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ISSN: 2663-9491 E-ISSN: 2789-6897

Original Article

Comparative Study of Short Segment Pedicle Screw Fixation with or without Intermediate Screw in the Treatment of Unstable Thoracolumber Fracture

DOI: dx.doi.org

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Received: 15 Oct 2024
Accepted: 27 Apr 2025
Published: 30 Apr 2025

Published by:
Gopalganj Medical College,
Gopalganj, Bangladesh

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ABSTRACT

Background: *Unstable thoracolumber fracture needs surgical stabilization. For many years short segment and long segment stabilization procedure were used. Short segment fixation including fracture vertebra is a technique of fixation.* ***Objectives:*** *To compare the outcome of short segment posterior fixation with incorporating fractured vertebra and short segment posterior fixation without incorporating fractured vertebra in the treatment of thoracolumber fracture.* ***Methods & Materials:*** *This prospective comparative observational study was carried out in the Orthopedic Surgery department of M.A.G. Osmani Medical College Hospital, Sylhet, during March 2019 to August 2021 including 23 patients of unstable thoracolumber fracture in group A(PFFV) and 23 patients in group B(SSPF). Assessment of Neurological outcome was done by ASIA impairment scale, functional outcome by Oswestry disability index, visual analogue score, modified Mcnab criteria,and radiological outcome by pre- and post-operative cobb kyphotic angle measurement. Statistical analyses were done by SPSS-22.* ***Results:*** *Most commonly involved level was at L1 (52.17%). In case of ASIA impairment, Scale 1 grade improvement in 16(69.6%) patients in PFFV group and 15(65.2%) patients in SSPF group, Scale 2 grade improvement in 7(30.4%) patients in PFFV group and 7(30.4%) patients in SSPF group. Functional outcome were improved in postoperative successive follow up. There was no significant difference in the neurological and functional outcomes between two groups (P>.05). The mean preoperative cobb's kyphotic angle was 22.26±7.56 in PFFV group and 22.30±4.74 in SSPF group. Immediate post operative cobb's kyphotic angle was 5.22±2.71 in PFFV group and 5.48±1.75 in SSPF group. The pre- and postoperative difference between 2 groups was not statistically significant.. In the last follow up at 6 months cobb's kyphotic angle was 8.96±3.30 in PFFV group and 10.91±3.06 in SSPF group, that was statistically significant. The loss of correction from immediate post-operative to final outcome was 3.74±2.18 in PFFV group and 5.43±2.41 in SSPF group, this was also statistically significant (p<.05).* ***Conclusion:*** *Functional and neurological outcome were similar in two techniques. But the intermediate screw fixation technique is better in maintainnance of kyphotic correction.*

Keywords: *Thoracolumber fracture, neurological outcome, functional outcome*

(The Insight 2024; 7(2): 4-10)

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INTRODUCTION

Spinal column injury represents approximately 3% of all trauma cases and 90% of these injuries involve the thoracolumbar region. The thoracolumbar segment of spine (D10 to L2) is an unstable zone between fixed dorsal and mobile lumbar spine and an acute injury to this segment is the second most frequent site after cervical spine injury in adults [1]. Each year, approximately 5 million new vertebral fractures occur worldwide [2]. They are more frequent in men, with peak incidence at 20 to 40 years [3]. 65% of thoracolumbar fractures occur due to motor vehicle injuries and falls from a height [4]. Approximately 50-60% of all spinal fractures are found in the thoracolumbar junction (D12-L2), which represent a mechanical transition zone between the rigid thoracic and more mobile lumber spine. 75% of them sustain some degree of neurological deficit [5]. A stable injury is one in which the vertebral components will not be displaced by normal physiological loads, whereas an unstable injury is one in which there is a significant risk of displacement and damage to the neural tissues [6]. All fractures involving the middle

ISSN: 2663-9491 E-ISSN: 2789-6897

column and at least one other column should be regarded as unstable [7]. An intact posterior column is a major determinant of stability of the vertebral column [6]. Radiographic signs of unstable fracture include; widening of the interspinous distances, kyphosis of more than 20°, vertebral body height loss of more than 50%, vertebral body translation of more than 2 mm, articular process fractures [8]. In general, operative treatment is indicated mainly for unstable fractures and fracture dislocation [9]. Other strong indication for surgical correction include; progressive neurological deficit, incomplete neurological deficit, spinal cord compression [10]. The main goal of surgery for unstable thoracolumbar fracture are; to provide stability for prevention of future neurological deficit, decompression of spinal canal to maximize neurological recovery, spinal realignment to prevent painful deformity, early mobilization, rehabilitation and return to work [11].

