Clinical and Radiological Evaluation of Patients with Chest Trauma in the 2023 Great Kahramanmaras Earthquake

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ABSTRACT

Objective: On February 6, 2023, two earthquakes of magnitude 7.8 and 7.6 occurred in Kahramanmaras, affecting south and central Türkiye as well as north and west Syria. The objective of this study is to present the clinical and radiological findings of chest trauma patients in a significant disaster like an earthquake. It aims to contribute to early diagnosis and intervention in multidisciplinary treatment approaches, thereby reducing mortality and morbidity rates.

Materials and Methods: This study was a cross-sectional type registry research. A total of 6,500 patients who presented to Kayseri City Hospital due to the earthquake between February 6, 2023 and February 20, 2023 were retrospectively reviewed through medical hospital records. Of these, 150 patients with blunt or penetrating chest trauma were included in the study.

Results: Among the 6,500 patients screened, chest trauma was identified in 150 cases. The average age was 45.1 years. Of the patients, 40.0% arrived at the hospital within 0–1 days, while 10.7% arrived after 6 or more days, with the longest duration being 11 days. While 30.7% of patients had no rib fractures, 31.3% had fractures on the right side, 10.7% had bilateral fractures, and 23.3% had 5 or more rib fractures. Complications occurred in 61.3% of cases, 69.3% received medical treatment, and 26.7% underwent tube thoracostomy. The patients' hospital stays ranged from 0 to 162 days, with an average of 18 days and a median of 11.5 days.

Conclusion: Türkiye and its surrounding regions are prone to frequent earthquakes, and similar events are expected in the future. A multidisciplinary patient approach, starting from the emergency department, plays a crucial role, with thoracic surgery being an integral part of this approach.

Keywords: Earthquake, Kahramanmaras earthquake, thoracic surgery.

INTRODUCTION

Earthquakes, one of the most significant natural disasters, have caused numerous casualties and property losses throughout history. Particularly, earthquakes with a magnitude of Mw (Moment Magnitude) 7 and above according to the Richter scale result in greater destruction and loss of life.[1] On February 6, 2023, a powerful earthquake measuring 7.8 Mw struck Kahramanmaras, affecting the southern and central parts of Türkiye as well as the northern and western regions of Syria. About 9 hours later, another earthquake with a magnitude of 7.6 Mw occurred to the northeast of the initial one in Kahramanmaras province. According to the Disaster and Emergency Management Authority (AFAD), as of March 6, 2023, the pair of earthquakes and the entire 2023 Kahramanmaras Earthquake Series resulted in over 45,000 confirmed deaths in Türkiye, and the total death toll exceeded 52,000, including Syria.[2]

Looking at the earthquakes that have occurred in the 21st century, the 2004 Indian Ocean earthquake was the most devastating event in terms of casualties, causing 227,898 deaths. It was followed by the 2010 Haiti earthquake with approximately 160,000 deaths, the 2008 Sichuan earthquake with 87,587 deaths, and the 2005 Kashmir earthquake with 87,351 deaths. In terms of fatality rates, the 2023 Kahramanmaras earthquake ranks as the 5th largest earthquake of the 21st century.[3] Both earthquakes are the largest ever recorded in the region. For instance, the estimated magnitudes of earthquakes in 1893, 1872, 1822, and 1513 are known to be in the range of 7.0–7.5 Mw.[4]

In major disasters like earthquakes, injuries often occur in the form of high-energy multi traumas.[5] Without early intervention or proper approaches, these patients may experience permanent disabilities or even face death. The rate of chest trauma after an earthquake has been reported as 1.1%.[6] Most of the serious injuries are due to extremity injuries.[1] In these patients, rhabdomyolysis and acute kidney failure are significant causes of mortality and morbidity.[7] There are limited studies in the literature on the clinical and radiological evaluation of chest trauma in earthquake victims.

