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Dr. PV Thirumalai Murugan
M.S. Ortho, D.N.B, Associate Professor, Dept. of Orthopaedics, Government Theni Medical College, Tamil Nadu, India

Dr. B Jeyakumar
M.S. Ortho, Professor of Orthopaedics, Dept. of Orthopaedics, Govt. Theni Medical College, Tamil Nadu, India

Correspondence
Dr. PV Thirumalai Murugan
M.S. Ortho, D.N.B, Associate Professor, Dept. of Orthopaedics, Government Theni Medical College, Tamil Nadu, India

Short same segment fixation of thoracolumbar fractures

Dr. PV Thirumalai Murugan and Dr. B Jeyakumar

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Abstract
Introduction: Thoracolumbar fractures are the most common injuries being treated by spine surgeons. Conventionally these fracture were treated with 2 levels above and 2 levels below the fracture site. The goal of internal fixation is to minimize the number of vertebral levels involved in fusion of a spine fracture. This is achievable by utilizing short same segment posterior fixation (SSPF). SSPF is the use of pedicle screw instrumentation one level cephalad to and one level caudal to the fracture vertebra and pedicle screw inserted into the fractured vertebra.
Materials & Methods: 15 patients who were operated between Jan 2012 to January 2015 were taken for the retrospective analysis. All patients were surgically treated with short same segment fixation using a posterior surgical approach with transpedicular instrumentation. Pedicle screws were placed at one level above and below the fracture site. Additionally, pedicle screws were also inserted at the level of the fracture. Connected with rods.
Results and analysis: All the patients were followed up at 3 months, 6 months and 12 months postoperatively. The Mean pre-operative kyphosis was 14° (range 6° to 24°). Average post-operative kyphosis was 0° (range 6° to −18°). Average follow-up kyphosis of all cases was 10° (range 0.85° to 35.00°). Excluding failures, average follow-up kyphosis was 8° (range 0.85° to 25.00°). The height of the vertebral body was maintained upto 95% in 6 patients, 80% in 6 patients, and 70% in 3 patients. At initial one-month follow-up, average Oswestry disability score was severe at 52.63% (range 16% to 84%). At most recent follow-up, average Oswestry disability score was minimal at 5.5% (range 0% to 16%). One patient was lost to long-term follow- up. Mean difference from one-month follow-up to most recent follow-up (excluding failures) was 47.27% ($P < 0.0001$).
Conclusion: In our study the short same-segment fixation decreases implantation failure rate and reoperation rate. However long term kyphosis correction was not maintained. Despite this loss of kyphosis correction, clinical pain and disability improved at long-term follow-up.

Keywords: short segment fixation of spine, thoracolumbar fractures, pedicle screws in fracture vertebra

Introduction
Burst fractures are the most common type of fracture of the thoracolumbar spine, accounting for greater than 50% of all thoracolumbar trauma. Conventionally these fracture were treated with 2 levels above and 2 levels below the fracture site [1]. Minimizing the number of vertebral levels involved in fusion of a spine fracture is a common goal of internal fixation.
This is achievable by utilizing short-segment posterior fixation (SSPF). SSPF is the use of pedicle screw instrumentation one level cephalad to and one level caudal to the fractured vertebra. The advantage is only fewer motion segments incorporated in the fixation [2]. However, a review of literature demonstrated that SSPF led to 9%–54% incidence of implant failure and longterm loss of kyphosis correction, and up to 50% of patients with implant failure had moderate to severe pain [3-8]. Failure of SSPF can be attributed to instrumentation failure (ie, bending and/or breaking of the screws), vertebral factors (i.e., primary osseous collapse or secondary to osteoporosis), or a combination of both [8]. Other possible factors include inadequate fixation points on the vertebrae and insufficient anterior column support [2].
A cadaveric study of short-segment posterior fixation with pedicle fixation at the level of the fracture (short same-segment fixation) showed that short same-segment fixation provides more biomechanical stability than traditional SSPF [9]. A recent study also clinically confirmed the increased stability provided by short same-segment fixation in maintenance of kyphosis correction [10].

