

# Evaluation of Vertebral Fractures and Associated Injuries in Multiple Trauma Patients

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## ABSTRACT

In this study, it was aimed to determine the accompanying organ injuries and their frequencies in trauma patients diagnosed with vertebral fracture in the emergency department.

In this study, trauma patients aged 18 years and older and with at least one vertebral corpus fracture who applied to the Emergency Department of Hafsa Sultan Hospital of Manisa Celal Bayar University Faculty of Medicine between January 2016 and December 2020 were retrospectively analyzed. In addition to vertebral fractures, the mechanism of trauma, accompanying organ injuries, the intervention and the prognosis of the patients were examined.

Of the patients, %72 were male and the mean age was 46,07. The two most common trauma mechanisms causing vertebral fracture were falling from height and traffic accident. The vertebral region most affected by trauma was the thoracolumbar (28.7%) region. Compression fracture was detected in 52% of the patients, and burst fracture was detected in 19,3% of the patients. Neurological deficit was observed in 8% of the patients, and death in 3,4%. Thoracic injuries were detected in 41.3% of the patients, and extremity injuries in 26%, and these were the most common injuries accompanying vertebral fractures. In our study, concomitant cranial and maxillofacial injuries in cervical vertebral fractures and concomitant thoracic injuries in thoracic vertebral fractures were found to be significantly higher.

Traffic accidents and falling from a height were determined as the two most common causes of vertebral fracture and were thought to be preventable causes. In addition, although distant traumas accompanied the affected vertebral region in vertebral fractures, it was observed that traumas of nearby structures were more common in general.

**Keywords:** Emergency department, vertebral fracture, accompanying injuries, multitrauma

## Introduction

The incidence of high-energy trauma is progressively increasing because of technological advancements and increased rates of traffic accidents. While these traumas are among the leading causes of particularly early-age mortality, they also cause mental, social, and economic problems because of individuals' irreversible disabilities (1,2).

Trauma is the first cause of mortality in the population aged under 40 years, whereas it has the fourth row among the causes of mortalities occurring at 40 years of age and over (3). The high mortality rate in multiple traumas draws attention to these traumas. The most common cause of multiple traumas is traffic accidents, followed by falling from height and gunshot wounds. Even though at least two body parts among the head and neck, thorax, abdomen, and extremities are required to name a trauma as multiple trauma, the

development of fractures in more than one long bone is also included in the description of multi-trauma. Patients with multiple traumas are at significant risk of morbidity and mortality, and vertebral fractures can be incredibly challenging for physicians and patients in this group (4).

Because vertebral fractures occur due to exposure to high-energy trauma, accompanying organ injuries are common. For this reason, in vertebral fractures, the patient's meticulous examination and additional imaging methods are necessary regarding adjacent or further organ injuries (5).

In this study we aimed to determine the concurrent organ injury types and their frequencies in trauma patients diagnosed with vertebral fractures.

## Material and Method

**Study design:** This retrospective study involved patients aged 18 years or over, diagnosed with at

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least one vertebral corpus fracture, and were admitted to the Emergency Service of Hafsa Sultan Hospital in Manisa Celal Bayar University, Faculty of Medicine, between January 2016 and December 2020.

The study's recorded parameters were age, gender, the trauma mechanism, location of the vertebra exposed to trauma, the type of vertebral fracture, injuries accompanying the vertebral fracture, the status of neurological deficit development, the type of surgical intervention, and outcome of the patients.

The inclusion criteria were the patient's age older than 18 years, the diagnosis of vertebral corpus fracture, and no missing data. The exclusion criteria were the age younger than 18 years, the diagnosis of transverse and spinous process fractures, and the presence of missing data.

**Ethical Issues and Permissions:** The Ethics Committee for Non-interventional Clinical Studies in Manisa Celal Bayar University, Faculty of Medicine approved the study (Decision # 20.478.486, dated: November 11, 2020). The study data was only used for scientific research, and the patients' descriptive characteristics were shared neither in the research report nor with third parties and institutions.

**Statistical Analysis:** The SPSS 21.0 software package performed the study's statistical analyzes. The categorical variables were presented as numbers and percentages, whereas the continuous quantitative variables as pivotal and frequency measures such as mean, standard deviation, median, minimum and maximum values. Pearson's Chi-square test made the inter-group comparisons for categorical variables. A p-value below 0.05 was considered statistically significant.

## Results

The study included one hundred and fifty patients diagnosed with vertebral fractures. 72% (n=108) of the patients were male, and the mean age was  $46.07 \pm 17.71$  years. The thoracolumbar vertebral region was affected by trauma in 28.7% (n=43), the lower lumbar region in 28% (n=42), the cervical region in 22% (n=33), and the thoracic region in 21.3% (n=32) of the patients. Compression fractures were the most common fracture type and present in 52% (n=78), burst fractures were second most common and present in 19.3% (n=29), of the patients. Besides, neurologic deficits were identified in 8% (n=12) of the patients (table 1).

