

POSTERIOR SHORT-SEGMENT PEDICLE INSTRUMENTATION WITHOUT FUSION FOR THORACOLUMBAR BURST FRACTURE

By

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ABSTRACT

Background: The treatment for thoracolumbar burst fractures is controversial. The aim of surgical treatment is promoting neurological recovery by decompression of spinal canal and nerve roots and Obtaining rigid fixation.

Methods: A consecutive series of 30 patients with thoracolumbar burst fractures were treated by posterior short segment pedicle screw fixation between January 2009 and June 2015. Five patients were lost during follow up and all the remaining 25 patients were followed up for a minimum of three years (average 42.24 months). All the patients were treated with short-segment pedicle instrumentation and laminectomy without fusion, and the restoration of retropulsed bone fragments. The mean operation time and blood loss during surgery were analyzed; the Regional Kyphotic Angle and neurological status were compared before and after the operation.

Results: The mean fracture kyphosis was 35.84° at the time of admission and 2.04° post-operative and 5.24° at the final follow-up evaluation. The mean operation time was 97.4 min (range: 70–120 min) and the mean intraoperative blood loss was 385.6 mL in all cases. No intraoperative or immediate postoperative complications were noted. The post-operative radiographs demonstrated a good fracture reduction. Neurological recovery of one to three Frankel grade was seen in six patients with partial neurological deficit, three grades of improvement was seen in one patient, two grades of improvement was observed in six patients and one grade of improvement was found in four patients. All eight patients with no paraplegia on admission remained neurological intact, and in two patients with Frankel D.

Conclusions: This technique allows for satisfactory canal clearance and restoration of vertebral body height and kyphotic angle, and despite the loss of kyphosis correction in the last follow up visit, clinical pain and disability improved at long-term follow-up.

Keywords : Instrumentation-Thoracolumbar-Treatment-Burst Fracture.

INTRODUCTION

Holdsworth 1963⁽¹⁾ firstly presented the definition of “burst fracture”.

Because of the fulcrum of increased motion at the T12-L1 junction, approximately 90% of spine fractures are located in the thoracolumbar region, and the burst fractures account for nearly 10–20% of spine injuries⁽²⁾.

Burst fracture is a common fracture, especially in the developed countries; the optimal managements are still controversial. These injuries mainly occur in younger patients associated with falls or motor vehicle accidents⁽³⁻⁴⁾.

According to the 3 columns theory of Denis⁽⁵⁾, thoracolumbar burst fracture often leads to compression fracture of anterior and

middle vertebral columns and an associated kyphotic deformity, and such compression fracture can cause the retropulsion of bone fragment into the spinal canal^(5,6).

The short-segment posterior fixation is easy to implement, offering the advantage of preserving spinal motion segments, shorter operative time, and less blood loss. With the improvement of rigidity and stiffness of pedicle screw based posterior spinal instrumentation systems, the short segment has become more reliable⁽⁷⁾.

Several studies have found that the restoration of normal canal dimensions may be associated with the recovery of neurological function for patients with partial deficits⁽⁸⁻¹⁰⁾. The spinal canal remodeling is shown to occur regardless of operative or nonoperative treatment, the "surgical clearance" can improve the neurological outcome partially⁽¹¹⁻¹³⁾.

MATERIALS AND METHODS

This prospective study includes a consecutive series of 25 patients (17 males and 8 females) with acute traumatic Thoracolumbar Burst fractures who were operated between January 2009 and June 2015 in our hospital. All cases were fractures of type A3. The patients aged from 16 to 50 years (mean 31.28 years). All patients were treated with the technique of posterior short-segment pedicle screw fixation without fusion.

Inclusion criteria were as follows: Presence of neurological involvement caused by the Fracture or CT scanning of the affected level showed more than 50% spinal canal compromise; More than 50% loss of anterior vertebral height or local kyphosis angle exceeds 25 degrees.

For clinical assessment, neurologic deficit was assessed using Frankel motor score system.⁽⁵⁾ Denis' Pain and Work scales⁽⁵⁾ were used to assess clinical outcomes. Associated lesions, intraoperative blood loss, operation time, hospital stay and complications were recorded for each case.

