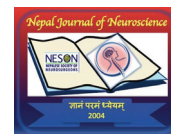


# Minimally invasive short segment pedicle screw fixation for thoraco-lumbar trauma: Where do we stand?



Vipin Kumar Gupta<sup>1</sup> , Arvind Malhora<sup>1</sup> , Ashwani Kumar<sup>1</sup> 

<sup>1</sup>Department of Neurosurgery, Government Medical College and Hospital, Chandigarh, India

Date of submission: 13<sup>th</sup> December 2021

Date of acceptance: 4<sup>th</sup> May 2021

Date of publication: 25<sup>th</sup> June 2022

## Abstract

**Background & Overview of Literature:** Use of MISS or Percutaneous pedicle screws for thoracolumbar trauma has shown superiority in terms of postoperative pain, blood loss, operating time, hospital stay and incision size as compared to open surgical method. The use of MISS in thoracolumbar trauma has been limited due to the high cost and lack of posterolateral fusion. There is conflicting evidence for and against the use of MISS in AO classification spine A3/A4 fractures without any neurological deficit and maybe managed conservatively as well.

**Objective:** To establish efficacy and safety of MISS, short segment pedicle screw fixation in patients of thoraco-lumbar fractures but without any neurological deficit.

**Study Design:** Retrospective case reports of 2 years in which 20 patients of thoraco-lumbar trauma that underwent minimally invasive short segment spine fixation were included.

**Material & Methods:** Retrospective analysis of 20 patients of thoraco-lumbar spine fractures that were operated from 2017 to 2019 at Government Medical College & Hospital, Chandigarh. Patients included were in the age group of 23-70 years, operated within one week of trauma, AO type A3 and A4, and operated using short segment fixation. Our exclusion criteria were trauma more than one week old, multiple levels of fractures and non-traumatic fractures. Clinical and radiological data were collected and tabulated.

**Results:** Most patients (8 out of 20) had fracture of D12 vertebra. 18 out of 20 patients were involved in a road traffic accident. The mean blood loss was 25.78 mL. Cobb's angle was used to measure focal deformity and the average gain in Cobb's angle after surgery was 10.9°. Mean loss in correction was 2.35°. All patients were pain-free after 6 months as measured on the VAS score. The average time taken in getting back to work after surgery was 26 days.

**Conclusion:** MISS is the ideal treatment of choice in patients of thoraco-lumbar spine trauma without any neurological deficit. MISS provides higher safety, early mobilization, less blood loss during surgery, shorter recovery time, and less post-operative pain.

**Key words:** AO MISS, Short segment fixation, Spine trauma classification, Thoraco-lumbar trauma

## Access this article online

Website: <https://www.nepjol.info/index.php/NJN>

DOI: <https://doi.org/10.3126/njn.v19i2.41429>

## HOW TO CITE

Gupta VK, Malhora A, Kumar A. Minimally invasive short segment pedicle screw fixation for Thoraco-Lumbar Trauma: Where we stand? NJNS. 2022;19(2):42-48.



## INTRODUCTION

Thoraco-lumbar spinal injuries most commonly result from high energy trauma like motor vehicle collision, fall from a height, etc. and are mostly associated with multiple injuries. The rate of thoracolumbar vertebral fracture in blunt trauma patients ranges between 3.2% to 10.6%, and burst fractures of the vertebral body constitute 23.2% to 55.8% of these injuries.<sup>1-4</sup> The most debated of these fractures are single-level burst fractures without any neurological deficit as the management of these fractures is subject to much controversy due to conflict in evidence recommending for or against the use of surgery.<sup>2</sup>

The management varies from non-operative bracing techniques to operative techniques. The key points for the management of these fractures are intact posterior longitudinal ligament complex [PLL] and quality of bone. If the patient is young with good quality of bone, intact

## Address for correspondence:

Dr. Vipin Kumar Gupta,  
Assistant Professor, Neurosurgery,  
GMCH-32, Chandigarh  
E-mail: [vipinkgupta77@gmail.com](mailto:vipinkgupta77@gmail.com)

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ISSN: 1813-1948 (Print), 1813-1956 (Online)



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PLL and, without any instability conservative approach is advocated. Discussions and differences of opinion in operative techniques include short segment fixation or long segment fixation and whether to fuse posterolaterally or not.

