Surgical Management Thoracolumbar Fractures in Patients with Ankylosing Spondylitis: Technical Note with Case Series

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■ OBJECTIVE: **Ankylosing spondylitis (AS) is a chronic inflammatory joint disease. Complications such as traumatic spinal fractures are mostly caused by hyperextension and are unstable. We report the cases of 5 patients with AS surgically treated for thoracolumbar fractures.**

■ METHODS AND RESULTS: **We shared our experience of posterior stabilization surgery performed for the treatment of thoracolumbar fractures after traumas such as fall-accident in patients with AS. Patients were all men, and their ages were between 52 and 77 years. The first 3 patients woke up with neurologic deficits and were managed surgically under general anesthesia. We managed the last 2 patients with unilateral short-level stabilization under local anesthesia followed by bilateral long-level stabilization under general anesthesia. No neurologic deterioration was found in the postoperative examination of these 2 patients. We assume that the reason for neurologic deterioration after general anesthesia is the relaxation of muscles. All 3 columns of the spine are affected in patients with AS and the stability is provided by the tone of the muscles around the spine.**

■ CONCLUSIONS: **To prevent postoperative neurologic complications after the surgical treatment of traumatic hyperextension thoracic and lumbar fractures in patients with AS, we recommend securing the fracture level with unilateral short-level stabilization under local anesthesia and then completing the operation with general anesthesia.**

INTRODUCTION

Ankylosing spondylitis (AS) is an inflammatory rheumatic disease that causes pain, progressive stiffness, and deformity as a result of axial skeletal involvement.[1,2] The site of inflammation is where fibrous tissue attaches to bone, such as tendons and ligaments. Over time, ossification of tendons and ligaments begins with bone erosion, and the "bamboo spine" emerges.[3] Posterior elements such as facet joints, supraspinous and interspinous ligaments, and ligamentum flavum also ossify. This autofusion in the spine causes movement restriction and loss of elasticity. As a result, spinal biomechanics deteriorate. Patients with AS are more prone to spinal fractures because of osteoporosis and impaired biomechanical features. Even minor traumas, which may not cause fractures in a healthy population, lead to fractures in patients with AS.[2,4]

Patients with AS with surgical contraindications and simple A-type fractures may be treated conservatively (thoracolumbosacral orthosis or plaster jacket) for thoracolumbar fractures.[5] However, close observation for clinical worsening should be practiced. Unstable fractures are the candidate for instrumentation. Depending on the patient's situation and the different characteristics of the spinal fractures, 2 or 3 segments above and below the affected segment are typically chosen for instrumentation and fusion.[2,5,6] With solid fixation and a reduction in stress concentration in each segment, this technique can aid in fracture healing and functional recovery.

Compared with nonsurgical treatment, surgical treatment resulted in neurologic improvement and a lower overall complication rate at both short-term and long-term follow-ups.[7,8] Complications from fractures of the ankylosed spine can take many different forms. Significant mortality is linked to aortic dissection, aortic pseudoaneurysm, and tracheal or esophageal ruptures. Many infections and issues with wound healing,

Key words
- Ankylosing spondylitis
- Posterior stabilization surgery
- Thoracolumbar fractures
- Trauma

Abbreviations and acronyms
AS: Ankylosing spondylitis

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venous thrombosis and pulmonary embolism, pneumonia, and respiratory insufficiency are considered general consequences. However, compared with operational treatment, the overall morbidity and mortality in the nonoperative patient group are higher.[5]

In this study, we report the cases of 5 patients with AS surgically treated for thoracolumbar fractures. Although inappropriate transfer conditions and patient positioning were reported as risk factors for new fracture formation and secondary injury in patients with AS, we present case series of patients with AS who had iatrogenic worsening of neurologic functions and required surgical intervention for the first time. We also offered a new surgical strategy to avoid this secondary injury. Patient demographics, fracture level, injury mechanism, neurologic status, and treatment outcomes were recorded. Computed tomography imaging was graded according to the indicated AO Spine Injury Classification System.

CASE SERIES

Case 1

A 56-year-old man was admitted with a neurologic examination ASIA D result after falling from stairs. His bilateral lower extremity muscle strength was 4/5. An L3-S1 posterior stabilization and fusion were planned for the patient with L4-L5 extension-distraction (AO Spine type C N3 M2) injury. It was observed that the existing L4-L5 distraction increased in the fluoroscopy imaging after general anesthesia (**Figure 1**). We performed fluoroscopy to determine the vertebral level and check the position of the screws. A postoperative neurologic deterioration was detected (ASIA A). This patient was operated on under emergency conditions, and we were unable to use neuromonitoring.