Anteroposterior and lateral radiographs, CT, and magnetic resonance imaging (MRI) of the thoracolumbar region were performed in all patients on admission. The regional kyphotic angle (RA) of fractured segment was measured as the angle between the superior endplate of the upper adjacent vertebra and the inferior endplate of the lower adjacent vertebrae by the Cobb method (Figure 1),⁽¹⁴⁾ where kyphosis is recorded as a positive one (alpha), and lordosis is recorded as a negative one (gamma).

Aiming to achieve temporary stability of the spine, the short-segment pedicle instrumentation was fixed before posterior decompression was implemented. The fixation was achieved by inserting four screws into the pedicles of the adjacent vertebra above and below the injured level, and then rods with appropriate length were inserted and connected to the screws.

Spinal process and both lamina of the affected level are removed by rongeurs to decompress the posterior aspect of the thecal sac. Once posterior decompression was completed, the retropulsed fragment of the fractured vertebral body are hammered anteriorly back into the corpus using an 'L' angle dissector to recontour the posterior wall of the fractured vertebral body, at the same time decompressing the anterior aspect of the thecal sac.

The screws of both sides were distracted axially with contoured longitudinal rods to restore the segmental height and realignment the spinal columns, which are verified by C-arm X-ray monitoring.

All patients were immobilized by a thoracolumbar sacral orthosis brace for preventing the implant failure and promoting neurological recovery. After appropriate 4 weeks, patients with sufficient motor movement were gradually mobilized according to personal neurological status and radiological review.

Anteroposterior and lateral film for several times Which included A week after surgery, regular interval of 3 months, and the final follow-up examination. CT scans were also obtained to assess the percentage of postoperative spinal canal compromise correction.

RESULTS

Table 1 lists the demographic data, perioperative characteristics and follow-up data for each of the 25 patients (17 males and 8 females). The patients aged from 16 to 50 years (mean 31.26 years). All the cases were type A3 fracture according to the AO classification system, and there were 7 type A3-1, 8 type A3-2 and 10 type A3-3.

The mean intraoperative blood loss was 421.6 mL, No need for blood transfusion. There were no major complications such as death, cerebrospinal fluid leak, or epidural hematoma. As for the other injuries complications, 2 cases suffered pneumonia that was cured by antibiotics.

At the last follow-up, twenty-one patients (84%) had no pain (Denis Pain Scale P1) (Tab.2), Three patients (12%) experienced occasional minimal pain with no need for medication (Denis Pain Scale P2), and one patient (4%) had moderate pain (Denis Pain Scale P3).

The last follow-up, twenty patients (80%) returned to previous employment (Denis Work Scale W1), four patients (16%) of the patients returned to previous employment but with labor restrictions (Denis Work Scale W2), one case (4%) was unable to return to previous employment but working full time at a new job (Denis Work Scale W3) (Tab.3).

Neurologic deficit was graded according to Frankel motor score system (Tab.4). Six patients were classified as Frankel B, six as Frankel C, 5 as Frankel D, 8 as Frankel E, there was no patient classified as Frankel A in this series.

The causes of injury included 14 cases of falling, 11 cases of Road Traffic

Accident (RTA), 21 cases suffered from multiple injuries, including multiple rib fractures in 2 cases (both had pneumothorax), 11 cases of limb fractures, 3 cases abdominal injury, 4 cases of pelvic fracture.

The average Injury Surgery Interval was 8.2 days, ranging from 1 to 20 days. In patients with associated thoracic, abdominal, pelvic or extremity injury, the average interval increased to 12.5 days, ranging from 6 to 20.

The mean operation time was 97.4 min (range: 70–120 min) and the mean intraoperative blood loss was 421.6 mL (Range 250-650). No intraoperative or immediate postoperative complications were noted. The mean fracture kyphosis was 35.84° at the time of admission and 4.56° at the final follow-up evaluation. Average hospital stay was 21.24 days, ranged from 12 to 32. (Table 1)

Neurological recovery of one to three Frankel grade was seen in six patients with partial neurological deficit, three grades of improvement was seen in one patient, two grades of improvement was observed in six patients and one grade of improvement was found in four patients. All eight patients with no paraplegia on admission remained neurological intact, and in two patients with Frankel D.

The mean of the Regional kyphosis angle was improved from 35.84° before surgery to 2.44° after surgery and changed to 4.56° at the last follow-up. There was a significant difference between preoperative and postoperative values ($P < 0.05$) and significant difference between the values of postoperative and last follow-up ($P > 0.05$).

