Nanotechnology Perceptions
ISSN 1660-6795
www.nano-ntp.com

Treatment of Dorsolumbar Spine Fractures by Posterior Spinal Fixation with Short Segment Versus Long Segment Fixation

Mahmoud Ahmed Mahfouz, Atef Mohamed Morsy, Emad Gaber EL Bana, Waleed Said Abd EL Khalik

Department of Orthopaedic Surgery and Traumatology, Faculty of Medicine, Beni-Suef University, Egypt

Background: Vertebral column fractures occur in about 6% of trauma cases, with half involving nerve roots or spinal cord. This research aims to assess the functional and radiological results of cases with thoracolumbar spine fractures managed by posterior spinal fixation with either long or short segment fixation.
Patients and methods: This cohort prospective research has been performed on 40 cases with dorso-lumbar spine fractures managed by posterior spinal fixation and separated into 2 groups: (Group A): 20 cases managed by long segment fixation and (Group B): 20 cases managed by short segment fixation with an index screw in a fractured vertebra in Beni-Suef University Hospital from October 2019 to October 2021.
Results: a statistically insignificant variance was observed among both groups regarding visual analogue scale (VAS) pre, VAS 3 months' post-operative, local kyphotic angle (LKA) pre, LKA post-operative, vertebral height loss (VHL) pre and VHL post-operative. There was statistically significant decrease in VAS, LKA and VHL after 3 months in Groups A and B. intra-operative time and blood loss is less in group (B) than in group (A).
Conclusion; In cases with compression or chance fractures in the dorso-lumbar region, the utilizing of short segment fixation with index screws shows favourable results, such as reduced operative time. less intra-operative blood loss, less costs, less scarifying with motion segment, smaller incision, less exposure to image intensifier and easier application in comparison to long segment fixation.

1. Introduction

According to reports, vertebral column fractures are present in approximately six percent of trauma cases, with half of these fractures affecting the nerve root or spinal cord nerve root. The thoracolumbar region is the site of approximately half of burst fractures, which are caused by the biomechanically weak junction among the T11 and L2 vertebrae. According to Denis, the failure of the middle and anterior columns of the spine is the cause of burst fractures. These fractures can be the result of high-velocity trauma in young adults, but in the geriatric age group, a trivial fall from a standing position can result in such fractures because of osteoporosis. It is estimated that neurological deficits are associated with twenty percent to forty percent of these injuries, that can be correlated with kyphotic deformity. [1,2].

The most effective therapy for thoracolumbar fractures remains controversial, as there isn't an established consensus on the matter. Rest and the use of a brace are non-operative alternatives. However, conservative methods may occasionally result in an increase in the pressure on the vertebral body, worsening in stenosis of the spinal, or progressive neurological deterioration, a worsening of neurological symptoms. or an incomplete neurodeficiency, canal narrowing of more than forty to fifty percent are all indications for surgery, and kyphotic deformity, more than fifty percent loss of vertebral body height [3].

In the management of the fractures of unstable thoracolumbar, posterior instrumentation with pedicle screws is the most frequently utilized posterior method. This method allows for an evaluation of all three columns of the spine and the correction of the deformity caused by the fracture without the potential complications of anterior surgery and progressive kyphosis [4].

Also, the most effective therapy for thoracolumbar spine fractures is controversial according to utilizing of long or short posterior fixation constructs. Long posterior fixation, which involves rods and pedicle screws that are positioned 2 levels above & below the fracture level, provides greater fixation. Nevertheless, it leads to an elevation in load on the lower discs and extraneous instrumentation [5 ,6].

Conversely, number of fixed segments is restricted by short posterior fixation, which employs pedicle screws with interconnected rods one level below & above the fracture level. Excessive loads on adjacent discs are additionally prevented by this method. Nevertheless, the failure rate of short posterior fixation for dorsolumbar fractures remains a topic of controversy [7].

The objective of the investigation was to assess the radiological and functional results of cases with thoracolumbar spine fractures managed by posterior spinal fixation with short segment versus long segment fixation.

