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## CASE REPORT

# Posterior surgical approach and stabilization procedure with “free-hand” technique in a 17-year-old patient with burst type fracture of the L1 vertebra and incomplete spinal cord injury (ASIA Impairment Scale C)

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## Abstract

Burst type fracture is commonly involved in the thoracolumbar spine, causing a spinal cord injury (SCI). This case represents a 17-year-old female patient presents with a complaint of cannot move both legs and experience a shearing-like pain in the low back. Five days prior, she fell from a 4-meter height abyss, and after that, she cannot move her both legs. On the physical examination, both lower extremities muscles are paralyzed, decreased in pain and temperature sensation in both lower extremities, preserved sacral function, and the neurological level of injury (NLI) is located on the L1 vertebra. The American Spinal Injury Association (ASIA) impairment scale is C. The plain X-ray and computed tomography (CT) scan of the thoracolumbar spine show compression of the L1 vertebra and narrowing of the spinal canal caused by retropulsion bone fragment. We treated the patient with laminectomy decompression and posterior stabilization with pedicle screw and rod instrumentation, which is done without the use of a C-arm and performed with a free-hand technique using the anatomical landmark. No complication found with this procedure. After periodically follow up, the neurological examinations, both the motoric and sensory function, are improved.

**Keywords:** *burst fracture, laminectomy decompression, posterior stabilization, spinal cord injury*

## Introduction

Burst type fracture is a type of fracture disrupting the anterior and middle column of the spine and account for 14% and 17% of all spinal injuries.<sup>1,2</sup> The thoracolumbar spine is the common side of injury in this type of fracture.<sup>1-3</sup> Due to causing an unstable spine, this fracture commonly caused damage to the spinal cord, causing an incomplete or complete SCI. As many as 86 patients from a total of 105 patients with burst type fractures will present with neurological deficits.<sup>4</sup> This fracture can be managed based on the stability of the segment involved. Laminectomy decompression and posterior stabilization are some of the most common surgical procedures. However, other approaches like anterior or combined approach can also be used based on considering the fracture



type, side effect, and complications of each procedure. Formerly, surgeons used the free-hand technique and anatomical landmark during the insertion of the posterior instrumentation with a rod and pedicle screw. Nowadays, with the help of C-arm, the surgeons can do this type of procedure more easily especially in developed countries.

In this case, we present a burst type fracture of L1 vertebra patient with an incomplete SCI which was treated with laminectomy decompression and posterior stabilization. Because there is no C-arm facility in East Nusa Tenggara, the surgeon performed a free-hand technique for the stabilization procedure. We used a pedicle screw and rod instrumentation in this procedure.

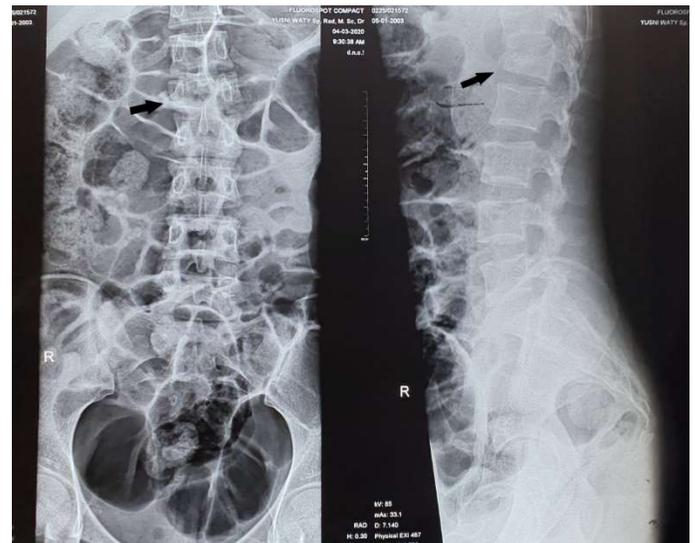
## Case report

A 17-year-old female patient came to the emergency unit with a primary complaint of unable to move both of her legs. She couldn't sit, stand, walk, or even move her body when she laid down due to the pain over the low back that was triggered when she move. The pain characteristic was a shearing-like pain and didn't spread to another region besides the low back. She could feel normal sensation on both of her legs and still have preserved function on defecation and urination. Five days prior, she fell from 4-meter height abyss and landed in a sitting position. Suddenly after that, she developed a weakness in both of her legs that worsen until she cannot move at all on day three after the injury. After the injury, she came home to get total bed rest and consumed over the counter (OTC) pain medication to improve the pain. She went to the hospital five days after the initial injury because the symptoms didn't improve at all.

