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Early Short Segment Pedicle Screw Fixation Including Fractured Vertebra of Thoracolumbar Burst Fracture with Incomplete Spinal Cord Injury

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Abstract **Original Research Article**

***Background*:** Fractures of the thoracolumbar region are the most common injuries of the vertebral column; among them burst fractures are the most frequent. Several studies were done to see the surgical outcome of thoracolumbar burst fracture hence surgery was recommended for a better outcome. So, the current study aimed to evaluate the clinical, functional, and radiological outcome of short-segment pedicle screw fixation including the fractured vertebral body. ***Objectives*:** The primary aim of this study is to comprehensively evaluate the functional and radiological outcomes of early short-segment pedicle screw fixation, particularly in cases involving fractured vertebrae in thoracolumbar burst fractures accompanied by incomplete spinal cord injuries. ***Materials & Method*:** In this prospective observational study, 31 cases were included between April 2017 and July 2018 through non-randomized purposive sampling. All patients, aged 15 to 60 years, underwent posterior decompression and short-segment pedicle screw fixation, including the fractured vertebral body, within 21 days of the fracture. Postoperative functional outcomes were clinically assessed using the Oswestry Disability Index (ODI), Visual Analog Scale (VAS), American Spinal Injury Association (ASIA) scale, Denis Work Scale, and radiologically evaluated by Cobb's kyphotic angle, kyphotic deformation, Beck index, and Bridwell criteria. Postoperative follow-ups were conducted at the 6th, 12th, and 24th weeks. ***Results*:** In this study, 31 cervical spinal injury patients underwent operative treatment with a 3 to 12-month follow-up. Most were day laborers (35.48%), experiencing falls from height (80.65%), mainly at L1 (54.84%). Initial ASIA grade D improved to E (54.58%). Postoperatively, significant improvements in kyphotic angles, Beck index, and vertebral height were noted, with some correction loss at the final follow-up. Complications occurred in 22.58% of cases, including per-operative hemorrhage, dural tear, early post-operative CSF leak, urinary retention, skin infection, and bed sore. The study emphasizes operative efficacy for cervical spinal injuries, highlighting functional and radiological outcomes. The average age was 31.42±11.2 years, with a male predominance (74.19%). Falls from height (80.65%), mainly affecting L1 (54.84%), were the primary causes. ASIA grade improvement was observed without deterioration. Significant improvements in Cobb's kyphotic angle, kyphotic deformity, Beck index, ODI, and VAS were seen. The Denis W2 group comprised 61.29% of cases, with 80.65% demonstrating grade II fusion at the last follow-up, accompanied by complications such as hemorrhage, dural tear, CSF leak, urinary retention, skin infection, and bed sore. ***Conclusion*:** Thoracolumbar burst fracture with incomplete spinal cord injury can be treated with short-segment pedicle screw fixation including the fractured vertebral body effectively. This method offered a better kyphosis correction, fewer instrument failures, appraisable clinical and functional recovery, reduced pain, and improved working status with early rehabilitation.

Keywords: Thoracolumbar fractures, Neurological deficit, Burst fractures, Pedicle screw fixation.

BACKGROUND

Ninety percent of all spine fractures are related to the thoracolumbar region [1]. Especially, the majority of thoracolumbar injuries occur at the T11 to L2 level, which is the biomechanically weak for stress [2]. The causes of thoracolumbar fracture are different depending on patient's age. In younger patients, fracture is more likely to occur due to a high-energy trauma, such as motor vehicle accident, motorcycle accident, and falling injury. However, in elderly, even falls from standing