Our study conducted a retrospective review of thoracolumbar burst fracture patients that were treated with short same-segment fixation. We hypothesized that short same-segment fixation would provide successful kyphosis correction with a low rate of instrumentation failure.

Materials and Methods

Our study is a retrospective study involving 15 patients with single- or two-level thoracolumbar burst fracture between Jan 2012 to January 2015. All patients with thoracolumbar fractures confirmed by plain radiographs, computed tomography, and magnetic resonance imaging were included for the study. Mechanism of injury and treatment course were recorded. Each patient was treated with short same-segment fixation for thoracolumbar burst fractures between levels T11 and L4. Plain radiographs were evaluated preoperatively and postoperatively (3 months, 6 months and 12 months) for Vertebral body height and kyphotic angulation using the traditional Cobb method [11]. Patients were also graded preoperatively and postoperatively based on the Frankel Scale. Clinical outcome was measured using the Oswestry Disability Index [14, 15].

Fig 1: L1 burst fracture with retropulsion of fracture fragment.

Surgical Technique

Through a posterior midline incision, Posterior spinal approach was made one level above and below the fracture [Figure 2]. Bilateral pedicle screws were used above and below the fracture [figure 2]. All patients were surgically treated with short same segment fixation using a posterior surgical approach with transpedicular instrumentation. Pedicle screws were placed at one level above and below the fracture site. Additionally, pedicle screws were also inserted at the level of the fracture. Connected with rods.

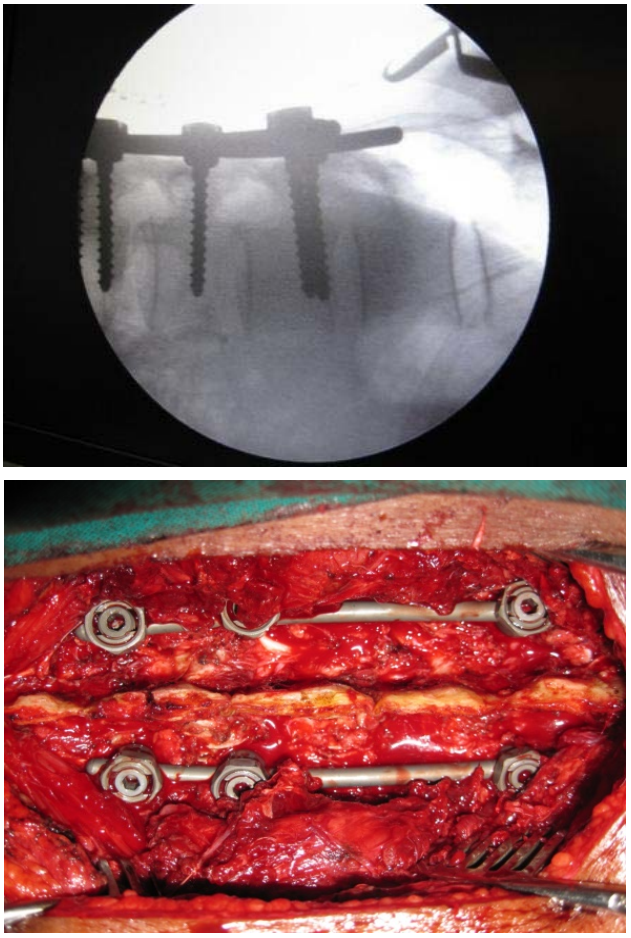

Fig 2: Pedicle screw insertion at level of fracture (L1) and adjacent levels.

Results and Analysis

15 patients with an average age of 45 years (range 18 to 74 years) comprised the study.

Mechanisms of injury were

1) Road traffic accident – 3 pt.
2) Fall from a height – 12 pt.

Preoperative Frankel grades were as follows: Grade A – 4 pt, Grade C – 7 pt, Grade E – 4 pt.

All the patients were followed up clinically and radio logically, (average 24 months: range 3 to 42 months). The Mean pre-operative kyphosis was 14° (range 6° to 24°). Average post-operative kyphosis was 0° (range 6° to −18°). Average follow-up kyphosis of all cases was 10° (range 0.85° to 35.00°). Excluding failures, average follow-up kyphosis was 8° (range 0.85° to 25.00°). The height of the vertebral body was maintained upto 95% in 6 patients, 80% in 6 patients, and 70% in 3 patients.

