

Original Research Article

Short segment pedicle screw fixation of thoracolumbar fracture: a case series of 33 patients

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ABSTRACT

Background: Pedicle screw instrumentation in case of fracture spine provides stable fixation. However in absence of experience and proper technique of pedicle screw insertion, it is associated with many complications. We aim to study the results of patients with thoracolumbar fracture stabilized with short segment pedicle screw instrumentation.

Methods: 33 cases of thoracolumbar wedge compression fracture spine presenting to Nair Hospital were included in the study. All patients were operated by the senior author via a posterior approach and short segment pedicle screw fixation. Patients were followed up for one year.

Results: 33 patients with a mean age were 37.6 years of which 3 were females and 30 were males in our study. Fall from height (93.93%) was the most common mode of injury followed by road traffic accident (6.07%). D12 and L1 were the most common vertebrae involved. Statistically significant ($p=0.01$) correction in the vertebral body height occurred in the immediate postop period and there was 4.1% loss of correction at final follow-up. There was statistically significant improvements in the Regional angle ($p=0.03$) and anterior wedge angle ($p=0.03$). Residual regional angle at final follow-up was found to be $>5^\circ$ in 3 patients. Neurological improvement was seen in 23 (74.19%) patients ($p=0.01$). No improvements were seen in 8 (25.81%) patients. None of our patients had postoperative worsening of the neurological status. None of the patients had pedicle wall breach on final follow up CT scan.

Conclusions: Short segment fixation in case of wedge fracture can restore the vertebral body height, mean regional angle and mean anterior wedge angle and provide good outcome. There are poor chances of recovery of patient with Frankel grade A. Meticulous dissection and careful technique of pedicle screw insertion, adequate decompression, good contouring of the rod with correction of kyphosis can provide excellent results.

Keywords: Thoracolumbar fracture spine, Pedicle screw, Vertebral body height, Anterior wedge angle, Regional angle, Neurology

INTRODUCTION

Vertebral column injuries are reported to occur in approximately 6% of trauma patients, with half of these patients (2.6%) sustaining spinal cord or nerve root level neurologic injury.¹ There is strong experimental and clinical evidence that early operative reduction, decompression of the spinal cord and stabilization of the injured spine, is an effective method of ensuring the

optimal environment for neurological recovery.²⁻⁴ Anterior stabilization has the advantage that it is more effective for restoration of neurological function and does not need laminectomy but it comes with the morbidity of anterior approach.⁵ Posterior spinal fixation system has the advantage of using less extensive approach with less blood loss and complications without compromising the quality of stabilization.⁵ Short internal fixation of the spine spares healthy mobile segments in fusion and thus

preserves mobility.⁶ Instrumented stabilization of spine can be done with Hartshil construct and pedicle screw fixation. Pedicle screw fixation provides short, rigid segmental stabilization that allows preservation of motion segments and stabilization of the spine in the absence of intact posterior elements, which is not possible with non-pedicular instrumentation however it can be associated with complications such as cord damage, dural leak which can occur due to malpositioned screw.

METHODS

The study was performed after receiving approval from the institutional review board. A retrospective study of 33 patients of dorso-lumbar fracture spine presenting to Nair Hospital, Mumbai between May 2015 to December 2016 were included in the study. All the patients consented to be included in the study.

Inclusion criteria

- Clinically and radiologically diagnosed cases of traumatic dorso-lumbar wedge fracture
- 50% or more loss of anterior vertebral body height.
- Between 20 to 70 years of age
- With neurodeficit
- Single level vertebral body fracture
- Minimum follow-up of 1 year