position to ground can cause fractures due to osteoporosis and decreased cognition [3]. The primary goal of treatment of the thoracolumbar fracture is keeping patients alive, protecting from the further neural damage, obtaining the stability by reconstructing anatomical alignment of spinal columns and returning patients to workplace through early mobilization and rehabilitation. Thoracolumbar spine fractures are one of the most common types of traumatic injury, with approximately 90% of spinal fractures occurring at the thoracolumbar segmen [4]. The presence of a neurological deficit ranges from 20% to 36% of the fractures at the thoracolumbar junction; however, even in patients who do not experience any complications, chronic pain and limitation of daily activities with difficulty to return to work are often encountered [5, 6]. Burst fractures account for up to 17% of all major spinal fractures [3]. The thoracolumbar region (T11 to L2) is the commonest site of burst fractures as the region forms a transition zone between the relatively fixed, kyphotic thoracic spine above, and the relatively mobile, lordotic lumbar spine below, which causes stress forces to concentrate upon the thoracolumbar vertebral column [7]. Burst fractures result from compression failure of both the anterior and middle columns under substantial axial loads [3]. The vast majority of burst fractures are associated with some degree of canal compromise, typically as a result of retropulsion of an osseous fragment or fragments from the posterior superior end plate. As a result neurologic injury has been reported to occur in 30% of the patients with thoracolumbar fractures [8]. There are standard classification systems that have been described based on fracture morphology, injury mechanism, neurological deficit and injury to posterior ligamentous complex (PLC). Radiographs are the basic investigation while computed tomography (CT) scan provides information on the extent on bony injury and magnetic resonance imaging (MRI) scan shows injury to the spinal cord and soft tissue structures [9]. The surgical treatment of unstable fracture & fracture dislocations of thoracolumber spine remain controversial. Traumatic fracture of the thoracolumbar spine can be treated conservatively, but the surgical treatment is the modern way of treatment. Among the surgery posterior transpedicular fixation has been the preferred method for stabilizing acute unstable thoracolumbar fractures [10]. Absolute indication of early surgery is progressive neurological deficit [11]. Other indication for surgical intervention are incomplete neurological deficit, >25-300 angle of kyphotic deformity, >50% of loss of vertebral body height, and >40-50% of canal narrowing [12]. The goal of treatment in thoracolumbar fractures are to restore vertebral column stability and obtain spinal canal decompression [13]. Long-segment pedicle screw fixation (LSPF) usually involves inserting eight screws: two levels above & below the fracture. Short-segment posterior fixation (SSPF) involves inserting four screws: one level above & below the fracture [14]. Short-segment posterior fixation is the most common and simple treatment. It offers the advantage of incorporating fewer motion segments in the fusion. Segmental fixation with additional screws at the level of the fracture an increase construct stiffness and shields the fractured vertebral body from anterior loads. Furthermore, this additional point of fixation allows for a 3-point reduction maneuver analogous to that used for reduction of long bone fractures [15]. In this study, we tried to evaluate the efficacy of the inclusion of the fractured vertebra in short segment fixation in terms of clinical and radiological outcomes in unstable thoracolumbar junction burst fractures.

OBJECTIVES

General Objectives

To assess the functional and radiological outcome of early short segment pedicle screw fixation including fractured vertebra of thoracolumbar burst fracture with incomplete spinal cord injury.

Specific Objectives

To achieve the above-mentioned general objective, specific objectives will be-

- To evaluate neurological outcomes.
- To assess functional outcomes.
- To see the radiological correction after surgery.
- To see the complications after surgery.

METHODS AND MATERIALS

This prospective observational study was conducted at NITOR, Dhaka, during the study period spanning from January 2017 to December 2018, with enrollment taking place from April 2017 to July 2018. The study focused on patients diagnosed with thoracolumbar burst fractures accompanied by incomplete spinal cord injuries, comprising the designated study population.

The sample size was determined by the following formula-

n= $\frac{z^2pq}{d^2}$

Where,

p=Expected proportion of even (prevalence or proportion of occurrence); if not known

[p = 50%= .50]

n= Desired sample size.

z=Value of standard normal distribution (z-distribution) at a given level of significance or a given confidence level (e.g. at 5% level significance or 95% confidence level, Z = 1.96). It is marked out from the standard normal distribution table.

d= usually set at 1.96 at a 5% level which corresponds to 95% confidence level (.05).

p=the assumed target proportion to have a particular characteristic,

However, a total of 36 cases were enrolled during the enrollment period. But, 5 cases did not come

for follow-up. Therefore final sample size was 31. Cases were selected for study from emergency or OPD after x-ray examination, then admitted to hospital. Each patient was followed up for at least 24 weeks, and clinical, radiological, and functional scoring was done and recorded for outcome evaluation. Editing is done of collected data for SPSS entry. Analysis was done by SPSS 20.0 for Windows software. The data were tabulated and quantitative parameters such as the age of the patient will be summarized in terms of mean and median. Standard deviation was computed to understand the variation present in the data. Percentage expression for positivity of scoring was estimated along with a 95% confidence interval. The significance of the results was determined in a 95.0% confidence interval.

Ethical Consideration

The research protocol was approved by the Research Review Committee of the National Institute of Traumatology and Rehabilitation (NITOR), Dhaka, before the study's commencement. Patients were informed about the study's objectives, procedures, alternative diagnostic methods, risks, and benefits in their local language, and informed consent was obtained from each patient before their inclusion. Confidentiality of records was assured. Patients covered the cost of the 4 mm partial threaded cannulated cancellous screw. No financial support was received from any organization or patient, and patients did not receive financial benefits for participating in the study. The study adhered to ethical research guidelines, including the Helsinki Declaration of 1977 as revised in 1983.

