ORIGINAL ARTICLE

Thoracolumbar fractures after the 2023 Türkiye earthquake and controversial mechanism of occurrence

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ABSTRACT

BACKGROUND: Earthquakes are devastating events that may severely injure the human body. The spine is one of the important parts of the human body that may be affected by earthquake trauma. The aim of this study is to focus on thoracolumbar fractures secondary to the 2023 Turkey Earthquake.

METHODS: The data of 15 patients who were affected by the earthquake, rescued from the rubble, and subsequently treated for spinal fractures in our department were reviewed retrospectively. The clinical, radiological, and surgical features of the patients were recorded, and the outcomes were investigated.

RESULTS: Among the 15 patients, 12 were female, and 3 were male. Their ages ranged from 22 to 79 years. The average duration of being trapped under debris was 4.7 hours. According to the Frankel classification, 12 patients (80%) were categorized as Frankel E, 2 patients (13.3%) as Frankel A, and 1 patient (6.6%) as Frankel C. Of these patients, 6 underwent surgical treatment, while a total of 9 patients received conservative treatment. Multiple vertebral fractures were identified in 4 patients. While 3 patients with multiple fractures were treated conservatively, 1 patient underwent surgery due to an L1 fracture. All surgeries consisted of spinal canal decompression and spinal instrumentation. Among patients without thoracolumbar junction fractures, 1 had a T8 fracture, 1 had an L4 fracture, and 1 had a sacral fracture along with an accompanying lumbar plexus injury.

CONCLUSION: Thoracolumbar fractures are frequently observed after earthquakes. However, the exact mechanism of these fractures is not well known. Surgical management should be reserved for patients with progressive neurological deficits, while conservative treatment is the option for stable fractures.

Keywords: Thoracolumbar fracture; earthquake; surgery; outcome.

INTRODUCTION

On February 6, 2023, the southeastern provinces of Turkey were struck by two major earthquakes occurring within a 9-hour interval, causing extensive and severe shaking. Registering magnitudes of 7.8 and 7.5 on the Richter scale, these earthquakes collectively impacted 14 million individuals and resulted in the loss of over 50,000 lives. More than 122,000 people sustained injuries and were admitted for medical treatment in healthcare facilities across various regions of Turkey.

Earthquakes are one of the most catastrophic natural disasters, leading to dramatic injuries. Proper and timely treatment of the injured individuals plays a crucial role in reducing morbidity and mortality rates.[1] Due to its geographical location, Turkey is situated in a primary seismic zone, making it prone to frequent earthquakes.[2]

The incidence of spinal injuries resulting from earthquakes is lower compared to extremity injuries. However, traumatic spinal cord injury is a recognized effect of earthquakes and carries a high risk of morbidity and mortality.[3,4] The rate of detecting spinal injuries in trauma patients related to earthquakes ranges from 13% to 15.2%, while the frequency of spi-

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nal injuries among all trauma patients is between 1.6% and 10%.[5-7] The region most commonly affected by spinal injuries caused by earthquakes is the thoracolumbar junction.[8] This transitional area between the less mobile thoracic spine and the more mobile lumbar vertebrae is inherently more vulnerable to injury.[9]

While there are studies on earthquake-related spinal trauma in the literature, information on this topic remains limited. Severe earthquakes frequently occur in various parts of the world, and it is important to have a thorough understanding of the characteristics of spinal injuries resulting from earthquakes. The purpose of this study is to describe the epidemiological data of patients with earthquake-related spinal injuries and to contribute to the existing literature by presenting our experiences following the earthquakes in Turkey.

MATERIALS AND METHODS

This study was designed as a single-center retrospective investigation. The study was conducted in accordance with the Declaration of Helsinki and was approved by the University of Health Sciences, Gülhane Scientific Research Ethics Committee (Date: May 20, 2021, Decision Number: 2021-238). Following the earthquakes on February 6, 2023, in the southeastern region of Turkey, a total of 15 patients who were trapped under debris and subsequently either rescued by rescue teams or managed to extricate themselves from the wreckage, then presented to our department either by ambulance or under their own means, and were diagnosed with spinal fractures, were included in the study.