2. Patients and methods

This cohort prospective research was performed on 40 cases with dorso-lumbar spine fractures that have been managed by posterior spinal fixation and separated into two groups: (Group A): 20 cases managed by long segment fixation and (Group B): 20 cases managed by short segment fixation with index screw in fractured vertebra in Beni-Suef University Hospital from October 2019 to October 2021.

Ethical considerations: The research was accepted by local ethical committee in the faculty of medicine, Beni-Suef University. Each case in this investigation has been presented with written, informed consent.

Inclusion criteria: compression fracture of dorsolumbar spine. (kyphotic deformity, >fifty percent loss of vertebral body height, canal narrowing of more than forty to fifty percent). distraction fracture of dorsolumbar region, intact neurology, and complete neurological deficits, age: 15 to 60 years and recent fracture

Exclusion criteria: fracture dislocation of dorsolumbar and lumbar spine, age greater than 60 years and incomplete neurology.

Methods: All patients were subjected to: Pre-operative assessment: History taking, neurological examinations, investigations

Operative details:

Anesthesia: A general anesthetic with endotracheal intubation was necessary. A remifentanil infusion was typically employed in conjunction with a propofol-based intravenous or inhalational technique that utilized a low minimum alveolar concentration (MAC) of sevoflurane or isoflurane (0.7 or less). To reduce the need for blood transfusions during surgery, it is important to avoid hypothermia, maintain controlled hypotension, and use pharmacological agents like vitamin K and tranexamic acid.

Bleeding Management: During the exposure, hypotensive anesthesia was administered by maintaining a mean arterial pressure (MAP) of 60–70 mmHg. Blood loss can be substantially diminished by antifibrinolytics, such as tranexamic acid.

Preoperative antibiotics: antibiotics were administered before the incision. A cephalosporin antibiotic that provides adequate coverage for gram-positive bacteria.

Patient Positioning (Prone Position): In order to prevent the spine from bleeding excessively due to high intra-abdominal pressure and concurrent venous pressure, the abdomen was suspended. The elbow and shoulder were in a comfortable 90-90° position, and the arms and shoulders were at rest. In order to prevent pressure sores, elbows and knees were adequately padded. The toes were hanging freely. The head was positioned in a face mask to allow the endotracheal tube to be free while the neck was in a neutral position, preventing pressure on the eyes. By avoiding the act of having the head lower than the rest of the body, which is caused by elevated hydrostatic pressure in the eyes, the risk of postoperative blindness was reduced. which results in reduction in blood perfusion. Both AP and lateral plane radiographic images must be accessible at all times. In order to prevent bladder distension from elevating intra-abdominal pressure during the procedure, a Foley catheter was inserted.

Approach:

Patients have been treated using the posterior approach to the spine. The lamina exposure, facet technique, and wound incision, were consistent among short- and long-segment approaches; however, the number and length of lamina exposed varied.

Technique:

The transpedicular screws have been inserted with the assistance of a C-arm. (owel, pedicular finder, ball-tipped probe, tap, measure) after the facets and laminae of the index level were exposed with one level above and one below in short segment fixation and two levels above and two below in long segment fixation. In the short segment group, the pedicular screw is inserted one level above and one below the fractured vertebra using an index screw. However, in the long segment group, the pedicular screw is inserted two levels above and two below the fractured vertebra.

Pedicle Screw Insertion:

Screw diameter: We used screws with a diameter between 5.5 and 6.5 mm for the lower thoracic and upper lumbar pedicles.

Screw type: We used polyaxial screws.

After confirmation, screws were inserted in an anatomical position after the bilateral vertebral pedicles were confirmed to be in the correct location: Lumbar spine: The confluence of any of the four lines utilized to define the pedicle screw of the entry point: Pars mid transverse process, lateral border of the superior articular facet, mamillary process, interarticularis.

Thoracic spine: The intersection of the superior portion of the transverse process and the mid portion of the facet joint was used to establish the entry point of the pedicle screw for the lower thoracic segments. The particular entry point was situated just caudal and lateral to this intersection. As one advances to more levels of proximal thoracic, the entry point becomes increasingly cephalad.

Landmarks: transverse process, Ridge of the pars interarticularis, facet, lateral border of the inferior facet and lateral border of the superior. Prior to wound closure, intraoperative imaging was conducted to verify the position of the screw and correct kyphosis. The application of a suction discharge was performed.