The patient's Visual Analog Scale (VAS) is six. The neurological examination was taken according to International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI) diagram worksheet from the American Spinal Injury Association (ASIA) and International Spinal Cord Society (ISCoS) as references. There is an increased pain on palpation in the back, but no deformity found in the back when the patient is log rolled. We performed a motoric and sensory examination to look for abnormalities on the upper and lower extremity, respectively. The motoric examination revealed that each of both lower extremities muscle groups that consist of hip flexors, knee extensors, dorsal ankle flexors, long toe extensors, and ankle plantar flexors function grade is 1. There is a decreased pinprick sensation in both L2 and S3 dermatome. There is no preserved sensation to pinprick from L3 to S2. We performed a warm and cold temperature test for both legs, and there is a decreased

sensation on the dermatome that innervated by L2 to S3. No abnormalities found on other sensory examinations. Rectal examination was performed, with the voluntary anal contraction, S4-S5 deep anal pressure, bulbocavernosus reflex, and sensory for pinprick and light touch sensation was still preserved. The bladder was not distended. Taken all the examination together, the neurological level of injury (NLI) in this patient is located in L1.

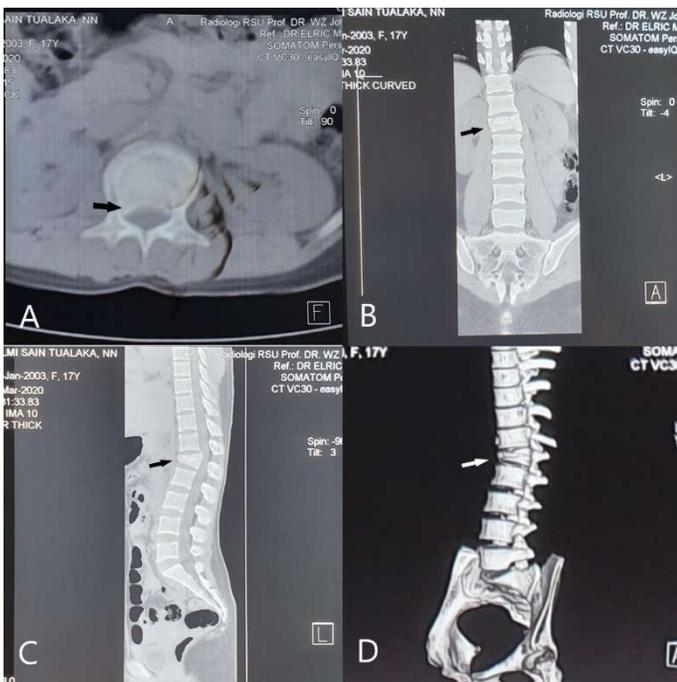
We did plain lumbar spine X-ray in anteroposterior (AP) and lateral view (Figure. 1); and then non-contrast computed tomography (CT) scan of the thoracolumbar region in axial view, sagittal view, coronal view, and 3D reconstruction (Figure. 2). The plain lumbar X-ray showed compression of the L1 vertebra. The CT scan showed a fracture on the L1 vertebra that disrupted the anterior and middle column, with disrupted integrity of the posterior column, which showed by the decreased anterior height <50% of the posterior height and slight increase in the interspinous distance. The bone fragment is displaced to the spinal canal, causing narrowing 30-40% of the canal diameter. We couldn't perform Magnetic resonance imaging (MRI) in this patient, as there is no any MRI facility in East Nusa Tenggara.



**Figure 1.** Plain lumbar spine X-ray in AP and lateral view showing the fractured L1 vertebra (black arrow).

After the complete history, physical examination, and supportive examination was obtained, the patient was diagnosed with burst type fracture of the L1 vertebra and incomplete spinal cord injury (ASIA C). The thoracolumbar injury classification and severity score (TLICS) is 7. Based on the TLICS system, the patient was a surgical candidate and, therefore, must be treated promptly. We advised the patient to take both medical and surgical management. The medical

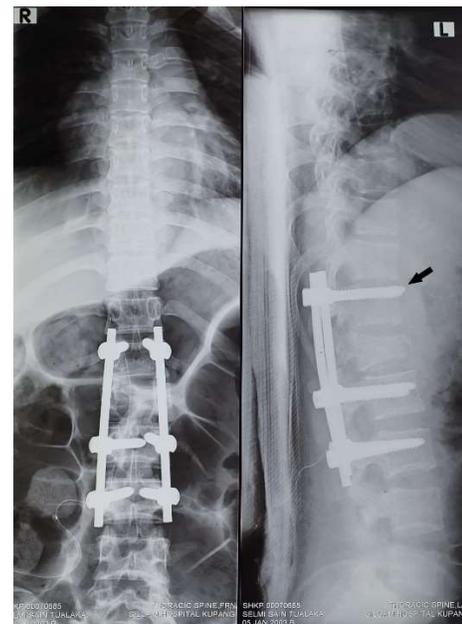
management was to keep the patient in inline position; 2 L/min O<sub>2</sub> with a nasal cannula; IVFD NaCl 0.9% 500ml for 24 hours; methylprednisolone 125mg IV three times daily, ceftriaxone 1gram IV twice daily; ranitidine 50mg IV twice daily; and ketorolac 30mg IV twice daily. We considered this patient to do laminectomy decompression and posterior stabilization instrumentations. Surgery in this patient aimed to correct the unstable L1 vertebra and release the pressure caused by compression of the spinal cord from retropulsion bone fragment in the spinal canal.