A mean of 15° of kyphosis correction was attained from pre-operation to post-operation ($P < 0.0001$). Average loss of kyphosis correction from immediate post-operation to most recent follow-up was −11°.

At initial one-month follow-up, average Oswestry disability score was severe at 52% (range 16% to 84%). At most recent follow-up, average Oswestry disability score was minimal at 5.5% (range 0% to 16%). Mean difference from one-month follow-up to most recent follow-up was 46.5% ($P < 0.0001$).

Case 1

Fig 3: preoperative x ray and ct scan showing 3 column injury.

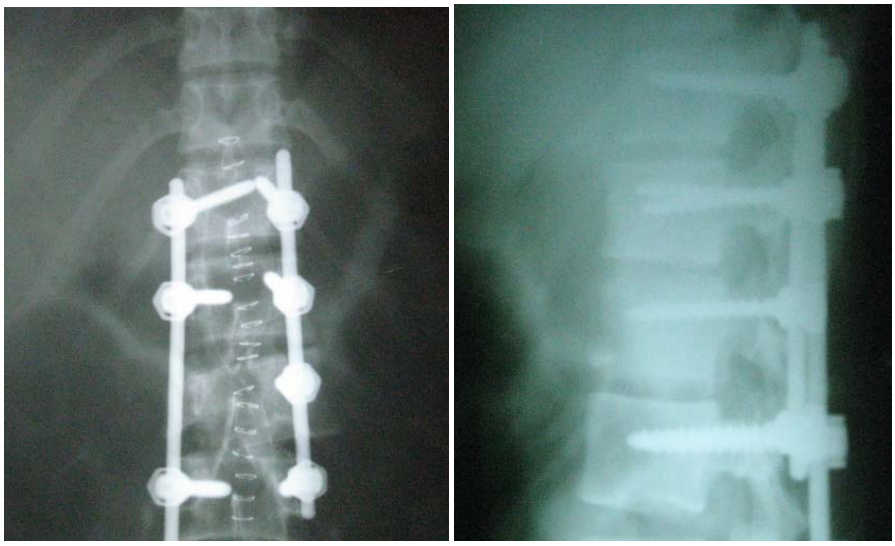

Fig 4: 12 month's posterative xray showing maintainance of kyphotic correction and verteebral body height.

Case 2

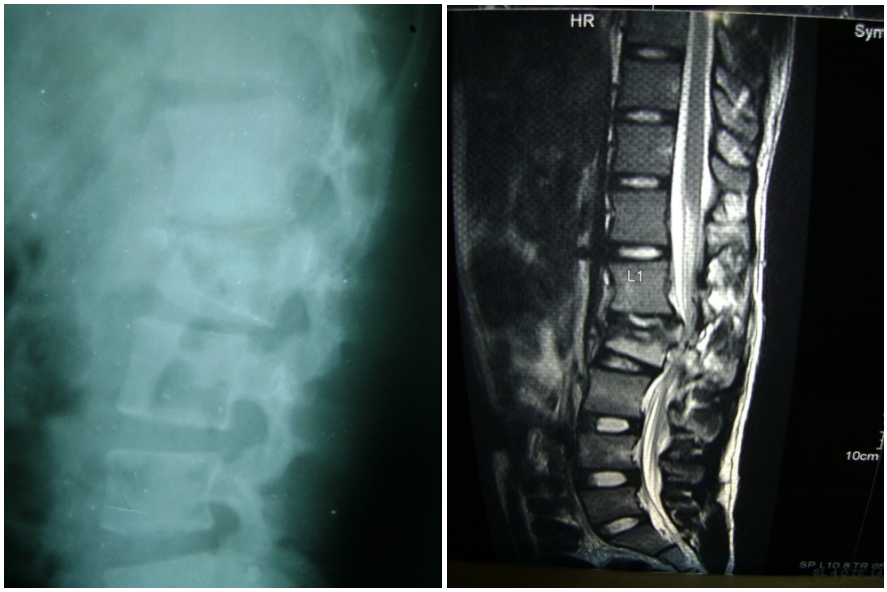

Fig 5: Preoperative Xray and MRI.