3. Results

Table 1 demonstrates that there was statistically insignificant distinction among both groups as regards characteristic data. The mean age

Table 2 demonstrates that there was statistically insignificant distinction among both groups as regards the ASIA score.

Table 3 demonstrates that there was statistically insignificant distinction among both groups as regards superficial infection, deep infection, and metal failure.

Table 4 shows that blood loss and intra-operative time are greater in group (A) than in group (B).

Table 5 demonstrates that there was statistically insignificant distinction among both groups according to ODI after 3 months.

Table 6 demonstrates that there was statistically insignificant distinction among both groups as regards VAS pre, VAS 3 months after surgery, LKA before, LKA after surgery, VHL before, and VHL after surgery. There was statistically significant reduction VAS, LKA, and VHL after 3 months in Groups A and B.

Table (1): Comparison between both groups as regards demographic data.

		Group A		Group B		Chi square test	
		No	%	No	%	X^2	P value
Sex	Female	9	45.00%	16	80.00%	5.227	0.052
	Male	11	55.00%	4	20.00%		
Age	Mean ±SD	31.25 ± 11.36		30.20 ± 10.47		0.304	0.763

Table (2): Comparison between both groups as regards ASIA score

		Group A		Group B		Chi square test	
		No	%	No	%	X^2	P value
ASIA score pre	A	4	20.00%	4	20.00%	0.000	1.000
	E	16	80.00%	16	80.00%		
ASIA score post	A	4	20.00%	4	20.00%	0.000	1.000
	E	16	80.00%	16	80.00%		

Table (3): Comparison between both groups as regards infection

		Group A		Group B		Chi square test	
		No	%	No	%	X^2	P value
Superficial infection	NO	16	80.00%	17	85.00%	0.173	0.677
	YES	4	20.00%	3	15.00%		
Deep infection	NO	20	100.00%	20	100.00%	NA	NA
Metal failure	NO	20	100.00%	20	100.00%	NA	NA

Table (4): Comparison between both groups as regard operative time and intra-operative blood loss:

	Group A		Group B	
	Mean	SD	Mean	SD
Operative time	110 m	7.24	80 m	6.89
Intra-operative blood loss	483.5 cc	41.14	352.5	18.13

Table (5): Comparison between both groups as regards ODI post 3 months

	Group A		Group B		Independent t test	
	Mean	SD	Mean	SD	t	P value
ODI post 3 m	5.44	1.15	5.00	0.89	1.199	0.240

Table (6): Comparison between pre and post 3 months (VAS, LKA and VHL) in group A and group B:

	Group A		Group B		Independent t test	
	Mean	SD	Mean	SD	t	P value
VAS						
Pre	6.6	0.503	6.65	0.489	-0.319	0.752
Post 3 months	1.55	0.51	1.6	0.503	-0.312	0.757
t	32.906		37.341			
P value	0.001		0.001			
LKA						
Pre	25.25	7.86	27	4.931	-0.843	0.404
Post 3 months	6.15	4.344	6.35	3.297	-0.164	0.871
t	14.238		20.113			
P value	0.001		0.001			
VHL						
Pre	46.85	8.851	49.45	8.062	-0.971	0.338
Post 3 months	15.55	8.581	16.15	4.44	-0.278	0.783
t	14.421		20.146			
P value	0.001		0.001			

4. Cases presentation

Demographic data: Female patient 35y

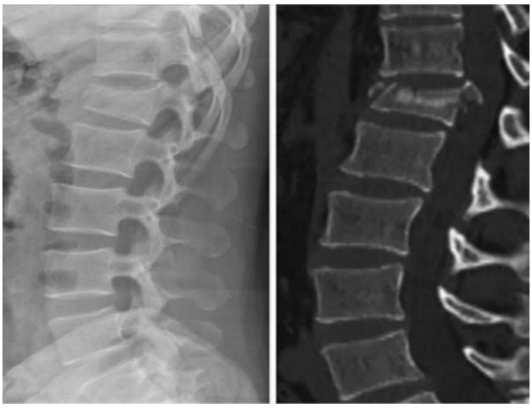
Mode of trauma: falling from height.

