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## Stand-alone anterolateral retro-peritoneal approach for traumatic lumbar burst fracture

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### Abstract

**Background:** Burst lumbar spine fractures are very common serious injuries. They make severe instability, disability, kyphotic deformities and affect patient quality of life. Present of intra canal bony fragments that cause neurological affection requiring surgical decompression and reconstruction. There are different surgical modalities to manage traumatic lumbar burst fractures anterior, post or combined approaches. The optimal treatment remains controversial.

**Methods:** We conducted prospective study that include 20 adult cases with traumatic lumbar burst spine fractures subjected to anterior-only decompression and stabilization through retro-peritoneal approach by single level fusion by mesh cage loaded with bone graft in the department of Neurosurgery, Tanta University Hospitals between July 2022 and July 2023.

**Results:** Anterior-only decompression and stabilization was done to 20 cases, 12(60%) patients were male and 8(40%) patients were female. Oswestry Disability Index (ODI) ranged from 80-90 with a mean  $85.6 \pm 4.03$  before surgery and 21-50 after surgery with a mean  $36. \pm 12.82$ . The pain was evaluated using an 11-point Visual Analog Scale for Pain (VAS Pain) Scale. It was ranged from 7-9 pre-operatively with a mean value of  $8.2 \pm 1.8$  and from 1-3 post-operatively with a mean value of  $2.3 \pm 1.6$ . 75% of neurological affected patients improved at least one grade according frank classification scale of neurological affection after surgery. Sagittal alignment, kyphotic angle and fusion was restored and maintained in 96% of patient

**Conclusion:** Anterior lateral retroperitoneal stand-alone technique in management of traumatic lumbar burst fracture shows promising outcome and many advantage. It allows direct anterior decompression of neural element, removal of bony fragment, short segment fixation, preservation of intact posterior column, improvement in segmental angulation and acceptable rate of arthrodesis.

**Keywords:** Anterior, burst fractures, lumbar, posterior, thoracic, thoracolumbar

### Introduction

The T10-L2 thoracolumbar region is the most common area of injury to the spine from trauma due to the specific biomechanics of this segment of the spine. Specifically, this is a transition area from the rigid and less mobile thoracic spine (due to the presence of the ribs which attach to the spine bilaterally) to a more flexible lumbar spine. Injury to this area can result in a permanent neurological deficit from compression or direct injury to the nerve roots of the cauda equina or the conus medullaris and warrants immediate attention and assessment [1].

The thoracolumbar junction (T11–L2) poses an anatomical dilemma to spine surgeons during lateral approaches due to the presence of the lower rib cage and the diaphragm, which is sandwiched between the pleura and peritoneum, understanding of its anatomy and relationship to nearby structures is critical during the approach [2].

The burst fracture results from failure of the vertebral body under axial load. This results in failure of the anterior and middle columns both under compression [3].

The optimal treatment of “unstable” thoracolumbar injuries remains controversial. Studies have shown the advantages of direct anterior decompression of thoracolumbar injuries along with supplemental posterior instrumentation as a combined or staged procedure. Others have also shown success in decompression as a single-stage anterior procedure, largely limited to two-column (anterior and middle) injuries [4].

Current types of anterior spinal instrumentation and reconstruction techniques can allow some types of unstable three-column thoracolumbar injuries to be treated in an anterior standalone fashion. This allows direct anterior decompression of neural elements, improvement in segmental angulation, and acceptable rates of arthrodesis without the need for supplemental posterior instrumentation [4].

After decades of treating spinal fractures with different methods and approaches, Treatment decisions in these patients require complete evaluation of the neurological status and identification of the presence of spinal instability. Most thoracolumbar and lumbar burst fractures can be treated conservatively in selected neurologically intact patients. The presence of neurological deficits and spinal instability require surgical treatment through the appropriate surgical approach [5].

This study was conducted to evaluate the surgical efficacy, clinical, and functional outcomes and post-operative complication of Anterior Lateral Retroperitoneal Approach Stand alone for treatment of Unstable Traumatic Lumbar Burst Fracture.

