



# Common Vertebral Fracture Level After the 2023 Turkey Earthquake: Thoracolumbar Junction - Due to Hyper-Flexed and Fixed Posture - at Triangle of Life Areas

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## ABSTRACT

**AIM:** To assess the frequency of thoracolumbar junction (TLJ) fractures (T10-L2) in survivors of the 2023 East Turkey earthquake.

**MATERIAL and METHODS:** This single-center retrospective study evaluated 10 earthquake survivors, who were trapped under the rubble and rescued alive by rescue teams, and were assessed for spinal trauma after the earthquake in Eastern Turkey on February 6, 2023. All patients underwent full spinal magnetic resonance imaging and computed tomography examinations to determine the level of spinal fracture and decide the treatment methods.

**RESULTS:** All patients had sustained spinal fractures. Eight underwent surgery, while two were managed conservatively. Nine out of ten patients had TLJ fractures. Five patients had L1 fractures, four of them were treated surgically. Three patients had a T12 level fracture, two of whom were treated surgically. One patient with a T7-level fracture was treated surgically. Only one patient had multiple fractures (T12 and L2 levels) and was treated surgically.

**CONCLUSION:** The TLJ was the commonest vertebral fracture level as of the 2023 Turkey earthquake survivors in our study population. In the event of an earthquake, people tend to take a fetal posture (flex and hyperflex the spine) when taking shelter in a narrow area (triangle of life). This position might place an excessive load on the TLJ, predisposing it to injuries.

**KEYWORDS:** Earthquake, Triangle of life, Thoracolumbar junction fractures, Spinal trauma

**ABBREVIATIONS:** TLJ: Thoracolumbar Junction, MRI: Magnetic Resonance Imaging, CT: Computed Tomography

## INTRODUCTION

The thoracolumbar junction (TLJ) is the spinal segment corresponding to the T10-L2 vertebral levels (3). Being a transition zone between the less mobile thoracic spine, which is fixed by ribs on both sides and the more flexible lumbar spine below it, the TLJ is particularly vulnerable to injuries (1). The etiology of thoracolumbar fractures may depend on the patient's age, motor vehicle accidents, fall from a significant height, sports accidents, and crime-related accidents are the

common reasons in the young population (6), whereas elderly individuals may sustain thoracolumbar fractures even from low-energy traumas, such as like simple falls, due to the high prevalence of osteoporosis in this age group (6).

Previous studies have shown that spinal fractures often occur in natural disasters, such as earthquakes (2). In particular, the TLJ region is the most frequently affected in earthquake-related spinal traumas compared to other spinal levels.

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## ■ MATERIAL and METHODS

The study was approved by the Ankara University Faculty of Medicine Ethics Committee (No: İ04-234-23, Date: 23/05/2023).

This single-center, retrospective study included ten patients who were trapped under the rubble after the severe earthquake that struck the eastern part of Turkey on February 6, 2023, and rescued alive by rescue teams from a narrow area. The patients were followed up for spinal fractures and underwent full spinal magnetic resonance imaging (MRI) and computed tomography (CT) examinations to identify levels of spinal fractures. All patients were operated on within the first three days of being rescued and hospitalized.

The following information was recorded for all patients: Age, the number of days after the earthquake when they were rescued, the level of spinal fractures, and the treatment method. The spinal segment between T10 and L2 vertebral levels was accepted as the TLJ, and fractures involving these levels were denoted as TLJ fractures. The number of patients in the TLJ and non-TLJ groups was compared.

## ■ RESULTS

Among the ten patients, there were six females and four males; all patients were diagnosed with spinal fractures. One patient had an accompanying fibular fracture and was recommended to be followed up with a leg brace by the Orthopedics and Traumatology Department; the remaining nine patients did not have any other fractures.

None of the patients had any deficits in the neurological examination. Eight out of ten patients were treated surgically. The remaining two were treated conservatively and discharged with a recommendation of using a thoracolumbar brace for one month.