RESULTS

During this study, a total number of 31 patients of cervical spinal injury who full-filled the inclusion criteria for this thesis were selected. Patients were treated operatively from September 2017 to August 2018. All patients were followed up for at least 3 months to 12 months. In this series the following results were obtained.

Table 1: Distribution of cases according to age (N=31)

Age (In years)	Frequency	Percentage (%)
11-20	7	22.58%
21-30	11	35.48%
31-40	7	22.58%
41-50	5	16.13%
51-60	1	3.23%
Total	31	100.00%

Table 1 shows the distribution of patients by age. In this study, the highest number of patients 11 (35.48 %) was observed in the 3rd, and the lowest number of patients 1 (3.23%) was observed in the 6th decade. The mean age was (31.42±11.2) years with a range from 17 to 60 years.

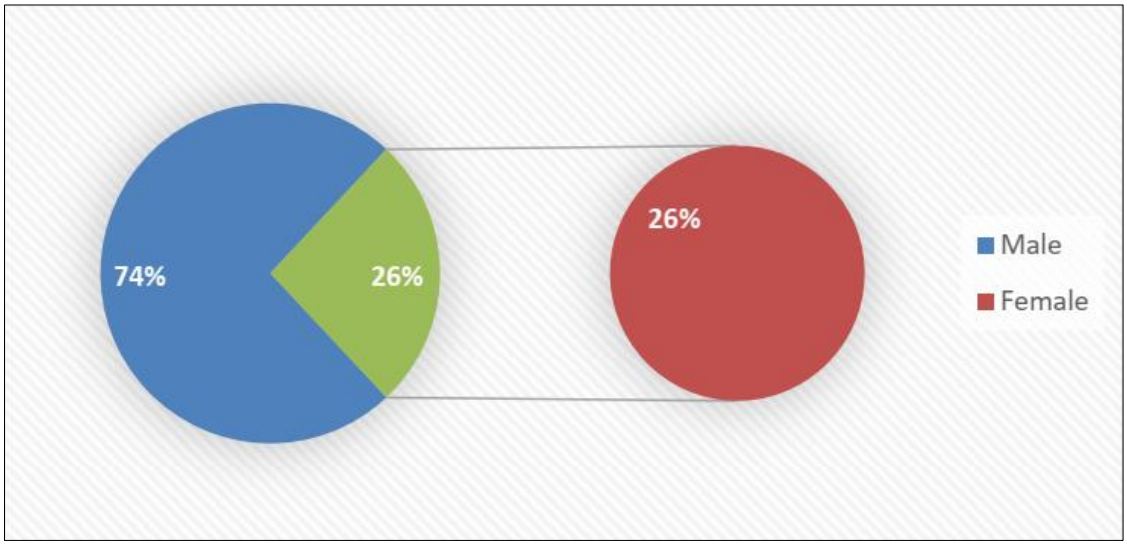

Figure 1: Gender distribution of the study patients (N=31)

The above pie chart shows the gender distribution of the study patients. Male was 23 (74.19%) and female 8 (25.81%)

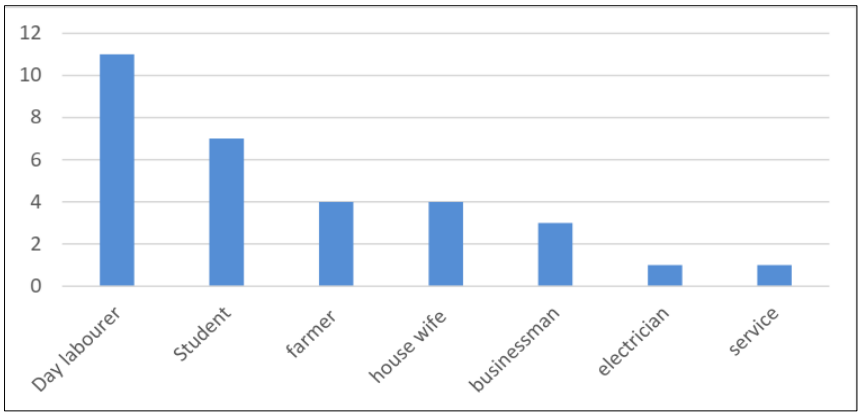

Figure 2: Distribution of patients according to occupation (N=31)

Occupation of the subjects demonstrates that most of the cases were day labourers which were 11 (35.48%). Other occupants were student 7 (22.58%), farmer and housewife 4 (12.9%) each, businessman 3 (9.68%), electrician and service holder 1 (3.23%) each. So, Most of the cases were manual workers (51.61%).