Surgical stabilization options include anterior, posterior and combined anterior-posterior instrumentation [12]. Although removal of the compressing bone fragment from anterior side of spinal cord directly addresses the pathology causing the neurodeficit [13], the morbidity of the surgery through anterior approach is higher than that of posterior approach [14]. So, there has been a tendency for posterior stabilization and instrumentation as the preferred treatment modality for these type of fractures [15]. Pedicle screw and rod system allow immediate stable fixation as they traverse all the three columns and provide stable three-column support [16].

Pedicle screw and rod system may be used to provide long segment or short segment posterior stabilization. Long-segment posterior fixation (LSPF) is the use of pedicle screw and rod two to three level above and below fractured vertebral body. These constructs may impart greater fracture stability, but at the cost of sacrificing larger motion segments. It causes significant increased vertebral immobility and dorsalgia. In addition, long operative time and increased the amount of blood loss is associated with LSPF [17]. Short-segment instrumentation with the pedicle screws introduced one level down and one level up from the fractured vertebra has become the preferable surgical method because of its ease of application, use of less surgical fixation material, reduction of blood loss, and smaller incision field. However, disadvantages of this method, such as inadequate long-term reduction, instrumentation insufficiency, and increases in kyphosis and pain, have also been reported [18].

Nevertheless, there is no consensus in clinical practice as to whether to use intermediate screws. Surgeons usually make this decision based on their preference and experience. This study aimed to observe the outcome of the use of intermediate screws at the fracture vertebra compared with that of traditional short-segment pedicle screw instrumentation for improving clinical outcomes, correcting the deformity, and maintaining correction in unstable thoracolumbar fractures.

OBJECTIVES

General objective:

To compare the outcome of PFFV and SSPF in the treatment of unstable thoracolumber fractures.

Specific objectives:

- To asses neurological outcome by ASIA impairment scale.
-To evaluate functional outcome by ODI, VAS and Modified Mcnab Criteria.
-To assess radiological outcome by cobb's kyphotic angle.
-Identify complications like implant failure, wound infection.

METHODS & MATERIALS

This is a prospective comperative,observational study done from March 2019 to August 2021 at Department of Orthopaedic Surgery, Sylhet M.A.G Osmani Medical College Hospital, Sylhet.

The estimated sample size was calculated by using the following statistical formula:

$$n = \frac{(Z_\alpha + Z_\beta)^2 \times (\sigma_1^2 + \sigma_2^2)}{(\mu_1 - \mu_2)^2}$$

Selection Criteria

Inclusion Criteria:

- Unstable thoracolumbar fracture with or without neurological deficit (ASIA type- B, C, D, E)
- Single Vertebral involvement.
- Progressive spinal neurological deficit
- Age - 18 to 60 years of age
- Presented within 03 weeks of trauma

Exclusion Criteria:

- Stable fracture
- complete neurological deficit (ASIA –A)
- Pathological fracture
- Severe Co morbid conditions (ASA > 2)
- Other site fracture requiring intervention
- Preexisting spinal deformity
- A history of previous spine surgery
- Polytrauma
- An infective disease of Spine

Measurement of Variable

A. Demographic variable

Age
Sex

B. Clinical Variables

Fracture level
Mode of Injury

C. Outcome variables

- Neurological Outcome
ASIA grading
- Functional outcome
VAS
ODI
Modified Mcnab criteria
– Radiological outcome
Cobb angle

ISSN: 2663-9491 E-ISSN: 2789-6897

- Complication
  - Implant failure
  - Neurological deterioration
  - Wound infection,

RESULTS

During this study, a total number of 46 patients of thoracolumber spinal injury who full-filled the inclusion criteria for this study were selected. All patients were followed up at 6th week, 3 month and 6th month post operatively. The follow up assesment included neurological evaluation by ASIA impairment scale, functional status by Oswestry disability index, visual analouge score, Modified mcnab criteria. And radiological outcome was assessed by cobb kyphotic angle measurement.

