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# Acute and hyper-acute thoracolumbar corpectomy for traumatic burst fractures using a mini-open lateral approach

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**Study Design**

Retrospective chart review.

**Objective**

The study purpose was to examine the feasibility of acute (<24 hours) and hyper-acute (<8 hours) treatment of thoracolumbar burst fractures to maintain or improve spinal injury scores.

**Summary of Background Data**

Historically, treatment of spinal burst fractures within 24 hours from injury was considered an "acute" treatment timeframe. Patient polytrauma triage, multiple surgical specialty and hospital resource coordination affect time to treatment. The mini-open lateral approach for thoracolumbar corpectomy obviates the need for an approach surgeon which may allow for early surgical intervention.

**Methods**

Sixteen patients treated within 24 hours with a mini-open lateral corpectomy for traumatic spinal pathology were reviewed for preoperative, perioperative, and postoperative data. Neurologic status was assessed using ASIA scores. Fractures occurred primarily from L1 to L3. Wide-footprint expandable titanium devices were used in 75% of patients. All patients received supplemental fixation.

**Results**

Average time from injury to admission to the hospital (ER) was 1.8 hours, with an average time from the ER to operating room (OR) of 8.2 hours and an average OR time of 2.7 hours. Eight patients required ≤8 hours from injury event to surgical initiation while 7 were completed between 8 and 24 hours (one patient with incomplete surgical timing record). Blood loss averaged 646 mL without intraoperative complication. One perioperative complication occurred and one patient developed an asymptomatic inferior vertebral body fracture. Length of hospital stay averaged 6 days. At last follow-up, nearly all patients

experienced full or near complete neurologic recovery with at least one ASIA grade improvement seen in 73% and 20% of patients improving two grades or more.

**Conclusions**

These results suggest that mini-open lateral approaches allow immediate decompression through hyper-acute (<8 hours) treatment of spinal burst fractures in eligible patients. Additionally, low perioperative and postoperative morbidity allow for hastened recovery.

**Key Words:** Thoracolumbar spine burst fractures, acute treatment, minimally invasive lateral corpectomy, XLIF, ASIA scores, outcomes, complications

**Level of Evidence:** 4

## Introduction

The treatment of acute fractures of the thoracolumbar spinal column requires careful consideration of fracture instability, integrity of the posterior ligamentous complex, polytrauma, and spinal cord injury.[1,2] Methods of surgical treatment may involve anterior, posterior, lateral, or combined procedures with various instrumentation types (anterolateral and/or posterior) through a variety of surgical exposures (i.e., endoscopic, open, mini-open).[3-6] The mini-open lateral approach allows for direct visualization of the pathology through a small incision exposure (typically 4-6 cm) with fewer complications and substantially less procedural morbidity than conventional thoracotomy without the need for an access surgeon.[2,7,8] The mini-open lateral technique and resultant outcomes in treating thoracolumbar fractures and tumors have been previously described.[2,8-13] While this treatment strategy has been shown to successfully treat thoracolumbar burst fractures, early decompression and stabilization when utilizing this technique on outcomes and complications is heretofore unreported.

The timing of surgical intervention remains of interest to understand how to improve, or at least maintain, neurological status following traumatic injuries. Early surgical intervention can provide these desired clinical needs and may also allow for the recovery of the neural anatomy. Harrop et al found that damage to the white matter is reversible within 72 hours of injury.[14] In fact, neural decompression within 8 hours of injury may have benefits of neuroprotection and reversal of symptoms as demonstrated in animal models and some Class II and Class III human studies.[15-23] Considering the technical advantages and effective utilization of the mini-open lateral approach to surgically treat thoracolumbar burst fractures, the purpose of this study was to examine the feasibility of acute (<24 hours) and hyper-acute (<8 hours) treatment of thoracolumbar burst fractures to maintain or improve spinal injury scores.

**Methods**

An institutional review board (IRB) approved retrospective chart review was performed at a Level 1 trauma center on patients admitted and treated with a mini-open lateral corpectomy within 24 hours for a thoracolumbar burst fracture. Sixteen patients had evaluable preoperative and perioperative data while one patient was lost to postoperative follow up. Data collection included baseline patient demographics, injury/operative timelines, operative and perioperative data (i.e., estimated blood loss, length of stay), complication information, and neurologic status (American Spinal Injury Association (ASIA) scores) at pre- and post-op time points. In evaluating the timing of events and interventions, the calculation for time of injury to end of surgery was separated into increments including the time from injury to emergency room (ER) admission, ER admission to the start of surgery, and time in the operating room to form the total aggregate timing from injury to end of surgery.