Exclusion criteria

- Patients not willing to be part of study
- Pathological fracture

Intra operative surgical steps

A posterior approach is used. An incision from one spinous process above the area to be instrumented to one spinous process below the area to be instrumented. The subcutaneous tissue and muscle is infiltrated with epinephrine 1:500,000 (20–30 ml). The paraspinal muscles are dissected from the spinous processes with Cobb elevators and electrocautery. The transverse process on both the side is exposed. The pedicle entry point is identified. A blunt awl is inserted into the pedicle and its position is confirmed with poster anterior and lateral C-arm images. The pedicle is probed to ensure continuity of the entire 4 wall. The depth of the screw is measured. The pedicle is tapped to at least one half of the depth of the vertebral body using a tap for a screw diameter chosen from preoperative pedicle measurements. A pedicle screw with a polyaxial head is inserted. C arm shoot is taken to confirm its placement in the pedicle. One level above and below the fracture is instrumented. A 6.5 mm rod contoured to the native anatomy of the spine is applied to the screws. A distractor is used to distract and achieve alignment and reduction of the spine. The reduction is confirmed using a C-arm. If there is a posterior laminar defect at or near the fracture

site, or if cerebrospinal fluid is visible, a total laminectomy is performed at the fracture level. The dura if damaged is repaired using prolene 4-0 sutures. Cross link is applied to the rod. The reduction is confirmed using PA and lateral C-arm images. A burr is used to decorticate the remaining lamina and transverse processes. The bone removed during the procedure is nibbled to remove the soft tissue and is inserted as a bone graft. The wound is closed in layers over a drain.

Postoperative

Patients were started on IV Cefuroxime 1.5 gm twice daily for two days and SC Inj. Clexan 1 mg/kg twice daily for five days. Patients were kept in a propped up position and started on chest physiotherapy. Drain was removed after the output reduced to <30 ml (usually 3rd day). Patients were mobilised with Taylors brace with axillary support after drain removal. Patients were discharged on day 7 and followed up on day 14 and then on monthly basis.

The patients are evaluated for their neurological recovery and radiological correction of deformity with a) regional angle b) anterior wedge angle c) vertebral body height at the time of admission, immediate post-op, 6th week, 3rd month, 6th month and 1 year follow-up.

Measurement of radiological parameters

- Regional angle: the angle formed by the cranial and caudal end plates of the adjacent intact vertebrae in lateral view
- Anterior wedge angle: the angle formed by the cranial and caudal end plates of the fractured vertebra in lateral view
- Vertebral body height ratio: it is measured by dividing the anterior end of the involved vertebra [Anterior corporal height] and posterior end of the involved vertebra [posterior corporal height] in lateral view as shown in Figure 1.

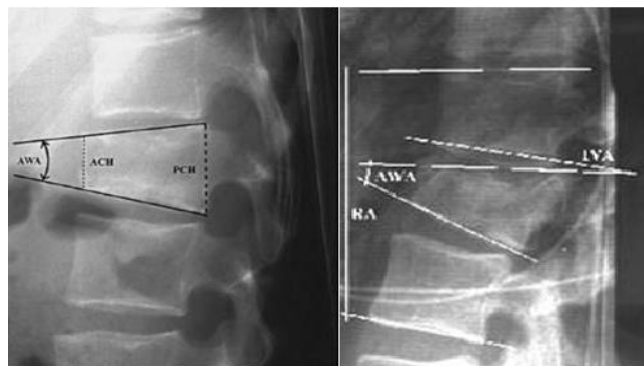


Figure 1: Measurement of anterior wedge angle, regional angle and vertebral body height ratio. RA = Regional angle, AWA = Anterior vertebral wedge angle, ACH = Anterior corporal height PCH = Posterior corporal height

Statistical analysis

A paired t test was used to compare the preoperative, postoperative and follow-up radiological parameters of regional angle, anterior wedge angle and vertebral height ratio. SPSS Statistics V 22 was used to perform the calculation.

RESULTS

A total of 33 patients included in the study with age range of 20-66 years, mean age were 37.6 years. There were 3 females and 30 males in our study (Table 1).

Table 1: Age and sex wise distribution.

