Minimally Invasive Temporary Posterior stabilization in Isolated Unstable L5 Burst Fracture with Predominant Radiculopathy: A Case Report

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To report an isolated L5 burst fracture with predominant radiculopathy treated with MIS, implant removal at one year and its clinical and radiological outcomes at two-year follow-up. A 29-year male sustained an isolated burst fracture of the fifth lumbar vertebra after a train accident. After being treated conservatively at a primary centre for 2 weeks, he presented with back pain with severe radicular pain and hypoesthesia over his left leg. CT and MRI showed a retro-pulsed fragment with 'reverse cortical sign' causing severe stenosis. As the symptoms were refractory, he was treated with MIS L4-S1 posterior instrumentation without direct decompression, with post-operative resolution of symptoms. The fracture healed and implant removal was done at one year. Clinical and radiological outcomes were evaluated at 2-year follow-up. Results: At 2-year follow-up, Oswestry Disability Index score was 4%; there was partial remodeling of the spinal canal from 0.5 cm² to 1.5 cm², lumbosacral motion of 15.4°, lumbar lordosis of 30.7°, and with 8.7° loss of segmental L4-S1 lordosis as compared to the immediate post-operative period. In this case of an isolated L5 burst fracture with radiculopathy treated with MIS, there was clinical improvement and motion preservation, with partial remodeling although there was some residual loss of lordosis.

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INTRODUCTION

Burst fractures of the fifth lumbar vertebra are rare, comprising 1.2% of all fractures of the spine and 2.2% of fractures of the thoracolumbar region⁴. They result from an axial compressive force, described first in 1963 by Holdsworth⁶. In view of the biomechanical stability of the lumbosacral junction due to its protected location below the pelvic brim, more vertically aligned facets, and strong ligamentous attachments, it results from a high impact trauma³⁻⁵. Generally, conservative management is recommended with surgery being reserved for the patients with significant instability and neurological deficit. Various surgical modalities include spinal decompression with posterolateral or circumferential fusion, corpectomy, and an anterior surgery³⁻¹¹. There is a single previous report of Minimally Invasive Surgery (MIS) described for L5 burst fracture, however radiological outcomes like the extent of canal remodeling, segmental lordosis, and preservation of lumbosacral motion have not been reported¹³. We report an isolated unstable L5 burst fracture

with predominant unilateral radicular symptoms, managed by posterior MIS stabilization after a conservative trial, implant removal at one year, with outcomes at 2-year follow-up.

CASE REPORT

A 29-year male was involved in a railway accident, falling between the train and platform. After being managed conservatively at a primary centre for 2 weeks, he presented with back pain and severe left leg radiculopathy, aggravating during movements. He was bowel and bladder continent. On examination, vital parameters were stable; there was axial tenderness over the lumbosacral junction with a hypoesthesia over left S1 dermatome, absent left ankle reflex, and no motor deficit. There were no associated injuries.

Radiology revealed a comminuted L5 burst fracture with retropulsion of the posteriorsuperior fragment (AO/Magerl type A3.3, Denis burst type A). There was 40% collapse of the vertebral height with retropulsed fragment demonstrating a 'reverse cortical sign', 90% stenosis of the central canal, and complete oblite-

ration of the left lateral recess causing compression of left traversing S1 root (Figure 1, 2).

The patient had been treated conservatively at the primary centre for two weeks with bed rest, intravenous analgesics, and oral pregabalin. As the symptoms were unrelenting, the option of surgical intervention was considered. In view of the predominant instability-associated aggravation of radicular symptoms, MIS posterior L4 to S1 in-situ instrumentation was done on a lordotic frame using DepuySynthes VIPER system with 6 x 40 mm and 35 mm pedicle screws for L4 and S1 respectively and 70 mm connecting rods. No direct or tubular lumbar decompression was performed in view of absence of a motor deficit. The post-operative course was uneventful, mobilization was started the immediate evening, and the patient was discharged within two days.

With the resolution of symptoms and improvement in dermatomal hypoesthesia post-operatively, the patient resumed light work within four weeks of surgery. The post-operative radiograph showed lumbar lordosis of 31.3° and L4-S1 segmental lordosis of 13°. CT revealed satisfactory implant position although there was no significant change in the position of the retropulsed bony fragment (Figure 3). At 1-year follow-up, radiographs showed a healed L5 fracture with no implant loosening; however L4-S1 segmental lordosis was reduced to 4.4°. Implant removal was done through the previous incisions with a daycare hospitalization in order to preserve the lumbosacral motion segment, as fusion was not performed during the index surgery.

At two-year follow-up, the patient had unrestricted movements and Oswestry Disability Index (ODI) of 4%. Radiographs

showed healed fracture with 30.7° of lumbar lordosis, segmental lordosis of 4.3°, and lumbosacral motion of 15.4° (Figure 4). CT and MRI revealed free lateral recess with the partial remodeling of the central canal from 0.5 cm² to 1.5 cm² (Table 1) (Figure 5).