Table 2: Distribution of cases according to Mechanism of injury (N=31)

Mechanism of Injury	Frequency	Percentage (%)
Fall from Height	25	80.65%
Motor Vehicle Accident	4	12.90%
Falling of Heavy object over head	2	6.45%
Total	31	100.00%

In this study, the most common cause of injury was fall from height which accounted for 25 (80.65%) cases. Other causes include motor vehicle accidents in 4 (12.9%) and falling of heavy objects overhead in 2 (6.45%) cases.

Table 3: Distribution of Patients according to level of injury (N=31)

Level of Injury	Frequency	Percentage (%)
D12	1	3.23%
L1	17	54.84%
L2	13	41.94%
Total	31	100.00%

In this series, most common level of injury was in L1 level, 17 (54.84%) followed by L2 level 13 (41.94%) and D12 level 1 (3.23%) in descending order.

Table 4: Distribution of cases according to duration between injury and operation (N=31)

Duration (In days)	Frequency	Percentage (%)
6-10	6	19.35%
11-15	12	38.71%
16-20	13	41.94%
Total	31	100.00%

The mean duration between injury and operation time was 14.45±3.72 days, ranging from 8 days to 20 days. Maximum patients were operated within 16 to 20 days (41.94%).

Table 5: Distribution of cases according to Post-operative shift of ASIA grade (N=31)

Grade	ASIA C	ASIA D	ASIA E	Total
ASIA B	1	0	0	1
ASIA C	6	6	1	13
ASIA D	0	1	16	17
Total	7	7	17	31

Pre-operative ASIA
ASIA grade at last Follow up

Table 5 shows the distribution of shift of patient's neurological status on admission to last follow up on the basis of ASIA grade. Highest number of patients 17 (54.84%) were in ASIA grade D on admission. Out of them, 1 (3.23%) remained in same grade. Sixteen (51.61%) cases improved 1 grade and moved to ASIA grade E on last follow up. Thirteen (41.94%) cases were in ASIA grade C on admission. Among them, 6 (19.35%) remained in same grade. Six (19.35%) improved 1 grade and 1 (3.23%) improved 2 grade on last follow up. The remaining 1 (3.23%) were in ASIA grade B on admission and improved 1 grade on last follow up.

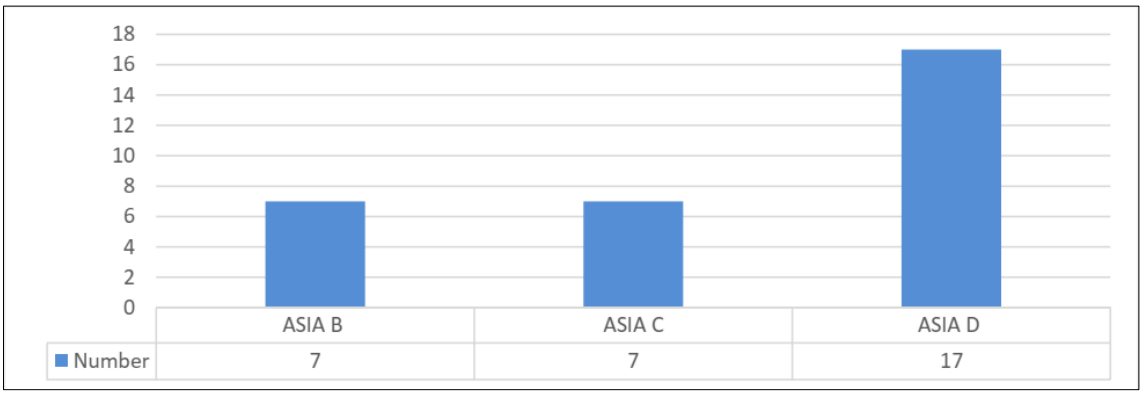

Figure 3: Neurological status on admission (N=31)

The figure shows the distribution of patient's neurological status on admission on the basis of ASIA grade. Highest number of patients 17 (54.84%) were in ASIA grade D. Thirteen (41.94%) were in ASIA grade C and lowest no of patients 1 (3.23%) were in ASIA grade