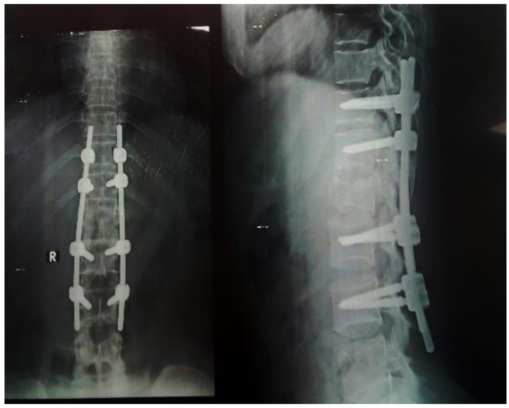
X ray: burst fracture L1, with LKA 35 and VHL 62.

Pre-operative data: ASIA (E) and VAS was severe.

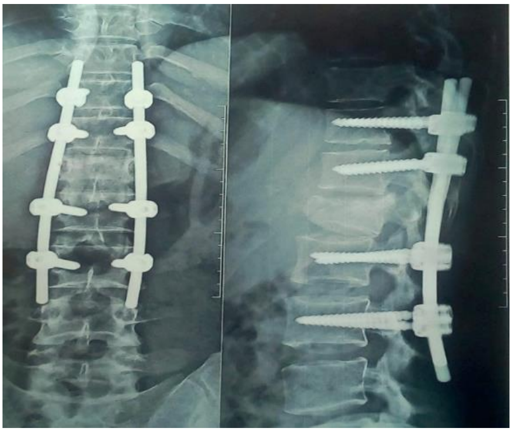
Type of fixation: long segment fixation was done

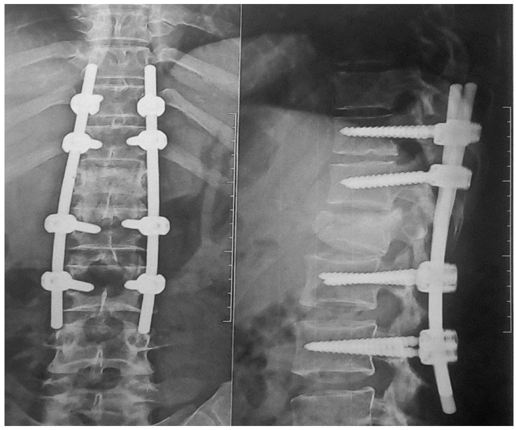
Post-operative data: ASIA score (E), no superficial infection, no deep infection, no metal failure, VAS after 3 m was mild, ODI after 3 m was 4, LKA post-operative 4 and VHL 10.

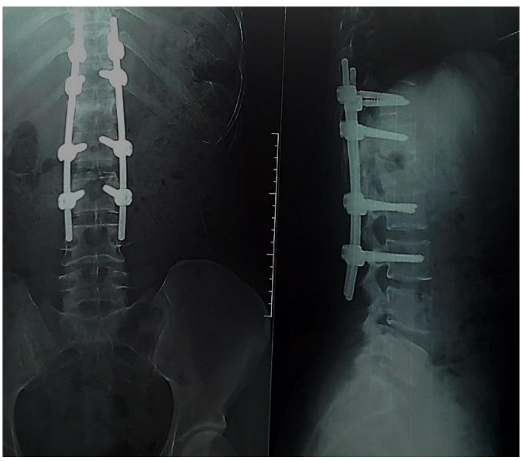

(A): Pre-operative x ray and CT case no 1

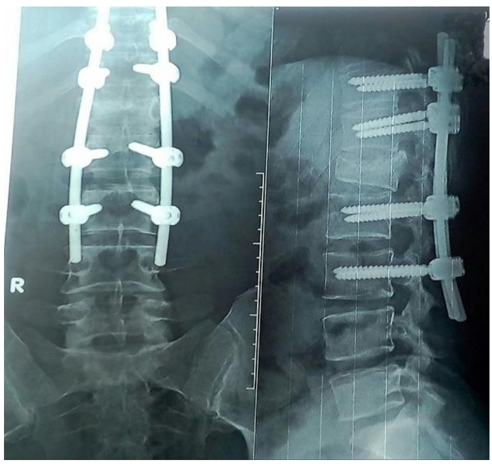


(B): Immediate post-operative x ray case 1


(C): Follow up x ray case 1 after 2 month


(D): follow up x ray case 1 after 4 month


(E): follow up x ray case 1 after 6 month



(F): follow up x ray case 1 after 12 m

Figure 1: Long segment fixation case

Case 2:

Demographic data: Male patient 30y.

