


# Our clinical experiences in the earthquake victims who came to our university after the 2020 Aegean Sea earthquake during the COVID-19 pandemic

 Zeynep Çağırın, M.D.,<sup>1</sup>  Nezh Sertöz, M.D.,<sup>1</sup>  Semra Karaman, M.D.,<sup>1</sup>  Didem Özen, M.D.,<sup>1</sup>  
 Mesut Demirkoparan, M.D.,<sup>2</sup>  Meltem Uyar, M.D.,<sup>1</sup>  Kemal Aktuglu, M.D.<sup>2</sup>

<sup>1</sup>Department of Anesthesiology and Reanimation, Ege University Faculty of Medicine, İzmir-Türkiye

<sup>2</sup>Department of Orthopaedics and Traumatology, Ege University Faculty of Medicine, İzmir-Türkiye

## ABSTRACT

**BACKGROUND:** Earthquakes are natural disasters that threaten human life and cause loss of life and property in a very short time. In our study, we aim to carry out the medical analysis of the earthquake victims who came to our hospital after the Earthquake in the Aegean Sea and to share our clinical experiences.

**METHODS:** We retrospectively analyzed patients the medical data records of earthquake victims brought to our hospital or the injured who applied due to the Aegean Sea earthquake. Patients demographic data, their complaints and diagnoses, hour of admission, their clinical courses, hospital arrangements (admission, discharge, and transfer), time spent until the operation, anesthesia methods, surgical interventions, intensive care needs, crush syndrome, presence of acute renal failure, number of dialysis, mortality, and morbidity were reviewed.

**RESULTS:** A total of 152 patients were brought to our hospital due to the earthquake. The most intense period of admission to the emergency department was the 1st 24–36 h. Mortality rate was found to be higher depending on the increase of age. While the most common cause of admission for the mortal earthquake survivors was to be trapped in the wreckage, the survivors applied for other reasons as well such as falling down. The most common type of fracture observed in survivors was the lower extremity fractures.

**CONCLUSION:** Epidemiological studies can make an important contribution to the management and organization of the future earthquake-related injuries by healthcare institutions.

**Keywords:** Anaesthesia; crush injury; earthquake; morbidity; mortality.

## INTRODUCTION

Earthquakes are natural disasters that threaten human life and cause loss of life and property in a very short time. In our country where a large part of the population faces the risk of earthquakes, unfortunately, devastating earthquakes which put the country at a disadvantage in terms of social and economic aspects, are frequently experienced.<sup>[1]</sup> Early and rapid identification of fatal earthquake-related trauma, providing optimal care, can be potentially valuable for reduc-

ing mortality after earthquakes in adult patients. The age of the earthquake victim, high respiratory rate and heart rate, low diastolic blood pressure and Glasgow Coma Scale, presence of crush injury, and chronic diseases such as congestive heart failure, malignant tumor, and chronic kidney failure are the risk factors that increase mortality.<sup>[2]</sup>

On October 30, 2020, at 14.51 local time in Türkiye, an earthquake with a depth of 14.9 km occurred at a distance of approximately 22 km from the district of Seferihisar with-

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Address for correspondence: Zeynep Çağırın, M.D.

Ege Üniversitesi Tıp Fakültesi, Anesteziyoloji ve Reanimasyon Anabilim Dalı, İzmir, Türkiye

Tel: +90 232 - 390 21 40 E-mail: zeynep.pestilci@gmail.com

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in the borders of Türkiye, its epicenter was subtly in north of the Greek island of Samos. According to the data of the Disaster and emergency management presidency, the earthquake was with a magnitude of 6.6 Mw, according to the data of the Kandilli Observatory it was 6.9 Mw, and according to the data of the US Geological Survey and Euro-Mediterranean Seismology Center, it was 7.0 Mw and lasted approximately 16 s. It went down as the Aegean Sea Earthquake. The incident, which killed 119 people in total, injured more than 1050 people and left nearly 15,000 people homeless in Türkiye and Greece.

The epidemic which emerged in December 2019 and was named as the COVID-19 pandemic by the World Health Organization in 2020 has caused to different principles in the working order and management of polyclinic, normal, and emergency operating room. These principles are based on measures such as rapid identification of infected patients for the control of the disease, isolation of possible cases, and pandemic-specific regulation of hospital triages in emergencies.