Case 2

A 52-year-old man was admitted with a neurologic examination ASIA E after falling from a height. In his examinations, L2-L3 extension-distraction (AO type C N3 M3) injury was detected. At the initial stage of the surgery, we started with the lateral decubitus position and tried the anteflexion maneuver and achieved good spinal alignment.[9] However, the patient's blood pressure decreased suddenly and the spine was fixated with the traditional method. It was observed that the existing L2-L3 distraction increased in the fluoroscopy imaging after general anesthesia (**Figure 2**). This patient was operated on under neuromonitoring. The operation was terminated quickly when a signal change was detected on the neuromonitor during the operation. T11-S1 posterior stabilization and fusion surgery was performed. Postoperative neurologic deterioration was detected (ASIA A). As the proof of dislocation on his late postoperative MRI, it was observed that the L1 vertebral body was dislocated from the normal localization to the middle part of the L2 vertebral body. The T12 vertebral body was also slightly dislocated posteriorly. A 50% loss of height secondary to destruction was observed in the superior L2 vertebral body. The continuity of the posterior longitudinal ligament is preserved at the dislocation level, and there is loss of the anterior longitudinal ligament (**Figure 2F**).

Case 3

A 77-year-old man was admitted with a neurologic examination ASIA D result after falling from a height. His radiologic investigation showed a T11-T12 extension-distraction (AO type C) injury in his spine (**Figure 3**). This patient was operated on under neuromonitoring. The operation was terminated quickly when a signal change was detected on the neuromonitor during the operation. Postoperatively, neurologic deterioration was ascertained in this patient, who was treated with T8-L3 posterior stabilization and fusion surgery under general anesthesia (ASIA C).

Case 4

A 68-year-old man was admitted with a neurologic examination ASIA E result after a traffic accident. T10-11 extension-distraction

Figure 1. (**A**) Computed tomography image showing L4-L5 extension-distraction injury. (**B**) First fluoroscopy image during operation. (**C**) Preoperative distraction between L4-L5 was 23.3 mm and (**D**) postoperative distraction between L4-L5 was 28.1 mm on computed tomography.

Figure 2. (**A**) Computed tomography (CT) showing L2-L3 extension-distraction injury. (**B**, **C**) Preoperative magnetic resonance T1 and T2 imaging. (**D**) Preoperative distraction between L2-L3 was 15.1 mm on CT and (**E**) postoperative distraction between L4-L5 was 49 mm on CT. (**F**) Postoperative magnetic resonance imaging showing the distraction injury.