One of the closest medical centers after the Kahramanmaras earthquake was Kayseri City Hospital. Our hospital and clinic provided services to numerous earthquake victims. The aim of this study is to contribute to early diagnosis and intervention and multidisciplinary treatment approaches by demonstrating the clinical and radiological findings of chest trauma in a major disaster like an earthquake, thus helping to reduce mortality and morbidity rates.

KEY MESSAGES

- The study shows that 2.3% of 6,500 patients screened after the 2023 Kahramanmaras earthquake suffered chest trauma, highlighting the prevalence of such injuries after major seismic events.
- Elevated creatine kinase (CK) levels, compartment syndrome, extremity fractures, and hemothorax significantly increased the need for dialysis in earthquake victims, stressing the importance of early intervention.
- The average hospital stay for chest trauma patients was 18 days, with factors like dialysis, tube thoracostomy, and fewer rib fractures contributing to longer stays, indicating complex recovery needs.

MATERIALS AND METHODS

Type of research: This study was cross-sectional registry research. Ethical approval: Kayseri City Hospital ethics committee decision no: 815/23.03.2023.

Participants: Between February 6, 2023 and February 20, 2023, a total of 6,500 patients who presented to Kayseri City Hospital due to the earthquake were retrospectively screened through medical hospital records. One hundred fifty patients with blunt or penetrating chest trauma were included in the study. Patients were evaluated based on the date of admission, age, gender, number of rib fractures, side of rib fractures, Creatine Kinase (CK) levels on admission, dialysis requirement, additional systemic pathologies, complications, treatment, length of stay, and survival criteria.

Power analysis: While a power analysis initially determined a sample size of 150, a post hoc analysis using G*Power 3.1 revealed that with this sample size (N=150), the Wilcoxon signed-rank test for a one-sample case would have sufficient power (0.999) to detect an effect size of 0.5.

Statistical Analysis

For the analysis of the data, IBM SPSS (Statistical Package for the Social Sciences) version 25.0 was used. The Shapiro-Wilk test and histogram were used to examine the normal distribution suitability of the variables. Descriptive statistics were presented as frequency, median, and 95% confidence intervals (CI) for the median. This study examined the significance of differences between groups in terms of averages. The Mann-Whitney U test and Kruskal-Wallis test were used for comparisons, while the chi-square test compared frequencies between groups. Additionally, correlation, linear regression, and binary logistic regression

Table 1. Dialysis need according to various characteristics of patients

| | Need for dialysis | | | | | | X² |
| | No | | Yes | | Total | | |
	Count	%	Count	%	Count	%	P
Gender							
Women	71	75.5	23	24.5	94	62.7	1.041
Men	38	67.9	18	32.1	56	37.3	0.308
Age groups (years)							
14–24	21	67.7	10	32.3	31	20.7	22.486
25–34	11	44.0	14	56.0	25	16.7	<0.001
35–44	20	83.3	4	16.7	24	16.0	
45–54	14	63.6	8	36.4	22	14.7	
55–64	12	75.0	4	25.0	16	10.7	
≥65	31	96.9	1	3.1	32	21.3	
Mean±SD	48.4	±20.4	36.2	±14.6	45.1	±19.7	
Hospital arrival time (days)							
0–1	42	70.0	18	30.0	60	40.0	1.916
2–3	29	69.0	13	31.0	42	28.0	0.590
4–5	22	75.9	7	24.1	29	19.3	
≥6	16	84.2	3	15.8	19	12.7	
Rib fracture side							
None	31	67.4	15	32.6	46	30.7	1.320
Right	35	74.5	12	25.5	47	31.3	0.724
Left	30	73.2	11	26.8	41	27.3	
Bilateral	13	81.3	3	18.8	16	10.7	
Number of rib fractures							
0	31	67.4	15	32.6	46	30.7	2.028
1–2	29	78.4	8	21.6	37	24.7	0.567
3–4	25	78.1	7	21.9	32	21.3	
≥5	24	68.6	11	31.4	35	23.3	
Complication							
No	50	86.2	8	13.8	58	38.7	8.729
Yes	59	64.1	33	35.9	92	61.3	**0.003**
Medical treatment							
No	30	65.2	16	34.8	46	30.7	1.854
Yes	79	76.0	25	24.0	104	69.3	0.173
Tube thoracostomy							
No	82	74.5	28	25.5	110	73.3	0.733
Yes	27	67.5	13	32.5	40	26.7	0.392
Hospitalization (days)							
0–3	26	92.9	2	7.1	28	18.7	25.034
4–7	24	92.3	2	7.7	26	17.3	<**0.001**
8–14	28	77.8	8	22.2	36	24.0	
15–21	13	56.5	10	43.5	23	15.3	
≥22	18	48.6	19	51.4	37	24.7	
Total	**109**	**72.7**	**41**	**27.3**	**150**	**100.0**	

