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ORIGINAL ARTICLE

Evaluation of the 2023 Kahramanmaras earthquake from the perspective of Plastic Surgery Department: A single-center experience

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ABSTRACT

Objectives: The aim of this study was to evaluate the treatment management and demographic data of earthquake victims admitted to Plastic Surgery Department of our center after the 2023 Kahramanmaras earthquake.

Patients and methods: Between February 6th, 2023 and February 15th, 2023, a total of 120 patients (65 males, 55 females; mean age: 36.3±17.3 years; range, 85 to 88 years) who were consulted to the Plastic Surgery Department of our center were included. Demographic data of the patients, time to admission to the emergency room, removal time under the rubble, type of injury, emergency operation requirement, fasciotomy requirement, hyperbaric oxygen therapy administration, and length of stay in the intensive care unit were evaluated. After the first intervention, patients with compartment syndrome underwent emergency fasciotomy immediately. Perioperative laboratory values of the patients were followed closely to prevent the development of crush syndrome.

Results: Due to stay under the rubble, upper extremity soft tissue injury was seen in 46.2% of the patients. The pelvic and abdominal region were the least affected soft tissues in 1.7% patients. Fasciotomy was performed in 75 patients who stayed under the rubble. Hyperbaric oxygen therapy was applied to 21 of 75 patients who underwent fasciotomy. Amputation was performed in four patients, three of which were in the upper extremity and one in the lower extremity, during follow-up after fasciotomy. A total of 10.83% of the patients were treated conservatively and 11.67% of them were reconstructed with free flaps. Totally 7.5% of the patients who stayed under the rubble were hospitalized in our clinic for maxillofacial injuries. A total of 66.6% of these patients were treated surgically, while 33.3% of them were further treated conservatively.

Conclusion: Proper triage, proper fasciotomy, and appropriate surgical interventions reduce the amputation rate, yielding clinically satisfactory results.

Keywords: Amputation, compartment syndrome, earthquake, fasciotomy, rubble.

According to the Center for Research on the Epidemiology of the Disasters (CERD), the number of natural disasters worldwide has increased four-fold in the last 25 years.[1] These disasters that cause economic and social losses, as well as environmental damage, is common life problems.[2] The number of individuals killed by natural disasters in the last two decades has reached 1.35 million, and more than half of them were killed by earthquakes.[1]

A magnitude 7.7 earthquake occurred at 04:17 A.M. on February 6th, 2023 in Kahramanmaras, Türkiye, followed by at least 78 aftershocks. The second strongest quake occurred in the same region with a magnitude of 7.5 at 01:24 P.M.[3] Eleven cities with a total population of over 16 million were severely affected by the earthquake.[4] After the earthquake,

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Hans Kluge, Director General of the World Health Organization (WHO), announced that a Level 3 state of emergency was declared.[5]

If the necessary precautions and measures are taken before the earthquake, the number of injured and dead after the earthquake can be significantly reduced. Good planning of necessary actions, particularly in the first 6 h, is the most important factor that reduces mortality.[6] Nearly 90% of patients who receive care in the first 24 h are able to survive.[6]

Soft tissue and extremity injuries are an important cause of morbidity in earthquakes, and life-threatening injuries are the second most common injury after treatment.[7] In addition, crush injuries and fractures occur mostly in the lower and upper extremities during earthquakes. Most of them require fasciotomy, but most of the fasciotomies opened under emergency conditions are inadequate. Metabolites produced as a result of crush injuries cause acute renal failure and increase the mortality rate in this case.[8]

In the present study, we aimed to evaluate the treatment management and demographic data of earthquake victims who were admitted to Plastic Surgery Department of our center after the 2023 Kahramanmaras earthquake.