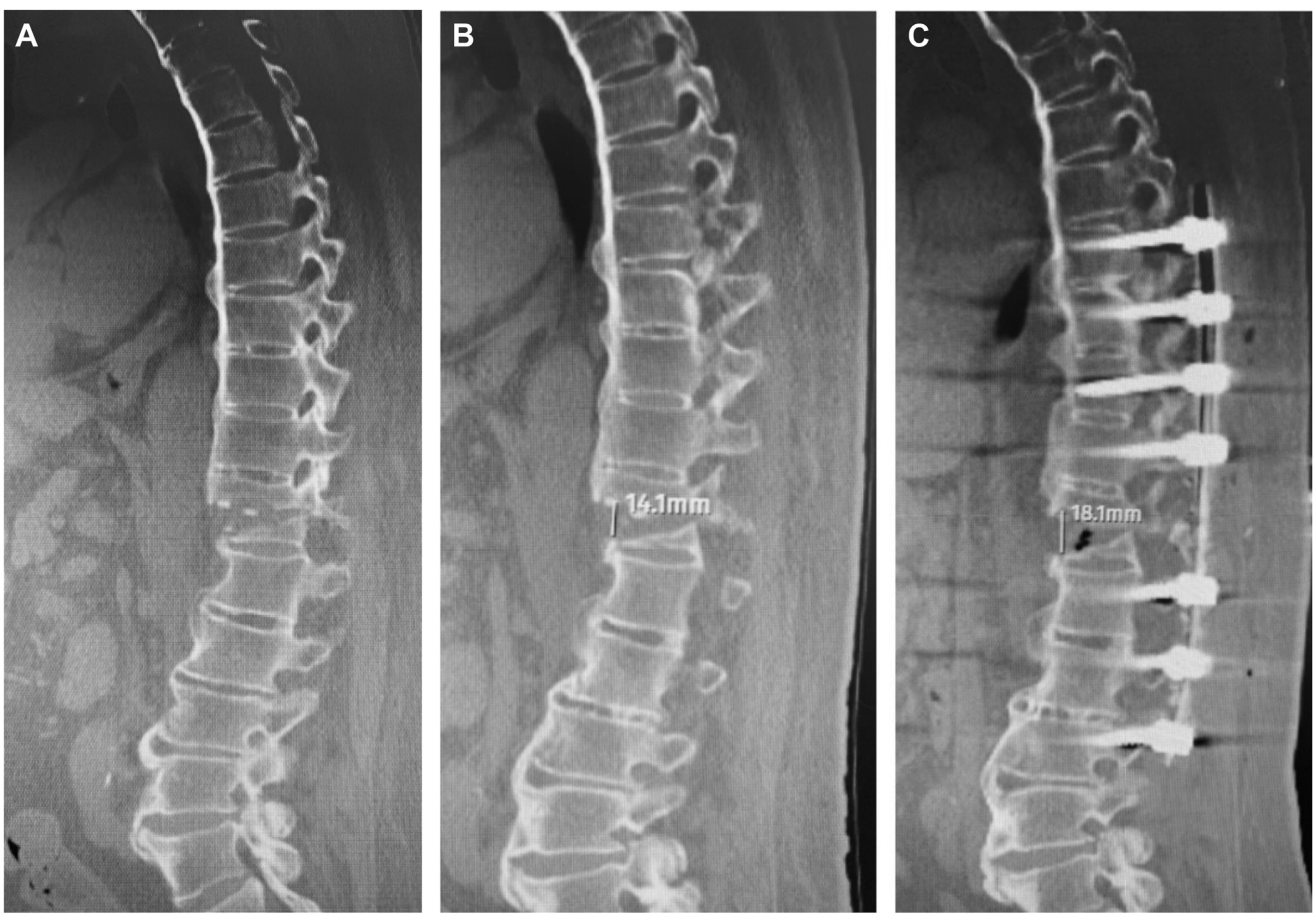

Figure 3. (**A**) Computed tomography showing T11-T12 extension-distraction injury. (**B**) Preoperative distraction between T11-T12 was 14.1 mm, and (**C**) postoperative distraction between T11-T12 was 18.1 mm on computed tomography.