**Figure 2.** Non-contrast thoracolumbar CT scan showed a burst type fracture of L1 vertebra. **A.** Axial view, narrowing of the spinal canal by the bone fragment (black arrow); **B.** Coronal view, a fracture extend from the superior to the inferior endplate of the vertebral body (black arrow); **C.** Sagittal view, showing a decrease in height of the anterior vertebral body and retropulsion of the bone fragment into the spinal canal (black arrow); **D.** 3D reconstruction in anterolateral view of the fractured segment (white arrow).

The patient had the surgery in a prone position, and the skin midline incision was made. Laminectomy of the L1 vertebra is done with drilling off both the lamina and spinous process, removal of the flavum ligament, with sparing both capsule and facet joint. We inspected the anterior spinal cord and found the posterior longitudinal ligament bulge into the central canal because it pushed backward by the adjacent fractured vertebral body forward to it. The fractured vertebral body was left alone, and the next step was to perform the stabilization procedure using the pedicle screw and rod fixation instrumentation into

the T12 vertebra above the fracture site, also the L2 vertebra and L3 vertebra below. This procedure was done without a C-arm. We made a careful attempt to approximate the pedicle screw positioning into the vertebral body based on the visible and palpable anatomical landmark. Start from T12 vertebra, we performed the partial facetectomy of the one-third inferior-lateral part of the inferior articular process of the T11 vertebra and search for the entry site of the pedicle screw using the intersection between a horizontal line that divided the transverse process into half and a vertical line that extends along the lateral part of the pars interarticularis. After determining the site of the entry point, the pedicle screw is projected with the direction of medial-lateral and cranial-caudal angulation of 20° and 10°, respectively. The same technique is performed in the opposite. On the L2 and L3 vertebra, we performed the partial facetectomy and determine the entry site of the pedicle screw using the intersection between a vertical line that extends from the lateral side of the superior articular process and a horizontal line that bisects the transverse process. The projection of the pedicle screw in medial-lateral angulation is 0° and 5° in the L2 and L3 respectively, with the cranial-caudal angulation is 10° in both. Same insertion technique for the opposite sites. The length of each pedicle screws for T12, L2, and L3 are 40 mm (millimeter). The rod is inserted and secured in place with each of the pedicle screws. This procedure went for about 2 hours.



**Figure 3.** Postoperative plain thoracolumbar spine X-ray in AP and lateral view. The pedicle screw of the T12 vertebra penetrate the anterior column (black arrow)

Postoperatively, we did a plain AP and lateral view of the

thoracolumbar spine X-ray to looked for direction and position of the pedicle screw and rod instrumentation (Figure 3). The pedicle screws were attached right above the fracture site into the T12 vertebra and below into the L2 vertebra and L3 vertebra. The T12 vertebra pedicle screws were located slightly further around 1cm and penetrate the anterior column, including the anterior longitudinal ligament. No bleeding was found perioperative and postoperative in the aorta and inferior vena cava. On a postoperative day 7, the patient was pain-free, and the neurological status was improved, with the L2 to S1 muscle function grading improved to 2. No change in the sensory function. This patient took a rehabilitation program every week to improve muscle function and prevent contracture. One month later, the patient developed an improvement in the L2 to S1 muscle function grading to 3 and also in the pinprick sensory L3 to S1 with each dermatome improved to 1. No improvement in the temperature sensory function.

## Discussion

A burst fracture is commonly involved in the thoracolumbar junction.<sup>1-3</sup> It caused by a pure axial load that caused a compression of the vertebral body involved, resulting in anterior and middle column failure.<sup>5</sup> Some studies accounted for the incidence of burst fracture as 14% and 17% of all spinal injuries.<sup>1,2</sup> This type of fracture commonly causes a neurological deficit. A study reported by Mohanty *et al.*,<sup>4</sup> approximately 86 (82%) patients have developed a neurological deficit, with the remaining 19 (18%) had no deficit. Burst fracture could be stable or unstable, depends on the involved segment. This patient was classified as an unstable burst fracture, due to anterior, middle, and posterior column involvement, and the presence of neurological deficit. She had signs and symptoms that correspond to an anterior cord syndrome, based on the history, clinical, and supportive examination. This condition can be caused by retropulsion bone fragment into the spinal canal, causing occlusion of the anterior spinal artery or compression to the anterior cord. The prognosis is worst among other incomplete injuries, with only 10-20% will get a recovery in motor function.<sup>5</sup>

There was a doubt whether to use a surgical or conservative approach alone in this patient. We chose the surgical over the conservative approach because the fracture site was unstable showed by development of incomplete neurological injury, the anterior vertebral body height is <50% of the posterior height and a slight increase in the interspinous distance which was a sign of insufficient posterior ligament complex, and also the TLICS score was 7, considering that the patient must be treated surgically. In addition, we

chose the surgical approach to achieved significant pain relief and early mobilization.

