to the long segment in the surgical management of unstable thoracolumbar fractures while requiring smaller incision, lesser operative time, and less blood loss.

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