Legend of figures:

Figure 1: Calculation of Cobb's angle in the lateral graphs [14].

Figure 2: Case 1) A) Sagittal MRI shows: Ant. Wedging of L1 with compression of the spinal cord; B & C) plain x ray Lat. & anteroposterior Views showing correction of

the kyphotic angle; D) Plain X ray Lat. View showing bony consolidation; E) CT axial cut shows no canal compromise.

plain X-ray AP, and lateral views; C) Preoperative MRI; D) Postoperative X-ray after correction and fixation.

Figure 3: Case No. 3: A & B) Preoperative

Table 2.

Functional pain scale according to Denis⁽⁵⁾.

Score	Pain scale criterion
1	No pain
2	Slight pain with no need for medication
3	Moderate pain with a need for occasional medication
4	Moderate to severe pain with a need for frequent medication
5	Severe pain and a chronic need for medication

Source: Translated from Denis F.⁽⁵⁾

Table 3.

Denis functional work scale⁽⁵⁾

Score	Work scale criterion
1	Returned to hard labor
2	Returned to sedentary work, without lifting restrictions
3	Returned to work, but changed work activities
4	Returned to work, reduced to part-time
5	Incapable of working

Source: Translated from Denis F.⁽⁵⁾

Table 4.

Frankel classification⁽¹⁵⁾.

Classification	Motricity	Sensitivity
A	Absent	Absent
B	Absent	Present
C	Present, not useful	Present
D	Present, useful	Present
E	Normal	Normal