Minimally invasive spine surgery [MISS] has revolutionized surgical practices worldwide. MISS has been successfully employed in degenerative spine conditions and is now being used in thoraco-lumbar trauma.

We reviewed the results of MISS with short segment screw fixation in 20 patients of thoraco-lumbar fractures without any neurological deficit. The study was aimed to assess the safety and evaluate the outcomes of minimally invasive surgery in these patients.

### Material & Methods

The present study is a retrospective cross-sectional study of patients with thoraco-lumbar fractures treated at Government Medical College & Hospital, Chandigarh over 2 years [2017 -2019]. All patients were operated by the authors themselves. All records were collected from the Medical Record Department of the hospital after taking approval from the institutional review board. A written informed consent was taken from all patients included in the study.

Patients included in the study had thoraco-lumbar fractures between D11 to L3 level, single level fracture [AO spine type A3/A4 fracture] that were fixed using short segment fixation. Patients with pathological fractures or inflammatory pathology, neurological deficits and with multiple spine fractures were excluded from the study. The minimum follow up time was 18 months after the surgery.

Neurological assessment was done by the American Spinal Injury Association [ASIA] impairment scale.<sup>3</sup> All patients were without neurological deficit, ASIA grade E. The pain was recorded on the Visual Analogue Scale [VAS].<sup>4</sup> VAS score was recorded preoperatively, postoperatively after 48 hrs, at 6 months, and at 18 months after surgery.

X rays were done (Antero posterior view and lateral view) to assess Cobb's angle and vertebral body height. CT Scans were acquired to find any bony segments impinging

on the canal and to understand the anatomy of pedicle screws. MRI of the spine was conducted to evaluate posterior longitudinal ligament [PLL] and any injury to the spinal cord. Fractures were classified according to AO spine classification.<sup>5</sup> Only Type A fractures were included. Focal kyphosis was measured using Cobb's angle.<sup>6</sup> Cobb's angle was measured preoperatively, and post operatively at 48 hours, 6 months, and at 18 months.

Standard Posterior MISS procedure was done for short segment pedicle screw fixation.<sup>7,8</sup> The amount of blood loss and duration of surgery were recorded. The time taken in mobilization from bed after surgery and time taken to going back to work was recorded as well. Radiological outcomes were measured by Cobb's angle correction and healing of fracture postoperatively.

Patients were followed up after four weeks, six months, and annually thereafter.

### Results

Mean age in our study was 44.8 years (range; 23 – 70 yrs). Five patients were female and 15 were males in the study. Eight patients presented with fracture of D12 vertebra, six with fractured L1 vertebra, Three with L2 level fracture, Two with D1 and 1 patient presented with L3 level fracture. 18 patients had a history of a road traffic accident and history of fall from a height was present in 2 patients.

The average time taken for surgery was 75 minutes. The mean blood loss was 25.78 mL Cobb's angle was ranged between 40 degrees to -10 degrees pre-operatively. The minus sign signifies lordosis. The average gain or deformity correction was 10.9 degrees post-operatively [Table 1].

The mean loss in correction measured after 18 months was 2.35 degrees. The mean pre-operative VAS score was 8.05 which was reduced to score of 3.75 after 48 hours. Within 4 weeks the score was dropped to 1.25 and after 6 months all patients were pain-free [Table 2].

There were no significant complications both intra-operatively and post-operatively and all patients had a swift recovery. Patients were mobilized from bed with a mean duration of 2.15 days. The mean time taken by patients in going back to routine lifestyle was 26 days.