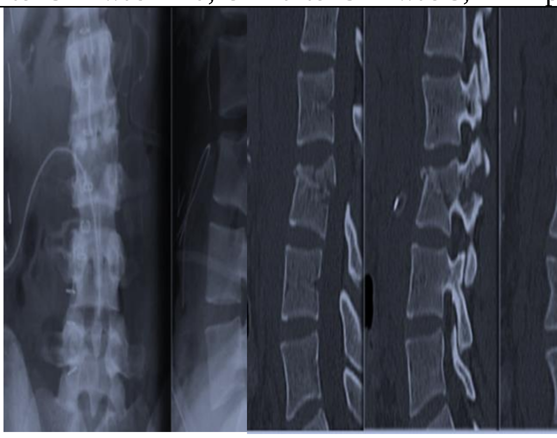
Mode of trauma: motor car accident.

X ray: chance fracture L2, LKA 20 and VHL 25

Pre-operative data: patient was ASIA (E) and VAS was severe

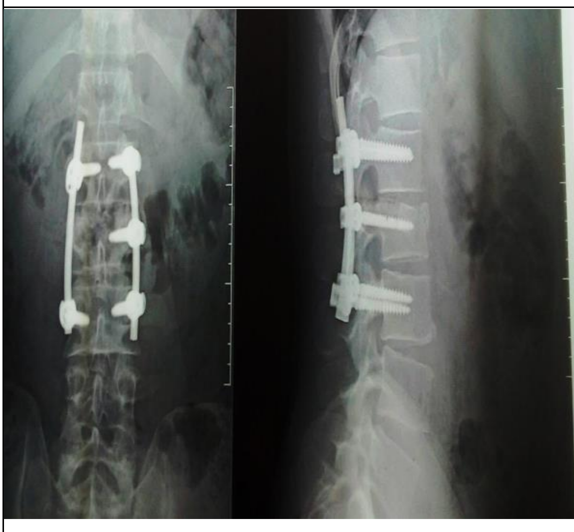
Type of fixation: short segment fixation with index screw

Post-operative data: ASIA E, no superficial infection, no deep infection, no metal failure, VAS after 3 m was mild, ODI after 3 m was 5, LKA post-operative 5 and VHL 9



(A): Pre-operative x ray and CT case no 2

(B): immediate Post- operative x ray case 2



(C): follow up x ray case 2 after 2 month

(D): follow up x ray case 2 after 4 month

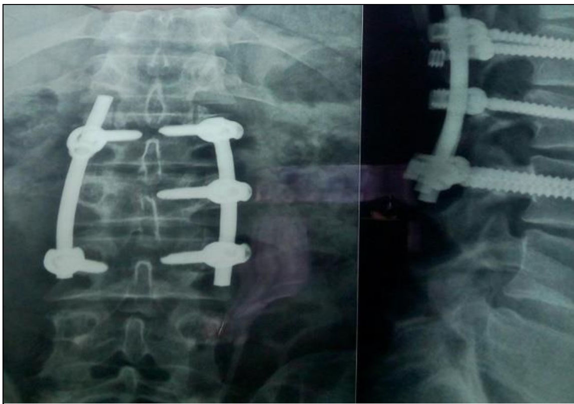
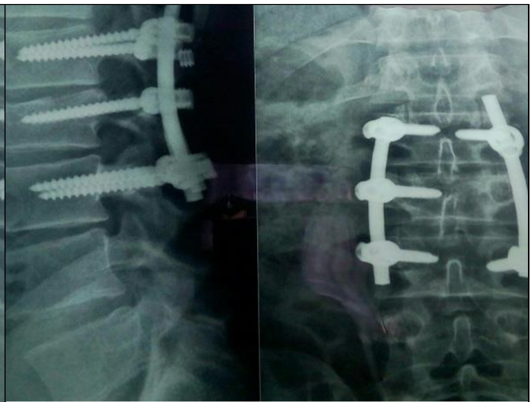
	
(E): follow up x ray case 2 after 6 months	(F): follow up x ray case 2 after 12 months

Figure 2: short segment fixation case

5. Discussion

In our research, we assessed forty cases with dorsolumbar spine fractures who received long or short segment fixation. The cases' mean ages were 31.25 ± 11.36.

