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Posterior only instrumentation without fusion in thoracolumbar burst fractures

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Abstract

Introduction: Thoracolumbar fractures are the most common vertebral injury. Burst fractures in this transition zone are often unstable, requiring surgery. Short-segment posterior instrumentation without fusion is preferred treatment to preserve spinal motion, but it can have complications like implant failure and increased kyphosis. This study aims to evaluate the outcome of short-segment fixation without fusion in thoracolumbar burst fractures.

Method: This was a prospective study conducted at Chitwan Medical College from 01 Oct 2022 to 31 Mar 2024. Ethical approval was obtained. Thoracolumbar burst fractures treated with short-segment pedicle screw fixation one-one level above and below, without fusion and with one-year follow-up, were included. Multi-level spinal injuries, osteoporotic/metastatic fractures and polytrauma were excluded. Visual Analogue Scale (VAS), Smiley-Webster Scale (SWS), and radiological anterior body height ratio and kyphotic angle were analysed. The IBM SPSS-16 was used for analysis, means were compared using a paired-samples t-test, at CI 95% and $p<0.05$ was considered statistically significant.

Result: There were 45 patients with thoracolumbar burst fractures, 18(40%) AO A3 and 27(60%) AO A4 fractures, mean age of 45.38±15.68 years, 29(64.44%) males and 16(35.56%) females, fall from height 30(66.67%), and L1 fractures 18(40%). All fractures united with 22(48.89%) excellent and 16(35.56%) good results on SWS. Anterior body height ratio improved by 0.42±0.11 and kyphotic angle by 18.81^0±4.52^0 ($p<0.001$). The VAS improved significantly from 4.87±1.11 at discharge to 0.82±0.94 at final follow-up ($p<0.001$). The overall complication rate was 6(13.33%).

Conclusion: Short-segment posterior instrumentation without fusion provides satisfactory results for surgically treated thoracolumbar burst fractures.

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Introduction

Thoracolumbar fractures are the most common injuries in the vertebral column owing to the significant biomechanical stress at this junction from a rigid thoracic spine to mobile lumbar spine.[1,2] Nearly 90% of spine fractures occur in the thoracolumbar region with 10-20% being burst fractures.[3] A study in central Nepal has reported thoracolumbar burst fractures in 35.25% of the patients admitted with spine trauma.[4] Burst fractures in this transition zone are often unstable and can affect the neurology requiring surgery.

The goal of treatment in thoracolumbar injury is to restore vertebral column stability and decompress spinal canal to allow early mobilization of the patient. Posterior instrumentation with pedicle screw is the most widely used treatment method today[5-8] and spinal fusion has long been used in addition to stabilize the fracture.[9-12] Recent trend is towards short segment posterior fixation[13,14] and fusion may not be necessary with an aim to preserve spinal motion segments.[15-17] However, short segment fixation can be accompanied by hardware failures and recurrence of kyphosis with or without clinical implications.[18-20] McCormack has even suggested providing additional anterior support to prevent biomechanical failure.[19]

The rationale of short segment fixation and no fusion is to use temporary stabilization till fracture union and removal of implant to preserve spinal motion. The aim of this study is to assess the usefulness of short segment posterior instrumentation without fusion in thoracolumbar burst fractures in our scenario.

Method

This prospective study was conducted at Chitwan Medical College- Teaching Hospital (CMC-TH), Department of Orthopaedics from 01 Oct 2022 to 31 Mar 2024. Out of total patients admitted to the Orthopaedics department in CMC-TH in 2020, 9.30% were related to spine and among them 2.55% were treated with surgery (p=0.0255). Taking 95% confidence level (z=1.96) and 5% allowable error (d=0.05), sample size calculated was 39. Using convenience sampling, the first 45 patients who met the inclusion criteria were treated with posterior instrumentation, and they were followed up for a minimum of one year, Figure 1. Approval of the study was taken from the Institutional Review Committee of Chitwan Medical College (CMC-IRC/077/078-205). Written informed consent was taken from all the participants.

Clinical evaluation was done including assessment for spinal shock, and neurological status using American Spinal Injury Association (ASIA) Impairment Scale (AIS). Radiological evaluation was done using plain X-rays and Computed Tomography (CT), and additional Magnetic Resonance Imaging (MRI) in patients having neurological deficits.

Surgery was performed under general anaesthesia with the patient prone in the radiolucent table. A midline incision was used centering the fractured vertebral level. Short segment pedicle screw fixation was done one level above and one level below the affected vertebra including instrumentation of one or both pedicles of the affected (index) vertebra. Pedicle screws were inserted freehand – titanium 6.2 mm or 5.5 mm as per pedicle morphology (Miraclus Orthotech Private Limited). Reduction was achieved with the patient positioning itself and also indirect reduction was obtained by distracting the proximal screws along the connecting rods (ligamentotaxis). When there was neurological involvement, decompression of the cord was done by laminotomy. Facet joints were protected during dissection as well as insertion of pedicle screws. No attempt of fusion was performed like decortication of posterior elements including facet joints or bone grafting. The final position of the implant was confirmed with the fluoroscopy and wound closed in layers.

