

# Is Fusion Mandatory with Spinal Fixation of Traumatic Thoracolumbar Burst Fractures? A Prospective Comparative Study

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**Abstract: Study design:** A prospective case series study. **Purpose:** To compare the outcome in cases of traumatic thoracolumbar burst fractures surgically treated by posterior pedicle screw instrumentation with fusion versus posterior instrumentation without fusion, focusing on functional outcome, radiological outcome, intraoperative and postoperative complications. **Overview of Literature:** According to the Denis three-column concept, burst fractures consist of anterior and middle columns injury with retropulsion of bony fragments into the spinal canal, which is the radiographic hallmark. Typical clinical symptoms include back pain, restricted motion and neurological impairments. Progressive kyphotic deformities are frequently seen. The ideal treatment for patients with a thoracolumbar burst fracture remains controversial. Benefit of fusion with posterior instrumentation is still questionable. Non-fusion obviates the need for bone grafting and hence reduces blood loss and operation time, preserve better segmental motion and avoid donor site complications. On the other hand, achievement of solid fusion reduces risk of re-kyphosis and implant failure. **Methods:** Study was prospectively conducted on 40 patients with T10-L2 traumatic burst fractures, assigned into 2 equal groups: a fusion and a non-fusion group. **Results:** Mean age of patients was 37.2 years with minimal male predominance. Fall from height was the most common mode of trauma (62.5%) followed by RTAs. T12 was the most commonly injured level followed by L1, L2 and T11, respectively. Both operative time and intraoperative blood loss were higher in the fusion group, but the difference was not statistically significant. The difference in loss of correction, loss of restored vertebral body height and VAS score between the groups after 6 months proved to be statistically insignificant. There was only one case of implant failure during our follow-up in the fusion group. **Conclusion:** Both techniques achieved similar radiological and functional outcomes. There was no significant difference in implant failure rate. In addition, non-fusion avoids bone harvest complications, saves high cost of synthetic bone substitutes and reduces duration of surgery and blood loss.

**Key words:** fracture, burst, thoracolumbar, fusion

## INTRODUCTION

Thoracolumbar burst fractures are one of the most common types of traumatic spinal fractures.<sup>1</sup> The ideal treatment of these fractures remains controversial. Conservative treatment can lead to satisfactory outcomes especially in patients with no neurological deficits.<sup>2</sup> Surgery aims at realigning the spine, maintaining its stability and optimizing the neurological outcome. Anterior

corpectomy and fixation has higher morbidity and requires more technical expertise. Posterior pedicle screw fixation provides easier exposure and a less morbid approach, but with higher incidence of implant failure and recurrent kyphosis.<sup>3</sup>

*However, the question “to fuse or not to fuse?” with posterior instrumentation remains unsolved. Studies in favor of non-fusion said that posterior fixation can lead to sufficient bone and soft tissue healing similar to internal fixation of limb fractures. Alone, this technique can reduce blood loss and operation time, preserve more segmental motion and avoid donor site complications.<sup>4</sup> On another hand, obtaining solid fusion results in less implant failure and better radiographic outcome.<sup>5</sup>*

## **METHODS**

### ***Study population:***

This study was prospectively conducted on **40** patients with thoracolumbar (T10-L2) traumatic burst spine fractures operated upon, within 2 weeks from injury, from February 2018 to May 2019 in Neurosurgery departments, Cairo University and Fayoum University.

### ***Selection of patients:***

Neurologically intact patients of both sexes, aging from 16 to 60 years, presenting with single level traumatic thoracolumbar burst fractures with a kyphotic angle more than 20° and/or ≥50% decrease in vertebral body height, and <50% canal compromise. We have excluded patients with pathological fractures, neurological deficits and cases indicated for decompression. Patients with other comorbidities (bed sores, deep venous thrombosis, etc.) or associated major injuries have also been excluded.

### ***Preoperative evaluation:***

All patients were subjected to complete history taking and full neurological examination then, routine laboratory investigations including; complete blood picture and coagulation profile. Radiological evaluation by plain X-rays, CT and MRI was done. Kyphotic angle and loss of vertebral body height were calculated in lateral plain X-rays. Narrowing of the spinal canal was checked in axial CT cuts.