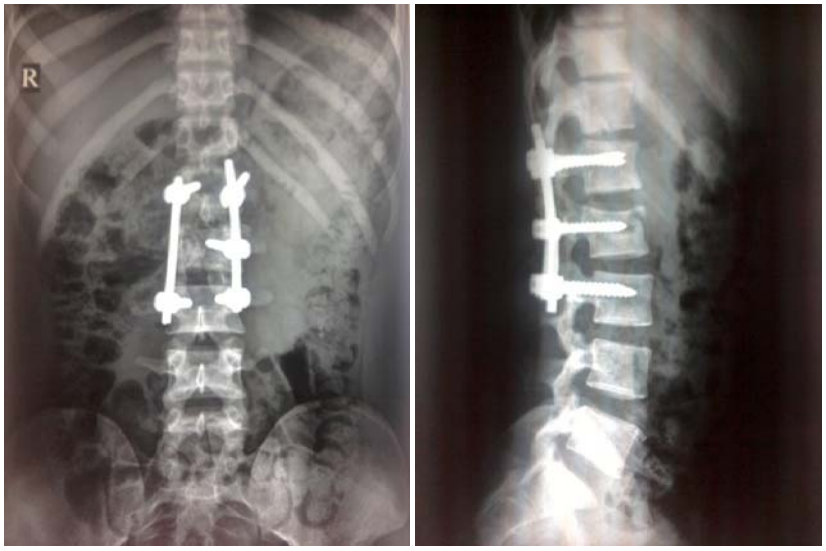

Fig 6: X rays at 6 mon. post op showing maintainance of kyphotic angle and vertebral body height.

Case 3

Fig 7: preoperative x rays and MRI.

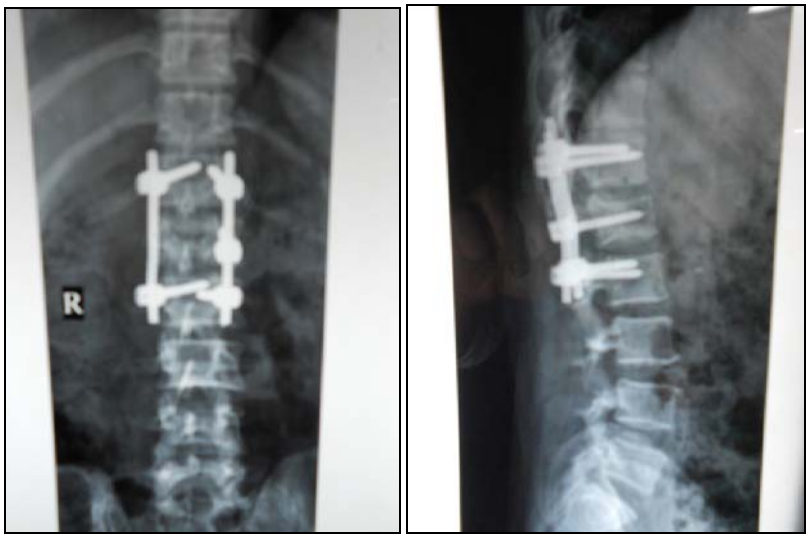

Fig 8: 12 mon. po showing loss of kyphotic angle correction and 80% vertebral body height maintainance.

Table 1: Master Chart.