Patients were allowed to sit up in bed on the first post-operative day. Mobilization (ambulation if neurologically intact or wheelchair mobilization) was initiated on day two or three as tolerated by the patient using thoraco-lumbo-sacral orthosis. The brace was

continued for six weeks, and strenuous physical activities and forward bending were prohibited for three months.

Patients were evaluated at one, three, six and twelve months after surgery. Neurological evaluation was done pre-operatively and at final follow-up using AIS. Clinical evaluation was done using the Visual Analog Scale (VAS)[21] score, on a 10cm scale: 0=no pain, 10=worst pain, measured at the time of discharge and at subsequent follow-ups. Functional outcome was assessed using Smiley-Webster Scale (SWS)[22] at the last follow-up.

Radiological evaluation was done pre-operatively, post-operatively, and at subsequent follow-ups using plain X-rays. Measurements included anterior body height ratio (ABHR) and local kyphotic angle. ABHR was calculated as the ratio of height of anterior portion of affected vertebra to that of average of upper and lower vertebrae, and the kyphotic angle was measured using Cobb angle, Figure 2.

Data entry and analysed using IBM SPSS v-16.0. Categorical variables were summarized as frequencies and percentages, while continuous variables were assessed for normality and expressed as mean ± standard deviation (SD). Comparisons of means between time points were performed using paired-samples t-test. A p-value <0.05 was considered statistically significant at a 95% confidence interval.

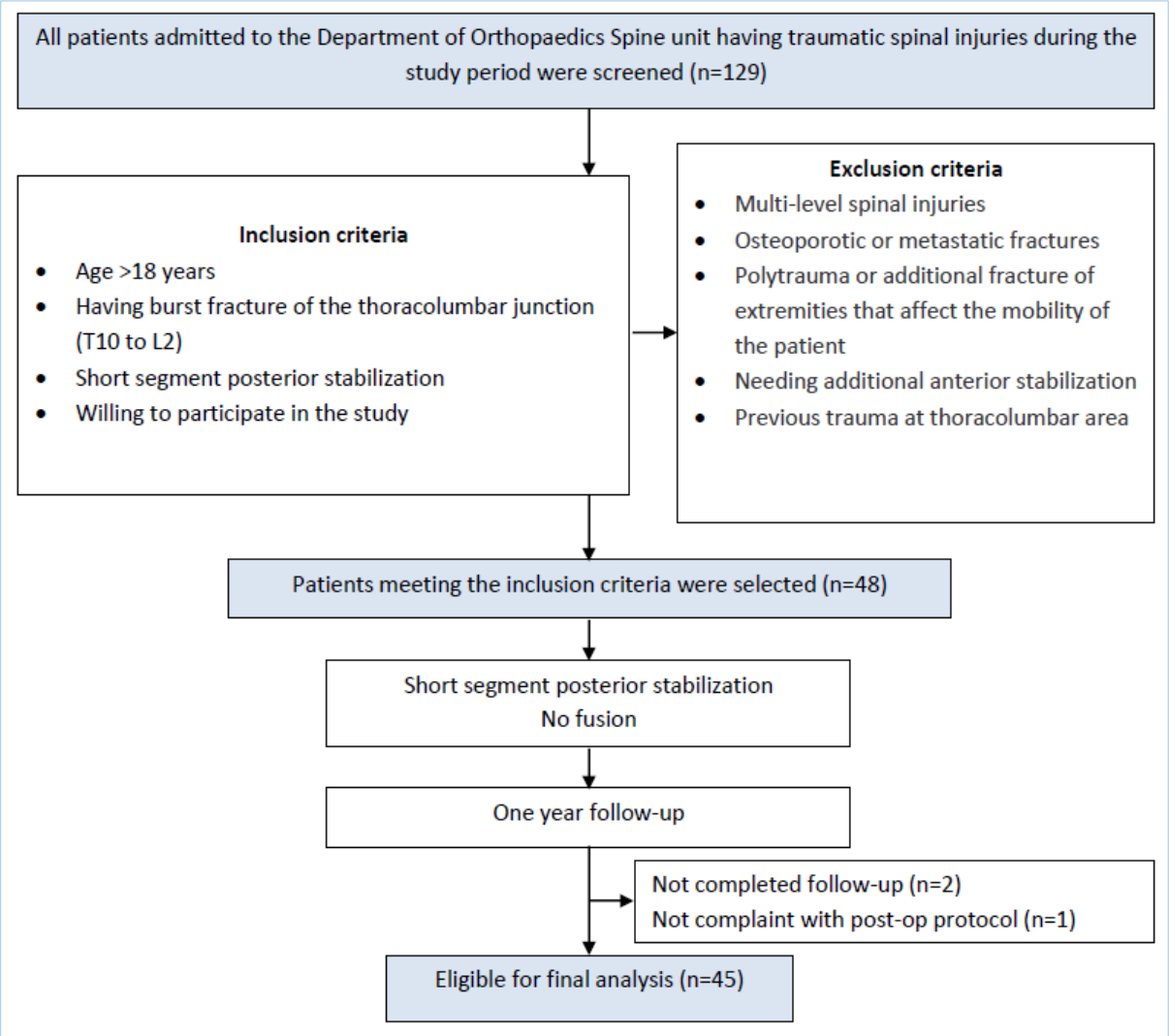

Figure 1. Flowchart of participants with thoracolumbar burst fractures included in the study