Since our institution is the closest full-fledged hospital to the region most affected by the earthquake, it became the center where the highest number of earthquake victims was transported. In addition, being in the COVID-19 pandemic period caused difficulties in patient triage and special precautions to be taken. In this study, we aim to perform the medical analysis of earthquake victims who came to our hospital after the Aegean Sea earthquake and to share our clinical experience.

## MATERIALS AND METHODS

After gaining the approval of the Local Ethics Committee, we retrospectively examined the medical records of the injured who applied to our hospital after the October 30, 2020, and November 10, 2020, Aegean Sea earthquake. The demographic data of these patients, their complaints, and diagnoses, what time they were brought to the hospital after the earthquake, their clinical courses, hospital arrangements (admission, discharge, and transfer), time spent until the operation, anesthesia methods, surgical procedures performed and their numbers, intensive care needs, crush syndrome and/or presence of acute renal failure (ARF), number of dialysis, mortality, and morbidity were scanned from the hospital computer system.

Statistical analyses in this study were carried out using the SPSS 24 (Statistical Package for the Social Sciences–IBM®) program. In the study, descriptive statistics regarding the distribution of responses given to independent variables were presented as numbers and percentages for categorical variables and mean, standard deviation, and median for numerical variables. The conformity of continuous variables to the assumption of normal distribution was evaluated with the Kolmogorov–Smirnov test. Chi-square test and Fisher's exact test were used for paired and multiple comparisons, whereas

Independent t-test and one-way Anova test were used quantitative variables. In more than two intergroup comparisons of quantitative variables, Tukey test was used. In addition, ROC analysis was used to determine the cutoff point for numerical variables. In multivariate analysis, independent predictors were examined to predict the mortality and survival outcome using logistic regression analysis. To determine the statistical significance level,  $p < 0.05$  at the 95% confidence interval was considered significant.

## RESULTS

During the study period, a total of 152 earthquake victims were brought to the emergency service related to the earthquake. As a result of the study, the number of mortal earthquake victims was 39 (25.7%) and the number of non-mortal earthquake victims was 113 (74.3%). Of all the earthquake victims who applied to the hospital, 60 (39.5%) were male and 92 (60.5%) were female. It was determined that 33 (21.7%) earthquake victims were under the age of 18 and 119 (78.3%) were aged 18 and over. The age average of the earthquake victims in the study was  $38.13 \pm 20.37$  years.

The differences between the groups of earthquake victims that develop and do not develop mortality in the study in terms of gender were not found statistically significant in terms of the differences between the age averages of the patients according to their gender, the difference between the duration of their operation, the difference between the number of surgical interventions, and the difference between the anesthesia methods ( $p > 0.05$ ).

In the study, the age average of the earthquake victims who developed mortality was  $45.97 \pm 21.99$  years, while the age average of the survivors was  $35.43 \pm 19.15$  years. There was a statistically significant difference between the ages of the patients and their mortality development status ( $p < 0.05$ ). In the study, the mean time from the moment of the occurrence of the earthquake to the emergency service admission was  $7.37 \pm 8.02$  h in the patients who progressed mortal, while it was  $9.64 \pm 17.70$  h in the surviving patients. This difference between both groups was significant ( $p < 0.05$ ). In the study, the mean time from the occurrence of the earthquake to the surgery in earthquake victims that progress mortality was  $5.17 \pm 30.71$  h, while it was founded as  $4.01 \pm 20.11$  h in survivors. This difference between both groups was significant ( $p < 0.05$ ) (Table 1).