Patient ages, genders, durations of being trapped under debris, times of hospital admission, levels of spinal fractures, neurological examinations, administered treatments, and hospitalization periods were all documented. Comprehensive computerized tomography (CT) and magnetic resonance imaging (MRI) scans were conducted on all patients to determine the levels of spinal fractures, covering the entire spine. Short-TI Inversion Recovery (STIR) images were used for easier diagnosis. Fractures between the T11 and L2 levels were classified as thoracolumbar junction fractures and were referred to as such throughout the study.

The neurological examinations of the patients were graded according to the Frankel classification: Frankel A (complete), Frankel B (sensory only), Frankel C (motor useless), Frankel D (motor useful), and Frankel E (normal).[10] Thoracolumbar fractures were examined using the AOSpine Thoracolumbar Spine Injury Classification System, individually for each vertebral fracture. This classification system divides fracture types into three main groups, which are further subdivided into subgroups. According to the AOSpine classification: Type A (compression injuries of anterior structures) includes subgroups A0 (minor injuries), A1 (wedge compression), A2 (split), A3 (incomplete burst), and A4 (complete burst); Type B (tension band injury) includes subgroups B1 (monosegmental bony posterior tension band injury), B2 (posterior tension band disruption), and B3 (hyperextension injury); and Type C (displacement/translational injury) includes subgroups C1 (type A with rotation), C2 (type B with rotation), and C3 (rotational-shear injuries).[11,12]

RESULTS

A total of 1,185 injured patients were transferred to our hospital between February 6, 2023, and August 6, 2023—a period of six months—following the earthquake. Of these, seventeen had sustained spinal injuries and were hospitalized. This study includes fifteen patients affected by the earthquake who were rescued from the rubble and subsequently treated for thoracolumbar (n=14) and sacral fractures (n=1) in our

Table 1. Epidemiological, clinical and radiological characteristics of 15 patients

Case No.	Age, Sex	Duration under the debris (hour)	Time of admission (day)	Fracture level	Frankel grade	Hospital stay (day)	Treatment
1	51, F	1	1	T11, L2, L4	E	3	Conservative
2	45, F	12	1	L1	E	3	Surgery
3	26, F	3	1	T11, T12, L1	E	3	Conservative
4	19, M	0,25	3	L1	A	8	Surgery
5	38, F	2	3	T3, T4, T5, T6, L1	E	5	Surgery
6	67, M	0,25	5	L1	E	4	Surgery
7	22, F	6	5	T12	E	4	Conservative
8	71, F	1	6	T11, T12, L1, L2, L3	E	10	Conservative
9	79, F	0,25	7	L1	E	1	Conservative
10	35, F	0,25	8	T12	E	1	Conservative
11	35, F	8	8	T8	E	2	Conservative
12	39, F	8	10	L1	A	11	Surgery
13	63, M	17	15	T12	E	10	Surgery
14	24, F	11	18	Sacrum	C	13	Conservative
15	30, F	1	1	L4	E	2	Conservative

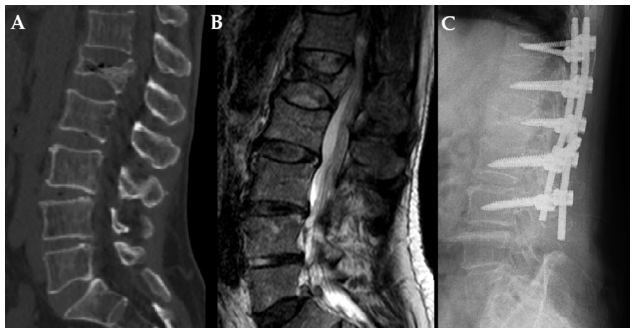

Figure 1. This figure shows AOSpine type A4 L1 burst fracture preoperative computerized tomography image (A), T2-weighted sagittal magnetic resonance image (B) and postoperative plain radiography (C).

department. Of the patients, 82.35% had a thoracolumbar fracture. Twelve of the patients were female, while three were male, with ages ranging from 22 to 79 years. The average duration of entrapment under debris was 4.7 hours, and the average time from rescue to hospital admission was 6.1 days. Hospitalization periods varied depending on the treatment administered, ranging from one to thirteen days, with an average hospital stay of 6.8 days for patients who underwent surgical treatment.