Thoracic injuries were diagnosed in 41.3% (n=62), extremity injuries in 26% (n=39), abdominal injuries in 21.3% (n=32), pelvic fractures in 18.7% (n=28), cranial injuries in 13.3% (n=20), and maxillofacial injuries in 10% (n=15) of the patients, in addition to their vertebral fractures. Surgical interventions were performed in 41.3% (n=62) of the patients (table 2).

39.3% (n=59) of the patients were hospitalized in the ward, whereas 34% (n=51) were in the intensive care unit. 26% (n=39) of the patients were discharged from the Emergency Service, whereas 0.7% (n=1) died. Regarding the one-month prognoses, 81.3% (n=122) of the patients were discharged to full recovery, 15.3% (n=23) were discharged with sequela, whereas 3.4% (n=5) died (table 3).

Concomitant cranial injuries were present in 33.3% (n=11) of the patients with cervical vertebral fractures, in 12.5% (n=4) of those with thoracic vertebral fractures, in 2.3% (n=1) of those with thoracolumbar vertebral fractures, and 9.5% (n=4) of patients with lower lumbar fractures. The rate of concomitant cranial injuries was significantly higher in cervical vertebral fractures when compared to the other vertebral fracture locations ( $p=0.001$ ).

On the other hand, concurrent maxillofacial injuries existed in 24.2% (n=8) of the patients with cervical vertebral fractures, in 12.5% (n=4) of those with thoracic vertebral fractures, in 2.3% (n=1) of those having thoracolumbar vertebral fractures, and in 4.8% (n=2) of patients with lower lumbar vertebral fractures. The maxillofacial injury frequency in cervical vertebral fracture was statistically higher than in the other sites ( $p=0.008$ ).

Associated thoracic injuries were present in 39.4% (n=13) of the patients with cervical vertebral fractures, in 65.6% (n=21) of those with thoracic vertebral fractures, in 39.5% (n=17) of those having thoracolumbar vertebral fractures, and in 26.2% (n=11) of patients with lower lumbar vertebral fractures. The thoracic injury incidence was significantly higher in thoracic vertebral fractures than in the other sites ( $p=0.008$ ).

Abdominal injuries were concurrently identified in 15.2% (n=5) of the patient with cervical injuries, in 25% (n=8) of those with thoracic vertebral fractures, in 23.3% (n=10) of those with thoracolumbar vertebral fractures, and 21.4% (n=9) of the patients having lower lumbar fractures.

**Table 1.** The Distributions of The Cases According To Trauma Mechanism, Affected Vertebral Regions, Vertebral Fracture Types, and Neurological Deficits

Trauma mechanism	n	%*
Falling from a height	60	40.0
In-vehicle traffic accident	50	33.3
Motocycle accident	20	13.3
Collision-entrapment	11	7.3
Non-vehicle traffic accident	9	6.0
Vertebral region	n	%*
Thoracolumbar	43	28.7
Lower lumbar	42	28.0
Cervical	33	22.0
Thoracic	32	21.3
Type of vertebral fracture	n	%*
Compression fracture	78	52.0
Burst fracture	29	19.3
Avulsion fracture	10	6.7
Distraction fracture	4	2.7
Other	29	19.3
Neurological deficit	n	%*
Present	12	8.0
Absent	138	92.0
Total	150	100.0

\*Percentage of the column was presented

Associated pelvic injuries were present in 9.1% (n=3) of the patients with cervical vertebral fractures, in 15.6% (n=5) of those with thoracic vertebral fractures, in 25.6% (n=11) of the patients having thoracolumbar vertebral fractures, and 21.4% (n=9) of those with lower lumbar vertebral fractures.

12.1% (n=4) of the patients with cervical vertebral fractures, 40.6% (n=13) of those with thoracic vertebral fractures, 23.3% (n=10) of the patients with thoracolumbar vertebral fractures, and 28.6% (n=12) of those having lower lumbar vertebral fractures presented with concurrent extremity fractures (table 4).

One patient who died in the Emergency Service had a cervical vertebral fracture. Regarding the one-month prognosis, cervical vertebral fractures were present in 60% (n=3), a thoracic vertebral fracture in 20% (n=1), and a lower lumbar vertebral fracture in 20% (n=1) of the patients who died.

## Discussion

Since vertebral fractures occur because of exposure to high-energy trauma, concomitant

organ injuries are frequently present. Therefore, the patients with vertebral fractures should be meticulously examined, and additional imaging methods are required to identify adjacent or other organ injuries (5).