Source: Translated from Frankel HL *et al.*⁽¹⁵⁾

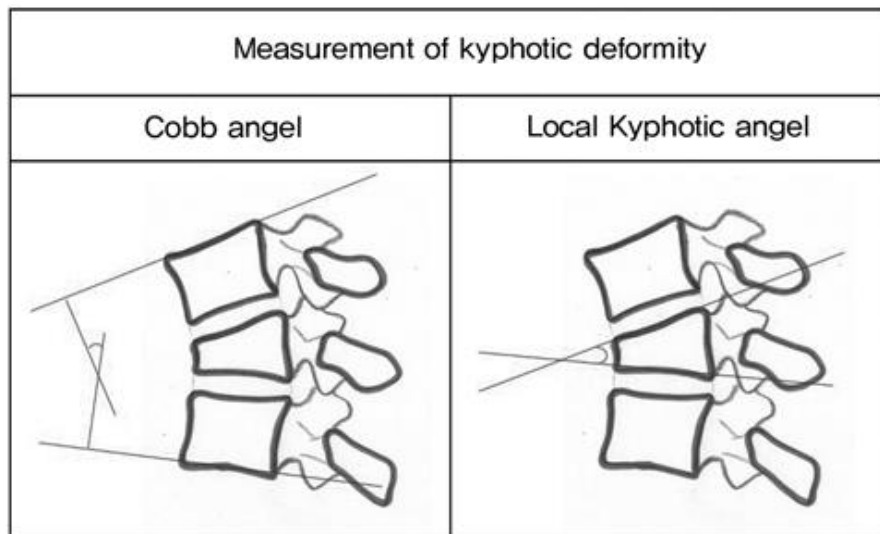


Fig.: 1 Calculation of Cobb's angle in the lateral graphs⁽¹⁴⁾

Fig.: 2

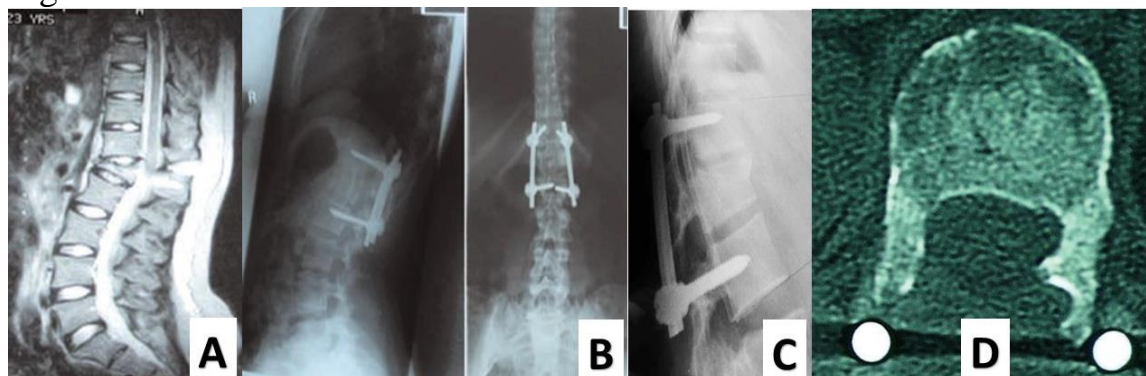
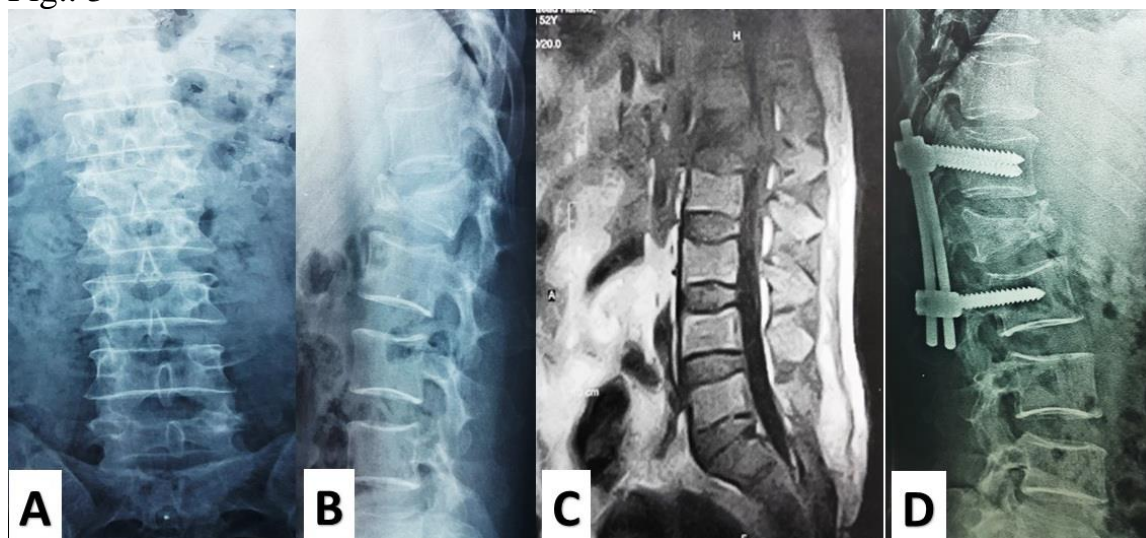


Fig.: 3



N	Age	Gender	Injury	AO type	Regional kyphotic angle			blood loss	surgery time	Neurology (Frankel)		FU period	hospital stay	Denis pain	Denis Work	follow up period/months
					pre	post	final			pre	post					
1	30	f	RTA	A3 1	30	1	5	290	90	E	E	40	14	1	1	39
2	34	m	fall	A3 2	35	3	6	300	120	D	E	41	23	1	1	36
3	35	f	fall	A3 1	30	1	4	270	110	E	E	42	32	2	3	37
4	40	m	RTA	A3 3	33	6	8	300	105	D	E	38	23	1	1	40
5	24	m	fall	A3 3	32	4	6	350	85	C	E	38	22	2	2	40
6	26	f	fall	A3 2	40	4	7	400	80	B	C	41	32	1	1	41
7	16	m	RTA	A3 3	45	6	9	370	70	B	E	40	24	1	1	44
8	48	m	RTA	A3 1	39	2	6	300	85	E	E	39	23	1	1	48
9	28	f	Fall	A3 3	35	1	4	250	95	C	E	38	19	1	1	45
10	30	m	RTA	A3 3	32	-1	3	470	100	D	E	39	19	1	1	41
11	35	f	Fall	A3 1	32	-2	3	500	95	E	E	36	22	1	1	45
12	26	m	Fall	A3 2	38	3	6	390	100	C	E	41	26	3	3	46
13	28	m	Fall	A3 3	40	5	6	400	105	B	D	40	21	1	1	43
14	24	m	RTA	A3 3	36	4	7	500	95	B	C	41	20	1	1	41
15	50	f	RTA	A3 1	41	2	7	470	100	E	E	43	18	1	1	40
16	36	m	Fall	A3 1	24	1	4	430	115	E	E	42	21	1	1	38
17	20	m	Fall	A3 2	36	-2	3	400	80	C	E	38	12	1	1	39
18	38	f	RTA	A3 2	40	-1	6	270	90	D	D	39	14	1	1	41
19	19	m	Fall	A3 3	41	-2	2	350	95	C	E	36	23	2	2	40
20	38	m	Fall	A3 3	30	1	4	450	85	B	D	38	22	2	2	39
21	19	m	RTA	A3 2	38	5	6	650	100	D	D	39	24	1	1	46