Upon neurological examination, twelve patients showed no neurological deficit, two were diagnosed with paraplegia, and one exhibited significant weakness in their right lower extremity. According to the Frankel classification, twelve patients (80%) were categorized as Frankel E, two patients (13.3%) as Frankel A, and one patient (6.6%) as Frankel C. Twelve patients were diagnosed with thoracolumbar junction fractures. Of these, six underwent surgical treatment, while a total of nine received conservative treatment. Those undergoing conservative treatment were discharged with analgesic therapy and a thoracolumbar brace (Table 1).

Table 2. Number of fracture types indentified in vertebras according to AOSpine classification system

Fracture level	AOSpine Thoracolumbar Spine Injury Classification			
	A1	A2	A3	A4
T3	1			
T4	1			
T5	1			
T6	1			
T8	1			
T11	3			
T12	4		1	
L1	3		1	4
L2	1	1		
L3	1			
L4		2		

All patients requiring surgical treatment presented with thoracolumbar junction fractures. Among the six patients who underwent surgery, five had L1 fractures (Fig. 1) and one had a T12 fracture. All six patients were classified as having a burst type of spinal fracture. According to the AOSpine Thoracolumbar Spine Injury Classification System, the most common fracture type was A1 (69.2%). Among the six patients requiring surgical treatment, two had A3 fractures, and four had A4 fractures (Table 2).

Multiple vertebral fractures were identified in four patients (Fig. 2). Three of these patients were treated conservatively, while one underwent surgery due to an L1 fracture. All surgeries involved spinal canal decompression and spinal instrumentation. Among patients without thoracolumbar junction fractures, there was one with a T8 fracture, one with an L4 fracture, and one with a sacral fracture, accompanied by a lumbar plexus injury.

Figure 2. T11, T12 and L1 fractures are revealed at the images. All of them are classified as A1 regarding AOSpine classification system. After performing computerized tomography **(a)** and magnetic resonance imaging **(b)**, the patient was treated conservatively and follow-up image after 5 months reveals no worsening **(c)**. Edema was obvious in T11, T12 and L1 bodies in STIR images at admission **(d)**.

DISCUSSION

When conducting a literature review on earthquake-related spinal injuries, prominent studies emerge from regions affected by significant seismic activity, including Van (Turkey), Nepal, Sichuan (China), Iran, Pakistan, Kashmir (India), and the Great Hanshin (Japan) region. These studies have examined patients with spine injuries, detailing their fracture levels, neurological conditions, and the treatments administered.

A study by Aycan et al.[13] on the 2011 Van earthquake reported spinal injuries in 12 patients. Among the six patients requiring surgery, four had thoracolumbar junction fractures. All surgical procedures involving the thoracolumbar junction included spinal canal decompression and stabilization. Ghabili et al.[14] explored spinal injuries resulting from the 2012 Iran earthquake, finding that the majority of patients had thoracolumbar fractures (71%), and 88% of the patients exhibited no neurological deficits. In our study, 1185 patients with varying injuries were transferred to our hospital post-earthquake. While most sustained soft tissue injuries, 17 had spinal injuries. Fifteen were hospitalized, and 14 (82.35%) underwent treatment for a thoracolumbar fracture. This injury rate aligns with previous studies, highlighting the importance of focusing on the thoracolumbar spine following earthquakes.

Spinal CT and MRI scans play a crucial role in detecting spinal fractures and spinal cord injuries. T2-weighted MRI sequences are particularly useful for identifying hematoma, whereas STIR images facilitate the detection of spine fractures, edema, and spinal ligament injuries.[8] In this study, we opted for CT scans to visualize fractures more effectively, while MRI was preferred for identifying spinal cord injuries.

Literature reveals a varied rate of detecting neurological deficits during initial patient assessments, ranging between 12% and 94.1%.[3,14-16] Our study found this rate to be 20%. The observed discrepancies in rates are thought to be influenced by the proximity of the study center to the earthquake-affected region. It is posited that patients with neurological deficits were less likely to be transferred to distant facilities, and those with severe neurological conditions were more likely to undergo surgery at hospitals closer to the earthquake zone.

