

## Anterior-Only and 360° Approaches for Thoracic and Lumbar Fractures

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### Abstract

**Objectives:** To retrospectively address and characterize two different surgical treatment options for thoracolumbar fractures: one concerning an anterior-only approach and the other adding a transpedicular posterior fixation, the so-called 360° circumferential approach.

**Methods:** For each case, several features were analyzed: neurologic status, fracture classification, and posterior ligament complex (PLC) integrity. The degree of deformity - quantified through vertebral height, angular kyphosis and the extent of spinal canal involvement - was pre- and post-operatively measured.

**Results:** In Clinical Case 1 (T5 fracture), a single-anterior approach was chosen, through a right-sided thoracotomy. During the 5-year follow-up period, there were neurologic (ASIA one level) and morphologic (20% of height, 10° of kyphosis and 30° of spinal canal) improvements. In Clinical Case 2 (L1 fracture), a combined (360°) approach was followed, through a left lumbotomy and a posterior approach. During the 3-year follow-up period, neurologic (ASIA one level) and morphologic (15% of height, 16° of kyphosis and 80% of spinal canal) improvements were verified.

**Discussion:** The anterior approach allowed direct decompression of the spinal cord in the acute setting and was associated with a better clinical outcome, besides being useful in the correction of the deformity. 360° circumferential approach granted superior stability, at the expenses of a more static construct.

**Conclusion:** The use of the anterior approach led to neurological improvement, sagittal alignment enhancement, with a low complication rate. Posterior transpedicular fixation was added to accomplish a stronger fixation. Stand-alone posterior fusion wouldn't have granted satisfactory results.

**Keywords:** Spine Fracture; Neurologic; Anterior; Expandable Cage; 360°

### Introduction

Traumatic spinal cord injury can be dramatic and inflict severe impairments. Burst fractures of the vertebral column are most commonly seen in the lower thoracic and lumbar vertebral bodies. The associated neurologic damage happens in 32% - 47% of patients and can vary from not present to critical [1]. Thoracic and lumbar vertebrae behave differently when axial loading is applied [2]. The first tend to flex, making the superior endplate more prone to fracture, as in the sagittal plane the thoracic vertebra has a considerable physi-

ological kyphotic angulation [3]. On the other hand, the endplates of the lumbar vertebrae are parallel and axial forces cause fracture of both. Important radiographic signs of fracture to be detected are: vertebral height loss, angular kyphosis, increase of the interpedicular and interfacetary distances and retropulsion of endplate fragments into the spinal canal. The transitional zone (T11-L2) is the most likely section of the thoracolumbar spine to injury when trauma occurs. Its inherent biomechanical fragility to deforming forces is due to the change from a rigid thoracic spine to a relatively mobile lumbar segment [4]. Given an intact posterior column, thoracolumbar fractures can, generally, be treated through ligamentotaxis, using standard posterior fusion. However, some challenging cases require an anterior approach, whether or not combined with posterior fixation. In the decision-making process, it is the personality of the fracture we should look at: a combination of patient and injury, comprising fracture pattern and its potential for further deterioration, and also an accurate and dynamic neurological examination of the patient.

The scope of this work is to present and characterize two clinical cases involving anterior approaches to the spine, used for thoracic and lumbar fractures.

### Material and Methods

In this work, we present two clinical cases (45 year-old female and 61 year-old male), surgically treated because of a thoracolumbar fracture. The levels involved were T5 and L1. Clinical and imagiological evaluation was performed. The items evaluated were: neurologic status - determined based on the American Spinal Injury Association (ASIA) impairment scale - fracture classification, posterior longitudinal complex (PLC) rupture, loss of height (%), kyphotic deformity (°), spinal canal invasion (%), as well as the presence of complications. The follow-up periods were 5 years for Clinical Case 1 and 3 years for Clinical Case 2.