22	29	f	Fall	A3 2	40	4	7	390	105	C	E	40	12	1	1	41
23	24	m	Fall	A3 1	30	3	5	450	110	E	E	49	32	1	1	43
24	45	m	RTA	A3 2	48	2	2	370	115	E	E	50	12	1	1	52
25	40	m	RTA	A3 3	31	1	5	320	105	B	D	40	21	1	1	51
	50	Max		average	35.84	2.04	5.24	385.6	97.4							
	16	Min														

DISCUSSION

There are still few studies showing any specific relationship between functional results and surgical treatment for thoracolumbar burst fractures. **Andress et al**⁽¹⁶⁾ conducted a study on a retrospective series of 50 patients with burst fractures who underwent surgical treatment, and were unable to prove any correlation between the radiographic findings and the patients' long-term functional results, in relation to pain.

In another retrospective study conducted by **Lakshmanan et al**⁽¹⁷⁾ in which they sought to correlate recurrence of kyphosis in 26 patients who had undergone surgical treatment, with the functional implications, no statistical correlation could be found. The results from those studies were similar to ours⁽¹⁸⁾.

Roy Camille et al⁽¹⁹⁾ And **Dick et al**⁽²⁰⁾ prove that pedicle screw fixation at one vertebra cranial to and one vertebra caudal to the fracture had several advantages but it has been associated with loss of surgical reduction and instrumentation failure⁽²¹⁾.

A cadaveric study by **Mahar et al**⁽²²⁾ reported increased biomechanical stability of short-segment fixation with additional pedicle fixation at the level of fracture (short same-segment fixation). A subsequent study by **Güven et al**⁽²³⁾ also showed increased stability and long-term maintenance clinically with short same-segment fixation.

Dunn,⁽²⁴⁾ concluded that short segment posterior instrumentation is a safe and effective option in the treatment of unstable thoracolumbar fractures as a standalone measure.

Sanderson et al⁽²⁵⁾ In a retrospective study of 28 patients had Implant failure was screw breakage in four patients (prevalence is 14%)⁽²⁶⁾. And in our study of 25 patients with three years follow up there were no Implant failure.

In our study, and **Defino et al**⁽²⁶⁾ on 20 patients and **Li yang et al**⁽²⁷⁾ published

the results of a 5 years prospective randomized clinical study of 73 patients that show the radiologic findings after surgery were improved compared to pre-operation; however; there were changes at the last follow-up and slight deterioration was noticed and In This study there was no intraoperative or immediate postoperative complications were noted.

In our study and **Li yang et al**⁽²⁷⁾ show the mean fracture kyphosis was 35.84° at the time of admission and 5.24° at the final follow-up evaluation. All patients recovered without main complications.

In a prospective randomized study, **Alanay et al**⁽⁶⁾ evaluated the efficacy of transpedicular fixation and established that similar results were obtained with and without grafting. The duration of the operation and blood loss were found to be statistically significantly lower in the nonfusion group ($p < 0.05$).

In a prospective study by **Robertson and Wray**⁽²⁸⁾ graft donor sites were examined in 106 patients who underwent posterior spinal fusion 3, 6 and 12 months after the surgery and it was demonstrated that the pain increased in the first 6 months and tended to decrease afterwards. Also, pain was observed but not considered to be a major problem in the study by **Li yang et al**⁽²⁷⁾. Consequently, they reported that fusion was not necessary when posterior short segment fixation was performed.

CONCLUSION

The short duration of the surgery, the absence of donor site related problems, preservation of motion segments, and decreased blood loss all were advantage of the procedure. However long-term kyphosis correction was not maintained. Despite this loss of kyphosis correction, pain and disability improved at long-term follow-up. There was no evident correlations were found between residual kyphosis, pain and functional results.

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