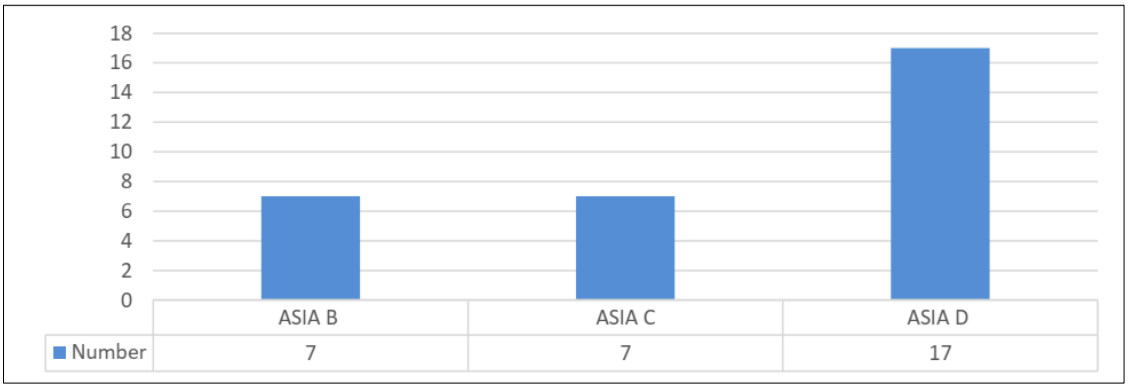

Figure 4: Neurological status on last follow up (N=31)

Figure shows the distribution of patient's neurological status on the basis of ASIA grade on last follow up. Highest number of patients 17 (54.58%) were in ASIA grade E. Seven (22.58%) cases were in ASIA grade D and C each.

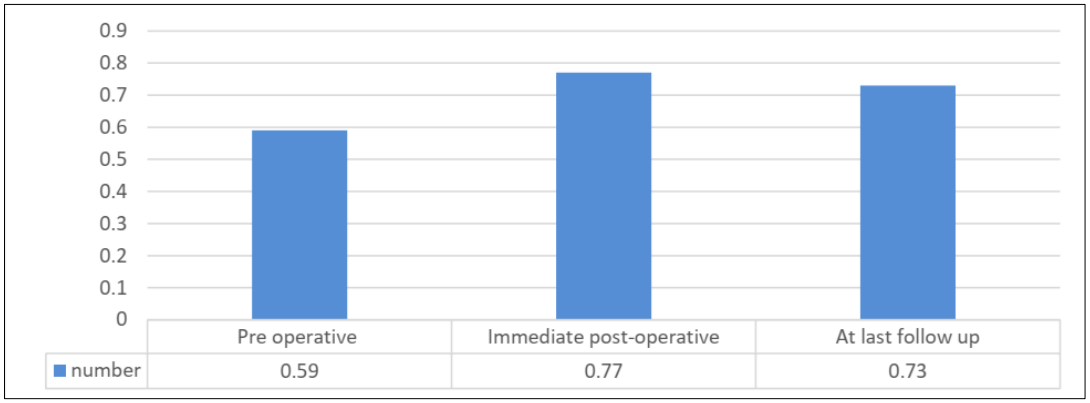

Figure 5: Cobb's Kyphotic Angle of the cases (N=31)

The mean pre-operative Cobb's kyphotic angle was 22.1±3.57, immediate post-operative was 7±1.71 and Cobb's Kyphotic angle at last follow up was 9.54±2.45. The average loss of correction at last follow up was 2.55±0.73. At last follow up, it reduces significantly pre- operative status. The p value is <0.05 (Measured by student t test).

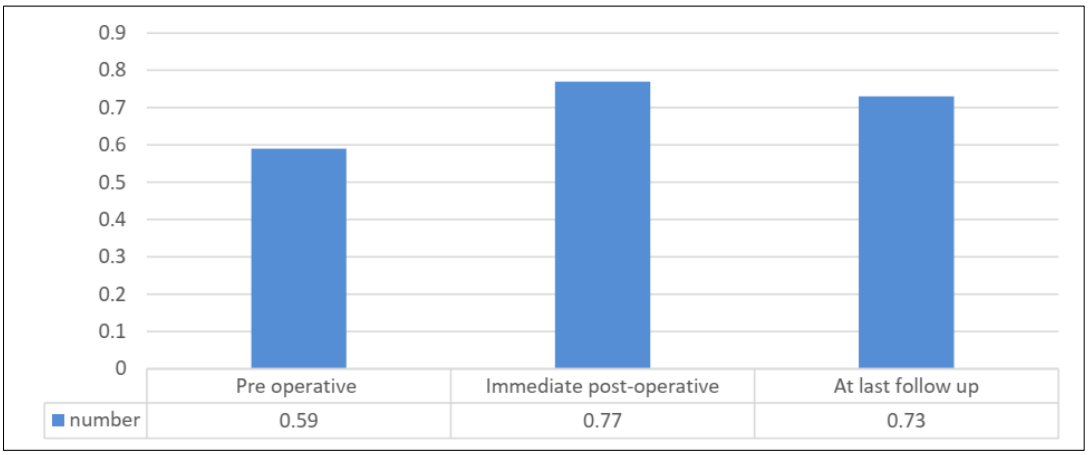

Figure 6: Beck index of the cases (N=31)

The mean pre-operative Beck index was 0.59±0.16; immediate post-operative was 0.77±0.12and kyphotic deformity at last follow-up was 0.73±0.12. The average loss of correction at the last follow-up was 0.08±0.01. The mean anterior and posterior vertebral height also showed significant improvements postoperatively, which were maintained at the final follow-up. The p-value is <0.05 (Measured by student t-test).