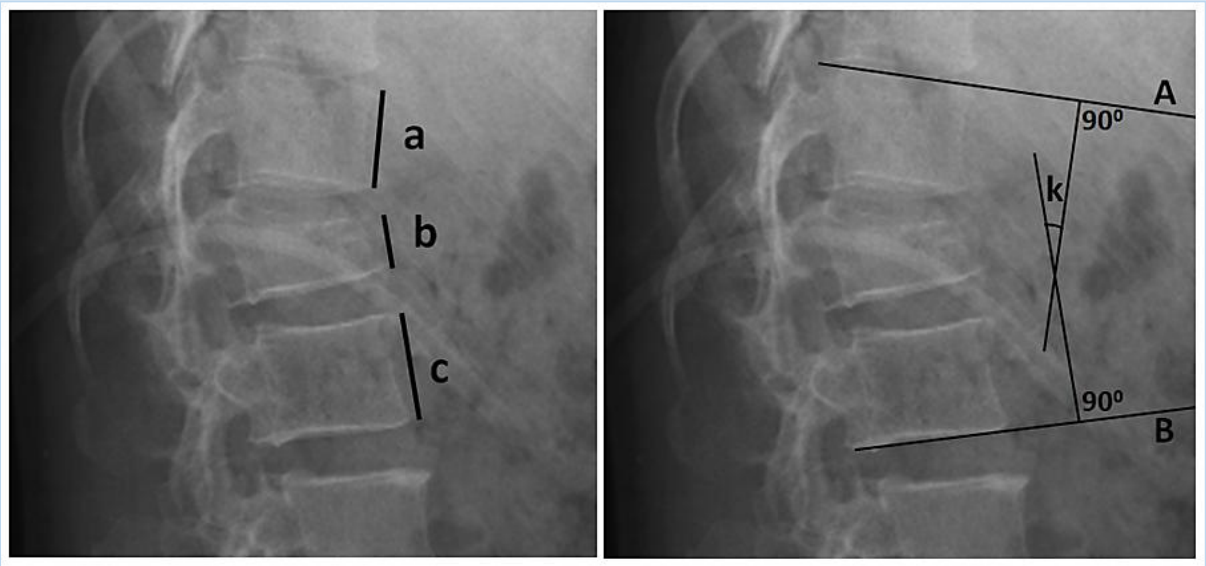

Figure 2. Anterior body height ratio (ABHR)=2b/(a+c); Two lines (A, B) drawn along upper end plate of upper normal vertebra and lower end plate of lower normal vertebra- angle between the lines perpendicular to the previous lines A and B gives the kyphotic angle (k)

Result

There were 45 patients available for final analysis, among which 29(64.44%) were males and 16(35.56%) were females. The mean age was 45.38±15.68 years (range 20-81 years) with most of the patients 15(33.33%) in 31-45 age group. Majority fell from height 30(66.67%) and involved L1 vertebra 18(40%), Table 1.

There were 24(53.33%) cases with intact neurology (ASIA E) at presentation which improved to 31(68.89%) at subsequent follow-up, Table 2.

The preoperative mean anterior body height ratio of 0.49±0.15 improved to 0.91±0.08 postoperatively with the mean correction of 0.42±0.11, which was statistically significant (paired-samples t-test, $t(44)=-25.61$, $p<0.001$). Similarly, the preoperative mean kyphotic angle of $23.67^0\pm5.51^0$ was corrected postoperatively to $4.85^0\pm2.87^0$, Figure 3.

The mean correction in kyphotic angle was $18.81^0\pm4.52^0$ which was also significant statistically (paired-samples t-test, $t(44)=27.91$, $p<0.001$). There was some loss of correction in body height ratio 0.08±0.04 as well as kyphotic angle $1.95^0\pm1.82^0$ from immediate postoperative to final follow-up period, however they were still statistically significantly improved when compared to preoperative values ($p<0.001$), Figure 4.

The mean VAS score at the time of discharge was 4.87±1.11 which improved subsequently to 0.82±0.94 ($p<0.001$) at final follow-up. Clinical outcomes using the Smiley-Webster Scale revealed 22(48.89%) patients had excellent, 16(35.56%) good, 6(13.33%) fair and 1(2.22%) poor result.