S. No	Pre-Op Cobb's angle	Post-Op Cobb's angle	Cobb's angle after 6 months	Cobb's angle after 18 months	Correction achieved after surgery	Loss in correction
1.	30	10	14	14	20	04
2.	10	00	02	04	10	02
3.	15	07	10	10	08	03
4.	12	02	04	05	10	03
5.	20	10	15	15	10	05
6.	16	12	12	12	04	00
7.	22	14	16	16	08	02
8.	-10	-26	-22	-22	16	04
9.	-4	-15	-15	-15	11	00
10.	40	24	27	27	16	03
11.	15	00	03	03	15	03
12.	-5	-14	-12	-12	09	02
13.	10	00	00	00	10	00
14.	24	14	16	16	10	02
15.	15	05	07	07	10	02
16.	10	00	03	03	10	03
17.	23	16	18	18	07	02
18.	28	14	16	16	14	02
19.	18	08	10	10	10	02
20.	25	15	18	18	10	03

Table 1: Cobb's angle measured in degrees

	Maximum	Minimum	Average
Pre op	9	7	8.05
Post op [48 hrs]	5	2	3.75
Post op [6 months]	3	1	1.25
Post op [18 months]	1	1	1

Table 2: Mean Visual Analogue Score [VAS]

Study	Year	Number of Patients	Neurological Deficit	Type of Fixation	Short term Improvement	Correction of Deformity [Mean Cobb's Angle]	Correction Loss	Final Follow Up Time [In Months]	Complications
H. Aono et al <sup>23</sup>	2019	76	Yes	Short Segment	Yes	13.4°	9.1°	24	None
Mehraj et al <sup>24</sup>	2018	25	Yes	Short Segment	Not Reported	15.2°	1.2°	9	Yes
Gajjar et al <sup>25</sup>	2016	32	Yes	Short Segment	Not Reported	4.2°	0.35°	12	Not Reported
M. Waqar et al <sup>26</sup>	2016	17	Yes	Short Segment	Not Reported	8.7°	3.4°	6	Not Reported
Tezeren et al <sup>27</sup>	2004	9	No	Short Segment	Not Reported	4°	6°	29+/-5	Yes
Ram et al <sup>28</sup>	2014	20	No	Short Segment	Yes	12°	0.5°	24	Yes

Table 3: Other studies on similar topic

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Figure 1A: Pre-operative fractured D12 vertebra