			Sex		Total
			M	F	
Age group	20-30	Count	10	1	11
		%	90.9	9.1	100
	30-40	Count	8	2	10
		%	80	20	100
	40-50	Count	9	0	9
		%	100	0	100
	>50	Count	3	0	3
		%	100	0	100
Total	Count	30	3	33	
	%	90.9	9.1	100	

Fall from height (93.93%) was the most common mode of injury followed by road traffic accident (6.07%). All the patients reported within 12 hours of trauma expect for 1 patient who came 5 days after the trauma. This patient remained Frankel grade A at final follow up. Among various vertebra involved, involvement of T12 and L1 vertebra (thoracolumbar junction) constitute 48.4%. In 60.5% of cases lumbar vertebra are involved. All the patients were operated by the senior author. Mean preoperative delay was 1 day after trauma. All patients were followed up for 1 year. Statistically significant correction in the vertebral body height occurred in the immediate postop period and there was 4.1% loss of correction at final follow-up (Table 2) (Figure 2 and 3).

Table 2: Vertebral body height in mm.

	Mean	SD
Preoperative	15.27	3.11
Immediate postoperative	24.33	2.08
3 rd month	23.90	2.27
1 year	23.30	2.78

There were statistically significant improvements in the regional angle and anterior wedge angle (Table 3 and 4). Residual regional angle at final follow-up was found to be >5° in 3 patients. These patients had chronic backache.

However they refused any operative intervention and hence were managed conservatively. Of the 11 patients with grade A, 8 patients showed no improvement even at one year of follow up (Table 5).

Table 3: Regional angle in degrees.

	Mean	SD
Preoperative	14.00	6.97
Immediate postoperative	1.61	0.97
3 rd month	1.82	1.13
1 year	2.21	1.56

Table 4: Anterior wedge angle in degrees.

	Mean	SD
Preoperative	15.91	8.50
Immediate postoperative	1.42	0.77
3 rd month	1.91	1.24
1 year	2.09	1.56

Table 5: Neurological status.

Frankel Neurological grade	Preoperative	3 rd month postop	6 th month postop	1 year postop
A	11	10	8	8
B	5	2	2	2
C	8	6	4	1
D	7	5	6	6
E	2	10	13	16

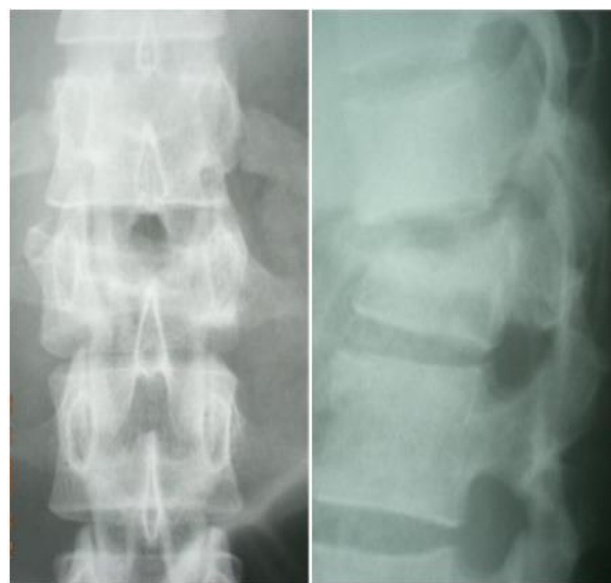


Figure 2A: Preoperative X-ray of 35 year male c/o L1 fracture spine with neurological status of Frankel grade C.