SD: Standard deviation.

Table 2. Analysis of the factors affecting the need for dialysis using binary logistic regression

	B	P	OR	95% CI for OR	
				Lower	Upper
CK value	0.000	0.002	1.000	1.000	1.000
Limb fracture	2.375	0.040	10.746	1.112	103.851
Compartment	3.124	0.037	22.726	1.213	425.818
Hemothorax	2.829	0.041	16.930	1.115	256.989
Systemic fluid overload	2.821	0.048	16.797	1.020	276.612
Hospitalization (days)	0.032	0.070	1.033	0.997	1.069
Constant	-12.253	0.001	0.000		

Hosmer and Lemeshow Test χ^2=0.672, p=1.000. Nagelkerke R^2=0.892; OR: Odd ratios; CI: Confidence interval; CK: Creatine kinase.

were employed to assess relationships between variables. To identify factors influencing patients' need for dialysis, binary logistic regression with the backward LR model was employed. Similarly, linear regression with the backward model was used to analyze factors affecting patients' CK values and hospital stay. Categorical variables included in linear regression were first converted into dummy variables and included in the analysis. The variables found to be statistically significant as a result of this analysis are shown in the table. Results with p<0.05 were considered statistically significant.

RESULTS

Among the 6,500 patients whose information was screened through the hospital information system, chest trauma was identified in 150 (2.3%) cases. Of the included patients, 62.7% were female, and 37.3% were male.

The mean age was 45.1±19.7 years, with an age range of 14 to 101 years. Forty percent of patients arrived at the hospital within 0–1 days, and 10.7% arrived after 6 days or more, with the longest duration being on the 11th day. The average duration of hospital stay was 2.9 days, with a median of 2 days. Rib fractures were absent in 30.7% of patients; 31.3% had fractures on the right side, 10.7% had bilateral fractures, and 23.3% had 5 or more rib fractures. Complications occurred in 61.3% of patients, 69.3% received medical treatment, and 26.7% underwent tube thoracostomy. Additionally, 24.0% of patients were hospitalized for 8–14 days, and 24.7% stayed in the hospital for 22 days or longer (Table 1). Hospital stays ranged from 0 to 162 days, with an average duration of 18 days and a median duration of 11.5 days.

Factors affecting the need for dialysis in patients were analyzed using binary logistic regression with backward elimination (Backward LR). The study found that an increase in CK value, extremity fractures, compartment syndrome, hemothorax,
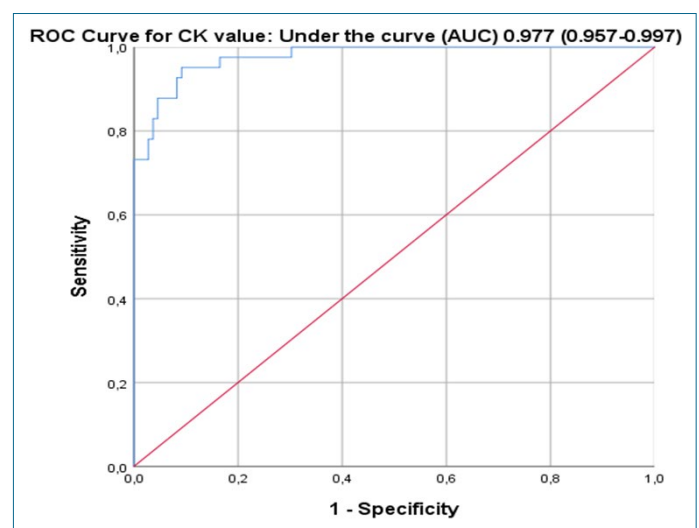

Figure 1. Receiver operating characteristic (ROC) analysis of CK values to determine the need for dialysis.

and the presence of systemic fluid overload all influenced the need for dialysis. The presence of brain trauma also had an impact (p=0.053); however, this result was borderline insignificant (Table 2).