S.no	Age sex	Mode Of injury	Diagnosis	Frankel grade	Body Collapse percentage	Associated injuries	Time interval for surgery days	Follow up Frankel grade months			Follow up Body height % Month			Post op complication	Functional outcome
								3		6	3		6		
									12			12			
1	20/m	Fall	D12,L1 Burst #	A	60	-	14	A	A	A	90	85	85	Bed sore	Wheel chair
2	36/m	Fall	L1Burst#	C	70	Distal radius# LT	6	C	D	E	90	90	90	-	Walking
3	40/m	RTA	D12Burst,D11 AWC#	C	50	-	16	C	D	D	95	90	90	-	Walking
4	40/f	Fall	L1Burst#	C	50	Lt Calcaneal#	14	C	D	E	95	95	95	-	Walking
5	35/m	Fall	D11#dislocation onD12	A	40	Body of scapula#	7	A	A	A	90	90	90	-	Wheel chair
6	24/f	RTA	D12 AWC#	E	60	Medial malleolus# Rt	15	E	E	E	85	80	80	-	Walking
7	18/m	Fall	L1burst#	C	65	-	4	D	D	D	90	90	90	Screw cutout	Walking
8	43/m	Fall	L1Burst#	A	50	-	18	A	A	A	85	80	80	Wound gapping, bed sore	Wheel chair
9	17/m	Fall	L2Burst, L3 AWC#	C	55	B/L Calcaneal#	6	C	D	E	85	85	85	Wound sinus discharge	Walking
10	26/m	RTA	D12Burst#	A	55	-	12		A	A	90	85	85	-	Wheel chair
11	46/m	Fall	L1Burst#	C	55	-	21	D	D	D	90	90	90	-	Walking
12	40/m	Fall	L1Burst#	E	60	-	14	E	E	E	80	80	80	-	Walking
13	58/m	Fall	D12Burst#	E	50	-	7	E	E	E	90	90	90	-	Walking
14	60/m	Fall	L1Burst#	E	50	-	14	E	E	E	95	95	95	-	Walking
15	50/m	Fall	D12 Sublux. on L1, L1Burst#	C	55	-	6	C	D	D	90	90	90	-	Walking

Discussion

Short segment pedicle screw fixation, involving one vertebra above and one vertebra below the fracture level, has become the most common method in the treatment of thoracolumbar burst fractures. It provides the benefit of decreased involvement of motion segments than fixation with longer instrumentation. However, many studies have reported loss of kyphosis correction and implant failure following short-segment fixation [3-8]. As loss of kyphosis correction progresses, more anterior stress is placed on the pedicle screws, which can eventually lead to breaking and dislodging of the screws. At the cost of involvement of more motion segments, longer instrumentation provides decreased anterior stress on each pedicle screw, thus decreasing the chance of failure.

A cadaveric study by Mahar, *et al*, reported increased biomechanical stability of short-segment fixation with additional pedicle fixation at the level of fracture (short same-segment fixation) [9]. A subsequent study by Guven, *et al*, also showed increased stability and long-term maintenance clinically with short same-segment fixation [10]. The present study showed that short same-segment fixation decreased implant failure and reoperation rate compared to traditional SSPF, however statistically significant long-term loss of kyphosis correction occurred. Despite loss of kyphosis correction, however, this study showed significant clinical improvement of patient disability over long-term follow-up.

In this study, immediate kyphosis correction was successfully attained through short same-segment fixation, with a mean postoperative angulation of 0.74° of lordosis compared to 14.49° of kyphosis pre-operatively as measured by the traditional Cobb method. At mean 21.64-month follow-up, however, patients had suffered statistically significant loss of kyphosis correction (11.46°, $P < 0.0001$), with two patients requiring reoperation due to hardware failure or pseudoarthrosis. Excluding failure cases, 5.51° of kyphosis correction remained at most recent follow-up compared to pre-operative kyphosis ($P = 0.0024$).

Despite loss of kyphotic correction, the patients in this study showed clinical improvement in pain and disability. After an initial Oswestry Disability Index score of 52% at one-month follow-up, patients experienced a mean absolute decrease of 46.5% in disability ($P<0.0001$), with a most recent follow-up average score of 5.50%. Importantly, although statistically significant kyphosis correction loss occurred, the absolute loss of kyphosis correction was relatively small, which may account for the improved clinical and functional status of patients despite loss of kyphosis correction. Furthermore, implant failure rate (8%) was lower than with short same-segment fixation compared to previous studies of traditional SSPF.

Conclusion

In our study the short same-segment fixation decreases implantation failure rate and reoperation rate. However longterm kyphosis correction was not maintained. Despite this loss of kyphosis correction, clinical pain and disability improved at long-term follow-up. More clinical studies regarding the efficacy of short same-segment fixation versus traditional SSPF are needed to explore the contrasting findings of recent studies.

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