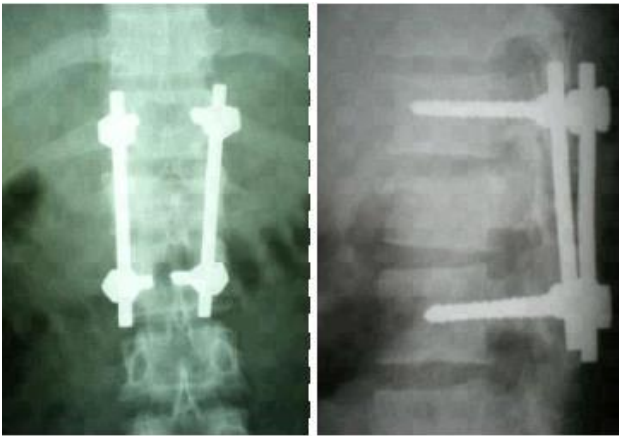


Figure 2B: 6 weeks postoperative X-ray.

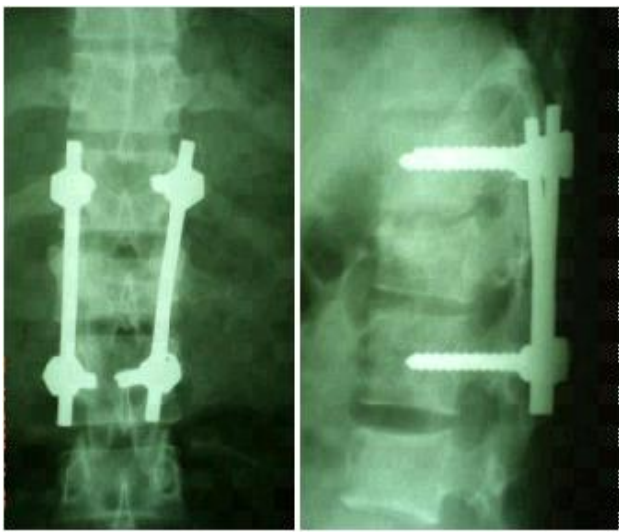


Figure 2C: 3 months postoperatively.

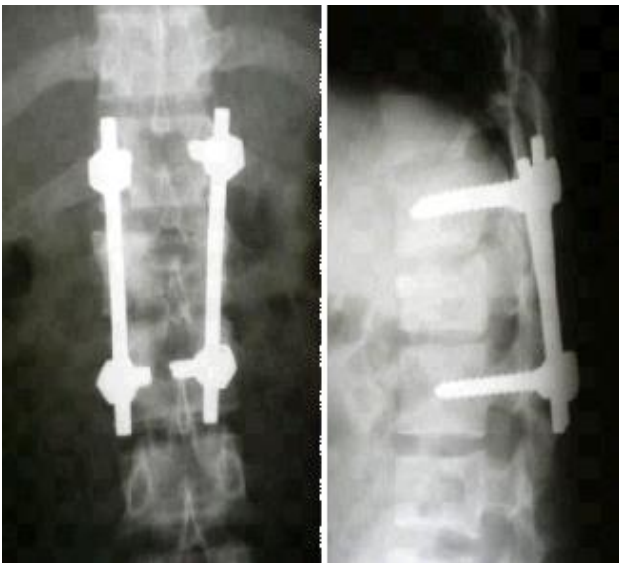


Figure 2C: 1 year follow up X-ray. Patient improved from Frankel grade C to grade E. There is minimum loss of correction.

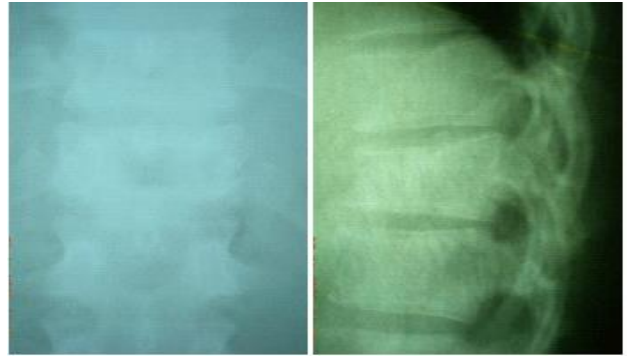


Figure 3A: Preoperative X-ray of 29 year male c/o D12 fracture spine with neurology of Frankel grade B.