In the study, when the patients' causes of admission to the hospital were examined; 23.6% ( $n=36$ ) of those who progressed mortality consisted of those trapped in the wreckage, there was only 1.97% ( $n=3$ ) patient in total, one patient each, who progressed mortality due to other reasons such as falling, headache, syncope, head, and eye trauma. At most, 38.82% ( $n=59$ ) of the surviving patients applied for being trapped in the wreckage. It was observed that 35.5% ( $n=54$ )

**Table 1.** Comparison of the mortality status of the patients with the mean values of age, time elapsed after the earthquake and time until surgery

Variable	Mortality (n=39)	Non mortality (n=113)	Total	p
	Mean±SD	Mean±SD	Mean±SD	
Age	45.97±21.99 (min: 6 max: 91)	35.43±19.15 (min: 1 max: 88)	38.13±20.37 (min: 1 max: 91)	0.005*
Time elapsed after the earthquake (hour)	7.37±8.02 (min: 1 max: 28)	9.64±17.70 (min: 0.5 max: 92)	9.05±15.79 (min: 0.5 max: 92)	0.011*
Time until surgery (hour)	5.17±30.71 (min: 0 max: 192)	4.01±20.11 (min: 0 max: 140)	4.33±23.18 (min: 0 max: 192)	0.042*

\*Significant at the p<.05.

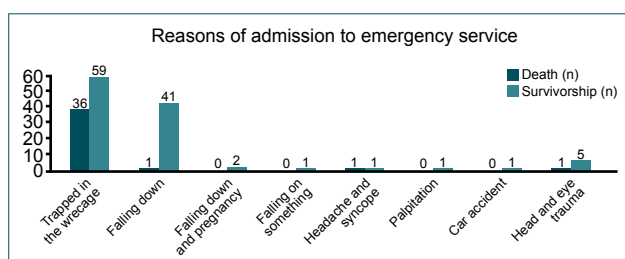
of the surviving patients applied to the hospital for falling down and other reasons. These differences were significant in terms of the causes of admission between the two groups (p<0.05) (Fig. 1).

About 11.8% (n=18) of earthquake victims had lower extremity fractures, 5.2% (n=8) had upper extremity fractures, 3.2% (n=5) had pelvis fractures, and 2.6% (n=4) had a vertebral fracture. One patient had shoulder dislocation, which was treated with reduction in the emergency room.

Conservative treatment was applied to 13.16% (n=20) of the surviving patients, while follow-up, splint and surgical treatment were applied to 35.53% (n=54), 3.95% (n=6), and 6.58% (n=10) of them, respectively. Surgery was performed in 3.95% (n=6) of patients who progressed mortality.

While 12 patients underwent emergency operations in the 1<sup>st</sup> 24 h after admission to the hospital, four patients were operated under elective conditions after 72 h.

In the study, it was founded that crush syndrome and ARF developed in 3.95% (n=6) of the patients who progressed mortality, and 1.32% (n=2) of these patients underwent dialysis. It was observed that crush syndrome/ARF developed in 8.55% (n=13) of the surviving patients and only 1.32% (n=2) of these patients underwent dialysis. These differences were not significant in terms of the development of crush syndrome/ARF and undergoing dialysis between the two groups (p>0.05).



**Figure 1.** The relationship between the mortality status of the patients and the reasons for admission to the emergency department.

About 7.9% (n=12) of the patients were treated in the intensive care unit (ICU) and 3.95% (n=6) of these patients progressed mortal. This difference between the patients who progressed mortal and the surviving patients in terms of the state of staying in the ICU is significant (p<0.05). Only 1.97% (n=3) of the surviving patients were transferred to somewhere else.

In terms of morbidity, ARF was developed in 1.32% (n=2) of the surviving patients, drop foot in 3.28% (n=5), compartment syndrome in 3.28% (n=5), shoulder dislocation in 0.66% (n=1) droopy eyelid, 0.66% (n=1) droopy eyelid, and dermatitis in 0.66% (n=1).

Mild injuries of various levels were detected in 67 (44.7%) of the wounded who were brought to the emergency service, and they were discharged on the same day after receiving the emergency care and interventions. Thirty-nine patients (25.6%) were monitored in the wards for observation and follow-up. Eleven (7.2%) patients were admitted to the ICU of our hospital for diagnosis and treatment. The longest hospitalization period of a patient to undergo a treatment in our hospital was 92 days.

It was observed that 16.45% (n=25) of the patients brought to the emergency were entered into the system as dead when they came to the emergency service, that 3.94% (n=6) came to the emergency with CPR in case of cardiac arrest, that cardiac arrest was developed in 1.32% (n=2). CPR was performed after a very short time, they had been brought to the emergency. Exitus developed in 3.94% (n=6) patients who were treated in the ICU in the following days. The period with the highest mortality in the Aegean Sea earthquake was founded as the 1<sup>st</sup> 24–36 h.