Bikato et al. [8] assessed 21 patients with dorsolumbar burst fractures who received long or short segment pedicle screw fixation from January 2016 to June 2019 in Wahidin Sudirohusodo Hospital Makassar. The cases mean age was 35 ± 13 years old.

There was statistically insignificant distinction among both groups regarding ASIA score and ODI post-3 months. Blood loss and intra-operative time are higher in group (A) than in group (B).

Agrawal et al. [9] assessed 119 cases with thoracolumbar spine fractures utilizing the AO classification system. During a minimum of one year of case follow-up, the angles of correction were measured on lateral X-rays using Cobb's method. Frankel's grading system was implemented during neurological evaluation. Additionally, perioperative blood loss, the time to mobilization, and operational time. The two groups did not exhibit a significant distinction in the loss of kyphosis after one year. The operative times and perioperative blood loss were substantially decreased in cases suffering from SS fixation, despite the absence of statistical distinctions in terms of neurological results, duration of hospitalization. or time to mobilization,

In our study, in LSF, the mean VHL pre-operatively was 46.85±8.85, and the mean VHL post-operatively was 15.55±8.58. In SSF group, the mean VHL pre-operative was 49.45 ±8.06, mean VHL postoperatively was 16.15±4.44.

Cetin et al, [10] evaluated seventeen cases who received LSF or SSF-P to treat unstable thoracolumbar fractures, in LSF group, mean VHL pre-operatively was 43.6, mean VHL post-operatively was 24.4. In SSF group, the mean VHL pre-operatively was 27.6, and the and the mean VHL postoperatively was 11.5.

In our study, in LSF group, pre-operative LKA was 25.25, post-operative LKA was 6.15. In SSF group, pre-operative LKA was 27, and post-operative LKA was 6.35.

Choudhury et al, z [11] assessed 80 patients with dorsolumbar spine fractures treated by long or short segment fixation. The mean preoperative kyphotic deformity in the SSF with indexscrew group was 22.75 ± 4.690°, while in the LSF group it was 21.48 ± 5.89° (p equal 0.351). The kyphotic deformity was 9° ± 2.9° and 8.48° ± 2.35° in the immediate postoperative period, respectively (p = 0.550). The final follow-up kyphotic deformity was 10.53 ± 3.11° and 9.88 ± 2.22°, respectively, which was statistically insignificant (p = 0.360).

In our study, in LSF group, pre-operative VAS was 6.6± .5, and post-operative VAS was 1.55± .51. In SSF group, preoperative VAS was 6.65± .49, postoperative VAS was 1.6± .5

Tammam, et al, [12] assessed 80 patients with dorsolumbar spine fractures treated by long or short segment fixation. in LSF group, post-operative VAS was 2.5. In SSF group, postoperative VAS was 2.27.

Sallam, et al. [13] assessed 91 cases that underwent posterior fixation and had single-level thoracolumbar fractures. Forty-four cases received short-segment fixation with screws into the index level, while 47 cases received long-segment fixation. The visual analogue scale (VAS) was 5.59 ± 2.09 prior to surgery; however, it was decreased to 1.39 ± 0.58 at the one-year follow-up. The preoperative VAS of the long segment group was 5.4 ± 2.01, which was subsequently reduced to 1.47 ± 0.58.

In this investigation, there has been statistically insignificant distinction among the two groups according to superficial infection, deep infection, and metal failure. Screw breakage or metal failure were not observed in either group.

The meta-analysis conducted by Aly, et al [14] has determined the implant failure incidence in all research, with a total of 13 cases from 328 cases (ten in the short segment group and three in the long segment group). The fixed-effects model was employed to assess the implant failure rate in the two groups at the end of the monitoring. The risk ratio of implant-related complications was 0.09 for both long and short segment fixation. In this comparison, the two groups did not demonstrate significant distinctions (p = 0.52).