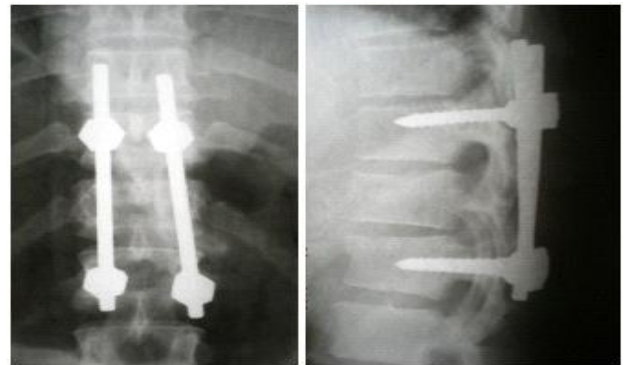


Figure 3B: 6 weeks postoperative X-ray.

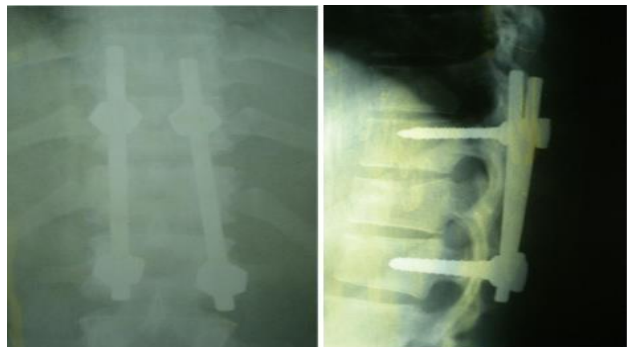


Figure 3C: 3 months postoperatively.

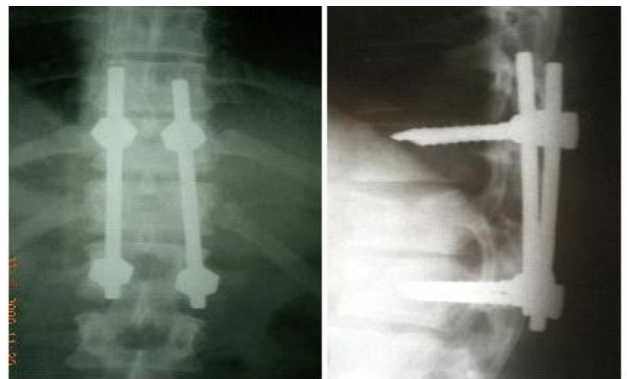


Figure 3D: 1 year follow up X-ray. Patient improved from Frankel grade B to grade E.

Neurological improvement was seen in 23 (74.19%) patients which is statistically significant. No improvement seen in 8 (25.81%) patients. It has been observed that out of 11 patients with preoperative Frankel's grade A only 2 improved to grade B and 1 to grade C. All patients who did not improve in the study were in grade A. None of the patients with grade A at admission were mobilized independently with orthosis. So the need for fixation in patient with preoperative Frankel's grade A is only to make them sit and mobilize by wheel chair to prevent pressure sores, pneumonia, and other complications related to prolonged recumbence. Among the remaining 20 patients with Frankel's grade B, C and D, all had neurological improvement. None of our patients had postoperative worsening of the neurological status. We had 2 cases of superficial wound maceration. They were treated with daily cleaning and dressing. 1 cachectic patient developed prominence of implant and skin breakdown 1 year postoperatively for which implant removal was done (Figure 4). Patient made uneventful recovery. We had one patient with dural tear that was repaired with Prolene 4-0 with a fat graft. None of the patients had pedicle wall breach on final follow-up CT scan.