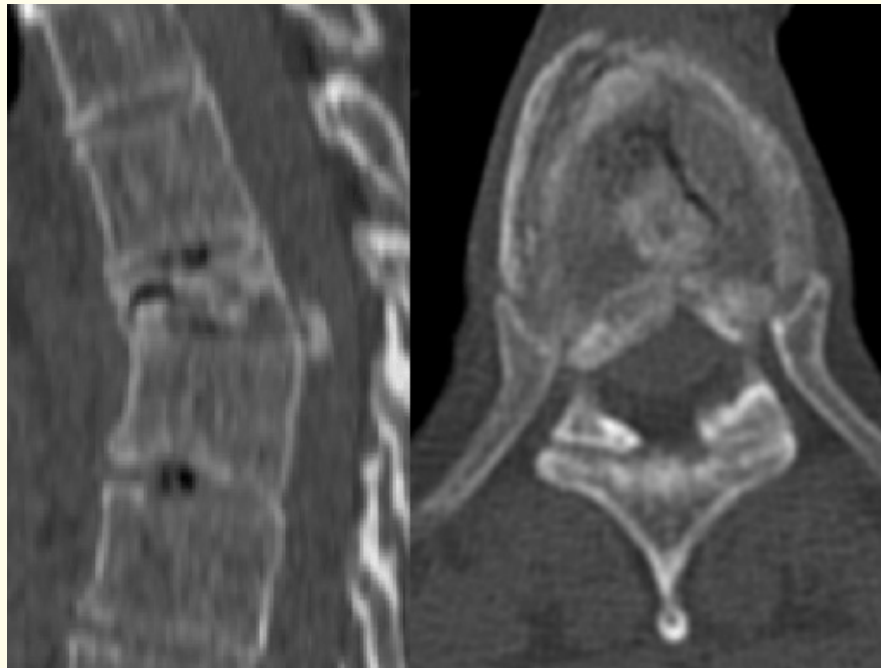
The surgical approach, in Clinical Case 1, was performed as follows, through a right-sided thoracotomy: in right lateral decubitus position: a) Incision beginning postero-superiorly at the scapular angle, in an antero-inferior direction, in order to have access to the above and below vertebrae; b) Rib removing, to improve visualization, and harvesting the bone to function later as an autograft; c) Using selective left intubation, opening the right pleura and gentle anterior lung retraction; d) Incising the parietal pleura to expose the vertebrae and disks and ligate segmental vessels.

In Clinical Case 2, a left lumbotomy was used, in a left lateral decubitus position: a) Incision centered at the L1 vertebra, one level above and one level below; b) Incising the external oblique, internal oblique and transverses muscles; c) Excising the distal 5 cm of the 12<sup>th</sup> vertebra to access the retroperitoneal space; d) Incising the transversal fascia, exposing and posteriorly retracting the psoas muscle; e) Exposing the above and below disk spaces and ligate segmental vessels anterior to the disks and vertebral body; f) Continuing posteriorly to the pedicles, avoiding vessel injury at the neural foramina; g) Going anteriorly, dissecting the fractured and the adjacent vertebrae, to the level of the anterior longitudinal ligament (ALL), avoiding great vessel injury, as well as isolating and protecting the sympathetic chain.

### Results

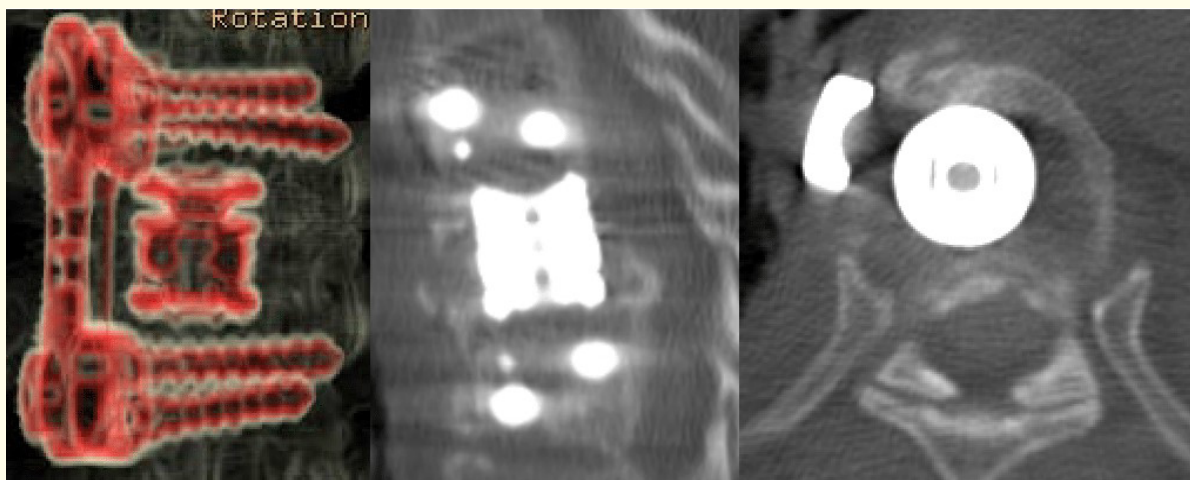
#### Clinical Case 1

46 year-old female, referred to the Vertebral Trauma Unit (VTU) because of a T5 collapsed fracture. She had had a fall from her height 6 months before, from which resulted a Denis two-column, AO:A3, T5 fracture. The PLC was apparently intact. She was ASIA E and conservatively treated with a *Jewet* orthosis. There was poor treatment compliance and, at 8 weeks of follow-up, there were neurological deficits (ASIA C), as well as deterioration of the fracture pattern, with 30 % of loss of height, 18° of kyphotic deformity and 55% of spinal canal invasion.