Age of the patients: Age of the patients was observed that 8(34.7%) patients in PFFV group and 9(39.0%) patients in SSPF group belonged to age 16-25 years. The mean was 32.43±9.88 years in PFFV and 30.83±11.9 years in SSPF. The difference was not statistically significant (p>0.05) between two groups.

Gender of the patients: It was observed that (82.6%) patients in PFFV group and 16(69.6%) patients in SSPF group were male. The difference was not statistically significant (p>0.05) between two groups.

Mechanism of injury: Mechanism of injury was observed that 16(69.6%) patients in PFFV group and 17(73.9%) patients in SSPF group had a history of FFH. The difference was not statistically significant (p>0.05) between two groups.

Level of injury of the patients: It was observed that 13(56.5%) patients in PFFV group and 11(47.8%) in SSPF group had L1 level injury. The difference was not statistically significant (p>0.05) between two groups.

Table I showed the improvement of the patient's neurological status on the basis of ASIA grade. 1 grade improvement in 16 patients in PFFV group and 15 patients in SSPF group. 2 grade improvement in 7 patients in both group.1 patient had no improvement in SSPF group. The difference was not statistically significant (p>0.05) between two groups.

Table – I: Postoperative improvement of ASIA Impairment Scale in cases (*n*=46)

Improvement in ASIA scale	PFFV (n=23)		SSPF (n=23)		Total (n=46)		*p* value
	n	%	n	%	n	%	
No improvement	0	0.0	1	4.3	1	2.2	0.597ns
1 grade	16	69.6	15	65.2	31	67.4	
2 grade	7	30.4	7	30.4	14	30.4	
Total	23	100.0	23	100.0	46	100.0	

ns = not significant

p value reached from Chi-square test

Table 2 showed the mean pre-operative Cobb's kyphotic angle was 22.26±7.56 in PFFV group and 22.30±4.74 in SSPF group. The difference between 2 groups was not statistically significant. In the last follow up at 6th month cobb kyphotic angle was 8.96±3.30 in PFFV group and 10.91±3.06 in SSPF group. The difference was statistically significant. The loss of correction from immediate post operative to final outcome was 3.74±2.18 in PFFV group and 5.43±2.41 in SSPF group and this was also statistically significant (p<.05).

Table 2: Cobb's kyphotic angle of the patients (*n*=46)

Cobb's Kyphotic Angle	Group	Mean±SD	*P* value
Pre-operative	PFFV (n=23)	22.26±7.56	0.983ns
	SSPF (n=23)	22.30±4.74	
Immediate post-operative	PFFV (n=23)	5.22±2.71	0.701ns
	SSPF (n=23)	5.48±1.75	
Final outcome	PFFV (n=23)	8.96±3.30	0.044s
	SSPF (n=23)	10.91±3.06	
Loss of correction	PFFV (n=23)	3.74± 2.18	0.016s
	SSPF (n=23)	5.43±2.41	

s= significant

ns= not significant

p value reached from Unpaired t-test

Mean pre-operative visual analogue score (vas) was 55.65±8.98 in PFFV group and 60±7.98 in SSPF group, and the final outcome was 18.70±6.94 in PFFV group and 20.87±7.33 in SSPF group. The difference was not statistically significant (p>0.05) between two groups.

ISSN: 2663-9491 E-ISSN: 2789-6897

Among 46 cases, 8(34.8%) and 5(21.8%) cases showed excellent results in the PFFV group and SSPF group at the final follow up. Good result was found in 12(52.2%) patients in PFFV group and 14(60.9%) patients in SSPF group. Fair result was found in 2(8.7%) patients in PFFV group and 3(13%) patients in SSPF group. The difference was not statistically significant (p>0.05) between two groups.