Consistently across studies, the thoracolumbar region, particularly the thoracolumbar junction, is identified as the most commonly affected spinal segment in earthquake-related injuries, a finding that aligns with our study.[3,4,8,13-18] Various studies have sought to understand why the thoracolumbar region is so frequently affected in spinal fractures resulting from earthquakes. Alpergin et al.[8] suggested that the high incidence of thoracolumbar junction involvement is due to the tendency of individuals to adopt a hyperflexed posture during an earthquake, seeking to protect themselves. Our study, which included 14 patients (82.35%) with thoracolumbar fractures, did not reach a definitive conclusion on this matter. We observed that individuals rescued from debris often could not recall their exact positions due to the intense stress experienced during the building collapse, and even if they could, the body posture they remembered might not have accurately reflected their actual posture at the time of the collapse. Rathore et al.,[16] in their study of spinal trauma patients affected by the 2005 Pakistan earthquake, found that only 28.9% of patients were in a sitting or flexed posture, even though the incidence of thoracolumbar junction fractures was 64%. Maruo and Matumoto[18] in their investigation of spinal fractures from the 1995 Japan earthquake, stated that thoracolumbar junction fractures were most common in patients running, standing, sitting, or lying prone, while rib and pelvic fractures were more frequent in those lying in lateral or supine positions.

Our study has limitations. It is retrospective in nature, and the patient sample size is too small to draw firm conclusions. Nevertheless, this study highlights the critical need for prompt detection and management of thoracolumbar fractures post-earthquake, emphasizing its importance for improved outcomes following such traumatic events.

CONCLUSION

Earthquakes represent a significant cause of multi-trauma affecting the entire body. A thorough, multidisciplinary examination of patients is imperative for the accurate and prompt identification of medical conditions. Due to their potential to cause severe morbidity and necessitate surgical intervention, spinal fractures must be promptly identified in the post-traumatic period. While spinal fractures resulting from earthquakes most commonly affect the thoracolumbar region, detailed studies are needed to better understand the injury mechanisms.

Ethics Committee Approval: This study was approved by the University of Health Sciences, Gülhane Scientific Research Ethics Committee (Date: 20.05.2021, Decision No: 2021-238).

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Conflict of Interest: None declared.

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ORİJİNAL ÇALIŞMA - *ÖZ*

2023 Türkiye depremi sonrası torakolomber fraktürler ve tartışmalı oluşum mekanizması

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AMAÇ: Depremler, insan vücuduna ciddi zararlar verebilen yıkıcı olaylardır. Omurga, deprem travmasından sıklıkla etkilenen, insan vücudunun önemli bir parçasıdır. Bu çalışmanın amacı, 2023 Türkiye Depremi'ne sekonder olarak gelişen torakolomber kırıkları incelemek ve klinik sonuçlarımızı ortaya koymaktır.

GEREÇ VE YÖNTEM: Depremden etkilenen, enkaz altından kurtarılan ve daha sonra omurga kırıkları nedeniyle kliniğimizde tedavi edilen 15 hasta verisi, geriye dönük olarak incelendi. Hastaların klinik, radyolojik ve cerrahi özellikleri kaydedildi ve sonuçları değerlendirildi.

BULGULAR: Onbeş hastanın 12'si kadın ve 3'ü erkekti. Yaşları 22 ila 79 arasındaydı. Enkaz altında kalma süresinin ortalaması 4,7 saatti. Frankel sınıflandırmasına göre, hastaların 12'si (%80) Frankel E, 2'si (%13.3) Frankel A ve 1'i (%6.6) Frankel C olarak kategorilendirildi. Bu 12 hastadan 6'sına cerrahi tedavi uygulandı, toplamda 9 hastaya ise konservatif tedavi verildi. Dört hastada birden fazla omur kırığı tespit edildi. Birden fazla kırığı olan 3 hastaya konservatif tedavi uygulanırken, 1 hasta L1 kırığı nedeniyle ameliyat edildi. Tüm ameliyatlar omurilik kanalının dekompresyonunu ve omurga enstrümantasyonunu içeriyordu. Torakolomber bileşke kırıkları olmayan hastalardan birinde T8 kırığı, birinde L4 kırığı ve birinde de eşlik eden lomber pleksus yaralanması bulunan bir sakral kırık vardı.

SONUÇ: Torakolomber kırıklar deprem nedeniyle sıklıkla oluşan omurga yaralanmalarından biridir. Ancak bu kırıkların oluşum mekanizması tam olarak bilinmemektedir. Cerrahi tedavi, ilerleyen nörolojik bozuklukları olan hastalarda öncelikli tedavi seçeneği iken, stabil kırıklar için ise konservatif tedavi tercih edilen bir tedavi yöntemidir.

Anahtar sözcükler: Cerrahi; deprem; sonuç; torakolomber fraktür.

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