Mean patient age at the time of treatment was 32 years (range: 19 – 69 years), 81% were male, and the mean body mass index (BMI) was 24. Four patients acknowledged tobacco use while three patients admitted to illicit drug use. Two patients reported coronary artery disease at baseline. Patients presented with the following ASIA scores of A (6), C (4), D (5) and E (1). There were 19 total levels treated with the most commonly treated levels being L1 (n=7 levels), L2, (n=3 levels) and L3 (n=4 levels) with the highest level treated being T4 (Figure 1).

Of these 16 patients, 12 were treated with an expandable titanium corpectomy cage (X-Core®, NuVasive Inc.) with conforming rectangular endplate features while four were treated with an expandable cylindrical cage. Each cage was then supplemented with internal fixation in the form of an anterolateral plate alone (n=13), pedicle screw and rod fixation

alone (n=1), or a combination of both (n=2). Autograft (local bone) was used in all cases. Descriptive statistics were used to characterize all variables for the cohort examined.

*Surgical Technique*

The mini-open lateral approach technique for thoracolumbar corpectomy has been previously described[2] but, in summary, includes placement of the patient in a true lateral decubitus position using fluoroscopic assistance to identify the appropriate level and mark the entry site for 90° off-midline access. The surgical technique is similar to the extreme lateral interbody fusion (XLIF®, NuVasive, Inc.) technique previously described.[24] In the thoracic spine, the mini-open lateral corpectomy can be performed using either a trans- or retro-pleural technique,[25] while the thoracolumbar junction allows for a trans- or retro-pleural approach if supradiaphragmatic, and a retroperitoneal approach if subdiagphramatic or in performing a lumbar corpectomy. Regardless of the area of the spine being treated, once the initial access has been performed, sequential dilators are introduced and a table-mounted split-blade retractor (MaXcess®, NuVasive, Inc.) is placed for direct visualization of the fracture. Standard surgical techniques and instruments are used for corpectomy and decompression. Vertebral body replacement (VBR) is performed using an expandable titanium VBR device and supplemental internal fixation is applied at the discretion of the treating surgeon. Lumbar closure is performed using the standard technique. In the thoracic spine and at the thoracolumbar junction, a retropleural approach allows for the patient to recover without a chest tube.

**Results**

The average total time from injury to completion of surgery was 12.7 hours with time from injury to ER, time from ER to OR, and OR time being 1.8 hours, 8.2 hours, and 2.7 hours, respectively (Figure 2). Eight (50%) patients were treated within eight hours of injury, with surgery initiation between eight and 24 hours in the remaining seven patients (one

patient with incomplete timing record). Mean total estimated blood loss from the entire surgery (including fixation) was 646±429 mL with no intraoperative complications observed. The postoperative length of hospital stay averaged 6 days (range: 1-17 days).

Following an average of 8.6 months follow up, 15 of 16 patients were available for neurologic status assessment (one patient lost to follow up). Of the 15 available patients, 11 (73%) demonstrated an improvement of at least one ASIA grade level from baseline. Of these patients, two patients that were surgically treated in less than 8 hours demonstrated improvements of two or three ASIA grades (there was one other patient with a two-grade improvement that had an incomplete timing record). Eleven (73%) patients were either completely (E) or nearly (D) neurologically intact at last follow up. No neurologic deteriorations were observed.

One patient experienced a pleural effusion in the perioperative period which was treated with a chest tube and resolved without sequelae. Another patient who was treated with a standard cylindrical endplate cage developed an asymptomatic inferior vertebral body compression fracture postoperatively. This vertebral compression fracture was treated conservatively with no subsequent consequential symptoms.

*Case Reports*

Case 1: A 21-year-old Airman (United States Air Force) was admitted to the ER with a burst fracture of the 1$^{st}$ lumbar vertebrae following a motor vehicle accident (Figures 3a-c) with an ASIA grade of C (incomplete motor and sensory injury). The length of time from injury to the initiation of surgery was 4.8 hours. The patient was treated with a corpectomy utilizing an expandable cage at the affected level with supplemental anterior fixation and the patient was graded as ASIA D at two months postoperative (Figures 4a & b). The kyphosis for this patient preoperatively was 20° which was corrected to 1° postoperatively as calculated by NuVaMap® (NuVasive, Inc.) radiographic analysis software.