DISCUSSION

Previously described treatment modalities are summarized in Table 2^{1,3,4,7,8,10-13,16}. In 1992, Finn described conservative management in a series of seven patients with L5 burst fractures, which included immobilization in a cast for two months followed by mobilization with an orthosis for three months. He suggested that the patients with minimal neurological⁴⁾ involvement could be managed well by conservative methods. Mick et al achieved excellent results with conservative management in patients with intact neurology and canal compromise less than 50%, but recommended surgical intervention in patients with neurological

Figure 1. Pre-operative CT scan: Comminuted L5 burst fracture with a sagittal split in the vertebral body. Retropulsed posterosuperior fragment showing 'reverse cortical sign' (yellow arrow).

Figure 2. Pre-operative MRI: Retropulsed posterosuperior fragment of L5 vertebra causing 90% central canal stenosis and complete obliteration of left lateral recess with compression of left traversing S1 nerve root (yellow arrow).

deficit and severe stenosis¹¹⁾.

Previously described operative modalities include posterior decompression with instrumentation, corpectomy with cage reconstruction, laminotomy for the tapping of fracture fragments followed by percutaneous short segment pedicle fixation, MIS stabilization without direct decompression^{3,4,7,8,10-13,16)}. With no fixed algorithm described, surgical intervention needs to be individualized depending on the clinical and radiological presentation. Aggressive decompression like a corpectomy is not indicated in the presence of an intact motor function^{3,4,5-8)}. Posterior stabilization alone provides an inadequate support until the bony healing

occurs⁹⁾, whereas the anterior approach carries a risk of injury to the large vessels in the proximity²⁾ and the superior hypogastric plexus, which may lead to retrograde ejaculation in males¹⁵⁾. The

Figure 3. Immediate post-operative CT scan: Well positioned L4 and S1 pedicle screws with persistent retropulsion of the posterosuperior fragment of L5.

Table 1. Radiological parameter evaluation

Modality	Parameter	Pre-operative	Immediate Post-operative	1-Year follow-up	2-Year follow-up
Erect radiograph	Lumbar lordosis (degree)	-	31.3°	31°	29°
	L4-S1 segmental lordosis (Degree)	-	13°	4.4°	4.2°
CT scan	Central canal area (cm ²)	0.5	0.5	-	1.5
	Anterior vertebral height (mm)	14.4	14	-	12.4
	L4-5 Disc space height (mm)	11.2	11.8	-	9.3
	L5-S1 Disc space height (mm)	10.5	9.4	-	7.6

Figure 4. Lateral radiographs of lumbar spine-immediate post-operative, at 1-year and 2-year follow-ups: Reduction of L4-S1 Segmental lordosis from 13° to 4.2°, whereas overall lumbar lordosis maintained at 29°.

Figure 5. Pre-operative, immediate post-operative and 2-year follow-up CT (sagittal and axial): Reduction of anterior vertebral height and L4-5, L5-S1 disc heights. Remodeled central canal with volumetric area increased from 0.5 cm² to 1.5 cm²