## DISCUSSION

The World Health Organization (WHO) defines all kinds of natural, technological, or man-made events as disasters, which cause loss of life and property for people, affect the so-

ciety physically and psychologically, and cannot be overcome with local opportunities.<sup>[3]</sup>

Due to the fact that we were in the pandemic period and there was a curfew for people under the age of 18 and over 65 on the day when the earthquake happened in the Aegean Sea, these age groups were more densely in the houses. We see that the average age of the earthquake victims who progressed as mortal is higher as a result of the fact that older earthquake victims have lesser capacity for mobility or due to being home care patients, they could not act quickly enough or enter to the life-saving life triangle during earthquake. In the results reported by Bulut and his friends after the Marmara earthquake, there was no difference between those who progressed mortal and those who did not in terms of age average. This may be attributed to the fact that the earthquake took place at a time when everyone was asleep.<sup>[4]</sup> It was stated that the number of children under the age of 15 who applied to the hospital in the 2015 Nepal earthquake was as low as 17.2%. They attributed this to the fact that the earthquake had occurred during daytime and most of the children had been outside, and they also stated that bone fractures required less surgical treatment due to growing bone structures.<sup>[5]</sup>

Most of the patients who progressed mortality were earthquake victims who were saved from the wreckage. However, only 38.82% of the non-mortal patients applied for being trapped in wreckage and 26.97% after falling down. This result was similar to the previous earthquakes. The earthquake victims who were trapped under the wreckage were generally the cases with multiple organ injuries and trauma that could not survive the transport that required the first intervention in the earthquake area and they either died on the scene or shortly after their admission to the hospital despite all the interventions.<sup>[6]</sup> However, as stated in the literature, it was determined that the traumas of patients who did not progress mortal were caused by the displacement of things during earthquake or loss of their balance and falling down during the shock.<sup>[5]</sup>

In the earthquake victims who were treated in the hospital, the types of injuries were head, thorax, abdomen, and eye trauma, while 21% of the patients had fractures. While 56.2% of the fractures consisted of lower extremity fractures, 25% consisted of upper extremity fractures, 15.6% consisted of pelvis fractures, and 12.5% consisted of vertebral fractures. As seen after the Hanshin-Awaji and Marmara Earthquake, fractures are the most common forms of trauma observed in the earthquake victims of the Aegean Sea earthquake as well.<sup>[4,7]</sup> As indicated in the previous publications containing earthquake analysis fractures, extremity fractures, especially lower extremity fractures, are the most common areas for fracture.<sup>[8-10]</sup> Later, upper extremity fractures were observed. Again, the second most common spinal fracture in the Marmara Earthquake, the Northridge, Armanian, and The Loma Prieta earthquakes, in which lower extremity fractures most

commonly observed, the third most common was pelvic fracture, while pelvic fractures were the second most common in the Aegean Sea earthquake, and the spinal fractures were the third.<sup>[4,7,11,12]</sup> Head, abdomen, and chest traumas consisted of <30%. As stated before, non-orthopedic injuries such as head, abdomen, and thorax progress more severely and result in death.<sup>[8,10]</sup>