Table 6: Operative complications of the cases (N=31)

Complication	Frequency	Percentage (%)
Per-operative complication		
Haemorrhage	1	3.23%
Dural tear	1	3.23%
Early post-operative complication		
CSF leak	1	3.23%
Urinary Retention	2	6.45%
Late post-operative complication		
Superficial skin infection	1	3.23%
Bedsore	1	3.23%
Total	7	22.58%

Among 31 cases, in 7 (22.58%) cases, there were complications during operative procedure. Haemorrhage and dural tears were present in 1 (3.23%) case each. These are the per-operative complications. Early post-operative complication including CSF leak was seen in only 1 (3.23%) case and urinary retention in 2 (6.45%) cases. Late postoperative complications included superficial skin infection in 1 (3.23%) and bed sore in 1 (3.23%) case

DISCUSSION

The thoracolumbar junction is a common site of spinal injury occurring in an estimated 6% of patients experiencing blunt trauma [16]. In more than 50% of the cases, spinal fractures affect the thoracolumbar junction [17]. The existence of the unstable burst fracture, with complete disruption of the posterior elements and increased potential for neural injury was described [18].

The present study was carried out between September 2017 and April 2018 at NITOR, Dhaka. A total of 31 patients with thoracolumbar burst fracture with incomplete spinal cord injury were selected. All the patients, after proper resuscitation and investigation, were treated by short segment pedicle screws and rod fixation including fractured vertebrae, and followed up. After an average of 06 months of follow-up for each patient, the following findings were compiled. All the relevant findings obtained from data analysis were presented in tables and figures. In this study, the highest number of patients 11 (35.48 %) was observed in the 3rd, and the lowest number of patients 1(3.23%) was observed in the 6th decade. The mean age was (31.42±11.2) years with a range from 17 to 60 years. It is clear from many studies that young people suffer spinal injuries more often than any other age group. The mean age was 30.74±10.31 in the study [19], among the 31 cases, males were 23 (74.19%) and females 8 (25.81%)