Table 2. Review of literature on L5 burst fractures

Author	No. of Cases & Year	Mode of Injury	Signs & symptoms	Treatment	Outcomes	Conclusion
Court-Brown ³⁾	3 (1987)	RTA - 2 Fall from height - 1	LBP - 3 L4,5 weakness - 2 L5 hypoesthesia - 1	Bed rest + Brace - 2 PD + L4-S1 Fixation with sacral bar + fusion - 1	Non-operative: Complete recovery - 2 Operative: IR + BG for pseudoarthrosis at 1 at year. Persistent LBP at 2 years	Conservative management preferable until L5 instrumentation improves
Finn C. ⁴⁾	7 (1992)	High impact trauma	LBP - 7 L5, S1 radicular pain - 2 L5 weakness - 2	Body jacket cast immobilization for 8 weeks, f/b Orthosis for 3 months	Occasional LBP - 7 Persistent deficit - 0 Kyphosis progression - 0	Stable fractures with minimal neurological involvement can be very well treated conservatively
Mick C.A. ¹¹⁾	11 (1993)	RTA - 6 Fall from height - 4 Lifting heavy weight - 1	LBP - 11 Radicular pain - 4 EHL weakness - 3 L5 hypoesthesia - 2	Bed rest + Body cast/TLSO - 5 PD + Fixation - 6 (Coutrel-Dubousset instrumentation - 4, Steffee plate - 2)	Non-operative: Recovery - 4 Delayed fixation for persistent radicular pain & deficit - 1 Operative: Recovery - 5 IR for local pain - 1	Excellent results in young pts with minimal canal compromise. Chances of neurological recovery greater with surgery.
Kaminski A. ⁷⁾	10 (2002)	Fall from height - 5 RTA - 3 Direct hit - 2	LBP - 10 L5 weakness - 2	AO internal fixator + PLF + Transpedicular BG - 10 L5 laminectomy - 5	Excellent - 4 Good - 3 Fair - 3 Improvement of neurodeficit of both pts	Internal fixator does not improve radiological parameters
Sahin S. ¹³⁾	1 (2005)	Jump from 3 rd floor (due to psychiatric illness)	Severe LBP	MIS L4-S1 fixation + IR at 4 months	Complete resolution of symptoms & restoration of activity	First MIS for L5 burst fracture: Effective technique in selective young pts where conservative Rx is not an option
Butler S. ¹⁾	14 (2007)	Fall from height - 7 RTA - 3 Agricultural accident - 1 Staircase fall - 1 Heavy object impact - 1	LBP - 14	Non-operative: Early mobilization with molded cast orthosis - 10 Operative: PD + L4-S1 Fixation - 4	Superior radiological and clinical outcomes with non-operative Rx	Largest ever series of L5 burst fractures: Strong recommendation of non-operative Rx in pts with minimal deformity, without neurological deficit
Ramieri A. ¹²⁾	19 (2012)	-	LBP - 19, L5,S1 Deficit: Paralysis - 6, Paresis - 13, Bladder inv - 12	PD + L4-S1 fixation + PLF - 18 Circumferential fusion - 1	Persistent LBP - 4, Complete neurological recovery - 5, Distal paresis - 3, Distal paralysis - 3 Persistent isolated bladder inv - 8	Spinal canal decompression + posterior stabilization highly recommended for neurological L5 burst fractures
Zeng ¹⁶⁾	1 (2014)	Direct trauma with heavy object	LBP B/L L5, S1 Paresis B/L L5 Parasthesia	PD + L5 vertebrectomy + Reconstruction with Titanium cage Screw & rod removal at 1 year	Complete recovery of neurology. ROM at LS junction improved post-IR.	Operative intervention a must in neurological L5 burst fracture. Should be individualized for every case
Kim JK ⁸⁾	1 (2018) L2 & L5 burst fractures	Fall from height	LBP Grade 2 power & hypoesthesia below L2 level	L1 & L4 laminotomy + Tapping of fracture fragments + L1-3 & L4-S1 PSSPSF IR at 1 year	Complete neurological recovery at 2 years	PSSPSF + tapping technique - a good alternative modality in young patients to preserve motion segment
Meyer M. ¹⁰⁾	6 (2020)	RTA - 6	LBP - 6 L5 paresis - 4	Step 1: MIS L4-S1 fixation - 2 PD + L4-S1 fixation - 4 Step 2: (after 1 week) Ant L5 corpectomy + Expandable cage + BMP	Complete neurological recovery - 4 Intermittent pain - 4	Alternative approach with better kyphosis correction & maintenance, but higher morbidity of dual approach

Abbreviations: LBP-Low back pain, RTA-Road traffic accident, MIS-Minimally invasive surgery, PD-Posterior decompression, IR-Implant removal, BG-Bone grafting, Ant-Anterior, Pts-Patients, F/b-Followed by, Rx-treatment, TLSSO-Thoraco-lumbo-sacral Orthosis, PSSPSF-Percutaneous Short Segment Pedicle Screw Fixation

anterior-only approach is adequate only when the posterior ligamentous complex is intact¹⁴⁾.

A railway accident as a mechanism of injury has not been previously described. Sahin et al first described minimally invasive stabilization (MIS) for an unstable L5 burst fracture in a poorly compliant patient with associated psychiatric illness, with implant removal performed at four months¹³⁾. They described MIS to be an effective technique in selective young patients, although the clinical and radiological outcomes were not described. MIS carries advantages of being a less morbid procedure with minimal blood loss, shorter hospital stay, facilitating early recovery and return to work^{10,13)}. Removal of implants has been described to preserve motion segment in cases treated without fusion, although ambiguity regarding the optimum time for the removal persists¹³⁾.

In our case, the patient had intractable radicular symptoms during movements due to the instability; hence MIS stabilization acted like an internal brace and resulted in immediate resolution of symptoms. Posterior decompression or vertebrectomy were avoided in view of the morbidity associated with these procedures. MIS has an advantage of motion segment preservation at the lumbosacral junction, although the disadvantage is requirement of an additional procedure of implant removal. Unlike thoracolumbar fractures, distraction ligamentotaxis is not advisable at the lumbosacral junction to maintain the segmental lordosis and in the presence of a reverse cortical sign^{7,13)}. Partial remodeling occurred with residual loss of lordosis, mainly due to the adjacent disc degeneration and loss of disc space heights.

CONCLUSION

MIS temporary posterior stabilization can be considered as an alternative middle path in a young individual with L5 burst fracture with predominant radicular symptoms refractory to conservative treatment, which allows early resumption of activities, helps to retain the lumbosacral motion segment; but with only partial canal remodeling and some residual loss of lordosis.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article.

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