**Figures 1 and 2:** Preoperative CT scan images: a collapsed, non-acute D5 fracture can be seen.

Surgical treatment was then decided, through a right-sided thoracotomy. After completing the discectomies, T5 corpectomy was performed, using a burr and *Kerrison* rongeurs, followed by a T4-T6 inter-somatic arthrodesis with interposition of a titanium expandable cage. The bone particles collected from the rib and the vertebra were harvested, the autograft loaded into the expandable cage and inserted into its position, between the two adjacent endplates. The final step was fixation of the construct with a right locking plate (T4-T6). An hypertensive pneumothorax occurred as an intra-operative complication, but was solved without repercussion on the final outcome.



**Figures 3, 4 and 5:** Postoperative images: CT reconstruction; CT coronal and CT axial.

During follow-up, neurologic improvement was verified, and at 5 years of follow-up, she was ASIA D classified. Height loss was reduced to 10%, kyphotic deformity to 8° and spinal canal invasion to 25%. There was no reduction loss neither cage displacement nor subsidence.

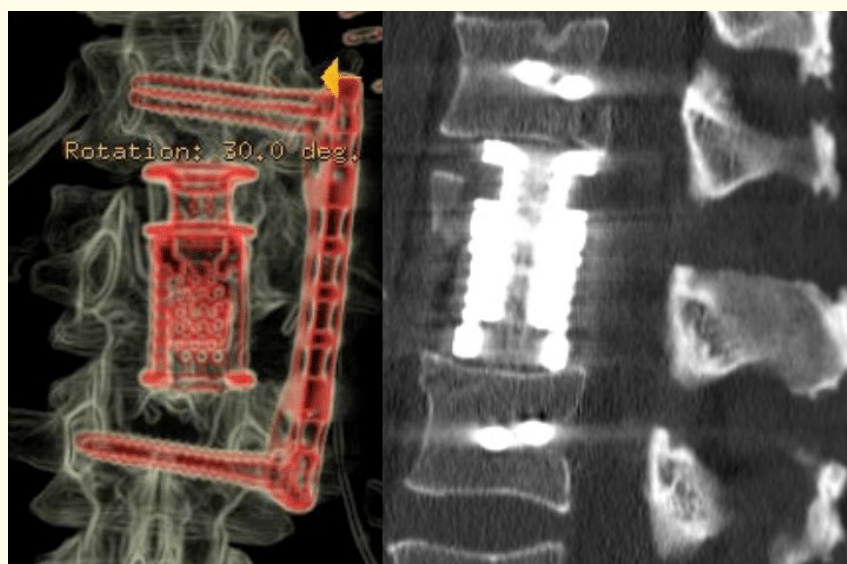
**Clinical Case 2**

61 year-old male, truck driver, admitted at the Emergency Department after a frontal collision with a tree. He was diagnosed with a comminuted, Denis three-column, AO:A4, L1 fracture. The PLC was assumed ruptured. There was serious neurological affection, ASIA A, 15% vertebral height loss, 16° of kyphotic deformity and 95% of spinal canal invasion.



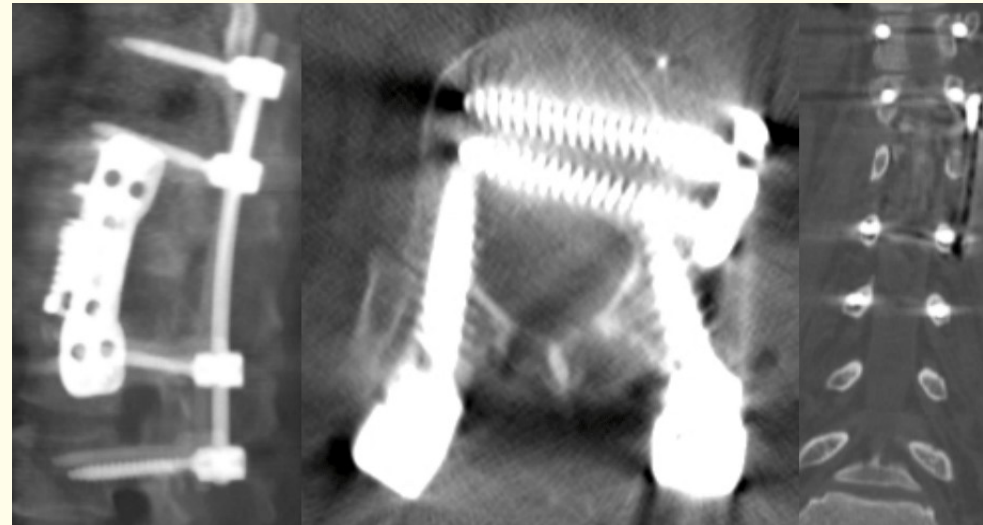
**Figures 6, 7 and 8:** Sagittal, axial and coronal CT scan views of a comminuted L1 burst fracture.