In nine of ten patients, the fracture was located in the TLJ region; only one patient had a non-TLJ spinal fracture. The patient characteristics, fracture levels, day of rescue after the earthquake, and treatment types are summarized in Table I.

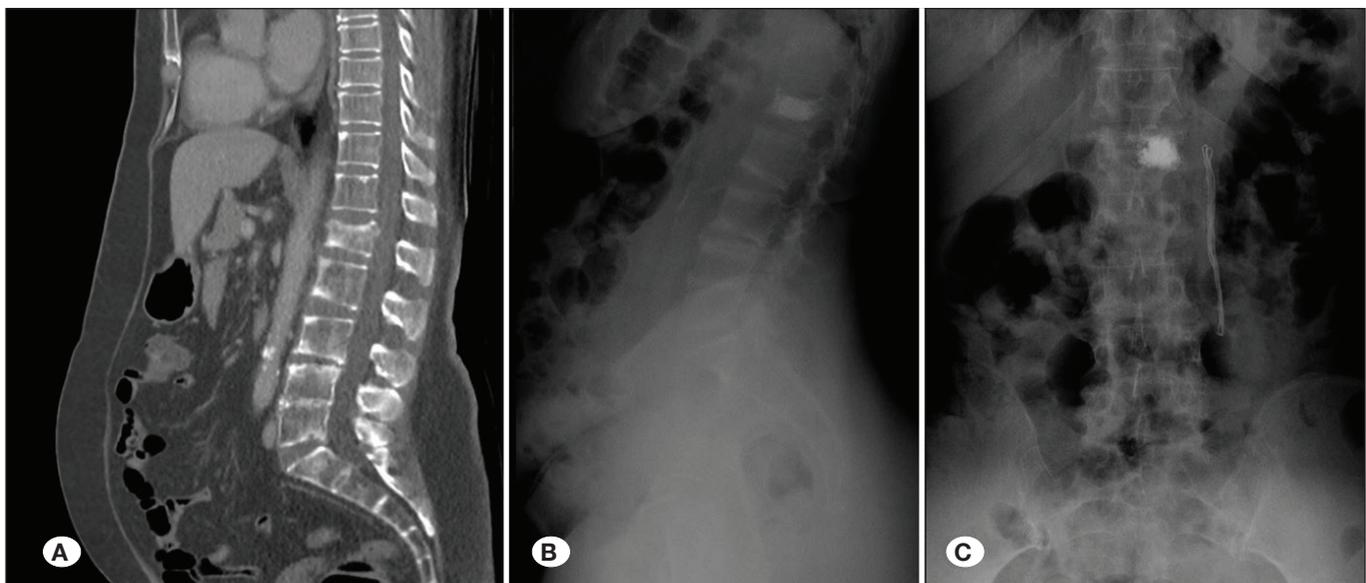
Regarding the fracture levels, five patients had a vertebral fracture at L1, four of whom were treated surgically. Figure 1 presents the preoperative and postoperative imaging data for one of the L1 fracture-level patients who were treated with kyphoplasty.

A T12-level fracture was detected in three patients. Two of them were treated surgically. Figure 2 presents the preoperative and postoperative imaging data for one of these patients who underwent spinal instrumentation surgery.