### ***Surgical technique:***

20 patients (group 1) were operated upon via posterior approach by fixation with trans-pedicular screws and rods. Length and diameter of the screws were determined based on the level and the size of pedicles and vertebral bodies in the preoperative CT images (4.5-6.5 mm diameter and 35-45 mm length were often used). Posterolateral fusion was done using a resorbable synthetic bone substitute (Bicera™, Wiltrom Co., Ltd, Taiwan): 1.0-2.0 mm bone granules composed of 60% Hydroxyapatite and 40% Tricalcium phosphate, mixed with bone dust obtained from decortication of the fusion bed. 3-4 cc of graft material were used for each fixed level after mixing with autologous blood. The graft is placed in the lateral gutter bilaterally after decortication of the transverse processes, followed by adequate distraction for correction of kyphosis guided by fluoroscopy. 20 patients (group 2) were operated upon via the same posterior approach but without fusion.

***Follow-up and outcome:***

On the 1<sup>st</sup> postoperative day, patients were subjected to neurological examination, radiological evaluation of placement of the hardware, alignment of the spine, correction of kyphosis (kyphotic angle) and restoration of vertebral body height (on lateral plain x-rays). After 6 months, patients were evaluated for improvement of back pain (using Visual Analogue Scale) and radiological outcome represented by loss of correction of kyphosis, re-collapse of the vertebral body (on plain X-rays) and late complications with the most important being implant failure.

***Statistical analysis***

Continuous variables were presented in the form of mean value and standard deviation. The categorical variables were presented in the form of numbers and percentages.

**RESULTS**

21 patients were males and 19 were females, with a mean age of 37.2 years. Regarding the mode of trauma, a history of fall from height (FFH) was found in 25 (62.5%) patients. Road traffic accidents (RTA), either motor vehicle accidents or pedestrian, were found in 14 (35%) patients. Only one patient was injured after a heavy object fell on his back. On analysis of the injured level, one case had a T11 fracture, 15 cases had T12 fractures, 13 cases had L1 fractures and 11 cases had L2 fractures. There was no statistically significant difference, with p-value >0.05, between study groups regarding the age, sex, mode of trauma and level of fracture which indicated proper matching. (Table 1)

**Table (1): Comparison of demographic characters mode of trauma and injured level.**

Variables	Technique				p-value	Sig.
	With fusion		without fusion			
Age (mean in years)	39.6±8.23		34.7±11.9		>0.05	NS
<b>Sex</b>						
Male	11	55%	10	50%	>0.05	NS
Female	9	45%	10	50%		
<b>Mode of trauma</b>						
FFH	11	55%	14	70%	>0.05	NS
RTA	8	40%	6	30%		
Fall of a heavy object	1	5%	0	0%		
<b>Level of injury</b>						
T11	0	0%	1	5%	>0.05	NS
T12	8	40%	7	35%		
L1	7	35%	6	30%		
L2	5	25%	6	30%		

\*Sig: significance      \*S: significant      \*NS: non-significant

13 (65%) cases in group 1 (fusion group) were operated upon by short segment fixation (1 level above and 1 level below) while 7 cases (35%) were operated upon by longer implants. In the non-fusion group, 14 (70%) cases had short implants while 6 cases (30%) were operated upon by

longer systems. Index level screws were placed in 10 cases; 4 of them in group 1 and 6 in group 2.

On comparing the duration of surgery, a mean operative time of  $105 \pm 9.8$  minutes was needed in the fusion group. In the non-fusion group, the mean operative time was  $100 \pm 13$  minutes. Estimated intraoperative blood loss had an average of  $319.5 \pm 50.3$  mL and  $284.5 \pm 32$  mL in the fusion and non-fusion cases respectively. Both operative time and intraoperative blood loss were higher in the fusion group, but the difference was not statistically significant. (Table 2)

**Table (2): Comparison of average duration of surgery and average blood loss.**

Extent of fixation	Technique				p-value	Sig.
	With fusion		Without fusion			
	Mean	SD	Mean	SD		
<b>Duration of surgery (average in minutes)</b>						
<b>Short segment</b>	101.9	7.8	95.4	11.7	>0.05	NS
<b>Long segment</b>	110.7	11.34	110	10.5	>0.05	NS
<b>Estimated blood loss (average in mL)</b>						
<b>Short segment</b>	358.6	42	298.5	41.2	>0.05	NS
<b>Long segment</b>	305.6	44.2	275	21.7	>0.05	NS