When Receiver Operating Characteristic (ROC) analysis was conducted to determine the cut-off value for the CK level predicting the need for dialysis, the area under the curve (AUC) was 0.977 (95% CI, 0.957–0.997). If the CK level is ≥7 IU/l/1000, its sensitivity in indicating the need for dialysis was 95.1%, and its specificity (1–0.092) was 90.8% (Fig. 1).

The mean CK value of the patients was 23,750.1±54,201.5 (median 2,357, min: 46, max: 354,476). When analyzing the factors affecting the CK values of patients upon hospital

Table 3. Analysis of the factors affecting creatine kinase values by linear regression upon hospital admission

	Unstandardized coefficients		Standardized coefficients	t	P	95% CI for B	
	B	SE	β			Lower bound	Upper bound
(Constant)	16.681	10.518		1.586	0.115	-4.109	37.471
Age	-0.443	0.192	-0.161	-2.308	0.022	-0.822	-0.064
Gender (male)	22.452	7.228	0.201	3.106	0.002	8.166	36.739
Intra-abdominal organ damage	47.614	10.679	0.293	4.459	0.000	26.506	68.723
Organ loss	45.549	12.369	0.245	3.683	0.000	21.102	69.997
Compartment syndrome	34.757	8.529	0.275	4.075	0.000	17.899	51.615

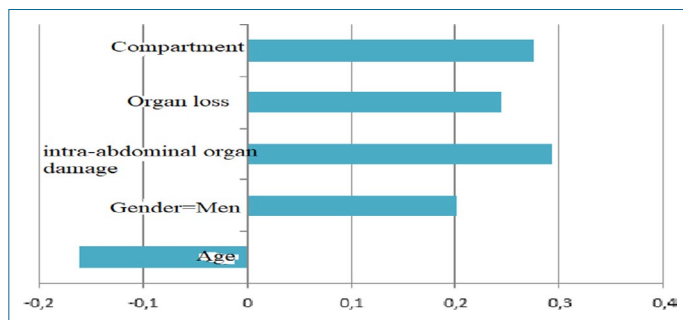CI: Confidence interval; SE: Stdard error.

Figure 2. Standardized β values of factors affecting the CK levels of patients upon hospital admission, according to linear regression analysis (Table 3).

Figure 3. Standardized β values of factors affecting the length of hospital stay, according to linear regression analysis (Table 5).

admission using linear regression, the following factors were found to influence CK values: the presence of intra-abdominal organ damage (β=0.293), compartment syndrome (β=0.275), organ loss (β=0.245), being male (β=0.201), and decreasing age (β=-0.161) (Table 3, Fig. 2). These variables accounted for 39.0% of the variation in CK values (Adj. R^2=0.390). There was no statistically significant relationship between CK values and the time of patient admission to the hospital, the number of rib fractures, vertebral fractures, brain injuries, extremity fractures, and the presence of tube thoracostomy (Table 3).