The young-middle-aged males constitute the majority of patients in studies investigating vertebral fractures (5-8). 72% of 150 patients with multi-trauma and vertebral fractures in our study were males, and the mean age was  $46.07 \pm 17.71$  years, which was consistent with the literature. We suggest that the reason might be that young working males have been occupied more in business life, have been interacting more in social life, and might have been exposed more to accidents, either work or traffic.

Among our study's cases, when traffic accidents were combined, the most common causes of vertebral fractures were traffic accidents (52.6%) and falling from a height (40%). A retrospective study conducted in China that investigated patients with spinal fractures for ten years reported that 36.7% of their patients were admitted to the Emergency Service due to falling from a height, and 20.8% following a traffic accident (9). A study involving 562 patients in the United States reported that spinal fractures

**Table 2.** Distributions of the Cases With Vertebral Fractures According To Their Accompanying Injuries and Performed Interventions

Accompanying injuries**	n	%*
Thoracic injuries	62	41.3
Costal fracture	45	30.0
Pulmonary contusion	36	24.0
Pneumothorax	30	20.0
Hemothorax	22	14.7
Clavicular fracture	9	6.0
Scapular fracture	7	4.7
Sternal fracture	4	2.7
Extremity injuries	39	26.0
Upper extremity fracture	23	15.3
Lower extremity fracture	23	15.3
Abdominal injuries	32	21.3
Liver	14	9.3
Spleen	8	5.3
Kidney	6	4.0
Other	22	14.7
Pelvic fracture	28	18.7
Cranial injuries	20	13.3
Subarachnoidal hemorrhage	16	10.7
Epidural hemorrhage	3	2.0
Subdural hemorrhage	9	6.0
Intraparenchymal hemorrhage	7	4.7
Scalp fracture	8	5.3
Maxillofacial injuries	15	10.0
Surgical intervention***	n	%*
Absent	88	58.7
Present	62	41.3
Orthopedic	36	24.0
Thoracic	30	20.0
Abdominal	9	6.0
Cranial	2	1.3

\*Percentage of the column was presented

\*\*A patient might have had more than one injury

\*\*\* A patient might have had undergone over one surgical intervention

occurred due to falling from a height in 39% and traffic accidents in 26.5% of the cases (10). Even though different percentages have been reported, the most common two causes of spinal and vertebral fractures are falling from a height and traffic accidents. The high ratio of falls from height in the study might have originated from the construction sector's development in developing countries like Turkey and the relatively high number of workers in this sector.

In our study, thoracolumbar vertebrae were affected by trauma in 28.7%, the lower lumbar

region in 28%, the cervical region in 22%, and the thoracic vertebrae in 21.3% of the patients. Various studies have reported that the thoracolumbar part was the most frequently affected site in vertebral fractures (11, 12). We believe that occurrence of fractures most frequently at this site might be explained by its anatomic structure. Our study identified compression fractures in 52%, burst fractures in 19.3%, avulsion fractures in 6.7%, distraction fractures in 2.7%, and other fractures in 19.3% of the cases. Similar to our study, the most commonly reported fracture types were

**Table 3.** The Distributions of patients' Outcomes and One-Month Prognoses

Outcome	n	%*
Hospitalized in the ward	59	39.3
Hospitalized in Intensive Care Unit	51	34.0
Discharged from the Emergency Service	39	26.0
Died in the Emergency Service	1	0.7
One-month prognosis	n	%*
Discharged to full recovery	122	8.3
Discharged with sequela	23	15.3
Exitus	5	3.4
Total	150	100.0

\*Percentage of the column was presented

**Table 4.** Distributions of Patients' Accompanying Injuries According To Vertebral Fracture Locations

Accompanying Injuries			Location of Vertebral Fracture				p
			Cervical (n=33)	Thoracic (n=32)	Thoracolumbar (n=43)	Lower Lumbar (n=42)	
Cranial Injury	Present	11 (33.3%)	4 (12.5%)	1 (2.3%)	4 (9.5%)	0.001	
	Absent	22 (66.7%)	28 (87.5%)	42 (97.7%)	38 (90.5%)		
Maxillofacial Injury	Present	8 (24.2%)	4 (12.5%)	1 (2.3%)	2 (4.8%)	0.008	
	Absent	25 (75.8%)	28 (87.5%)	42 (97.7%)	40 (95.2%)		
Thoracic Injury	Present	13 (39.4%)	21 (65.6%)	17 (39.5%)	11 (26.2%)	0.008	
	Absent	20 (60.6%)	11 (34.4%)	26 (60.5%)	31 (73.8%)		
Abdominal Injury	Present	5 (15.2%)	8 (25.0%)	10 (23.3%)	9 (21.4%)	0.776	
	Absent	28 (84.8%)	24 (75%)	33 (76.7%)	33 (78.6%)		
Pelvic Injury	Present	3 (9.1%)	5 (15.6%)	11 (25.6%)	9 (21.4%)	0.289	
	Absent	30 (90.9%)	27 (84.4%)	32 (74.4%)	33 (78.6%)		
Extremity Fracture	Present	4 (12.1%)	13 (40.6%)	10 (23.3%)	12 (28.6%)	0.067	
	Absent	29 (87.9%)	19 (59.4%)	33 (76.7%)	30 (71.4%)		

compression and burst fractures in the medical literature (5, 11, 13).