### Patients and Methods

This work involved 20 cases. All cases were operated at the Neuro-surgery department, Tanta University Hospital from between July 2022 and July 2023. Cases were prospectively gathered from the hospital admitted patient. Cases data, diagnoses, and treating outcomes were privately kept and cases were marked by codes. Informed consent was obtained from all cases preoperatively.

### Inclusion criteria

1. Traumatic lumbar burst fracture with anterior canal compromise.
2. Anterior vertebral body height  $\leq$  50% of the posterior height.
3. Residual canal diameter  $\leq$  50% of normal.
4. More than 25 to 35 angles of kyphotic deformity.
5. Progressive kyphosis.
6. Progressive neurological deterioration.

### Exclusion criteria

1. Medically unfit patient,
2. Osteoporotic patient
3. Pathological fractures.

**Preoperative protocol:** All cases were assessed and exposed to clinical history, general and neurological examinations, and routine laboratory tests. Pre-operative clinical examinations were performed and muscle strength of the lower limbs of all patients was classified by the motor power classifying system from 0 to 5 and Frank grade classification.

**Radiological investigations:** All cases were pre-operatively exposed to radiological assessment via X-ray in both anteroposterior and lateral views. Kyphotic angle was measured from the superior endplate of the vertebral body above the fractured level to the inferior endplate of the vertebral body below the affected vertebra was measured on lateral film in the neutral position, CT-scan, and MRI-imaging and DEXA scanning in selected patient. Figure (1)

**The surgical technique:** The patient was positioned in left lateral decubitus with right side down. The approach was done from the left side to avoid the liver and IVC, dealing and mobilization with the aorta was easy and less susceptible to injury than IVC. Oblique skin incision on the level of exposure was required. The incision was centered on the approached level based on fluoroscopy image. The skin and subcutaneous tissue were opened, resection of 10th or 11th ribs was done after subperiosteal separation to reach L1-L2 and we released the diaphragm in L1 fracture cases to put screws in D12, lateral fibers of the abdominal muscles (external oblique, internal oblique, and abdominal transverse) could be opened carefully. Our guide was the extraperitoneal fat, retroperitoneal area was reached without entering the pleural cavity, peritoneum with the ureter and aorta are retracted anteriorly and medially protected with moist gauze. The psoas muscle was stripped from its attachments to the L1 and L2 vertebrae using the vertebral column as a guide, we used a self-retaining retractor, the segmental vessels were ligated, and the periosteum was exposed. Identification of the level by C-arm partial corpectomy started trying to preserve its anterior portion to avoid injury to soft structures using a high speed drill, with exposure of the anterior dural sac. Afterwards, short segment instrumentation and bone fusion was done by putting the screws one vertebral body above and one below to the fractured level then mesh loaded by bone graft applied with rode above it and tightening of set screws after that closure with drain insertion. Figure (2, 3)

### Follow up

**Clinical outcome:** All cases were assessed immediately post-operative then in the outpatient clinic at a steady period after 2 weeks from the operation then after 3 and 6 months. ODI: has been utilized for pre and postoperative disability evaluation in all patients, pain before and after surgery was assessed with Visual Analogue Score scale. Also Frank grade classification is assessed to compare neurological state before and after operation.

**Radiological follow-up:** Approximately one day after surgery, a CT scan and x-ray was done to ensure that instrumentation was in a good position and efficacy of decompression and fixation.

At 3 and 6 months after surgery plain x-rays were done to assess fusion. Figure (4)

Patients were advised to start mobilization while wearing lumbar brace, drain usually removed 48 hours after surgery, Lumbar support were worn for one month postoperatively. The duration of follow-up ranged from 6 to 12 months.

### Results

The current work comprises 12-male and eight female. The ages of the patients at the presentation time ranged between 25-50 years with a mean value of  $34.2 \pm 7.84$  years.

The commonest level is L1 in all of our patients (40%). Table (1)

Patient had a TLICS score with mean 7.4 ranging from 4 to 8. Table (2)

Oswestry Disability Index (ODI) ranged from 80-90 with a mean  $85.6 \pm 4.03$  before surgery and 21-50 after surgery with a mean  $36. \pm 12.82$ .