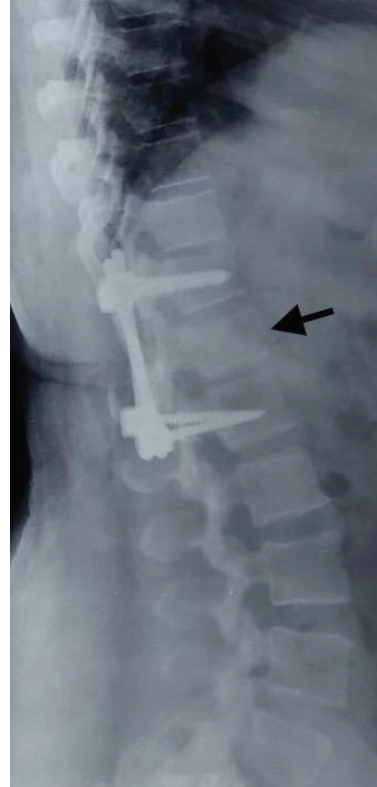


Figure 1B: Post-operative short segment fixation

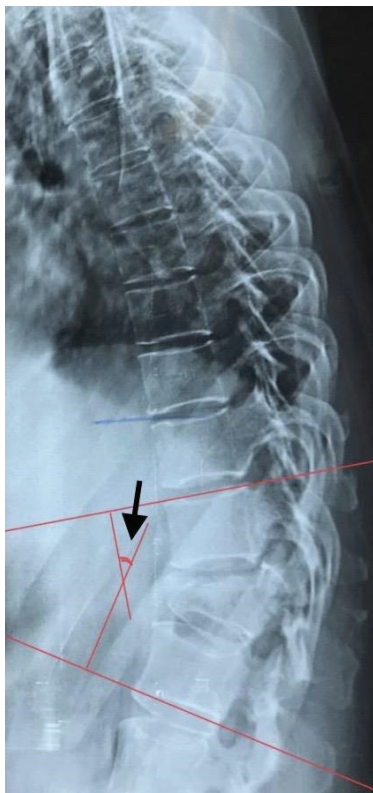


Figure 2A: Pre-operative kyphotic (Cobb's) angle

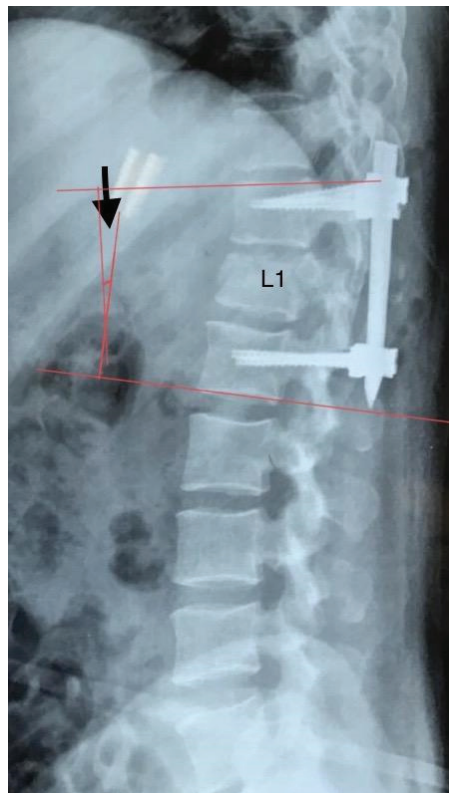


Figure 2B: Post-operative kyphotic (Cobb's) angle showing the gain in angle.

## Discussion

Thoraco-lumbar fractures often occur in high energy trauma and are associated with multiple injuries. Thoraco-lumbar spinal injuries may present with pain, neurological deficit, muscle spasms and with kyphotic or scoliotic deformity.

Management of AO Spine type A burst fracture [A3 or A4] without any neurologic is an ongoing debate among spine surgeons. This fracture group comprises of the majority of patients and proposed treatments range from ambulation with a brace to highly invasive open surgery. Surgery offers early mobilization and pain control, avoids gruelling orthotic treatment and, significantly decreases chances of deformity. Non-operative care avoids surgical intervention, post-operative pain, associated morbidity and higher costs.<sup>9</sup>

Minimally invasive spine surgery is not a new entity but its use in thoraco-lumbar spine fractures has been a topic of debate across the globe as no concrete evidence is present for or against it in patients with no neurological deficit and intact PLL, but minimally invasive surgery does give patients an easier way out to choose between open surgery and non-surgical treatment. When compared to open surgery, MISS has shown equivocal final results but with smaller incision, less intraoperative blood loss, shorter recovery time, less post-operative pain, and higher safety.<sup>10,11</sup> Studies have shown that percutaneous screws have minimal trauma to paraspinal musculature compared to open methods which cause denervation and devascularisation of muscles.<sup>12</sup> The only drawback of MISS over open surgery is a significantly higher amount of radiation exposure.<sup>13</sup>

The use of short segment fixation in comparison to long or intermediate screws has been debated as well, as studies have shown results both for and against it.

Wood et al observed that operative treatment of patients with a stable thoracolumbar burst fracture with no neurological deficit provided no major long-term advantage over non-operative management.<sup>14</sup> However, patients with significant pain, elderly patients in need of immediate mobilization to avoid sedentary complications and patients who are unable to tolerate brace and want early mobilization presents a treatment dilemma.

There was unacceptably high failure rates observed in short segment fixation in early published literature. Kramer et al reported hardware failure in 4 of 11 thoracolumbar fractures, treated with short-segment fixation performed via a standard open approach with posterolateral fusion within a 2-year follow-up.<sup>15</sup>

Over the past few years, spine surgeons have wandered from long segment fusions to short segment fusions for thoraco-lumbar fractures using index pedicle screw at

fractured vertebra of mechanically stronger construct though this has not been an evidence-based decision but a personal choice of surgeons. Aly TA in a meta-analysis of 9 spinal trials reports no significant difference in short vs long segment pedicle screw fixation of thoracolumbar fractures in terms of improvement in back pain, time took in returning to work, and correction of kyphotic deformity.<sup>16</sup>