Case 2: A 19-year-old male was injured while snowboarding and was admitted to the ER with a burst fracture of the 1st lumbar vertebrae with retropulsion of the vertebral body into the spinal canal (Figures 5a-c). The patient demonstrated incomplete motor and sensory deficits and was graded as ASIA C. The timing from injury to the initiation of surgery was 14 hours. The patient was treated with a corpectomy at the affected level including an expandable cage and anterior fixation. The patient was graded as ASIA E and returned to full activities (lacrosse and normal recreation) by 12 months postoperative (Figures 6a & b). The kyphosis for this patient preoperatively was 21° which was corrected to 5° postoperatively.

**Discussion**

Traumatic fractures of the thoracolumbar spinal column must be evaluated across a spectrum of clinical considerations such as fracture/ligament instability and potential spinal cord injury.[1,2] For those patients deemed appropriate for surgical intervention, studies have shown that early treatment can have beneficial outcomes and potential reversal of symptoms.[15-23] Gertzbein in 1992 published a multi-center series of 1,019 spinal fractures from the Scoliosis Research Society reporting that patients with surgical intervention demonstrated greater neurologic improvement than those treated conservatively and that anterior procedures allowed for better canal decompression compared to posterior techniques.[6] However, the timing of surgical intervention was not clearly defined. With regards to the timing of surgery, a few small case series have reported a reduced morbidity/mortality and neurological improvement for patients treated with early intervention.[26,27] In more recent studies, one a prospective study and the other a treatment guideline based on the literature, those authors have concluded that early intervention for burst fractures or spinal cord injuries was beneficial in reducing hospital length of stay, wound and pulmonary complications and demonstrated a greater likelihood of neurological improvement than those patients taken to surgery after 24 hours.[28,29]

Time-limiting factors in early surgical intervention involve the potential need for an access surgeon and the allocation of facility resources. Recent reports on the feasibility and success of treating thoracolumbar burst fractures and tumors via the lateral mini-open approach may provide a new, valuable technique for treatment of patients in an acute setting obviating the need for an access surgeon or multiple resources.[2,9,12,25] For these reasons, the purpose of this study was to evaluate patients being surgically treated via a mini-open lateral approach for thoracolumbar burst fractures in hyper-acute (<8 hours) and acute (8 – 24 hours) time frames.

The current study reported on 16 patients with thoracolumbar fractures that were treated surgically within 8 hours of injury and those that were treated within 8 to 24 hours of injury. Fifteen patients were available for last follow up with 73% reporting an improvement of at least one ASIA score and the same percentage achieving a final ASIA score of E or D, without evidence of neurologic deterioration in any patient. The complications associated with the mini-open lateral approach were a pleural effusion that resolved with placement of a chest tube and an asymptomatic inferior endplate fracture which was treated conservatively. Considering the improvements in ASIA scores, the subjective improvement in sagittal alignment, and the limited complications in the postoperative course for these patients, the acute and hyper-acute intervention for thoracolumbar fractures via the mini-open lateral approach seems an attractive surgical option compared to traditional thoracotomy or posterior approaches.

While not within the scope of the current study, one must also consider the financial costs/benefits of early intervention for treatment of thoracolumbar fractures. In a retrospective study by Boakye et al, the authors examined patients treated in less than 72 hours of injury to those treated later and found lower in-hospital complications and shorter length of stay for patients treated early while there was an increase of nearly $40,000 for in-

hospital costs associated with patients receiving late fixation.[30] Croce et al reported on a case series of 291 spine fractures, with 122 thoracolumbar cases treated within 72 hours and 133 thoracolumbar cases treated after 72 hours.[31] These patients treated early had a lower incidence of pneumonia, fewer ventilator days, shorter intensive care unit (ICU) stays and earlier mobilization leading to lower hospital costs. Kerwin et al reported on hospital resources for patients receiving early or late fixation for thoracic fractures and found fewer complications with lower hospital resource requirements with the group treated within 72 hours.[32] A prospective, randomized study evaluating patients with thoracolumbar fractures treated with surgery within 8 hours versus patients having surgery between 3-15 days after injury found that patients with early surgery had decreased hospitalization time, lower complication rates and demonstrated improved neurological outcomes than those having surgery 72 hours or later after injury.[22] The literature supports early intervention (within 72 hours) for thoracolumbar fractures and acute or hyper-acute treatment may have additional benefits. Data from the current study validate the results from previous studies on early intervention and provide support for acute or hyper-acute intervention via the mini-open lateral approach for thoracolumbar fractures as it limits or eliminates complicated hospital resource allocation.[32] The 73% improvement in ASIA scores and 73% of patients achieving ASIA scores of D or E from the current study provide further evidence for this conclusion.