The pain was evaluated using an 11-point Visual Analog Scale for Pain (VAS Pain) Scale. It ranged from 7-9 pre-

operatively with a mean value of  $8.2 \pm 1.8$  and from 1-3 post-operatively with a mean value of  $2.3 \pm 1.6$ . Regarding Frankel score, 75% of neurological affected patients improved at least one grade according to the frank classification scale of neurological affection after surgery except 3 cases with preoperative score A didn't improve. Table (3)

The kyphotic angle improved from the mean angle  $9.5^\circ$  (range from  $0^\circ$  to  $20^\circ$ ) before surgery to the mean angle  $2.8^\circ$  (range from  $0^\circ$  to  $8^\circ$ ) after surgery and final follow-up. A significant difference was seen between kyphotic angle preoperatively and at final follow-up ( $p < 0.001$ ) in all cases. One patient needed supplementary posterior Instrumentation and fusion 6 months after the anterior approach due to worsening of the kyphotic angle after failure of bone fusion.

Six cases had complications, 3 cases had intra operative complications during the surgery presenting 15% of all cases. Two patients had peritoneal injury and managed directly by suturing the peritoneum with non-absorbable sutures. One patient had pleural injury and managed by suturing and inserting an intercostal chest tube. The other 3 cases had postoperative complications presenting 15% of all cases, the first two had superficial wounds treated by systemic antibiotics, the third had worsening of the kyphotic angle after failure of bone fusion. Supplementary posterior Instrumentation and fusion two levels above and two levels below the fracture level were done 6 months after the anterior approach. Table (4)



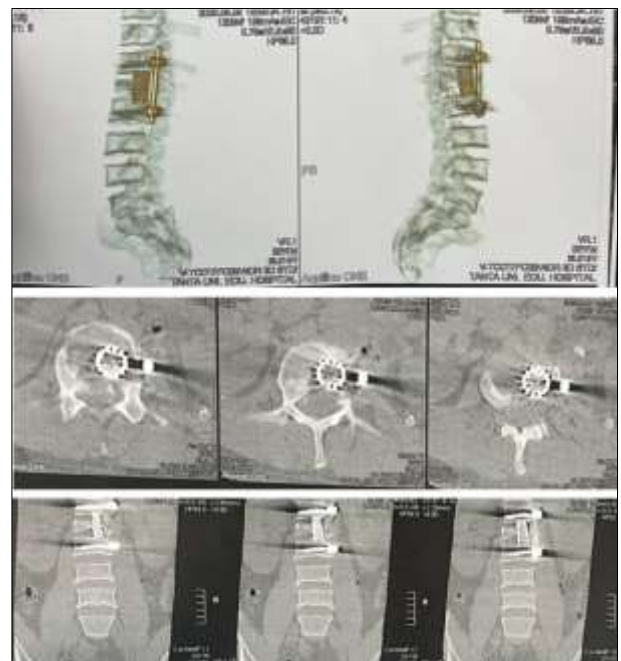
**Fig 1:** Intra operative image showing corpectomy of L1, mesh loaded with bone graft



**Fig 2:** Fluoroscopic image after reconstruction



**Fig 3:** Pre-operative CT Lumbosacral spine showing L1 burst fracture



**Fig 4:** Post-operative CT Lumbosacral spine showing L1 burst fracture

**Table 1:** Level of fracture in studied patient

		(n=20)
Level of fracture	Lumbar 1	8 (40%)
	Lumbar 2	7 (35%)
	Lumbar 3	5 (25%)

**Table 2:** TLICS and LSS of the studied patients

		(n=20)
TLICS	Median	6
	IQR	4 - 8
LSS	Median	7
	IQR	6 - 8

TLICS: Thoracolumbar injury classification and severity score, LSS: Load sharing scores.