There were 3(6.67%) cases of superficial infection which were managed with change of antibiotics and dressing changes while 1(2.22%) with deep infection required debridement with retention of implants. Breakage of pedicle screws occurred in 2(4.44%) patients, Figure 5.

Table 1. Baseline demographic characteristics of patients with thoracolumbar burst fractures treated with posterior instrumentation, n=45

Variables	n(%)
Gender	
Male	29(64.44)
Female	16(35.56)
Age group	
18-30 years	9(20)
31-45 years	15(33.33)
46-60 years	13(28.89)
>60 years	8(17.78)
Mode of injury	
Fall from height	30(66.67)
RTA*	14(31.11)
Direct impact	1(2.22)
Level of fracture	
T10	2(4.44)
T11	4(8.89)
T12	13(28.89)
L1	18(40)
L2	8(17.78)
AO† classification	
A3	18(40)
A4	27(60)
Operative delay, median (days)	3(Range:0-6 days)
Length of hospital stay, median (days)	7(Range:4-14 days)

*Road Traffic Accident, †Arbeitsgemeinschaft für Osteosynthesefragen

Table 2. American Spinal Injury Association (ASIA) impairment scale at presentation and final follow-up of patients with thoracolumbar burst fractures treated with posterior instrumentation, n=45

ASIA preoperative, n(%)	ASIA at final follow-up, n(%)				
	A	B	C	D	E
A 3(6.67)	2(4.44)	1(2.22)	-	-	-
B 4(8.89)	-	3(6.67)	1(2.22)	-	-
C 8(17.78)	-	-	-	7(15.56)	1(2.22)
D 6(13.33)	-	-	-	-	6(13.33)
E 24(53.33)	-	-	-	-	24(53.33)
Total	2(4.44)	4(8.89)	1(2.22)	7(15.56)	31(68.89)

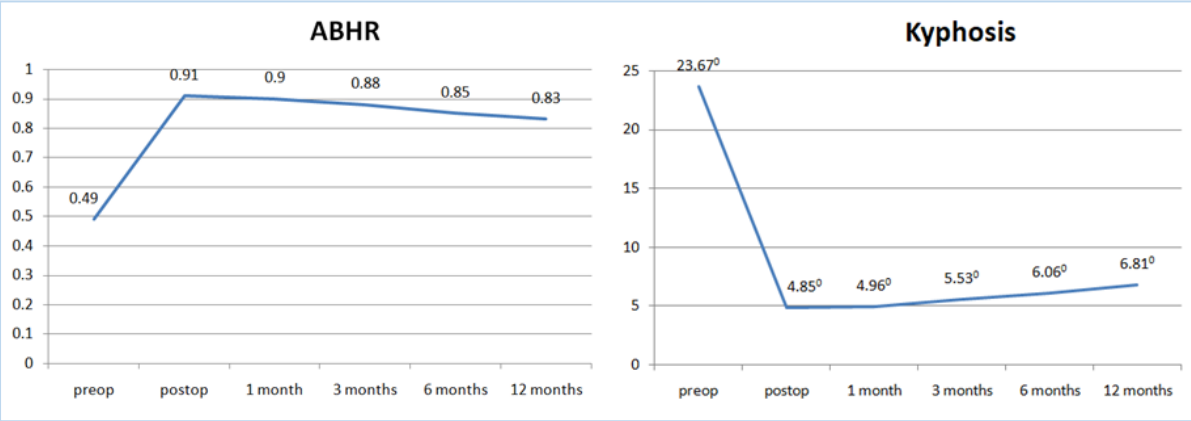

Figure 3. Anterior body height ratio (ABHR) and Kyphotic angle on subsequent follow-ups after posterior instrumentation for thoracolumbar burst fractures, n=45

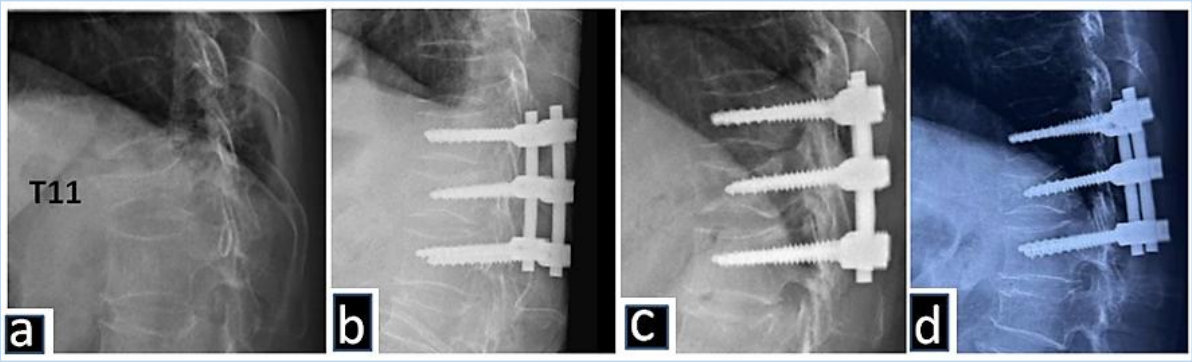

Figure 4. A 70-year female with T11 burst fracture (AO A4). Postoperative X-ray (b) shows improvement in kyphotic angle from preoperative radiograph (a), which is maintained on subsequent follow-ups at 1 month (c) and 1 year (d)