75 minutes was the average time taken for surgery in our study (range; 45 - 165 minutes). MIS surgery involves numerous equipment and operative steps. The learning curve is steep, but once the surgeon gets familiar with the equipment, the duration of the surgery and radiation exposure is considerably reduced. The duration was comparable to a similar study by Ram GG et al in 2014.<sup>17</sup>

25.78mL was the mean blood loss and was consistent with the other studies. Studies performed on the use of minimally invasive techniques have consistently shown a lesser amount of blood loss than open techniques. The average blood loss reported with MISS in other studies ranges between 100mL to 1200mL<sup>14,18,19</sup>

The other advantage of minimally invasive surgery is early mobilization. Most patients were mobilized on day 2 post operatively.. The average time taken for mobilization after surgery was 2.15 days. Li Yang Dai, in study of 36 patients, observed that the mean time taken from surgery to walking was  $3.7 \pm 1.6$  days ranging from 1day to 7 days.<sup>19</sup> Patients undergoing MISS had lesser need for analgesics and were more amenable to get up and walk around in comparison to open surgery.

Mean pain score was 8.05 preoperatively which was reduced to 3.75 on day 2 after surgery and was further reduced to 1.25 at final follow up. Measurement of Cobb's angle has been a reliable indicator to compare results between minimally invasive and open techniques. Cobb's angle in our study was ranging from  $40^\circ$  to  $-10^\circ$  pre operatively [Figure 1A and Figure 2A]. Mean post-operative gain in the Kyphotic angle was  $10.9^\circ$ , and was reduced to  $2.35^\circ$  [Figure 1B and 2B] at the last follow up. K Wood et al. described mean Kyphosis of  $10.1^\circ$  [range;  $-10^\circ$  to  $25^\circ$ ] on admission and  $5^\circ$  [range;  $-10^\circ$  to  $5^\circ$ ] at the time of discharge from the hospital, and mean loss of  $8^\circ$  [range;  $-4^\circ$  to  $22^\circ$ ], resulting in an average kyphosis of  $13^\circ$  [range,  $-3^\circ$  to  $42^\circ$ ] at final follow up.<sup>14</sup> Similarly Li Yang Dai also noted net gain in kyphosis in range of 3 to  $6^\circ$ .<sup>19</sup> Whether open or MIS technique is used the final kyphosis gain remained the same in most studies (Table 3).

In our study, we had no major complications. In one case the bone was osteoporotic and K wire penetrated through the vertebral body anteriorly. In 2 cases the Jamshidi needle jammed which was pulled out with difficulty, this usually happens with repeated use of the same Jamshidi needle, hence it's worthwhile to use a fresh Jamshidi for each port site as recommended. No significant

complications were recorded post-operatively in our study. Most studies conducted on minimally invasive spine surgeries showed a significant decrease in surgical site infections when compared with open procedures.<sup>20-22</sup>

### Conclusion

Minimally invasive percutaneous screw placement for thoraco-lumbar spine fractures is a safe procedure, reduces tissue trauma, results in better wound healing with less post-operative pain, reduced analgesic intake, and no blood transfusions. Early mobilization of patients is possible which prevents complications such as DVT, pulmonary embolism, pressure sores etc. Smaller incision and quicker recovery in MIS surgery make the patient comfortable and the mental stigma of long incision on the back is avoided. Another important factor is going back to work earlier than conservative treatment or open surgery. But there are some drawbacks such as lesser effective distraction inability to put inter rod connectors and radiation exposure as compared to open surgery. Even though the long-term results of MISS and open surgery in thoracolumbar spine trauma remain the same MISS is a safe and less painful alternative technique with early return to work.

**Conflict of interest:** The authors show no conflict of interest

### List of Abbreviations

ASIA –	American Spinal Injury Association
CT –	Computed tomography
DVT –	Deep venous thrombosis
GMCH –	Government Medical College and Hospital
MISS –	Minimal invasive spinal surgery
MRI –	Magnetic resonance imaging
PLL –	Posterior longitudinal ligament
VAS –	Visual analogue scale

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