Complication of the patients. 1(4.3%) patient developed wound infection in each group. Only patient developed urinary retention in SSPF group. The difference was not statistically significant (p>0.05) between two groups.
Figures of two illustrations (**Fig. 1a, 1b, 1c and 2a, 2b, 2c**) are shown below- Case-01

Figure – 1 (a): Preoperative MRI shows fracture of L1 vertebra with retropulsion of bone fragment into spinal canal

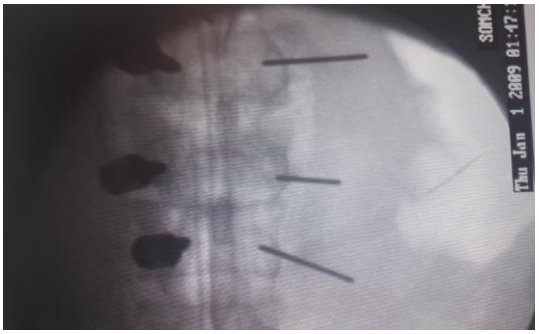

Figure – 1 (b): Peroperative x-ray shows screw introduction in pedicle

Figure – 1 (c): X-ray after 3 months shows fixation with pedicle screw and rod Case 02

Figure – 2 (a): Preoperative MRI shows fracture of L1 vertebra

Figure – 2 (b): Peroperative xray shows introduction of pedicle screw pedicle and rod

ISSN: 2663-9491 E-ISSN: 2789-6897

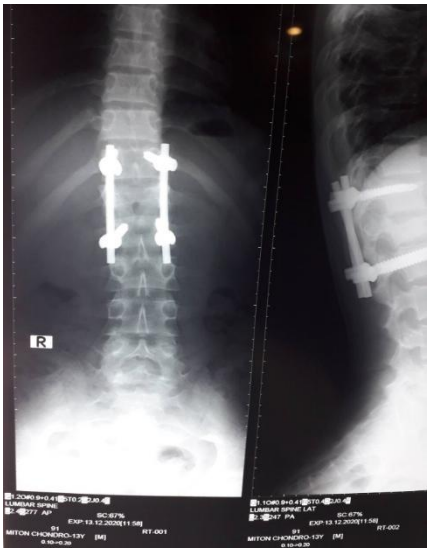

Figure – 2 (c): X-ray after 3 months shows fixation with pedicle screw and rod

DISCUSSION

In this present study it was observed that 34.7% patients belonged to age 16-25 years in PFFV and 39.0% in SSPF. The mean age was 32.43±9.88 years in PFFV and 30.83±11.9 years in SSPF. The mean age difference was not statistically significant (p>0.05) between two groups. Farghaly et al. (2021) study found that the mean age was 31.20 ± 14.85 years in PFFV Group and 37.10 ± 9.72 years in SSPF group[19]. The mean age was not significantly different between the two groups (p> 0.05), which is similar with the present study. Ye et al. (2017) study showed the mean age 39.6 years varied from 16–63 years in PFFV group and 38.7 years varied from 14–60 years in SSPF (A) group[20]. There was no difference in age between the 2 groups, which support with the present study. In another study Sun et al. (2016) observed the mean age of the patients was 41.86 years varied from 30–55 years in PFFV (B) group and 40.67 years varied from 31–54 years in SSPF (A) group[21], which is higher with the present study. Higher mean age also observed by Shao et al. (2021) and Hur et al. (2015)[22, 26]. The higher mean age and age range obtained by the above authors maybe due to geographical variations, racial, ethnic differences and genetic causes may have significant influence in their study subjects.

It was observed in this present study that almost all the patients in both group improved neurologically on the basis of ASIA grade. 1 grade improvement in 16 patients in PFFV group and 15 patients in SSPF group. 2 grade improvement in 7 patients in both group. The difference was not statistically significant (p>0.05) between two groups. 1 patient had no improvement in SSPF group. In the series of Muralidhar et al. (2014)[23], 26 (86.7%) were improved, in that 17(56.6%) cases showed one grade improvement, 8(26.6%) showed two grade improvement and one (3.33%) improved three grade. The current study showed no decrease in the ASIA impairment scale.