The difference between the age groups of 25–34 and 65+ was found to be significant (p=0.002) (Table 4). Post hoc analysis revealed significant differences in median length of stay between the 25–34 age group (16 days) and the 65 and over group (5 days). There were no statistically significant differences between the other age groups. As patients' age decreases, the length of hospital stay increases (r=-0.206, p<0.05). A moderate positive relationship (Rho=0.565,
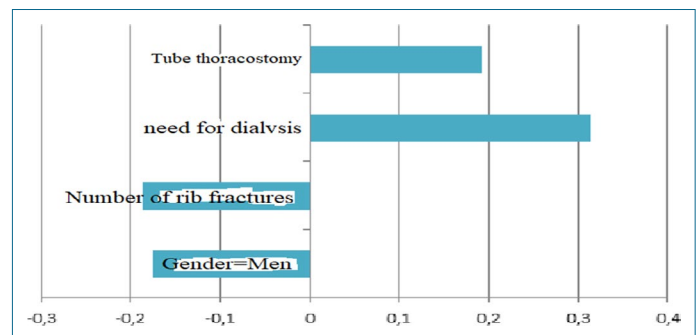
p<0.001) was detected between the CK value and the length of hospital stay. Patients who arrived at the hospital 6 days or more after the event had a shorter hospital stay compared to those who arrived earlier. However, there was no correlation (r=-0.139) between the time of arrival at the hospital and the length of hospital stay (p>0.05).

When analyzing the factors affecting the length of hospital stay using linear regression, the following factors were found to influence hospitalization duration: the presence of dialysis requirement (β=0.314), the presence of tube thoracostomy (β=0.193), a decrease in the number of rib fractures (β=-0.185), and being female (β=-0.175) (Table 5, Fig. 3).

No significant relationship was found between the length of hospital stay and age, CK value, time of arrival at the hospital, vertebral fractures, brain injuries, intra-abdominal organ damage, extremity fractures, organ loss, and compartment syndrome.

Table 4. Length of stay in the hospital according to various characteristics of the patients

	Median	Hospitalization		
		95% lower CI for median	95% upper CI for median	
Gender				
Women	13	10	17	1.229[a]
Men	10	7	13	0.219
Age groups (years)				
14–24	13	10	22	18.802[b]
25–34	16	12	19	**0.002**
35–44	16	13	24	
45–54	8	3	11	
55–64	14	6	23	
≥65	5	4	10	
Arrival time to hospital (days)				
0–1	14	11	16	14.745[b]
2–3	11	6	19	0.002
4–5	13	10	21	
≥6	4	1	7	
Rib fracture side				
None	15	11	21	6.073[b]
Right	9	5	13	0.108
Left	12	7	17	
Bilateral	11	6	21	
Number of rib fractures				
None	15	11	21	8.482[b]
1–2	5	4	14	0.037
3–4	12	10	16	
≥5	10	8	17	
Complication				
No	8	6	16	2.487[a]
Yes	13	11	16	0.013
Medical treatment				
No	14	12	19	2.229[a]
Yes	10	8	14	0.026
Tube thoracostomy				
No	10	7	14	2.316[a]
Yes	14	12	19	0.021
Total	12	9	14	

CI: Confidence interval; a: Mann-Whitney U Test; b: Kruskal-Wallis Test.

Table 5. Analysis of factors affecting hospitalization time using linear regression

Adj.R²=0.150	Unstandardized coefficients		Standardized coefficients	t	P	95% CI for B	
	B	SE	β			Lower bound	Upper bound
(Constant)	16.211	3.363		4.820	0.000	9.563	22.859
Gender (men)	-8.541	3.801	-0.175	-2.247	0.026	-16.055	-1.027
Number of rib fractures	-1.877	0.857	-0.186	-2.191	0.030	-3.570	-0.183
Need for dialysis	16.618	4.053	0.314	4.100	0.000	8.607	24.629
Tube thoracostomy	10.300	4.474	0.193	2.302	0.023	1.457	19.143

CI: Confidence interval; SE: Stdard error.

DISCUSSION

The Great Kahramanmaras earthquake has been recorded as one of the top 5 deadliest earthquakes of the 21st century in terms of death toll. Such large-scale disasters are unpredictable catastrophes. However, by taking individual and societal precautions, the destructive effects of natural disasters can be minimized. For instance, the development of early warning systems for earthquakes is an ongoing valuable effort.[8]

In earthquakes, injuries typically occur as high-energy multi traumas.[9] Extremity injuries are the most common, and orthopedic interventions are often crucial.[10,11] Consistent with the literature, our study also found that the majority of patients had extremity fractures.