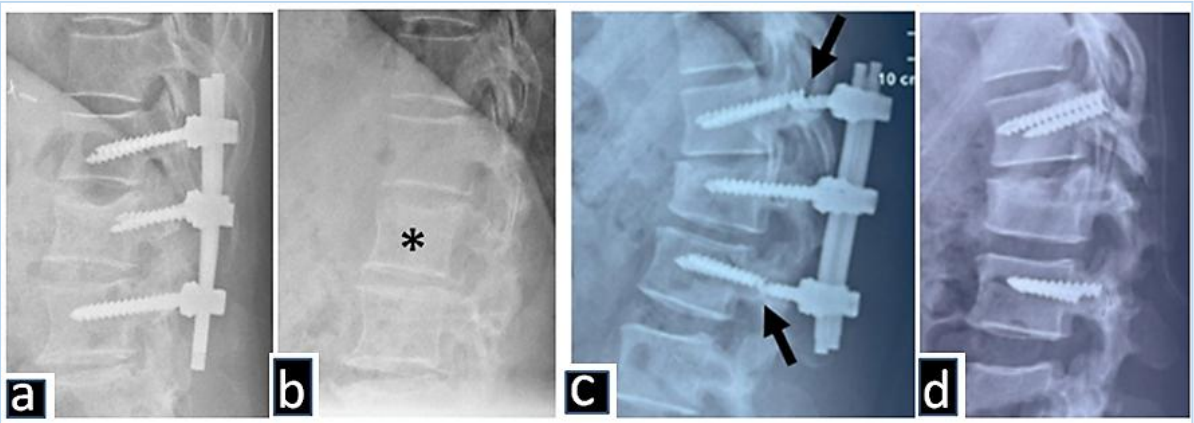

Figure 5. United L1 fracture at 20 months follow-up (a), vertebral height well maintained (asterisk) 6 months after implant removal (b); another case of L1 fracture with broken pedicle screws at 13 months follow-up (arrows), fracture had united (c); following implant removal (d)

Discussion

In our study all fractures united with the final SWS showing 22(48.89%) excellent and 16(35.56%) good results. There were 6(13.33%) cases of fair and 1(2.22%) poor outcome, and these were the cases who had initial severe neurological involvement of AIS A and B. A similar study had 83.33% good to excellent clinical outcomes.[22]

There is a consensus that acute, traumatic, unstable or severely kyphotic fractures need surgical management.[23-26] Even in stable burst fractures without neurological deficit that can be managed nonoperatively, surgery provides immediate spinal stability, early mobilization, and more reliable correction of spinal alignment and canal dimensions.[27]

Added advantages of posterior fixation without fusion are decreased operative time, decreased perioperative blood loss and eliminated risk of related comorbidities when iliac crest graft is harvested.[17] Many authors have reported that fusion procedures are not required for stabilization.[15-17,20,22] Furthermore different systematic review and meta-analysis suggest that fusion does not improve clinical or radiological outcomes.[28-30]

Radiological outcomes showed a mean correction of 0.42±0.11 in anterior body height ratio, which decreased by 0.08±0.04 at final follow-up. This is similar to other studies with mean correction ranging from 0.36 to 0.41 and a loss of correction of 0.04 to 0.05.[22,31] The kyphotic correction showed a loss of 1.95^0±1.82^0 at final follow-up when compared to post-operative values. Different studies noticed loss of kyphotic angle of 0.57^0 to 3.58^0 during subsequent follow-ups.[4,20,22,31]

A long-term study with an average follow-up of eight years showed loss of angular correction as high as 12.1^0.[32] We did not find the loss of radiological parameters to be statistically significant. This loss of correction occurs due to compromised load sharing ability of the fractured vertebral body. Correction loss also takes place at the adjacent disc spaces, especially the superior one. Non-fusion also contributes to cyclical loading of the pedicle screws with deformation of implants.[32]

Postoperatively we used braces for six weeks whereas some studies have continued braces for three months.[13,20,32] A study that analyzed postoperative bracing after pedicle screw fixation for thoracolumbar burst fractures suggested that brace does not significantly improve stability and may not be a cost-effective measure.[33]

Regarding the demographics, the mean age of our patients was 45.38±15.68 years with the majority 28(62.22%) in the age group 31-60 years. Other similar studies done in Nepal had a mean age of about 40 years.[4,31] We had a male preponderance of 29(64.44%), similar to the studies from Nepal[4,31] and other international studies[20,22] possibly because men are involved more in outdoor activities compared to women.