**Table 3:** ODI, visual analogue scale and segmental kyphotic angle of the studied patients

	Preoperative	Postoperative	P value
<b>ODI (%)</b>			
Mean $\pm$ SD	$85.6 \pm 4.03$	$36.8 \pm 12.82$	<0.001*
Range	80 - 90	21 - 50	
<b>Visual analogue scale</b>			
Median	8	1	<0.001*
IQR	7 - 9	1 - 2	
<b>segmental kyphotic angle</b>			
Mean $\pm$ SD	$9.5 \pm 6.35$	$2.8 \pm 1.89$	<0.001*
Range	0 - 20	0 - 8	

\*: Significant as P value  $\leq 0.05$ . ODI: Oswestry disability index.

**Table 4:** Complication of approach in studied patient

Complication	N(20)	Percentage
Wound infection	2	10%
Kyphosis	1	5%
Intraoperative Vascular injury	0	0%
New deficit	0	0%
Retrograde ejaculation	0	0%
Peritoneal injury	2	10%
Pleural injury	1	5%
Sympathetic dysfunction	0	0%

## Discussion

### Summary of finding in this study

In this study, twenty patients have been admitted to and operated in Tanta University Hospitals from September 2022 to September 2023 in the Department of Neurosurgery. Those patients came with traumatic lumbar burst fracture and were operated by anterior reconstruction with fixation by anterolateral retroperitoneal approach alone.

### Explanation of study result

Back pain was found in all patients (100%). Neurological examination was affected in 12 (60%) patients and wasn't affected in eight (40%) patients. Half of neurologically affected patients (6 from 12 affected patients) have visceral affection. There were 8 (26.7%) without any neurological symptoms.

Sasso *et al.* [4] reported 37 (92.5%) patients are neurological affected pre-operatively and 3 (7.5%) patients are intact in comparison to our study, the difference may come from different inclusion criteria in both studies. Sasso *et al.* [4] include more aggressive type of fractures with three column affected; on the other hand, we just include burst fracture (two column affected fractures).

In our study, the median of TLICS for patients was six (4-8) and the median of LSS was seven (6-8). Hammad *et al.* [6] reported all his patients scored more than five in TLICS and more than six in LSS, they use this values as inclusion criteria to their research

The operation time in our study ranged from 100 to 150 min with a mean value ( $\pm$  SD) of 119.3 ( $\pm$ 17.34) min. Xu GJ *et al.* [7] reported mean operation time in their research 176.3 min. On the other hand, Roblesgil-Medrano *et al.* [8] revealed that posterior approach procedures are associated with a significantly shorter operative time than anterior approach procedures.

Regarding blood loss, Intraoperative blood loss ranged from 200 to 400 mL with a mean value ( $\pm$  SD) of 317.5 ( $\pm$ 66.48) ml. Roblesgil-Medrano *et al.* [8] revealed that both approaches undergo similar blood loss. This concurs with the results of Tang *et al.* [9].

The kyphotic angle improved from the mean angle 9° (range from 0° to 20°) before surgery to the mean angle 2.8° (range from 0 - 8°) after surgery and final follow-up. A significant difference was seen between kyphotic angle preoperatively and at final follow-up ( $p = 0.0001$ ) in all cases.

Hammad *et al.* [6] reported improved from the mean angle 8.8° (range from -6° to 20°) before surgery to the mean angle -1° (range from -10° to 4°) after surgery and final follow-up one patient (Case 8) needed supplementary posterior Instrumentation and fusion due to worsening of the kyphotic angle after failure of bone fusion.

Sasso *et al.* [4] reviewed stand-alone single-stage anterior surgical management of three-column thoracolumbar injuries in 39 patients their Mean preoperative segmental kyphosis measured 22.7 (range 10–42, SD 8.3) with significant early postoperative correction to 7.4 (range 0–28, SD 7.4). Kaneda *et al.* [10] also reported mean kyphotic deformity of 19 (corrected to 7 postoperatively, without significant loss at latest follow-up. Lin Bin *et al.* [11] also reported improvement in kyphotic deformity before / after surgery 24.2°/5.2°.