While these results are promising, one must also acknowledge that this is a retrospective review of a limited, non-randomized case series involving a surgeon and team already trained with this technique/approach at a Level 1 trauma center. In addition, the samples sizes for groups treated within 8 hours of injury or between 8 and 24 hours of injury were too limited to make definitive comparisons. The selection of patients for surgery in hyperacute and acute time settings may have had non-intentional selection bias based on the severity of the patient's trauma and the ability to take the patient to the operating room.

While several patients did have more severe ASIA scores of A or B, an isolated thoracolumbar fracture or limited polytrauma may have been contributing factors in the positive response found when performing early surgery for these fractures. The improvements seen with early surgery for these fractures must also be carefully considered as there was no control arm to this study. However, the results of the current study are supported by previous reports that examined clinical improvements from baseline to post-operative follow up between groups treated early versus late. Thus, while the authors acknowledge the limitation of no control arm, the authors feel that current results and the conclusions drawn from them are supported by these previous studies. It should also be understood that the surgical technique does not involve the complexity associated with other approaches where an access surgeon may be involved or, at a minimum, be available to assist. Thus, some direct comparisons to other studies where an access surgeon may or may not have been utilized should be carefully considered. It is clear that the results of the current study warrant expansion to include a greater number of patients with longer follow up. In addition, the immediate and long term cost savings from the benefits of emergent surgery for these patients suffering from thoracolumbar burst fractures when utilizing the minimally invasive lateral approach is also potentially significant information.

In conclusion, acute or hyper-acute surgical intervention utilizing an extreme lateral mini-open approach to the spine with treatment utilizing an expandable corpectomy cage with supplemental fixation appears to be a viable technique for patients with thoracolumbar burst fractures.



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**Figure legends**

**Figure 1**: Distribution of the number of instrumented levels.

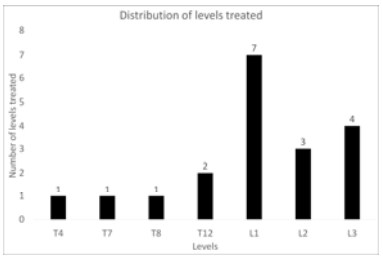
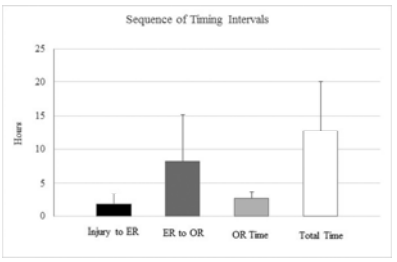
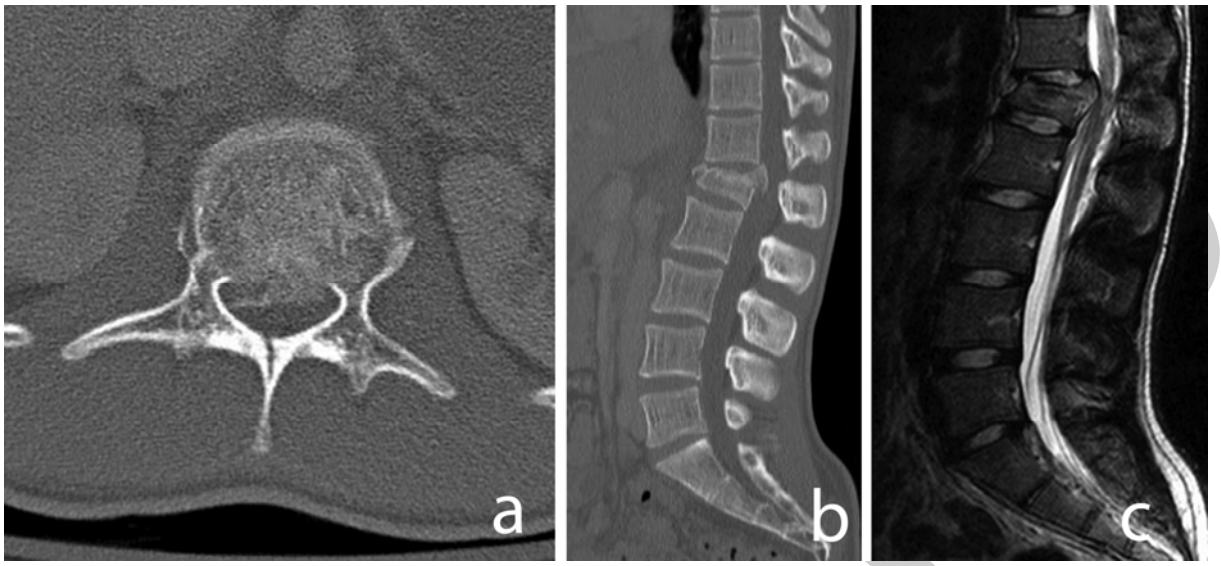