\*Sig: significance      \*S: significant      \*NS: non-significant

By measuring the angle of kyphosis, average lost correction of kyphosis in fusion group after 6 months of follow-up was  $8.05 \pm 3.71^\circ$ . In group 2 (non-fusion), the average lost correction was  $8.35 \pm 3.86^\circ$ . Regarding the vertebral body height (VBH) in the fusion group, average loss of restored VBH after 6 months of follow-up was  $6.1 \pm 4.47\%$ . In the non-fusion group, this loss had an average of  $7.7 \pm 3.47\%$ . The final mean functional outcome was  $2.7 \pm 1.17$  points (range: 1 to 5 points) on the visual analogue scale (VAS) for the fusion group. Score was  $3.1 \pm 1.45$  points (range: 1 to 6 points) in non-fusion group. The difference in loss of correction, loss of restored VBH and VAS score between the 2 groups after 6 months proved to be statistically insignificant. (Table 3)

**Table (3): Comparison of radiological parameters and functional outcome.**

	Technique				p-value	Sig.
	With fusion		Without fusion			
	Mean	SD	Mean	SD		
<b>Average Kyphotic angle (<math>^\circ</math>)</b>						
<b>Preoperative</b>	$20^\circ$	$7.21^\circ$	$19.8^\circ$	$7.28^\circ$	>0.05	NS
<b>On 1<sup>st</sup> postoperative day</b>	$6.65^\circ$	$4.32^\circ$	$5.7^\circ$	$5.21^\circ$	>0.05	NS
<b>After six months</b>	$14.7^\circ$	$3.5^\circ$	$14.1^\circ$	$5.53^\circ$	>0.05	NS
<b>Loss of correction</b>	$8.05^\circ$	$3.71^\circ$	$8.35^\circ$	$3.86^\circ$	<b>&gt;0.05</b>	<b>NS</b>
<b>Average loss of Vertebral body height (%)</b>						
<b>Preoperative</b>	55.2	7.98	56.8	7.32	>0.05	NS
<b>1<sup>st</sup> postop. day</b>	18.9	11.6	22.8	13	>0.05	NS
<b>After six months</b>	24.5	11.6	30.5	12.1	>0.05	NS
<b>Lost correction of VBH</b>	6.1	4.47	7.7	3.47	<b>&gt;0.05</b>	<b>NS</b>
<b>VAS score after 6 months</b>						
<b>VAS score</b>	2.7	1.17	3.1	1.45	<b>&gt;0.05</b>	<b>NS</b>

Regarding intra- and postoperative complications, 5 patients had maldirected screws but none of them needed revision. Pedicular fractures were encountered in 2 cases in the fusion group and 3 cases in the non-fusion group. Superficial wound infection occurred in 2 patients in each group. All cases responded to medical treatment and repeated dressing. Delayed Deep wound infection was documented in one case in group 2 in which the implant had to be removed with postoperative resolution of infection. There was only one case of implant failure during our duration of follow-up in the fusion group. (Table 4)

**Table (4): Comparison of surgical complications.**

Operative complications	Technique				p-value	Sig.
	With fusion		Without fusion			
	No.	%	No.	%		
Maldirected screws	2	10%	3	15%	>0.05	NS
Revision surgery	0	0%	0	0%	>0.05	NS
Pedicle fracture	2	10%	3	15%	>0.05	NS
Superficial Wound infection	2	10%	2	10%	>0.05	NS
Deep Wound infection	0	0%	1	5%	>0.05	NS
Hardware failure	1	5%	0	0%	<b>&gt;0.05</b>	<b>NS</b>
Implant removal	0	0%	1	5%	<b>&gt;0.05</b>	<b>NS</b>

\*Sig: significance      \*S: significant      \*NS: non-significant

Regarding postoperative hospital stay, average hospital stay in group 1 was  $4.2 \pm 1.15$  days (range: 3-7 days). In group 2, average hospital stay was  $3.9 \pm 1.02$  days (range: 3-6 days). The difference was not statistically significant.