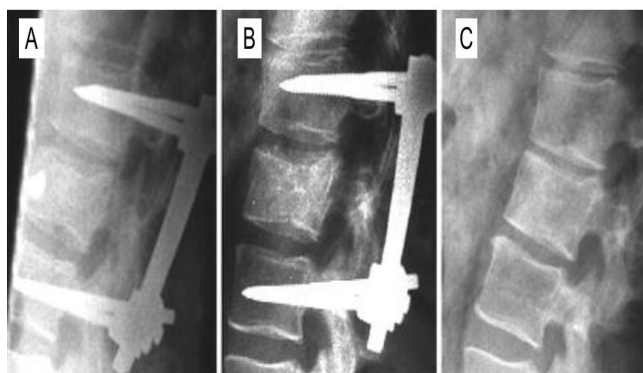


Figure 4: A) 3 month follow up; B) 1 year follow up showing radiological maintained correction but the implant was exposed; C) postoperative X-ray after removal of the implant.

DISCUSSION

Curtis et al in their met analysis of surgical treatment alternatives for fixation of unstable fractures of thoracic and lumbar spine, they analyzed 15 articles including 614 patients concluded that neurological recovery occurred in 74 (24.34%) patients, neurological status unchanged in 228 (75.49%) patients and neurological worsening in 2 (0.66%) patients.⁷ They noted loss of fixation by disconnection of rod in 21 patients (3.4%). Screw rod interface loosening and disconnection of rod with failure of construct was seen in 1 patient (3.1%). We in our study had a neurological recovery of 74%. The earlier available versions of the single locking screw-rod interface systems had bulky screw heads which lead to prominence when used in children and lean individuals. These earlier locking mechanism designs of the inner nut

did not provide adequate gripping force thus leading to occasional interface failure.⁸⁻¹⁰

The Table 6 demonstrate significant improvement in the anterior wedge angle and mean regional angle in both our study and study by Leferint et al in patients with thoraco-lumbar spine fracture.¹¹

Robert et al in their study of thoracolumbar fractures treated with pedicle screw instrumentation involving 52 patients reported a measurable loss of reduction of more than 5° of kyphotic angle in 10 patients out of which 8 had more than 10°. ¹² They concluded that primary cause for progressive deformity was failure of fixation construct due to bending or breakage of screws, loosening or pull out of screws or translation of vertebra that had been included in the instrumentation. However, in our study, there was a mean loss of 0.8° which was not statistically significant. This could be because of our meticulous approach of screw placement and the refinement of the operating techniques and instrumentations over the past many years. Regional angle of >5° is significant because this can cause chronic backache postoperatively.¹³ In our study residual regional angle at final follow-up was found to be >5° in 3 patients.

Hansen et al in their historical cohort study of pedicle screw instrumentation included 3863 patients of which 586 patients were in trauma group. They calculated total rate of screw fracture as 0.7% and compared with contemporary literature available at that time which was 0.4% among trauma group.¹³ They also opined that screw fracture usually does not result in any clinical consequences. We did not encounter any screw breakage, however according to us in case of short segment fixation, fracture of the screw can result in loss of correction and instability. A revision surgery might be required in such patients. We did not have any case of screw fracture in our series. In a study by Yaser in 2001 involving 70 patients with thoracolumbar fractures treated with pedicle screw instrumentation with mean follow up of 10 months.¹⁴ No patient had breakage or loosening of screws. There was significant improvement in kyphosis from 34° preoperatively to 4° postoperatively during last follow up. Table 7 describes in brief the complications of thoraco-lumbar spine fracture stabilized with pedicle screw.

Table 6: Comparative analysis of mean AWA and mean RA.

		Preoperative	last follow up
Mean anterior wedge angle	Leferint ¹¹	18.8	5.9
	Our study	15.9	2.21
Mean regional angle	Leferint ¹¹	9.9	0.3
	Our study	14	2.09

Table 7: Comparative analysis of complications.