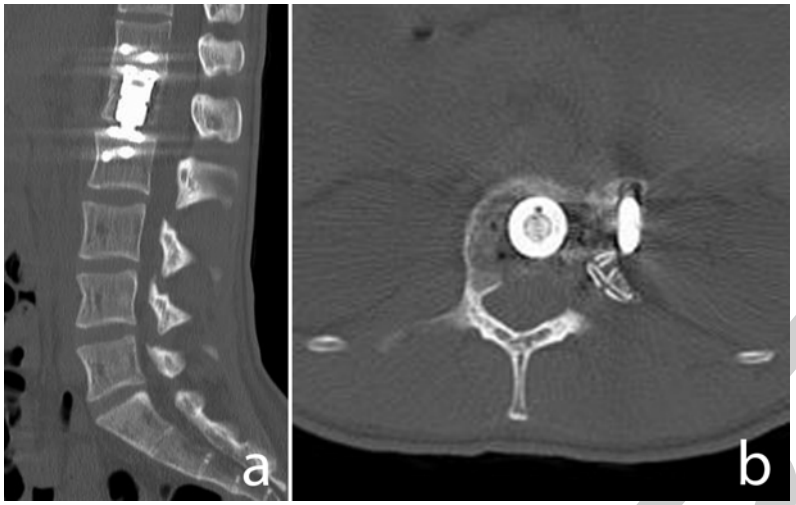
**Figure 2:** Sequence of timing presentation and treatment intervals.



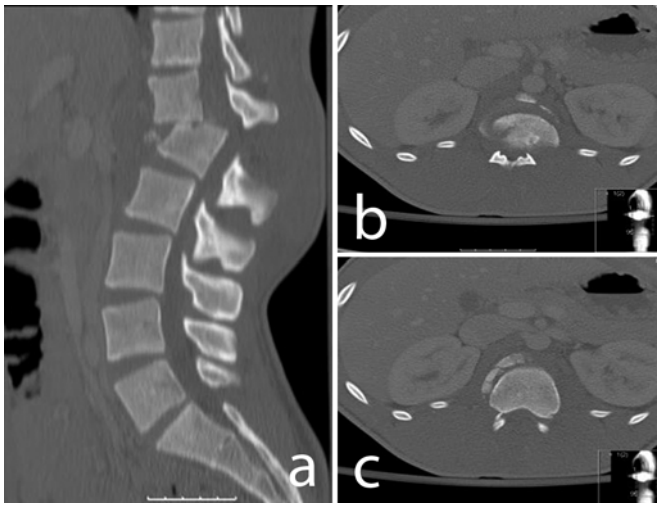
**Figures 3a-c:** Imaging of 21-year-old male patient demonstrating an L1 burst fracture on both CT and MRI with vertebral body fragmentation and retropulsion into the spinal canal.



**Figures 4a & b:** Postoperative computed tomography scan showing improvement in focal alignment and decompression of the spinal canal with a wide-footprint expandable cage and anterolateral plating.



**Figures 5a-c:** Computed tomography scan demonstrating an L1 burst fracture with anterior fragmentation and retrolisthesis of the vertebral body into the spinal canal.



**Figures 6a & b:** Imaging demonstrating decompression of the spinal canal and solid fixation with sagittal alignment of the thoracolumbar spine following placement of a wide-footprint expandable vertebral body replacement device and anterolateral plating.