Most of studies that manage burst fracture with anterior only decompression and fixation show significant improvement between pre-operative and post-operative kyphotic angle and good ability to maintain that correction with follow up, the difference in numbers may due to difference in measure kyphotic angle, some use local kyphotic angle and some use segmental kyphotic angle and different instrumentation used in reconstruction of anterior and middle column.

In our study, regarding neurological improvement, nine patients (75% of neurological affected) improved at least one grade according to the frank classification scale of neurological affection and 3 (15%) patients did not improve two of them score preoperative was grade A. This is consistent with what is reported in literature. Since neurological deficit is due to ventral compression, direct visualization provides optimal decompression of the spinal canal. There was no progression of initial neurologic deficit in any of the other 20 patients

Regarding our result, Hammad *et al.* [6] reported a significant difference was seen between neurological examination before and after operation all of the patients improved at least one level after surgery except 2 cases with preoperative score A didn't improve.

Also Sasso *et al.* [4] documented no patients deteriorated neurologically as a result of operative treatment. Thirty of 33 patients (91%) with incomplete injuries improved at least one modified Frankel grade (range one to three grades). Three of four patients categorized as modified Frankel A demonstrated some improvement.

In Zhang *et al.* [12] study, no neurological deterioration occurred postoperatively. Thirteen out of 27 patients (48%) had improvement of at least one Frankel grade on hospital discharge. At final clinical follow-up, 22 patients (82%) had improvement in their neurological function.

Five patients had complications, 3 cases had intra operative complications during the surgery presenting 15% of all cases. Two patients had peritoneal injury and managed directly by suturing the peritoneum with non-absorbable sutures. One patient had pleural injury and managed by suturing and inserting an intercostal chest tube. The other 2 cases had postoperative complications presenting 10% of all cases, the two had superficial wounds treated by systemic antibiotics and daily dressing.

Zhang *et al.* [12] reported similar results with 26% of patients developing some form of perioperative complication. There were no mortalities and no incidences of increased neurological deficits in any of those patients. No intraoperative or late vascular injuries were noted. Two patients demonstrated on radiographic imaging evidence of minor graft movement that did not progress. Dural tears occurred in two cases. One urinary tract infection, three superficial wound infections treated with antibiotics, ileus, left diaphragm tear with pneumothorax, and pneumomediastinum.

### Study strength

Anterolateral approach offers direct decompression of the spinal canal and improved spinal kyphotic deformity correction compared to posterior instrumentation. The placement of allograft and anterior instrumentation allows for direct reconstruction of the spinal column and fusion of the column, thus limiting the number of motion segments to be fused. Posterior instrumentation usually requires pedicle screws 2 levels above and below the fracture with fusion rate of around 90% as reported in McBride study<sup>[13]</sup>. Short segment posterior instrumentation remains controversial.

Finally, Anterolateral approach is a feasible, effective, and safe approach for unstable lumbar burst fractures causing angular deformity with incomplete neurological deficit. Anterior approach provides successful correction of angular deformity by reconstruction of anterior and middle columns with fusion; it helps to improve the neurological status in patients with neurological deficits by safe and efficient decompression of the spinal canal with less operative time and less blood loss.

### Limitation

Our study has various limitations such as fewer numbers of cases, short follow up duration (due to low education level and patients' compliance) and shortage in facilities.

We recommend in further studies include more cases with longer follow up duration and encouragement of further studies that compare between different modalities in management of burst fracture.

### Conclusion

Modern anterior spinal instrumentation and reconstruction techniques can allow unstable burst fracture to be treated in an anterior stand-alone fashion especially burst fractures without posterior column disruption.

Sagittal alignment, kyphotic angle and fusion was restored and maintained in 96% of patient, nine patients (75% of neurological affected) were improved at least one grade according to frank classification scale of neurological affection

The advantages of this anterior lateral stand-alone technique are allowing direct anterior decompression of neural elements, improvement in segmental angulation, doesn't violate intact post column, short fusion segment in compare to post fusion and acceptable rates of arthrodesis without the need for supplemental posterior instrumentation with acceptable operation time and perioperative complication.

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