## DISCUSSION

The ideal treatment for a burst thoracolumbar fracture remains questionable. Pedicle screw fixation has emerged as the treatment of choice. This study addressed the question of whether a simultaneous fusion is essential when treating such fractures with posterior fixation.<sup>2</sup>

Our study included 40 patients with traumatic thoracolumbar burst fractures operated upon within 2 weeks from injury. Patients were classified into: group 1 (fusion group) and group 2 (non-fusion). Mean age of the patients was 37.2 years. Male to female ratio was 1.1:1. The mean age was not much different in most studies as these fractures usually occur in active middle-aged population.

The mode of trauma was fall from height (FFH) in 62.5% of patients. RTAs were the 2<sup>nd</sup> most common cause. While most studies showed predominance of FFH, Sanderson<sup>6</sup> reported predominance of RTAs (75%). On analysis of the injured levels, we found slight predominance (37.5%) at T12 level. Others found L1 to be the level of injury in most of their cases.<sup>7,8</sup> Wang<sup>9</sup> found more fractures at L2 (41%).

In this study, we have excluded any patient with a neurological deficit. Sanderson's study has also included only intact patients while other surgeons didn't exclude patients with variable deficits.<sup>7,8,9</sup>

Our average estimated blood loss was  $319.5 \pm 50.3$  mL in fused cases, and  $284.5 \pm 32$  mL for those with the non-fusion. Average operative time was  $105 \pm 9.8$  minutes in the fusion group, and  $100 \pm 13$  minutes with non-fusion. These differences proved to be insignificant. In contrary to our

results, Chou<sup>10</sup>, Hwang<sup>11</sup>, Wang<sup>9</sup> and others reported significantly higher mean operative time and intraoperative blood loss in cases operated upon by fusion. This was mostly related to using autologous bone grafts from iliac crest.

Regarding postoperative hospital stay, Hwang<sup>11</sup> reported a longer hospital stay than ours, but the difference was also not significant. Many patients in other studies had a second admission for implant removal; either routinely (in non-fusion cases), for implant failure or on demand.

By measuring the kyphotic angle (KA), it significantly decreased in 1<sup>st</sup> day images in both groups. In the final follow-up, the difference in average loss of correction (8.05° with fusion and 8.35° with no fusion) was statistically insignificant.

Despite their longer follow-up period, Wang<sup>9</sup> and Jindal<sup>8</sup> also found no significant difference between the techniques. Dai<sup>7</sup> and Yang<sup>4</sup> reported similar results. In contrast, Hwang<sup>11</sup> demonstrated that correction in non-fusion group was only partially maintained: it decreased from 12.6° to 5.6° ( $p < 0.0001$ ). In fusion group, correction was fairly maintained at final follow-up. On the basis of many reports, progressive kyphosis may be inevitable in spite of fusion, and the residual deformity did not correlate with the symptoms at the time of follow-up.

Regarding the analysis of VBH, the difference between the 2 groups after 6 months proved to be statistically insignificant. Chou<sup>11</sup> also reported a progressive collapse, and was not significant ( $p > 0.05$ ). Similar results were noted in other reports<sup>12,13</sup>. Wang<sup>9</sup> mentioned that VBH loss was significantly higher in fusion group, which may have been due to compromising posterior column while performing posterior fusion.

In our study, functional outcome was similar at the latest follow-up (average VAS score: 2.7 vs. 3.1). Having longer follow-up periods, Dai<sup>7</sup> found lower final VAS scores but 25 of his fused patients still had donor-site pain. In contrary, Hwang found significantly lower final VAS scores in his fusion cases ( $p < 0.001$ ).<sup>11</sup>

The lack of decompression in our study helped in avoiding injury to the dura mater, spinal cord or nerve roots. Dai<sup>7</sup> had a CSF fistula in one non-fused case. Superficial wound infection occurred in 2 patients in each of our groups. Delayed Deep wound infection was encountered in one case in the non-fusion group in which the implant had to be eventually removed. Sanderson<sup>6</sup>, Wang<sup>9</sup> and Yang<sup>4</sup> had no incidence of infection among their cases regardless of the technique.

## LIMITATIONS

- The study needs to include a larger number of patients.
- Relatively short follow up period.

## CONCLUSION

Our results suggested that fusion was not necessary with posterior fixation of traumatic thoracolumbar burst fractures. Both techniques achieved similar radiological and functional outcomes. There was no significant difference in implant failure rate. In addition, non-fusion avoids bone harvest complications and saves high cost of synthetic bone substitutes. Non-fusion also decreases operative time and perioperative blood loss and preserves more motion segments.

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