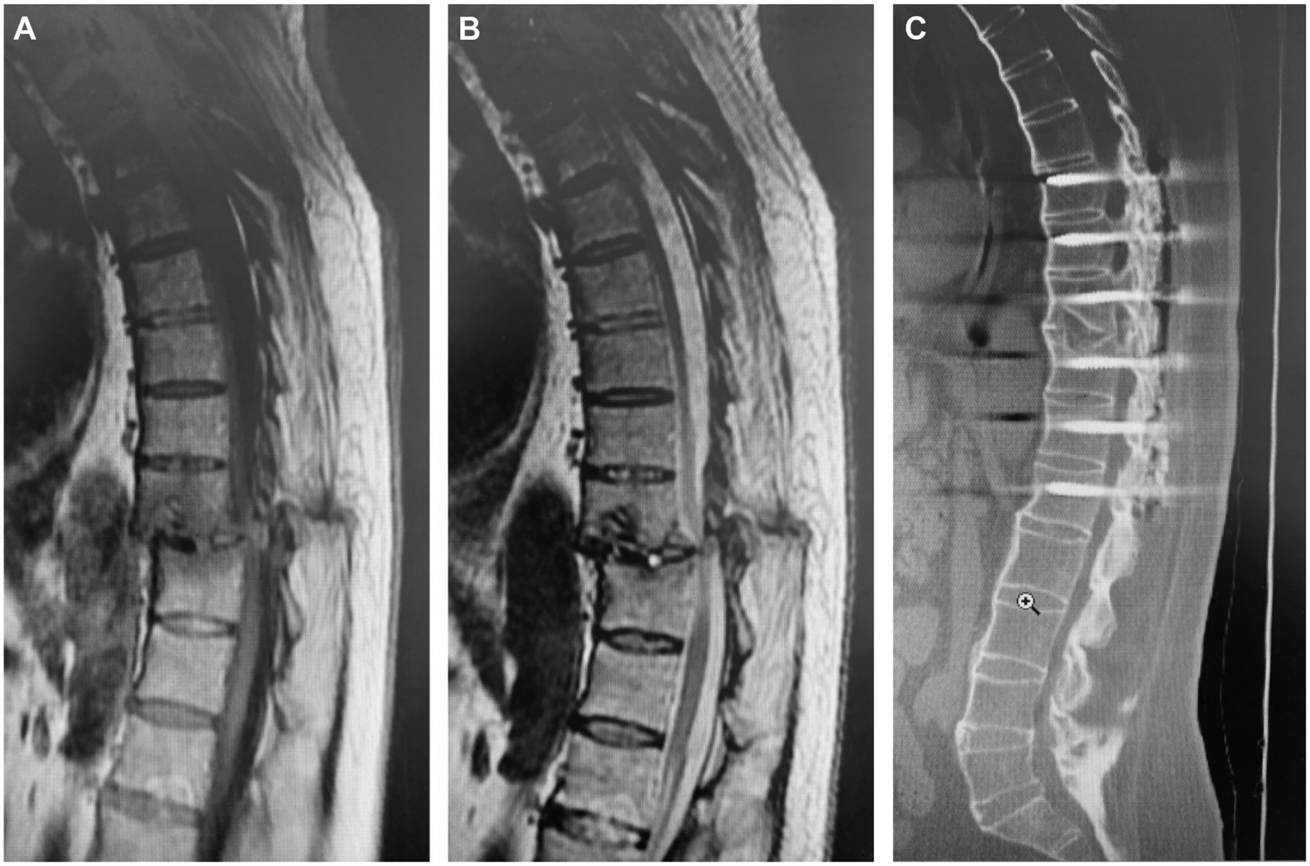

Figure 4. (**A, B**) T1 and T2 magnetic resonance imaging showing T10-T11 extension-distraction injury. (**C**) Computed tomography showing postoperative screw fixations and alignment of spine.

(AO type C) injury was detected in the radiologic examinations (**Figure 4**). Initially, a unilateral (left-side) short-level (T10-T11) stabilization was performed under local anesthesia (thoracolumbar compartment nerve block) to prevent increased distraction in the fracture area and possible neurologic deterioration. Afterward, T7-L2 posterior stabilization and fusion surgery was performed by induction of general anesthesia. There was no neurologic deterioration in the postoperative examination (ASIA E). This patient was also operated on under neuromonitoring without any pathologic signal change.

Case 5

A 67-year-old man was admitted with a neurologic examination ASIA E result after falling from a height. An L1-L2 extension-distraction (AO type B3) injury was detected in the radiologic examination (**Figure 5**). An initial unilateral (left-side) short-level (L1-L2) stabilization was performed under local anesthesia (thoracolumbar compartment nerve block) to prevent increased distraction in the fracture area and possible neurologic deterioration. Afterward, T7-L3 posterior stabilization and fusion surgery was performed under general anesthesia. There was no neurologic deterioration in the postoperative examination (ASIA E). This patient was also operated on under neuromonitoring without any pathologic signal change.

DISCUSSION

The purpose of this study is to share our experiences with surgical treatment of the spinal fractures of patients with AS. We observed neurologic deterioration after surgery in 3 of 5 patients who underwent surgical treatment for thoracolumbar spine fractures. In these patients, we applied a unilateral screw fixation system for the fracture level under local anesthesia and completed the operation under general anesthesia. This method stabilized the bamboo vertebra and avoided secondary injury caused by overpositioning of the patient after the muscle relaxation. The spinal and paraspinal muscles are the only support system for a fractured ankylosed spine. There was no neurologic deterioration in patients who were operated on with this technique. We were disappointed with the outcome of these 3 patients, and we propose a new method to avoid this catastrophic outcome. Reinhold et al.[5] reported that insufficient immobilization and patient transfers lead to secondary injury; patient positioning could lead to iatrogenic spinal fractures in patients with AS who require surgical intervention under

Figure 5. (**A**) Computed tomography showing L1-L2 extension-distraction injury. (**B**) Preoperative distraction between L1-L2 was 14.0 mm and (**C**) postoperative distraction between L1-L2 was 23.9 mm on computed tomography.

general anesthesia. This is the first report about patients with AS having additional neuronal injury caused by a lack of support systems under general anesthesia.

In AS, long-term inflammation causes pathologic ossification of the entire spine, resulting in kyphosis and loss of range of motion.[10] Patients with AS are more prone to falls.[11,12] The spine that has lost its flexibility because of AS cannot distribute the trauma energy to the surrounding soft tissues and acts like a long lever arm, creating an intense bending force. Trauma energy applied to the spine cannot be absorbed by flexible structures such as ligaments, discs, and facet joints.[2] Particularly in hyperextension injuries, secondary neurologic injuries have been reported as a result of the displacement of broken segments during transport.[13,14] In these cases, the neurologic deficit develops as a result of axial stretching of the spinal cord that occurs at a higher level than the injury level.