In our study, 8% of the cases developed neurologic deficits, whereas 3.4% died in the one-month prognosis. A study investigating traumatic spinal fractures reported neurologic deficit in 4% and exitus in 3% of patients (7). Another study, retrospectively analyzing spinal fractures in Qatar, identified a neurologic deficit in 5.4% and exitus in 5% of patients (14). One study reported a neurologic deficit rate of 7% and a mortality rate of 5.2% (13). Our study had a slightly higher neurologic deficit rate compared to the literature. This result might have originated from the fact that because the hospital where the study was conducted was a tertiary level hospital, and the district sizes were large, patients were admitted not only from the urban center but also from the

city districts, and thus, the treatment, mainly surgical intervention, might have been delayed.

Thoracic injuries were present in 41.3%, extremity injuries in 26%, abdominal injuries in 21.3%, pelvic fractures in 18.7%, cranial injuries in 13.3%, and maxillofacial injuries in 10% of the patients, accompanying vertebral fractures in our study. A study conducted in China, which investigated concomitant injuries in spinal fractures, determined that 40.7% of their patients encountered thoracic injuries, 40.5% extremity injuries, 20% head and neck injuries, and 13.5% pelvic injuries (9). Even though there were percentage differences compared to other studies, our study results were consistent with the results in the medical literature, and the thorax and extremities were the most common concomitant injury sites in vertebral fractures.

Our study revealed that surgical intervention was performed in 41.3% of the patients. A single-center study conducted in Turkey reported a surgical intervention rate of 80.4%. (15) Another study investigating spinal traumas and their prognoses in the Emergency Service for three years determined a surgical intervention rate of 69.2% (16). Therefore, our study's surgical intervention rate was lower than other studies. Even though lower than the literature, treatments of almost half of our patients involved surgery. Severe damage and concurrent injuries due to high-energy traumas, especially traffic accidents, which are the leading causes of vertebral fractures, might have been the reasons for high surgical intervention rates in our study and the literature.

In our study, concomitant cranial and maxillofacial injuries had significantly higher rates in cervical vertebral fractures compared to other vertebral fracture sites. Moreover, a considerably higher rate of thoracic injuries was present in thoracic vertebral fractures than in the other vertebral fracture locations. Many studies have shown that cervical vertebral fractures were accompanied frequently by cranial and maxillofacial injuries (17-19). Studies have reported that thoracic vertebral fractures were more commonly associated with thoracic injuries such as rib fractures, pulmonary, cardiac, esophageal, and vascular injuries (20-22). Our study results were consistent with the literature.

The higher prevalences of cranial and maxillofacial injuries in cervical vertebral fractures might be because cervical vertebrae are small structures with a wide range of movement. Thus, the damage is accompanied by injuries to adjacent structures instead of other vertebral locations when exposed to trauma. The frequent accompaniment of thoracic vertebral fractures with thoracic injuries can be explained by the fact that the costae are also affected by vertebral trauma because of their tight anatomic interfaces with vertebrae. Thus, costal fractures may develop, causing injuries to adjacent thoracic organs.

Our study had various limitations. First, the study's retrospective characteristics led to a dependency on the quality of the medical data recorded and limited the data that should have been collected. Second, the occupational data of the patients included might have enabled us to have an opinion about the relationships of traumas with occupations.

Even though our study had a descriptive characteristic, it provided critical data about vertebral fractures and common concomitant

injuries that could shed light on prevention studies and treatment. Our study showed that the two essential factors causing vertebral fractures were traffic accidents and falls. The high rate of in-vehicle accidents among traffic accidents suggested deficiencies regarding wearing a seat belt. Therefore, concentrating on seat belt use in traffic and enhancing relevant inspections would be beneficial in this context.

Our study's high neurologic deficit and surgical intervention rates suggest that most traumas were high-energy traumas. For this reason, vertebral fractures should be kept in mind in unconscious patients with multi-trauma who are admitted to the Emergency Service. Until the absence of vertebral fracture is confirmed by routine bilateral vertebrography and when required tomography, the patient should be managed as if there is a vertebral fracture. Moreover, as shown in our study, vertebral fractures are accompanied by injuries in different body regions when exposed to high-energy trauma. Therefore, emergency physicians should pay utmost attention and must not miss minor traumas because of focusing on major injuries.

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**Conflict of interest:** The Authors declare that there is no conflict of interest'.

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