In this current study it was observed that pre-operative Cobb's kyphotic angle was 22.26±7.56 in PFFV group and 22.30±4.74 in SSPF group. The difference between 2 groups was not statistically significant. In the last follow up at 6th month cobb's kyphotic angle was 8.96±3.30 in PFFV group and 10.91±3.06 in SSPF group. The difference was statistically significant. The loss of correction from immediate postoperative to final outcome was 3.74±2.18 in PFFV group and 5.43±2.41 in SSPF group and this was also statistically significant (p<.05). As regards to compare the short-term post-operative Cobb kyphotic angle between the 4-screw and 6-screw construct group[20]; showed patients in the 6-screw construct group had significantly better short term and long-term post-operative Cobb kyphotic angles with a mean difference of 1.6° and 3.8° respectively. Kapoen et al. (2020) meta-analysis revealed that a 6 screw construct significantly improves outcomes concerning postoperative pain[24], short-term and long-term Cobb kyphotic angles, correction loss of Cobb kyphotic angle and AVBH and implant failure. The mean difference in long-term Cobb angle of almost 4 degrees. Farghaly et al. (2021) study found significant statistical differences in the measurements of Cobb kyphotic angles immediate postoperatively[19], after three months and after six months 3.0±2.87 and 5.22±3.06 and 7.39±3.97 for PFFV group and 7.38±5.23 and 11.13±6.98 and 12.88±7.27 for SSPF group respectively (p<0.001)[19], but not preoperatively as the preoperative mean Cobb kyphotic angle was 17.67±7.06 for PFFV group and 15.56±7.04 for SSPF group (*p*>0.05). They found also that the better correction in favor of intermediate screws was maintained in the follow up visits 6 and 12 months after the surgery. The recent meta-analysis of Tong et al. (2018) also showed that the combined intermediate screws fixation technique was associated with significantly improved radiologic outcomes [25].

In this present study it was observed that the mean pre-operative oswestry disability index (ODI) was 64.96±13.11 in PFFV group and 66±12.46 in SSPF group, and the final outcome was 19.3±10.61 and 20±9.07. The difference was statistically not significant (p>0.05) between two groups. Shao et al. (2021) study observed that all the ODI scores between this two groups before surgery[22], one week after surgery and one year after surgery had no statistical significance (*p*>0.05), while ODI scores in the respective group before surgery, one week after surgery and one year after surgery had downward trend. The ODI was determined by Sun et al. 2016[21]; Ye et al. (2017) showed no significant difference between the 6-screw and 4-screw construct group (*p>0.05)* after one year[20], which may be explained by the fact that the ODI was only studied in 3 RCTs and 2 retrospective studies. As for ODI score Sun et al. (2016) study found that 16.7% at final follow-up in PFFV Group[21], while that of SSPF group was 15.5%. There was no statistically significant difference in ODI score between two groups. Similar observations also observed by Farghaly et al. (2021) and Ye et al. (2017)[19-20].

In this present study it was observed that among 46 cases, 34.8% and 21.8% cases showed excellent results in the PFFV

ISSN: 2663-9491 E-ISSN: 2789-6897

group and SSPF group at the final follow up. Fair and good results found in 8.7%, 13.0% cases and 52.2% and 60.9% cases. Only 1 case in each group showed a poor result. The difference was statistically not significant (p>0.05) between two groups. Hur et al. (2015) study observed that patients in both groups achieved satisfactory clinical outcomes according to the modified Mcnab criteria[26]. In the PFFV group, 34.1%, 50.0%, 11.4% and 4.5% cases were considered to have excellent, good, fair, and poor outcome. In the SSPF group, 18.8%, 62.5% and 18.8% cases were considered to have excellent, good, and fair outcome, respectively. Furthermore, according to the modified Mcnab criteria, the clinical outcomes in the short-segment 81.3% and long-segment group 84.1% were "good" with no significant difference between the groups.

Complication is a very important factor for assessing surgical safety. In this current study it was observed that among 46 cases, In PFFV and SSPF group, 4.3% and 8.6% cases showed complications. Wound infection 4.3% case in each group, urinary retention 4.3% in the SSPF group. The difference was statistically not significant (p>0.05) between two groups. There were no serious complications such as infection, blood vessel injury, spinal cord or nerve root injury and no patient needed revision for loss of correction or failure of instrumentation observed by Sun et al. (2016)[21]. Farghaly et al. (2021) studied 40 patients and 7 patients had postoperative complications[19], out of which 1 patient had a seroma in PFFV group, 2 patients had chest infection in SSPF group and 2 patients had wound infection in each group, which showed no significant statistical differences between the two groups as regards to postoperative complications. Dong et al. (2009) study found no significant differences between the two techniques as regards to rate of complications. They also reported the same types of complications.

CONCLUSIONS

Functional and neurological outcome are similar in two techniques. But the intermediate screw fixation technique is better in maintenance of kyphotic correction.

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