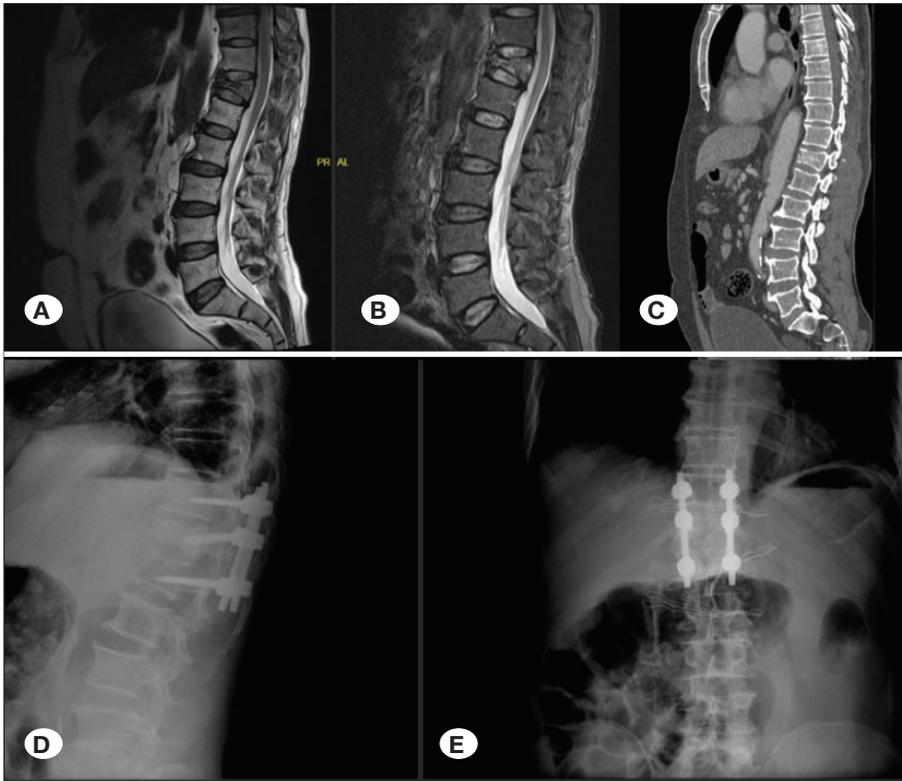
One patient had multiple fractures at T12 and L2 levels and was treated surgically with spinal instrumentation (Figure 3). One patient had a T7 fracture and was treated surgically with spinal instrumentation.

## ■ DISCUSSION

Several case series have been reported in the literature on spinal injuries following major earthquakes that occurred in the world which have examined features in the survivors, such as the accompanying spinal cord injury, the level and severity of the vertebral fractures, and the degree of neurological damage. Dong et al. assessed 223 patients who had sustained spinal trauma following the earthquake in Sichuan in 2008 and reported that lumbar fractures were the most common ones, followed by thoracic and cervical fractures (2). Likewise, Rathore et al. evaluated 187 patients with spinal trauma following the 2005 earthquake in Pakistan and found that the most common injuries were in the thoracolumbar region (8). Similar findings were observed by Keshkar et al. who had examined 2621 people injured in the Kashmir earthquake of



**Figure 1:** A) Preoperative computed tomography (CT) scan shows a fracture at the L1 level. B, C) Postoperative X-ray images after kyphoplasty procedure: lateral (B) and anteroposterior (C) views.



**Figure 2:** Preoperative T2-weighted sagittal (A) magnetic resonance imaging (MRI), short tau inversion recovery (STIR) sequence MRI (B), and sagittal reconstruction images in computed tomography (CT) scan (C) showing fracture at the T12 level. Postoperative X-ray images after the instrumentation surgery: lateral (D) and anteroposterior (E) views.



**Figure 3:** Preoperative T2-weighted sagittal (A) magnetic resonance imaging (MRI), short tau inversion recovery (STIR) sequence MRI (B), and sagittal reconstruction images in computed tomography (CT) scan (C) showing fractures at the T12 and L2 levels. Postoperative X-ray images after the instrumentation surgery: lateral (D) and anteroposterior (E) views.