PATIENTS AND METHODS

This retrospective study was conducted at University of Health Sciences, Ankara City Hospital,, Department of Aesthetic, Plastic and Reconstructive Surgery between February 6th, 2023 and February 15th, 2023. After this great disaster, a total of 1,800 patients (53% female, 47% male) were applied to the emergency service of our hospital. The first intervention of the patients in the emergency department was provided by physicians, and the necessary treatment and consultations were made without delay. The consultations of the patients were prioritized according to the injury site and the severity of the general condition. The distribution of primarily consulted patients is as follows: 225 of them were consulted to the General Surgery Department, 532 to the Orthopedics and Traumatology Department, 128 to the Neurosurgery Department, and 1,130 to the Internal Diseases Department. Patients with open wounds, neural deficit, and hand and wrist fractures were consulted to Plastic Surgery Department. Patients with lower and upper extremity fractures, excluding hand and wrist fractures, were consulted to the orthopedic service. A total of 120 patients (65 males, 55 females; mean age: 36.3±17.3 years; range, 85 to 88 years) were consulted to the Plastic Surgery Department. To promptly treat the admitted patients, the total of 48 senior residents in our hospital were divided into four groups of 12 in a 24-h shift system. In each group, four physicians were assigned to monitor and treat in the emergency room, four surgeons were assigned to the operating room, and four physicians were assigned to inpatient service. Patients' demographic data, time to admission in the emergency department, removal time under the rubble, type of injury, emergency surgery requirement, emergency fasciotomy requirement, hyperbaric oxygen therapy (HBOT) application, and intensive care unit (ICU) length of stays were evaluated. The hospital information procedure was used in this study.

Systematical triage was done without delay in the ICU and inpatient service. The patients who needed emergency surgery, such as compartment syndrome, were directly transferred to the operating room for fasciotomy. In our hospital, 131 operating rooms are reserved for earthquake patients, and a large number of patient beds are available for postoperative care. All elective surgeries were delayed, and patients in good general condition were discharged to receive earthquake victims. Since crush syndrome was suspected in these patients, pre- and postoperative blood values (hemoglobin, blood urea nitrogen, creatinine, creatinine kinase [CK]) were followed to determine their metabolic status. A serum CK value of >1,000 U/L was used to diagnose rhabdomyolysis.[9]

Statistical analysis

Statistical analysis was performed using the SPSS version 25.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were expressed in mean ± standard deviation (SD), median (min-max) or number and frequency, where applicable. Non-parametric tests were used in the analyses, as the variables did not conform to the normal distribution. The Mann-Whitney U test was used to analyze numerical variables. A p value of <0.05 was considered statistically significant.

RESULTS

According to the age distribution of patients, the most affected group was aged between 21 and 30 years. The longest length of stay under the rubble ranged between 12 and 24 h. After the Kahramanmaras earthquake, it took a mean of 112.6±18.2 (range, 24 to 236) h for patients to be admitted to our

TABLE I
Demographic characteristics of the patients

Characteristics	n	%	Mean±SD
Age (year)			36.3±17.3
Sex			
Male	65	54.2	
Female	55	45.8	
Age classification (year)			
0-10	6	5	
11-20	15	12.5	
21-30	30	25	
31-40	23	19.2	
41-50	20	16.7	
51-60	9	7.5	
61-70	15	12.5	
70 up	2	1.7	
Length of stay under the rubble (h)			
0-3	16	13.8	
3-6	13	10.8	
6-12	19	15.8	
12-24	39	32.5	
24-36	12	10	
36-48	9	7.5	
48-72	10	8.3	
72 up	2	1.7	
Serum CK (u/L)			
0-1000 CK	17	14.2	
1000 up CK	65	54.2	
Hospital admission time (h)			112.6±18.2
Duration of intervention (min)			9.75±2.63

SD: Standard deviation; CK: Creatinine kinase.

hospital. The mean duration of intervention for the patients was 9.75±2.63 (range, 7 to 15) min (Table I).

While 40.8% of patients were hospitalized directly in the ICU, 59.2% were admitted to the Plastic Surgery Department. Three of 120 patients died and these patients had a CK of >1,000U/L. Sepsis and multiorgan failure secondary to crush syndrome were diagnosed in two and pulmonary thromboembolism was in one of these patients. When the patients were applied to the emergency department, 61.7% (n=74) had CK values above the upper limit (>1,000 U/L) and the overall mortality rate was reported to 2.5% (n=3).

Surgical intervention was not considered in the reconstruction of patients, which was followed in 13 (10.83%) patients. Negative pressure wound therapy (NPWT)[10] was performed in seven patients for soft tissue infections that could not be controlled by simple debridement and, then, primary closure was performed. The autologous grafts after debridement were performed in 59 (49.17%) patients. The free flap after serial debridement was required in 14 (11.67%) patients (Table II). The most commonly used free flap was the anterolateral thigh flap. The other flap types are shown in Figure 1.