with a male: female ratio of 2.88:1. Occupation of the subjects demonstrates that most of the cases were day laborers which were 11(35.48%). Other occupants were student 7(22.58%), farmer and housewife 4(12.9%) each, businessman 3(9.68%), electrician and service holder 1(3.23%) each. The total manual workers were 16(51.61%). This agrees with the notion that manual workers are more susceptible to spinal injuries.) 32 (61.53%) patients were manual workers and rest 20 (38.46%) patients were sedentary workers [21]. In this study, the most common cause of injury was fall from height which accounted for 25 (80.65%) cases. Other causes include motor vehicle accident 4 (12.9%) and falling of heavy object over head in 2 (6.45%) cases. Fall was the most common cause of thoracolumbar burst fracture in 92% and 59.25% cases which has also been observed respectively but other study showed road traffic accident is the common cause of injury [19, 20]. In this series, most common level of injury was in L1 level-17 (54.84%) followed by L2 level 13(41.94%) and D12 level 1(3.23%) in descending order. Body of L1 vertebrae is the commonest site of thoracolumbar burst fracture. This is supported by other literatures (46% cases), (51.6% cases), and (44.23% cases) [14- 21]. Highest number of patients 17(54.84%) were in ASIA grade D on admission. Out of them, 1(3.23%) remained in same grade. Sixteen (51.61%) cases improved 1 grade and moved to ASIA grade E on last follow up. Thirteen (41.94%) cases were in ASIA grade C on admission. Among them, 6(19.35%) remained in same grade. Six (19.35%) improved 1 grade and 1 (3.23%) improved 2 grade on last follow up. The remaining 1(3.23%) were in ASIA grade B on admission and improved 1 grade on last follow-up. 6 patients (11.5%) was ASIA scale C, 22 patients (42.3%) was ASIA scale D and 24 (46.2%) was E on admission whereas, 51 patients (98.1%) was in ASIA scale E and one patient (1.9%) was ASIA scale D on last follow up [21].The current study showed no decrease on ASIA impairment scale suggesting the credibility of the procedure. The mean pre-operative Cobb's kyphotic angle was 22.1±3.57, immediate post-operative was 7±1.71and Cobb's Kyphotic angle at last follow up was 9.54±2.45. At last follow up, it reduces significantly pre-operative status. The p value is <0.05 (Measured by student t test). The average loss of correction at last follow up was 2.55±0.73 and there was no correlation was found between the final amount of Cobb angle and the degree of pain reported. The mean kyphotic angle at pre-, postoperative and final follow- up was 13.5 ±6.3°, 13.4 ± 4.3°, 8.5 ± 6° [21]. In the present study, the mean pre-operative kyphotic deformity was 24.42±3.67; immediate post-operative was 6.7±1.62 and kyphotic deformity at last follow up was 7.87±2.24. The mean pre- and post-operative kyphotic deformation of vertebral body was 5.1 ± 3.2, 4.8 ± 2.3 and at final follow-up was 4.5 ± 4.0. The mean pre-operative Beck index was 0.59±0.16; immediate post-operative was 0.77±0.12 and kyphotic deformity at last follow up was 0.73±0.12 [21]. The average loss of correction at last follow up was 0.08±0.01. Showed similar results where pre-operative Beck index was 0.60±0.1 and at final follow up was 0.92±0.2 [22]. Among 31 cases, in 7(22.58%) cases there were complications during operative procedure. Haemorrhage and dural tear was present in 1(3.23%) case each. These are the per-operative complication. Both of these complications were managed per-operatively. Dural tear was repaired with 6/0 prolene. Early post- operative complication include CSF leak was seen in only 1(3.23%) case and urinary retention in 2(6.45%) cases. These two cases were managed conservatively. Late post-operative complications included superficial skin infection in 1(3.23%) and bed sore in 1(3.23%) case. Superficial skin infection was managed by appropriate antibiotic according to C/S. Bed sore was managed by regular dressing and changing posture. 2(7.4%) patients with superficial wound infections responded to antibiotics and antiseptic dressing and 1 (3.7%) patient with bed sore required plastic surgery of total 27 patients [23]. Same things showed bed sore was found in 3 (10%) patients and wound infection was found 2(6.67%) patients in a series of 30 patients [24]. Both of those study results were similar to mine. But 1 (3.22%) screw breakage, 2 (6.45%) screw loosening and 1(3.22%) superficial wound infection in a series of 31 patients [25]. In present study there was no hardware complication [25].

CONCLUSION

As seen from the result of this study, thoracolumbar burst fracture with incomplete spinal cord injury can be treated with short-segment pedicle screw fixation including the fractured vertebral body effectively. This method offered a better kyphosis correction, fewer instrument failures, appraisable clinical and functional recovery, reduce pain and improve working status with early rehabilitation.

Limitations of the Study

Homogenous group of patients could not be selected which would reveal finer result analysis. Follow-up period was only 06 months so long term outcome could not be evaluated. Modern operative facilities like intra-operative neuro-monitor, high speed burr, operating microscope is not available in our settings. Operating surgeons were not same in all cases, which renders the operator dependent variation to some extent. Lack of supervised physiotherapy is another problem in final outcome of the patient.

Recommendation

The results of the study can be utilized for future large study. A long term study with a large series for comparison is needed. Multi-centric study should be done to validate the procedure.

REFERENCES

1. Wood, K. B., Bohn, D., & Mehbod, A. (2005). Anterior versus posterior treatment of stable thoracolumbar burst fractures without neurologic