The most common mode of injury was fall from height 30(66.67%) followed by road traffic accidents 14(31.11%). Fall remains the most common cause in many studies.[4,22,31,34] Road traffic accidents account for most of the cases in western countries.[35,36] As with other studies L1 was the most common fractured vertebra 18(40%) followed by T12.[4,20,22,31]

There were no cases of neurological deterioration following surgery. Apart from patients with intact neurology (ASIA E), 15(33.33%) had one grade improvement in ASIA impairment scale, 1(2.22%) had two grades improvement and the remaining 5(11.11%) had the same neurology at final follow-up. In other studies, one grade improvement ranged from 42%[20] to 80%,[34] and two grades from 7%[4] to 21%.[34] The neurological recovery depends upon the initial insult of the spinal cord during trauma, delay in treatment, decompression achieved during surgery and post-operative rehabilitation of the patient. The median delay for surgery in our study was three days.

Back pain was measured using VAS score, which significantly improved from 4.87±1.11 at discharge to 0.82±0.94 at final follow-up. With time as the fracture heals the amount of pain decreases. This improvement in VAS score is also reported in other studies, though their final score was slightly higher ranging between 1.39 to 1.64.[4,31,34,37]

Overall complication rate in our study was 6(13.33%), among which 2(4.44%) had implant failure. In similar non-fusion studies, the implant breakage ranged from 4%[20] to 14%.[15] Broken pedicle screws in two of our cases were seen at 13 and 18 months after surgery, whereas one study showed failure of implant as early as seven months postoperatively.[20]

In our series there were 3(6.67%) superficial and 1(2.22%) deep infection. The rate of infection ranged from 3%[4] to 10%[31] in different studies.

These complications depend on various factors like quality of bone, type of implant used, duration of surgery along with surgical expertise, medical co-morbidities present, post-operative patient compliance etc.

Different comparative studies have shown similar functional scores between the fusion and non-fusion groups.[16,20,30] Our study also had satisfactory functional outcome with high union rates despite non-fusion surgery. Though higher implant failure rates have been reported in other non-fusion surgeries, 14%[15] and 10.71%[16]; such complications were lower in our study.

There was an overall improvement in radiological parameters during subsequent follow-ups. The clinical significance of small losses in correction (e.g., 0.08 ABHR, 1.95^0 kyphosis) is unclear- and this did not have any impact on patient outcome measures (VAS, SWS).

Including the index vertebra in screw fixation enhances the stability compared to traditional short-segment constructs. This aligns with the biomechanical principles of load sharing, reducing kyphosis and reducing stress in implants. Studies have shown that 57% cases with no index screw had $>10^0$ loss of correction (vs. 23% with one and 14% with two index screws).[38] Also, a 6-week bracing protocol in our study showed lower implant failure at 4.44% compared to other studies reporting 12.5%[13] treatment failure despite thoracolumbar orthosis for 3-months or more. This implies that shorter, targeted immobilization may suffice to protect the fixation without compromising mobility. Studies have suggested that there is no added benefit of bracing for more than 6-weeks after pedicle screw fixation.[33]

Our study reinforces that short-segment non-fusion fixation achieves stable fracture union with motion preservation, but implant failure rates (4.44%) suggest need of careful patient selection, like McCormack load-sharing classification[19] and osteoporosis.

As for the clinical implications for surgeons adopting this technique, we recommend: (1) index-level screws to improve load distribution and stability, (2) six weeks bracing to balance stability and early rehabilitation, and (3) consideration of implant removal after fracture union especially in younger individuals. This approach mitigates complications like recurrence of kyphosis or failure of implants while preserving motion segments. One should be aware that the benefit of motion preservation by non-fusion technique comes with the risk of implant failure.

Limitations of our study include, a convenience sampling which can introduce possible selection bias. There was lack of power analysis to detect specific effect sizes, for example, clinical outcomes like VAS or kyphotic angle, and lack of subgroup analysis like AO A3 vs. A4 fractures or age groups to explore variability in outcomes. These factors may limit the wider inference. Also, we did not have a comparative fusion group, and long-term outcomes or results after removal of implants remain unknown. In future a randomized sampling, preferably multicenter studies with longer follow-ups may provide robust evidence.

Conclusion

Our study in burst fractures of the thoracolumbar region treated surgically using short segment posterior instrumentation with pedicle screw in index vertebra showed satisfactory functional and radiological outcomes. Our study reinforces that short-segment non-fusion fixation achieves stable fracture union with motion preservation, but implant failure rates (4.44%) suggest careful patient selection is critical.

Author contribution

Concept design: BDS, APR; Literature search: BDS, TPD; Data collection: BDS, DA; Data analysis: BDS, TPD; Draft manuscript: BDS, APR, DA; Final manuscript and accountability: All

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Conflict of interest

None

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Supplementary material

The data and supplementary material that support the findings of this study are available from the corresponding author upon reasonable request.