The post-earthquake chest trauma rate has been reported to range between 1.1% and 15.6%.[6,12] In our study, out of a total of 6,500 patients, 150 (2.3%) were identified to have chest trauma.

Chest trauma after earthquakes often involves rib fractures. Serious complications include pneumothorax, hemothorax, major vascular injuries, cardiac injuries, and bronchial rupture. These complications can lead to death if not treated early. In our study, among the included 150 patients, 34 (22%) developed pneumothorax, and 28 (18%) underwent tube thoracostomy. Similarly, 42 patients (28%) developed hemothorax, and 16 (10%) underwent tube thoracostomy.

Rhabdomyolysis and acute kidney failure are significant causes of morbidity and mortality in these patients. Crush syndrome, resulting from injury to muscle cells and known as rhabdomyolysis, is a condition where increased intracellular calcium levels lead to cellular breakdown through protease activation. Many systems in the body, especially the urinary system, are affected by this condition. The most common cause of mortality in this syndrome is the disruption of hemodynamics and the toxic effect of circulating muscle breakdown products on the kidneys.[13] In our study, factors influencing the need for dialysis in patients were the increase in CK value, compartment syndrome, extremity fracture, and the presence of hemothorax. The length of hospital stay also had an impact (p=0.070), although this finding was borderline insignificant. It should be noted that in the presence of hemothorax, acute kidney failure that could require dialysis might develop.

CK is present in various striated and smooth muscles as well as the brain. It is an important regulatory enzyme for high-energy phosphate production and utilization in contractile tissues. Serum CK activity is routinely measured as a sensitive indicator of skeletal muscle and myocardial injuries. It is a useful marker for indicating the severity of muscle injuries and is commonly used in routine practice.[14] In our study, elevated initial CK levels were statistically significantly associated with intra-abdominal organ damage, compartment syndrome, organ loss, being male, and decreasing age. However, no statistically significant relationship was found between CK levels and the time of patient admission to the hospital, the number of rib fractures, vertebral fractures, brain injuries, extremity fractures, and the presence of tube thoracostomy. Elevated CK levels are closely related to the need for dialysis. In natural disasters causing high-energy traumas such as earthquakes, CK levels should be measured and monitored upon initial presentation.

After earthquakes, the length of hospital stay in field hospitals varies between 24 hours and 1 week.[15] In hospitals without field capabilities, this duration is naturally longer. In our study, the average length of hospital stay for patients with chest trauma was found to be 18 days. The factors influencing the length of hospital stay are the presence of a dialysis requirement, the presence of tube thoracostomy,

a decrease in the number of rib fractures, and being female. No significant relationship was found between the length of hospital stay and age, CK value, time of arrival at the hospital, vertebral fractures, brain injuries, intra-abdominal organ damage, extremity fractures, organ loss, or compartment syndrome. This situation was thought to be due to the non-homogeneous distribution of age groups and the fact that the young adult age group was the most affected.

The duration of being trapped under debris and the time it takes to reach the hospital are of critical importance in earthquakes. Contrary to expectations, in our study, patients who arrived at the hospital 6 days or more after the event had a shorter hospital stay compared to those who arrived earlier. However, there was no correlation (r=-0.139) between the time of arrival at the hospital and the length of hospital stay (p>0.05). This could be explained by the fact that those who arrived at the hospital later were less affected by the trauma, and as the time spent under the rubble increases, the chances of survival decrease.

CONCLUSION

In conclusion, Türkiye and its surrounding regions are geographically prone to earthquakes, which frequently occur and will likely continue to do so in the future. Therefore, all earthquake-related data should be collected and analyzed. The first few hours after an earthquake and search and rescue operations are of vital importance. Following that, a multidisciplinary patient approach starting from the emergency department is crucial, with thoracic surgery being a part of this multidisciplinary approach.

Ethics Committee Approval: The Kayseri City Hospital Clinical Research Ethics Committee granted approval for this study (date: 21.03.2023, number: 815/23.03.2023).