Complications	Study	Percentage
Pedicle screw breakage	Curtis ⁷ (n =641)	12%
	Ache ¹⁶ (n =163)	5.5%
	Our study (n =33)	0%
Improper placement of pedicle Screws	Ache ¹⁶ (n =163)	10.4%
	Stephen ¹⁷ (n =236)	5.2%
	Our study (n =33)	0%
Dural tear	Stephen ¹⁷ (n =236)	1.9%
	Robert ¹² (n =52)	2-4%
	Ache ¹⁶ (n =163)	1.84%
	Our study (n =33)	3%
Infections	Robert ¹² (n =52)	1.2-2.4%
	Stephen ¹⁷ (n =236)	4.2%
	Our study (n =33)	6%
Deep vein thrombosis	Ache ¹⁶ (n =163)	1.84%
	Stephen ¹⁷ (n =236)	4.2%
	Our study (n =33)	0%
Screw breakage	Ache ¹⁶ (n =163)	5.5%
	Stephen ¹⁷ (n =236)	0.6%
	Robert ¹² (n =52)	2.6-3.6%
	Yaser ¹⁴ (n =70)	0%
	Our study (n =33)	0%
Screw loosening	Ache ¹⁶ (n =163)	20%
	Stephen ¹⁷ (n =236)	1.1%
	Our study (n =33)	0%
Screw misplacement	Stephen ¹⁷ (n =236)	5.2%
	Ache ¹⁶ (n =163)	10.42%
	Robert ¹² (n =52)	0-25%
	Martin ¹⁵ (n =5756)	2.5%
	Our study (n =33)	0%

Martin et al in his comprehensive literature review on pedicle screw fixation devices analyzing 101 articles including 5756 patients, calculated malposition of screws was at the rate of 2.5%.¹⁵ According to us pedicle wall breach can be avoided by

1. Sound probing of the pedicle to make sure all the walls are intact
2. Sequentially tapping of the pedicle at 1 mm increments (3.5 mm ≥4.5 mm ≥5.5 mm). This avoids pedicle fracture during screw insertion.
3. Probing the pedicle after tapping
4. Check C-arm shoot. In AP view we make sure the pedicle screw doesn't cross the midline or the outer vertebral border (medial and lateral wall breach) and the superior end plate. And in lateral view we check for the screw to remain within the superior and inferior pedicle borders.

A meticulous technique is the pre-requisite to avoid any screw related complication. Ache et al in 1994 studied complications of transpedicular decompression and pedicle screw stabilization of spine in 163 patients and found dural leak in 3 patients, inaccurate screw

placement in 17 patients, screw loosening in 34 patients, disconnection between rod and screw in was seen in 3 cases, screw fractures in 9 patients, rod fracture in 3 cases and pulmonary embolism in 3 cases.¹⁶ Stephen et al included 617 patients treated with pedicle screw instrumentation in the survey in 1993 and among those 236 were for trauma. They concluded that over all complications rate was 27.4% among those intra-operative complications were 9.6% and post-operative complications were 17.8% which included screw misplacement 5.2%, pedicle fracture during surgery 2.3%, dural tear 1.9%, permanent nerve root injury 2.3%, postoperative deep vein thrombosis 4.2%, deep infection 4.2%, screw loosening 1.1%, screw breakage 0.6%.¹⁷ In our study we had 1 case of dural tear, 1 case of exposed implant. No patient had screw misplacement, screw breakage, neurological deficit.

Limitations of the study

The sample size and follow-up is small. Long term studies will help in deciding the optimal technique.

CONCLUSION

Pedicle screw-rod instrumentation is an excellent implant system used in treatment of vertebral fractures. Short segment fixation in case of wedge fracture can restore the vertebral body height, mean regional angle and mean anterior wedge angle and provide good outcome. There are poor chances of recovery of patient with Frankel grade A. Meticulous and careful technique of pedicle screw insertion, adequate decompression, good contouring of the rod with correction of kyphosis can provide excellent results.

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Conflict of interest: None declared

Ethical approval: The study was approved by the institutional ethics committee

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