6. Conclusion

Using short segment fixation with an index screw in patients having compression or chance fractures in dorso-lumbar region shows favourable results, including less operative time, less intra-operative blood loss, less costs, less scarification with motion segment, smaller incision, less exposure to the image intensifier and easier application in comparison to long segment fixation.

References

1. Bharadwaj, A., Bhardwaj, A. R., & SHARMA, G. (2018). Comparison of Posterior Short-segment Pedicle Screw Fixation with or without Fusion in Thoracolumbar Burst Fractures. Journal of Clinical & Diagnostic Research, 12(12).

2. Singh, R., Rohilla, R. K., Kamboj, K., Magu, N. K., & Kaur, K. (2014). Outcome of pedicle screw fixation and monosegmental fusion in patients with fresh thoracolumbar fractures. Asian spine journal, 8(3), 298.
3. Tian, N. F., Wu, Y. S., Zhang, X. L., Wu, X. L., Chi, Y. L., & Mao, F. M. (2013). Fusion versus nonfusion for surgically treated thoracolumbar burst fractures: a meta-analysis. PloS one, 8(5), e63995.
4. Tezeren, G., & Kuru, I. (2005). Posterior fixation of thoracolumbar burst fracture: short-segment pedicle fixation versus long-segment instrumentation. Clinical Spine Surgery, 18(6), 485-488.
5. Thanappan, N., Saravanamuthu, T., Singaravel, K., & Sivakaran, P. (2019). Functional analysis of effectiveness of short segment with index vertebra fixation as compared with long-segment fixation in the management of thoracolumbar spinal injuries. INTERNATIONAL JOURNAL OF SCIENTIFIC STUDY, 6(12), 146-150.
6. Zoccali, C., Rossi, B., Walter, C. M., & Baaj, A. A. (2017). Short-segment versus long-segment stabilization in thoracolumbar burst fracture: A review of the literature. Journal of Orthopedic and Spine Trauma.
7. Aoui, M., Sahnoun, N., Abid, M., Maatoug, M., Hsairi, M., Hentati, Y., & Keskes, H. (2020). Posterior short segment pedicle screw fixation for the treatment of thoracolumbar fracture. Pan African Medical Journal, 35(1).
8. Biakto, K. T., Usman, M. A., Limoa, W., & Putra, L. T. (2020). Comparison between short segment pedicle screw fixation and long segment pedicle screw fixation for treatment of neglected single level thoracolumbar burst fracture. International Journal of Surgery Open, 26, 145-149.
9. Agrawal, H., Sharma, A., Singh, V., Naseem, A., Gaddikeri, M., & Amin, A. (2022). Long-segment fixation versus short-segment fixation with instrumentation of index vertebra for thoracolumbar fractures. Surgical Neurology International, 13.
10. Çetin, E., & Öner, A. (2020). Comparison of short segment pedicle screw fixation including the fractured vertebra versus long segment fixation in thoracolumbar fractures. JAREM. Journal of Academic Research in Medicine, 10(1), 32.
11. Choudhury, A. A. M., Alam, M. S., Jonayed, S., Dastagir, O. Z. M., & Jahan, M. S. (2023). Long-segment versus short-segment pedicle screw fixation including fractured vertebrae for the management of unstable thoracolumbar burst fractures. Cureus, 15(2).
12. Tammam, H., Alkot, A., Ahmed, A. M., & Said, E. (2022). Long-versus short-segment fixation with an index vertebral screw for management of thoracolumbar fractures. Acta orthopaedica Belgica, 88(3), 423-31.
13. Sallam, A. M., Abdel Ghany, W. A., Ali, A. K., Habib, M. A., Toubar, A. F., Kabil, M. S., ... & Nada, M. A. (2018). Short-segment posterior fixation with index level screws versus long-segment posterior fixation for thoracolumbar spine fracture: angle of correction and pain. Egyptian Journal of Neurosurgery, 33, 1-6.
14. Aly, T. A. (2017). Short segment versus long segment pedicle screws fixation in management of thoracolumbar burst fractures: meta-analysis. Asian spine journal, 11(1), 150.