Among the variety of surgical approach to treat burst fracture of the thoracolumbar junction, there is some surgical approach that commonly used, which is the anterior, posterior, or combined approach.<sup>6-11</sup> We preferred the posterior approach over the anterior or combined approach because of some consideration. First, it is more effective than the anterior approach based on reports by some studies. Xu GJ *et al.*,<sup>6</sup> reported that the posterior approach was associated with lower operation time, lower cost, and lower estimated blood loss compared to the anterior approach. It did not show significant differences in neurological status and complication rate. In another study reported by Han W *et al.*,<sup>7</sup> the posterior approach is more suitable especially for thoracolumbar burst fractures than the anterior approach because it produces a lower complication rate. Second, there is no significant difference between the posterior and combined approach in improving the neurological status. The surgical time and blood loss are significantly higher in the combined approach.<sup>8</sup> Mayer M *et al.*,<sup>9</sup> reports no significant impact of sagittal balance in longterm outcomes of patients who treated with a posterior and combined approach. A study by Opel PP *et al.*,<sup>10</sup> reported that the combined approach is commonly associated with more estimated blood loss, operation time, more expensive, and higher complications that require a re-operation. Third, it's more feasible to do the posterior approach than the anterior approach in this case, due to no anterior instrumentation such as anterior plate, interbody fusion instrumentation like allograft cadaver bone or titanium cage were available in East Nusa Tenggara, and the patient also refuses to take an implant procedure from her iliac crest as an autologous bone to facilitate the fusion.

The posterior approach procedure includes the laminectomy procedure and stabilization with pedicle screw and rod instrumentation. This approach is the most common technique performed in the thoracolumbar fractures.<sup>11</sup> Laminectomy decompression was done to decompress the spinal canal from the retropulsion vertebral bone. Some studies reported the success of this procedure.<sup>12,13</sup> The fixated vertebral segment in the stabilization procedure in which the pedicle screw and rod is attached includes the rostral and caudal vertebral from the involved segment.<sup>5</sup> The rostral part included the T12 vertebra, and the caudal part included the L2 vertebra and L3 vertebra. The caudal part was attached in 2 vertebral segments, which was the L2 vertebra and L3 vertebra. The rostral part only attached to the T12 vertebra. It is because that the caudal part does not have a supporting structure like rib in T12 vertebra, and it maintained most axial load from the body.

We inserted the pedicle screw into the pedicle and vertebral body with a blind free-hand technique based on the anatomical landmark parameters because of no C-arm available in East Nusa Tenggara. There are many studies reported the safety and accuracy of this technique.<sup>14-19</sup> Although this technique is considered safe to approach, there is some displacement of pedicle screw insertion reported. The overall missing rate for the lumbar spine is 21%, and the thoracic spine is 18.75%.<sup>20</sup> In a study reported by de Marco FA *et al.*,<sup>21</sup> pedicle screws misplacement were seen in 36.08% of cases, and most of them do not cause any risk to the spinal cord, nerve root, vascular structure, and visceral structures. Only 16.66% from the total of misplaced cases that the pedicle screws were perforated into the anterior side. We didn't find any vascular, visceral, nerve, and spinal cord injury in this patient perioperative and postoperatively.

Although these approaches were commonly used, some complications still may occur. It includes an instrumentation failure such as pedicle screws loosen, breaks, dislodges, or disconnected from the rod; pseudoarthrosis, CSF leakage, infection, wound breakdown, and bleeding. This patient had an improvement in the neurological function on both legs, which from the preoperative exam earlier, we found a profound deficit in the motoric and sensory function. The functional outcome in this patient is mainly based on the type of the SCI (trauma or non-trauma), the level and completeness of the initial neurological injury and the patient treated surgically or not.<sup>22-24</sup> More advance the SCI, more severe and less the ability to achieve functional independence.<sup>22,24</sup> Younger patients have a much better outcome than older patients.<sup>25</sup>

## Conclusion

Laminectomy decompression with posterior stabilization is one of the accepted procedures that indicated to treat thoracolumbar burst type fracture. This surgery was done without the use of a C-arm and performed with a free-hand technique using only the anatomical landmark. No complication is encountered perioperative and postoperatively. Further follow up is needed to look for long term outcomes and the occurrence of complications.

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