Because the spine segments on both the cranial and caudal sides of the fracture level act as a single rigid segment (long moment arms), the moment forces acting on the fracture level are high.[8] The ligamentous structures at the trauma level have already ossified and lost their flexibility because of AS. Bone and ossified ligamentous structures of all 3 columns were injured and separated by translational forces. Only myofascial structures remain that stabilize the spine. Spinal injuries lead to a higher rate of spinal cord injury and epidural hematoma in patients with AS.[15] It is challenging to obtain firm fixation if just 2 or 3 spinal segments are fixated.[2] Increased activity-induced stress on a single segment may result in the weakening, breaking, and dislocation of a stabilized system.

Vertebral pedicle screw fixation should be carried out in 3 segments above and below the damaged vertebral body for most patients with AS with spine fractures to achieve effective stabilization. Ye et al.[16] also reported that posterior percutaneous long-segment internal fixation would be an alternative to the traditional approach with the advantages of less trauma to spinal muscles, less blood loss, and less surgical time, with similar effectiveness. Bredin et al.[17] also proposed that percutaneous surgery in patients with AS with thoracolumbar fractures has a low complication rate and good healing results and preserved mobility. Trungu et al.[18] also reported that cement augmentation–aided percutaneous instrumentation has good clinic and radiologic outcomes for traumatic hyperextension thoracolumbar fractures in patients with AS.

In our first 3 patients, general anesthesia resulted in postoperative paraplegia, which was at higher level than the lesion because of stretching of the spinal cord. The spine segments on both the cranial and caudal sides of the fracture level acted as a single rigid segment, causing distraction at the fracture level. We believe that the neurologic deterioration in case 2 with the fracture at the L2-3 level was caused by spinal cord ischemia secondary to the distraction. As a result of this experience, our last 2 patients underwent short-segment stabilization under local anesthesia, followed by long-segment stabilization under general anesthesia. These patients returned to daily life without a postoperative neurologic deficit.

We believe that there is a general relaxation of the anatomic structures with the effect of general anesthesia and the muscle relaxant used. All 3 columns of the spine are affected in these patients and stability is provided by the tone of the muscles around the spine. Applications such as using a trauma board in the translation process of the patients and using the Trendelenburg position to eliminate the gravitational effect did not prevent the distraction at the fracture distance. In these patients, there is a risk of increased distraction at the fracture line and clinical worsening. To reduce this risk, we recommend securing the fracture level with unilateral short-level stabilization under local anesthesia and then completing the operation with general anesthesia as an option.

Irrespective of surgeons' level of experience, neurologic deterioration caused by positioning should always be suspected, especially in patients with lumbar trauma and fractures involving all spinal bone structures (the thoracic cage has an additional stabilizing effect in thoracic region fractures). Radiologic evaluation should be performed immediately after positioning for surgery (because muscle relaxants increase the likelihood of distraction under general anesthesia). Thus, it can be confirmed that there is no neurologic deterioration by positioning the patient while awake. Afterward, short-segment stabilization can be continued with local anesthesia followed by general anesthesia. Posterior internal fixation is the preferred surgical method for patients with AS requiring surgical intervention for thoracolumbar spinal fracture.[19] We also performed long-segment stabilization for surgical intervention in our patients.

The limitations of this report are the low number of presented cases and the lack of statistical comparison. Multicenter studies of this technique may enable reporting of the outcome in an evidence-based manner.

CONCLUSIONS

In this technical note, we propose a new technique of unilateral short-level fixation under local anesthesia before general anesthesia to avoid secondary injury as an option when repositioning patients with AS with thoracolumbar fractures. Previously reported studies have recommended the percutaneous stabilization technique in the surgical treatment of traumatic hyperextension thoracic and lumbar fractures with AS because of the low postoperative complication rates. We believe that the described technique is an alternative technique for surgeons who do not have sufficient experience in percutaneous stabilization.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

Ali Börekci: Conceptualization, Data curation, Writing – review & editing. **Pınar Kuru Bektaşoğlu:** Data curation, Writing – original draft. **Ali Fatih Ramazanoğlu:** Data curation, Writing – review & editing. **Jülide Hazneci:** Data curation, Writing – review & editing. **Bora Gürer:** Conceptualization, Data curation. **Tayfun Hakan:** Data curation, Writing – review & editing. **Erhan Çelikoğlu:** Conceptualization, Data curation, Writing – review & editing.

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