Surgery was performed on 16 patients with polytrauma. While 12 patients were operated urgently in the 1<sup>st</sup> 24 h, five patients were operated under elective conditions. Osteosynthesis and fixation were performed in 14 patients, fasciotomy in five patients, and amputation in one patient by the orthopedics clinic. Cervical instrumentation was performed by neurosurgery, embelectomy by cardiovascular surgery, thoracotomy by thoracic surgery, maxillary fracture operation by plastic surgery, cesarean section for one patient by gynecology and obstetrics service, and vitrectomy for one patient by ophthalmology. In the anesthesia management, both general and regional anesthesia was applied to the earthquake victims. When the previous literature was examined, it was seen that general, regional, local, or monitored anesthesia care with sedation were applied in the selection of anesthesia for the patients. Predicting the hemodynamic instability that may be accompanied by dehydration and bleeding and the risk of aspiration as a result of being full, induction of anesthesia with ketamine can be considered in these patients. We also used ketamine in the induction and maintenance of anesthesia in patients on inotropic support with unstable hemodynamics. Neuraxial anesthesia may be considered when it is assured that patients do not have a volume deficit. We were able to perform neuraxial anesthesia in patients whose vascular access was opened by health-care teams even when they were just being removed out of the wreckage, their fluid treatment was started or fluid treatment was awaited in the semi-emergency position and they were taken under the operation after being hemodynamically stable. Although peripheral blocks are the ideal anesthesia technique due to providing excellent anesthesia and post-operative analgesia, peripheral (popliteal) block was applied to only one patient due to lack of time, equipment, and team at that time. As in the meta-analysis written by Missair et al.,<sup>[10]</sup> general anesthesia has been the most applied anesthesia technique after the Aegean Sea earthquake. Although neuraxial anesthesia reduces the need for mechanical ventilators, the frequency of use of neuraxial anesthesia is limited by the admission of the patient in chaotic emergency conditions such as earthquakes, unknown volume status, and possible hypotension and bradycardia after neuraxial anesthesia.<sup>[13]</sup> Since peripheral blocks will provide more stable hemodynamics, minimal side effects, and long-term post-operative analgesia with catheters compared to neuraxial blocks and general anesthesia, they are considered to be an excellent choice of anesthesia.<sup>[14]</sup> We preferred general anesthesia in the operations because of the multitrauma and possible or existing hemodynamic instabilities of the earthquake victims.

Crush injury is observed as a result of injuries such as crushing of the tissue caused by being trapped in wreckage and Crush syndrome is observed as a result of the damage to the kidneys caused by myoglobin arising from the muscle tissue.<sup>[15,16]</sup> Intensive fluid treatment, alkalization, forced diuresis, or renal replacement therapy in necessary cases may prevent ARF or fatal course crush syndrome in patients with crush injuries. It has been argued that the development of myoglobinuric ARF can be prevented if the people trapped under the wreckage are rescued in the 1<sup>st</sup> 6 h.<sup>[17,18]</sup> The time spent under the wreckage and the number of extremities subjected to trauma and applied fasciotomy and amputated are directly proportional. In addition, these patients have more severe compartment syndromes and higher risk of infection.<sup>[19]</sup> That's why the 1<sup>st</sup> 6–8 h, which are considered golden hours, have critical importance.<sup>[19–21]</sup> There were no differences between patients who survived or progressed mortal after the Aegean Sea earthquake in terms of the development of Crush syndrome or ARF. We also attributed the successful crush syndrome management to the establishment of vascular access by experienced teams even before they were removed under the wreckage and the initiation of fluid replacement treatment at this stage and close monitoring of the kidney functions and electrolytes of these patients at the hospital and dialyzed early in necessary cases. The duration of being rapped under the wreckage for the patients who progressed mortal crush syndrome was more than 6 h in our case, except for one patient, but no significant relationship was found between the duration and the development of ARF.

As expected, the need for intensive care was higher in patients who progressed mortal than those who did not. These patients were polytraumatized cases who had stayed under the wreckage for a long time.

ARF was faced as a morbidity in two of the surviving patients. The duration of these patients' stay under the wreckage was long hours such as 34 and 57 h. Again, two cases of the patients who developed drop foot as morbidity were patients that had stayed under the wreckage for a long time and underwent fasciotomy.

The patient with the longest hospital stay was a female patient with multitrauma who was removed from the wreckage after 16 h. After the fasciotomy opened urgently due to compartment syndrome in the right arm and leg, the patient required debridement operations many times. The patient, who also had facial injury, was discharged with lagophthalmos due to tissue loss in the frontal region and amputation of the right leg below the knee on the 92<sup>nd</sup> day. The patient had no abdominal or chest trauma. As stated before, although the number of extremities traumatized increases the morbidity such as the time spent under the wreckage and infection, the absence of abdominal and chest trauma in patients suggests to have a positive effect on survival.