**Table I:** Ages and Genders, Fracture Levels, Rescue Days and Treatment Methods of 10 Patients

Patients	Age (years)/Gender	Fracture Level	Rescue Day	Treatment
1	45, F	L1	1 <sup>st</sup> day	Kyphoplasty
2	52, M	L1	1 <sup>st</sup> day	Conservative
3	57, F	L1	2 <sup>nd</sup> day	Instrumentation
4	47, M	L1	3 <sup>rd</sup> day	Instrumentation
5	65, F	L1	1 <sup>st</sup> day	Kyphoplasty
6	34, M	T12	2 <sup>nd</sup> day	Instrumentation
7	36, F	T12	1 <sup>st</sup> day	Kyphoplasty
8	46, M	T12	1 <sup>st</sup> day	Conservative
9	52, F	T12 & L2	2 <sup>nd</sup> day	Instrumentation
10	16, F	T7	1 <sup>st</sup> day	Instrumentation

*F: Female, M: Male.*

2005 in India, Kashmir, 38 of these patients were extensively examined for spinal injuries, and the thoracolumbar region was most frequently affected, followed by sacrococcygeal and cervical levels (5). Groves et al. examined 117 earthquake survivors in 2015 from the neighboring region of Nepal; 108 of these patients had suffered spinal injuries (4). TLJ fractures were the most common fractures among these patients (n = 71), followed by the lumbar, thoracic, and cervical regions (4).

There is extensive literature on the mechanisms of spinal fractures, especially those observed in the thoracolumbar region, while these fractures can occur in the normal spinal posture, a particularly strong association has been reported with a hyperflexed posture (10). It is known that the center of gravity of the human spine is located anterior to the TLJ. Increasing the degree of kyphosis in this region heightens the axial forces on the TLJ vertebrae, thus intensifying the risk of developing compression fractures (9). This may explain the high incidence of TLJ fractures in earthquake victims who tend to adopt a kyphotic posture to reduce their body surface area when taking shelter in the triangle of life area. Furthermore, Li and Guo examined the effects of vertical loading and fracture-causing mechanisms that take place in different spinal postures, namely extension, flexion, and axial rotation, in their modeling study on thoracolumbar fractures (7). They concluded that fractures that occur as a result of vertical loading during flexion had the highest risk of vertebral height loss.

Based on these findings, it can be reasonably assumed that there is a strong relationship between hyperflexion or kyphotic spinal postures and thoracolumbar fractures. In most of the studies examining the spinal fractures following major earthquakes, thoracolumbar fractures were the most common variety as compared to other spinal regions (2,4,5,8). However,

the mechanism of spinal fractures occurring in earthquake survivors trapped and rescued from the “triangle of life areas” and the relationship of these fractures with acquired posture in that narrow area have not been emphasized so far. Presumably, an individual acquires a fetal posture when taking shelter in this narrow area; in doing so, the apex of the body is located near the thoracolumbar region, which makes it more susceptible to injury.

In this study, we aimed to examine whether TLJ fractures may be more common in earthquake survivors who are trapped and rescued from narrow spaces under the rubble, compared to other spinal levels. Such patients require urgent surgical care which involves a large amount of surgical equipment and materials, such as thoracolumbar pedicle screws and rods. Therefore, understanding the mechanism of anticipated injuries in times of a natural disaster, such as an earthquake, and preparing with sufficient supplies is essential to plan effective disaster management and help expedite the response efforts.

Despite offering novel insights, this study had a significant limitation. We could include only a small number of patients from the earthquake survivors in this region; further studies from multiple healthcare centers are warranted to corroborate our results.

## ■ CONCLUSION

In the event of an earthquake, people tend to take shelter in a narrow area, which is termed the triangle of life. In this area, the person tends to fix and hyperflex their spine to increase the chances of survival under the collapsing structure. However, this posture might place an excessive amount of load and stress on the flexed spine, which predisposes them to fractures of the TLJ.

**AUTHORSHIP CONTRIBUTION**

Study conception and design: BCA, EBM, MZ, OO, SH, YSC, UE

Data collection: BCA, EBM, UE

Analysis and interpretation of results: MZ, OO, SH, EBM, BCA

Draft manuscript preparation: YSC, UE, EBM, BCA

Critical revision of the article: OO, SH, EBM, BCA, YSC

Other (study supervision, fundings, materials, etc...): UE

All authors (BCA, EBM, MZ, OO, SH, YSC, UE) reviewed the results and approved the final version of the manuscript.

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