deficit: a prospective, randomized study. *Clinical Spine Surgery*, *18*, S15-S23.
2. El-Khoury, G. Y., & Whitten, C. G. (1993). Trauma to the upper thoracic spine: anatomy, biomechanics, and unique imaging features. *AJR. American journal of roentgenology*, *160*(1), 95-102.
3. Denis, F. (1983). The three column spine and its significance in the classification of acute thoracolumbar spinal injuries. *spine*, *8*(8), 817-831.
4. Dewald, R. L. (1984). Burst fractures of the thoracic and lumbar spine. *Clinical Orthopaedics and Related Research (1976-2007)*, *189*, 150-161.
5. McAfee, P. C., Yuan, H. A., Fredrickson, B. E., & Lubicky, J. P. (1983). The value of computed tomography in thoracolumbar fractures. An analysis of one hundred consecutive cases and a new classification. *JBJS*, *65*(4), 461-473.
6. Gurr, K. R., McAfee, P. C., & Shih, C. M. (1988). Biomechanical analysis of anterior and posterior instrumentation systems after corpectomy. A calf-spine model. *JBJS*, *70*(8), 1182-1191.
7. Gertzbein, S. D. (1992). Scoliosis Research Society. Multicenter spine fracture study. *Spine*, *17*(5), 528-540.
8. Tator, C. H., & Koyanagi, I. (1997). Vascular mechanisms in the pathophysiology of human spinal cord injury. *Journal of neurosurgery*, *86*(3), 483-492.
9. Rajasekaran, S., Kanna, R. M., & Shetty, A. P. (2015). Management of thoracolumbar spine trauma: An overview. *Indian journal of orthopaedics*, *49*, 72-82.
10. Liu, L., Gan, Y., Zhou, Q., Wang, H., Dai, F., Luo, F., ... & Lü, Y. (2015). Improved monosegment pedicle instrumentation for treatment of thoracolumbar incomplete burst fractures. *BioMed Research International*, *2015*.
11. Bohlman, H. H. (1985). Treatment of fractures and dislocations of the thoracic and lumbar spine. *JBJS*, *67*(1), 165-169.
12. Hur, J. W., Rhee, J. J., Lee, J. W., & Lee, H. K. (2015). A comparative analysis of the efficacy of short-segment pedicle screw fixation with that of long-segment pedicle screw fixation for unstable thoracolumbar spinal burst fractures. *Clin Med Res*, *4*(1), 1.
13. Alvine, G. F., Swain, J. M., Asher, M. A., & Burton, D. C. (2004). Treatment of thoracolumbar burst fractures with variable screw placement or Isola instrumentation and arthrodesis: case series and literature review. *Clinical Spine Surgery*, *17*(4), 251-264.
14. Altay, M., Ozkurt, B., Aktekin, C. N., Ozturk, A. M., Dogan, Ö., & Tabak, A. Y. (2007). Treatment of unstable thoracolumbar junction burst fractures with short-or long-segment posterior fixation in magerl type a fractures. *European Spine Journal*, *16*, 1145-1155.
15. Mahar, A. (2007). Short-Segment Fixation of Lumbar Burst Fractures Using Pedicle Fixation at the Level of the Fracture. *Spine*, *32*, 1503-7.
16. Ponnappan, R. K., & Lee, J. Y. (2008). Thoracolumbar trauma. In: J. Fischgrund, ed. *Orthopaedic knowledge Update 9*. Illinois: American Academy of Orthopedic Surgeon, 579.
17. Dai, L. Y., Jiang, L. S., & Jiang, S. D. (2009). Posterior short-segment fixation with or without fusion for thoracolumbar burst fractures: a five to seven-year prospective randomized study. *JBJS*, *91*(5), 1033-1041.
18. Whitesides Jr, T. E. (1977). Traumatic kyphosis of the thoracolumbar spine. *Clinical Orthopaedics and Related Research®*, *128*, 78-92.
19. Raja, R. A. (2010). Management of thoracolumbar spine injuries at a tertiary care hospital. *Journal of Ayub Medical College Abbottabad*, *22*(1), 171-175.
20. Payer, M. (2006). Implantation of a distractible titanium cage after cervical corpectomy: technical experience in 20 consecutive cases. *Acta neurochirurgica*, *148*, 1173-1180.
21. Ahsan, M. K., Zahangiri, Z., Awwal, M. A., Zaman, N., Haque, M. H., & Al Mahmud, A. (2016). Posterior fixation including the fractured vertebra in short segment fixation of unstable thoracolumbar junction burst fractures. *Bangabandhu Sheikh Mujib Medical University Journal*, *9*(2), 81-87.
22. Sapkas, G., Kateros, K., Papadakis, S. A., Brilakis, E., Macheras, G., & Katonis, P. (2010). Treatment of unstable thoracolumbar burst fractures by indirect reduction and posterior stabilization: short-segment versus long-segment stabilization. *The open orthopaedics journal*, *4*, 7.
23. Lee, G. W., Jang, S. J., Kim, J. D., Son, J. H., & Jang, J. H. (2013). The efficacy of percutaneous long-segmental posterior fixation of unstable thoracolumbar fracture with partial neurologic deficit. *Asian spine journal*, *7*(2), 81.
24. Alam, M. S. (2011). *Transpedicular Screw Fixation of Thoracolumbar Spine fractures*.
25. Modi, H. N., Chung, K. J., Seo, I. W., Yoon, H. S., Hwang, J. H., Kim, H. K., ... & Yoo, J. H. (2009). Two levels above and one level below pedicle screw fixation for the treatment of unstable thoracolumbar fracture with partial or intact neurology. *Journal of orthopaedic surgery and research*, *4*(1), 1-6.