The treatment consisted of a two-stage surgical program. Firstly, through a left lumbotomy: after completing the discectomies, L1 corpectomy was performed, using a burr and Kerrison rongeurs; next, T12-L2 inter-somatic arthrodesis was done, with interposition of a titanium expandable cage and autograft. The bone particles collected from the rib and the vertebra were harvested and loaded into the expandable cage. The latter was inserted into its position, between the two adjacent endplates. The anterior part of the construct was then fixed with a left locking plate.



**Figures 9 and 10:** Reconstruction coronal and sagittal CT scan post-operative views, after the first stage of the surgical programme.

In the second stage of the surgical program, a posterior fusion (T11-L3) was performed.



Figures 11, 12 and 13: Postoperative (second-stage surgery) CT scan views, showing lateral and posterior fixations and the correction achieved.

Postoperatively, it was verified a regain of the vertebral height, no kyphotic deformity, and 15% residual spinal canal invasion. The clinical improvement was only discrete, as an ASIA B, at the end of the 3-year follow-up period. Comparatively, the last images obtained overlap the first post-operative ones.

	Denis classification	AO classification	PLC integrity	Surgical Procedure	ASIA classification		Vertebral height loss (%)		Kyphotic deformity (°)		Spinal Canal invasion (%)		Intra-operative complications	Mid-term/Late complications	Follow-up period (years)
					PRE	POST	PRE	POST	PRE	POST	PRE	POST			
<b>Case 1 (T5)</b>	2 column	AO: A3	YES	- Anterior corpectomy with expandable cage - Lateral locking plate	C	D	30	10	18	8	55	25	Hypertensive pneumothorax (no effect on outcome)	None	5
<b>Case 2 (L1)</b>	3 column	AO: A4	NO	360° - Anterior corpectomy with expandable cage - Lateral locking plate - Posterior long segment fusion	A	B	15	0	16	0	95	15	None	None	3

Table 1: Case 1 and 2 characterization.

### Discussion

Both patients presented with neurologic deficits. It was verified that in these two cases, the anterior approach granted direct decompression of the spinal cord in the acute setting and was associated with neurologic improvement, leading to sagittal alignment enhancement, with a low complication rate [5]. Furthermore, as there is a 80%-85% distribution of the axial forces through the anterior column, this intensifies the importance of addressing it to ensure the reestablishment of spinal biomechanics [1]. The use of expandable cages yielded immediate weight bearing and the rebuilding of the anterior column through a stronger architecture [6]. Regarding postoperative complications, there were no cases of hardware failure, nor cage subsidence. The use of autograft, harvested from ribs and corpectomy fragments, functioned as a low-morbidity means of achieving fusion [7]. The lateral locking plate added stability to the construct. Further stability was accomplished in Clinical Case 2, through a circumferential (360°), staged, reconstruction [8]: anterior corpectomy of L1 with an expandable cage placement, followed by transpedicular posterior instrumentation. The 360° approach originated a static construct with less mobility but, theoretically, may reduce subsidence and kyphotic recurrence [9].

### Conclusion

Anterior corpectomy with expandable cage interposition and autograft, and locking plate fixation proved to function as a stable construct, resulting in an effective treatment for these two patients diagnosed with thoracolumbar fractures [10]. In the second patient, with ruptured PLC, stability was further increase through a combined procedure, with posterior transpedicular instrumentation [11]. We believe that, in this particular cases, it wouldn't have been possible to achieve the above mentioned results using a single posterior approach with ligamentotaxis, proven the lack of posterior integrity with retropulsed comminuted fragments. Laminectomy would have further unstabilized the already compromised sagittal balance.

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