The number of COVID-19 cases in Türkiye had increased by 20% in the week before the earthquake.<sup>[22]</sup> In the statement made by the Izmir Governor's Office 3 weeks after the earthquake, it was stated that the number of COVID-19 (+) cases and virus-related deaths increased 3 times as of that day due to the chaos and uncontrolled contamination.<sup>[23]</sup>

The limitations in our study are caused by the fact that our study is retrospective and the information was gathered from the hospital computer system after receiving the names of the patients.

## Conclusion

As in our study, epidemiological studies provide a systematic approach to earthquake-related injuries and treatment of all hospitalized earthquake victims. Data from epidemiological studies can make an important contribution to the management and organization of the future earthquake-related injuries by healthcare institutions. In addition, providing disaster-related training, practices, and intermittent controls of devices can reduce secondary injuries during earthquakes.

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**Ethics Committee Approval:** This study was approved by the Ege University Medical Research Ethics Committee (Date: 10.06.2021, Decision No: 21-6T/67).

**Peer-review:** Externally peer-reviewed.

**Authorship Contributions:** Concept: Z.Ç., K.A., M.U.; Design: Z.Ç., S.K., K.A.; Supervision: Z.Ç., M.U., N.S.; Data: M.D., D.Ö.; Analysis: M.D., D.Ö.; Literature search: M.D., D.Ö., N.S.; Writing: Z.Ç., S.K., N.S.; Critical revision: S.K., K.A., M.U.

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## ORJİNAL ÇALIŞMA - ÖZ

### COVID-19 pandemisi sırasında gerçekleşen 2020 Ege Denizi depremi sonrası üniversitemize başvuran depremzedelerde klinik deneyimlerimiz

Dr. Zeynep Çağiran,<sup>1</sup> Dr. Nezh Sertöz,<sup>1</sup> Dr. Semra Karaman,<sup>1</sup> Dr. Didem Özen,<sup>1</sup> Dr. Mesut Demirkoparan,<sup>2</sup> Dr. Meltem Uyar,<sup>1</sup> Dr. Kemal Aktuglu<sup>2</sup>

<sup>1</sup>Ege Üniversitesi Tıp Fakültesi, Anesteziyoloji ve Reanimasyon Anabilim Dalı, İzmir

<sup>2</sup>Ege Üniversitesi Tıp Fakültesi, Ortopedi ve Travmatoloji Anabilim Dalı, İzmir

**AMAÇ:** Depremler insan yaşamını tehdit eden çok kısa sürede can ve mal kaybına yol açan doğal afedlerdir. Çalışmamızda Ege Denizi depremi sonrası hastanemize başvuran depremzedelerin tıbbi analizini gerçekleştirmeyi ve klinik deneyimlerimizi paylaşmayı amaçladık.

**GEREÇ VE YÖNTEM:** Ege Denizi depremi nedeniyle hastanemize getirilen depremzedelerin veya deprem nedeniyle başvuran yaralıların tıbbi veri kayıtlarını geriye dönük olarak inceledik. Hastaların demografik verileri, şikayet ve tanıları, başvuru saatleri, klinik seyirleri, hastane düzenlemeleri (yatış, taburculuk, nakil), ameliyata kadar geçen süre, anestezi yöntemleri, cerrahi müdahaleler, yoğun bakım ihtiyaçları, ezilme sendromu, akut böbrek yetersizliği varlığı, diyaliz, mortalite ve morbidite gözden geçirildi.

**BULGULAR:** Deprem nedeniyle hastanemize toplam 152 hasta getirildi. Acil servise başvurunun en yoğun olduğu dönem ilk 24-36 saattir. Mortalite oranı yaş artışıyla birlikte daha yüksek saptandı. Mortal seyreden depremzedelerin en sık başvuru nedeni göçük altında kalma iken sağ kalanlar göçük altında kalmanın dışında düşme gibi başka nedenlerle de başvurmuştu. Sağ kalan hastalarda en sık görülen fraktür şekli alt ekstremitelerde fraktürleriydi.

**TARTIŞMA:** Epidemiyolojik çalışmalar, gelecekteki depreme bağlı yaralanmaların sağlık kurumları tarafından yönetimine ve organizasyonuna önemli katkı sağlayabilir.

**Anahtar sözcükler:** Anestezi; crush yaralanma; deprem; morbidite; mortalite.

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