References

1. Wood KB, Li W, Lebl DR, Ploumis A. Management of thoracolumbar spine fractures. Spine J. 2014;14(1):145-64. DOI PubMed Google Scholar
2. el-Khoury GY, Whitten CG. Trauma to the upper thoracic spine: anatomy, biomechanics, and unique imaging features. Am J Roentgenol. 1993;160(1):95-102. DOI PubMed Google Scholar Full Text
3. Oken F, Yildirim O, Oken O, Gulcek M, Yavuzer G, Ucaner A. Short or long fusion after thoracolumbar burst fractures does not alter selected gait parameters: a preliminary study. J Orthop Res. 2011;29(6):915-8. DOI PubMed Google Scholar Full Text
4. Gautam S, Paudel KP, Panta S. Thoraco-lumbar burst fractures among patients admitted to spine unit of the department of orthopedics of a tertiary care centre: a descriptive cross-sectional study. J Nepal Med Assoc. 2023;61(259):232-6. DOI PubMed Google Scholar Full Text
5. Mikles MR, Stchur RP, Graziano GP. Posterior instrumentation for thoracolumbar fractures. J Am Acad Orthop Surg. 2004;12(6):424-35. DOI PubMed Google Scholar
6. Alpantaki K, Bano A, Pasku D, Mavrogenis AF, Papagelopoulos PJ, Sapkas GS, et al. Thoracolumbar burst fractures: a systematic review of management. Orthopedics. 2010;33(6):422-9. DOI PubMed Google Scholar Full Text
7. Kaya RA, Aydin Y. Modified transpedicular approach for the surgical treatment of severe thoracolumbar or lumbar burst fractures. Spine J. 2004;4(2):208-17. DOI PubMed Google Scholar Full Text
8. McLain RF. The biomechanics of long versus short fixation for thoracolumbar spine fractures. Spine. 2006;31(11 Suppl):S70-9; discussion S104. DOI PubMed Google Scholar Full Text
9. Carl AL, Tromanhauser SG, Roger DJ. Pedicle screw instrumentation for thoracolumbar burst fractures and fracture-dislocations. Spine. 1992;17(8 Suppl):S317-24. DOI PubMed Google Scholar
10. Esses SI, Botsford DJ, Kostuik JP. Evaluation of surgical treatment for burst fractures. Spine. 1990;15(7):667-73. DOI PubMed Google Scholar
11. Kaneda K, Abumi K, Fujiya M. Burst fractures with neurologic deficits of the thoracolumbar-lumbar spine. Results of anterior decompression and stabilization with anterior instrumentation. Spine. 1984;9(8):788-95. DOI PubMed Google Scholar
12. Kostuik JP. Anterior fixation for burst fractures of the thoracic and lumbar spine with or without neurological involvement. Spine. 1988;13(3):286-93. DOI PubMed Google Scholar
13. Lee YS. Long-term follow-up results of short-segment posterior screw fixation for thoracolumbar burst fractures. J Korean Neurosurg Soc. 2004;37:416-21. Google Scholar Full Text
14. Aly TA. Short segment versus long segment pedicle screws fixation in management of thoracolumbar burst fractures: meta-analysis. Asian Spine J. 2017;11(1):150-60. DOI PubMed Google Scholar Full Text
15. Sanderson PL, Fraser RD, Hall DJ, Cain CM, Osti OL, Potter GR. Short segment fixation of thoracolumbar burst fractures without fusion. Eur Spine J. 1999;8(6):495-500. DOI PubMed Google Scholar Full Text
16. Wang ST, Ma HL, Liu CL, Yu WK, Chang MC, Chen TH. Is fusion necessary for surgically treated burst fractures of the thoracolumbar and lumbar spine?: a prospective, randomized study. Spine. 2006;31(23):2646-52; discussion 53. DOI PubMed Google Scholar
17. Dai LY, Jiang LS, Jiang SD. Posterior short-segment fixation with or without fusion for thoracolumbar burst fractures. a five to seven-year prospective randomized study. J Bone Joint Surg Am. 2009;91(5):1033-41. DOI PubMed Google Scholar
18. McLain RF, Sparling E, Benson DR. Early failure of short-segment pedicle instrumentation for thoracolumbar fractures. A preliminary report. J Bone Joint Surg Am. 1993;75(2):162-7. DOI PubMed Google Scholar Full Text
19. McCormack T, Karaikovic E, Gaines RW. The load sharing classification of spine fractures. Spine. 1994;19(15):1741-4. DOI PubMed Google Scholar