Author Contributions: Concept – MAE, BM; Design – MAE, MAT; Supervision – MAE, BM; Resource – İEÖ, MK; Materials – İEO, BM; Data Collection and/or Processing – MAE, MK; Analysis and/or Interpretation – HE, MK; Literature Search – İEÖ, MAT; Writing – MAE; Critical Reviews – MAE, MAT.

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REFERENCES

1. Huang X, Guo Q, Li C, Wang Y, Song L, Shang K, et al. Intensive care unit treatment strategy and algorithm for critical patients from Lushan earthquake. Zhonghua yi xue za zhi 2014; 94(15): 1130–4.

2. AFAD. Kahramanmarasta-meydana-gelen-depremler-hk-36. 2023 Available from: URL: https://www.afad.gov.tr/kahramanmarasta-meydana-gelen-depremler-hk-36. Accessed Jul 3, 2024.

3. Wikipedia: Lists of 21st-century earthquakes. Available from: URL: https://en.wikipedia.org/wiki/Lists_of_21st-century_earthquakes. Accessed Jul 3, 2024.

4. Ambraseys NN. Temporary seismic quiescence: SE Turkey. Geophysical J Int 1989; 96(2): 311–31. [CrossRef]

5. Daito H, Suzuki M, Shiihara J, Kilgore PE, Ohtomo H, Morimoto K, et al. Impact of the Tohoku earthquake and tsunami on pneumonia hospitalisations and mortality among adults in northern Miyagi, Japan: a multicentre observational study. Thorax 2013; 68(6): 544–50. [CrossRef]

6. Sato K, Kobayashi M, Ishibashi S, Ueda S, Suzuki S. Chest injuries and the 2011 Great East Japan Earthquake. Respiratory investigation 2013; 51(1): 24–7. [CrossRef]

7. Fan Z, Li A, Lian B, Zhou W, Wei H, Chen C, et al. Injury types of victims in the 12th May 2008 Wenchuan earthquake: analysis of 1,038 patients in Jiangyou City. European J Trauma and Emer Surg 2011;37:3–7. [CrossRef]

8. Cremen G, Galasso C. Earthquake early warning: Recent advances and perspectives. Earth-Science Reviews 2020; 205: 103184.

9. Uz İ, Çetin M, Songur Kodik M, Güvenç E, Karbek Akarca F, Ersel M. Emergency department management after the 2020 Aegean Sea - Izmir earthquake. 2020 Ege Denizi - İzmir depremi sonrası acil servis yönetimi. Ulus Travma Acil Cerrahi Derg 2022; 28(3): 361–8. [CrossRef]

10. Lee C, Rasmussen TE, Pape HC, Gary JL, Stannard JP, Haller JM. The polytrauma patient: Current concepts and evolving care. OTA Int 2021; 4(2S): e108. [CrossRef]

11. Bulut M, Fedakar R, Akkose S, Akgoz S, Ozguc H, Tokyay R. Medical experience of a university hospital in Turkey after the 1999 Marmara earthquake. Emerg Med J 2005; 22(7): 494–8.

12. Seyed MG, Moosa Z, Ali K, Mojgan K. Chest injury in victims of Bam earthquake. Chinese J Traumatology 2006; 9(6): 345–8.

13. Dimitriou N. Basics of Trauma Management: Crush Injuries. Emergency Medicine, Trauma and Disaster Management: From Prehospital to Hospital Care and Beyond: Springer; 2021. p. 299–309.

14. Takagi Y, Yasuhara T, Gomi K. Creatine kinase and its isozymes. [Article in Japanese]. Rinsho Byori 2001; Suppl 116: 52–61.

15. Bar Dayan Y, Mankuta D, Wolf Y, Levy Y, Van Rooyen M, Beard P, et al. An earthquake disaster in Turkey: an overview of the experience of the Israeli Defence Forces Field Hospital in Adapazari. Disasters 2000; 24(3): 262–70. [CrossRef]