20. Jindal N, Sankhala SS, Bachhal V. The role of fusion in the management of burst fractures of the thoracolumbar spine treated by short segment pedicle screw fixation: a prospective randomised trial. J Bone Joint Surg Br. 2012;94(8):1101-6. DOI PubMed Google Scholar Full Text
21. Huskisson EC. Measurement of pain. Lancet. 1974;2(7889):1127-31. DOI PubMed Google Scholar
22. Ko SB, Lee SW. Result of posterior instrumentation without fusion in the management of thoracolumbar and lumbar unstable burst fracture. J Spinal Disord Tech. 2014;27(4):189-95. DOI PubMed Google Scholar
23. Vercoulen TFG, Niemeyer MJS, Peuker F, Verlaan JJ, Oner FC, Sadiqi S. Surgical treatment of traumatic fractures of the thoracic and lumbar spine: A systematic review. Brain Spine. 2024;4:102745. DOI PubMed Google Scholar Full Text
24. Soultanis KC, Mavrogenis AF, Starantzis KA, Markopoulos C, Stavropoulos NA, Mimidis G, et al. When and how to operate on thoracic and lumbar spine fractures? Eur J Orthop Surg Traumatol. 2014;24(4):443-51. DOI PubMed Google Scholar
25. Kim HY, Kim HS, Kim SW, Ju CI, Lee SM, Park HJ. Short segment screw fixation without fusion for unstable thoracolumbar and lumbar burst fracture: A prospective study on selective consecutive patients. J Korean Neurosurg Soc. 2012;51(4):203-7. DOI PubMed Google Scholar Full Text
26. Been HD, Bouma GJ. Comparison of two types of surgery for thoraco-lumbar burst fractures: combined anterior and posterior stabilisation vs. posterior instrumentation only. Acta Neurochir (Wien). 1999;141(4):349-57. DOI PubMed Google Scholar Full Text
27. Siebenga J, Leferink VJ, Segers MJ, Elzinga MJ, Bakker FC, Haarman HJ, et al. Treatment of traumatic thoracolumbar spine fractures: a multicenter prospective randomized study of operative versus nonsurgical treatment. Spine. 2006;31(25):2881-90. DOI PubMed Google Scholar Full Text
28. Diniz JM, Botelho RV. Is fusion necessary for thoracolumbar burst fracture treated with spinal fixation? A systematic review and meta-analysis. J Neurosurg Spine. 2017;27(5):584-92. DOI PubMed Google Scholar Full Text
29. Tian NF, Wu YS, Zhang XL, Wu XL, Chi YL, Mao FM. Fusion versus nonfusion for surgically treated thoracolumbar burst fractures: a meta-analysis. PLoS One. 2013;8(5):e63995. DOI PubMed Google Scholar Full Text
30. Lan T, Chen Y, Hu SY, Li AL, Yang XJ. Is fusion superior to non-fusion for the treatment of thoracolumbar burst fracture? A systematic review and meta-analysis. J Orthop Sci. 2017;22(5):828-33. DOI PubMed Google Scholar Full Text
31. Thapa BB, Shah RP. Functional and radiological outcome of short same segment instrumentation in thoracolumbar burst fracture. J Nepal Health Res Counc. 2023;21(1):15-8. DOI PubMed Google Scholar Full Text
32. Xu BS, Tang TS, Yang HL. Long-term results of thoracolumbar and lumbar burst fractures after short-segment pedicle instrumentation, with special reference to implant failure and correction loss. Orthop Surg. 2009;1(2):85-93. DOI PubMed Google Scholar Full Text
33. Piazza M, Sinha S, Agarwal P, Mallela A, Nayak N, Schuster J, et al. Post-operative bracing after pedicle screw fixation for thoracolumbar burst fractures: A cost-effectiveness study. J Clin Neurosci. 2017;45:33-9. DOI PubMed Google Scholar
34. Choudhury A, Alam M, Azad A, Akhter K. Outcome of unstable thoracolumbar fracture following long segment posterior fixation. J Bangladesh Coll Phys Surg. 2021;39:114-22. DOI Google Scholar Full Text
35. Altay M, Ozkurt B, Aktekin CN, Ozturk AM, Dogan Ö, Tabak AY. Treatment of unstable thoracolumbar junction burst fractures with short- or long-segment posterior fixation in Magerl type A fractures. Eur Spine J. 2007;16(8):1145-55. DOI PubMed Google Scholar Full Text
36. Sapkas G, Kateros K, Papadakis SA, Brilakis E, Macheras G, Katonis P. Treatment of unstable thoracolumbar burst fractures by indirect reduction and posterior stabilization: short-segment versus long-segment stabilization. Open Orthop J. 2010;4:7-13. DOI PubMed Google Scholar Full Text
37. Sallam AM, Abdel Ghany WA, Ali AK, Habib MA, Toubar AF, Kabil MS, et al. Short-segment posterior fixation with index level screws versus long-segment posterior fixation for thoracolumbar spine fracture: angle of correction and pain. Egypt J Neurosurg. 2018;33(1):11. DOI Google Scholar Full Text
38. Gelb D, Ludwig S, Karp JE, Chung EH, Werner C, Kim T, et al. Successful treatment of thoracolumbar fractures with short-segment pedicle instrumentation. J Spinal Disord Tech. 2010;23(5):293-301. DOI PubMed Google Scholar