Eighty (46.2%) patients had upper extremity injuries. The number of patients with lower extremity injuries was 47 (27.2%). Soft tissue injuries occurred in the abdomen in three (1.7%) patients and in the pelvic in three (1.7%) patients. Fasciotomy was performed in 75 patients, 30 of whom underwent fasciotomy in our plastic

TABLE II
The reconstruction types of defects

	n	%
Treatments		
Non-surgical intervention	13	10.83
PWC + NPWT	7	5.83
PWC	7	5.83
FTSG	12	10
STSG	9	7.5
STSG and PWC	38	31.67
Local flap	10	8.33
Free flap	14	11.67
Amputation	4	3.33
MFFF	6	5

PWC: Primary wound closure; NPWT: Negative pressure wound therapy; FTSG: Full-thickness skin graft; STSG: Split-thickness skin graft; MFFF: Maxillofacial fracture fixation.

TABLE III
The distribution of injuries area, amputation levels, and maxillofacial fractures

	n	%	Mean±SD
Part of body areas			
Head-neck	27	15.6	
Thorax	13	7.5	
Upper extremity	80	46.2	
Abdominal	3	1.7	
Pelvic	3	1.7	
Lower extremity	47	27.2	
Multitrauma	53	44.2	
Fasciotomy of limbs			
Upper extremity	59	78.7	
Lower extremity	16	21.3	
Amputation levels			
MCP	2	65.3	
PIP	1	21.3	
Lower extremity (MTP)	1	13.3	
Amputation times (days)			14.8±3.4
Maxillofacial fractures			
Orbital blow out	4	44	
Mandible	3	33	
Zygomatic arch	1	11	
Maxilla	1	11	

SD: Standard deviation; MCP: Metacarpophalangeal; PIP: Proximal interphalangeal; MTP: Metatarsophalangeal.

surgery department, 45 patients were admitted to the external service due to defect closure and inadequate fasciotomy. An expansion fasciotomy was performed in 12 patients due to an incomplete fasciotomy. A total of 75 patients underwent fasciotomy for extremity crush syndrome, of which 59 (78.7%) were upper extremity and 16 (21.3%) were lower extremity. In patients with fasciotomy, the mean time to stay under the rubble was 89±67.7 (range, 283 to 288) h. In patients without fasciotomy, the mean time to stay under the rubble was 130.4 (range, 1 to 220) h. No significant difference was found between the groups who underwent fasciotomy and did not, in terms of the duration of stay under the rubble (p=0.263). Primary amputation was not performed in any of the cases. Amputations without finger and toe were performed by the orthopedic service. The decision for amputations was made in a mean of 14.75±3.4 (range, 10 to 18) days with consultation of cardiovascular surgery and orthopedics specialists and with the use of clinical and imaging techniques. Four patients underwent amputation

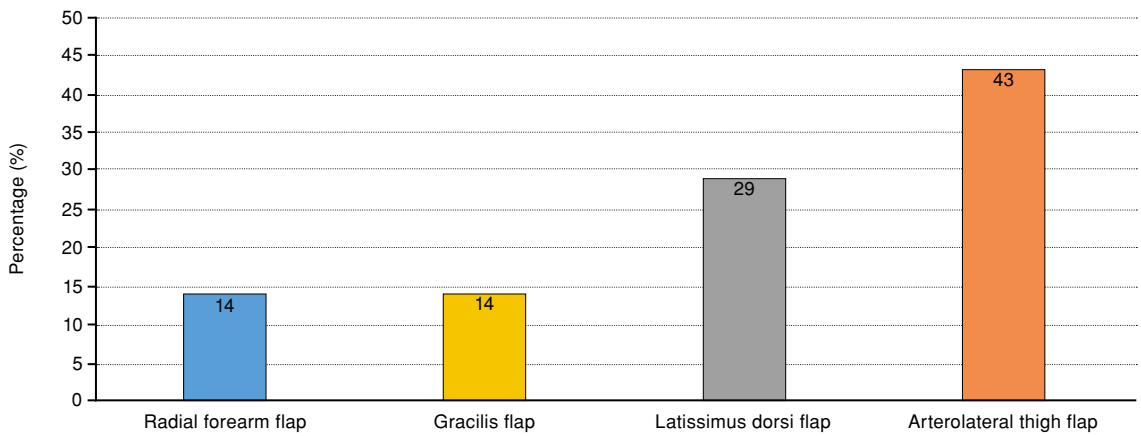


FIGURE 1. Flap types.

after fasciotomy; three of them involved the upper extremities and one of them involved the lower extremities. These data only belonged to Plastic Surgery Department (Table III).

Hyperbaric oxygen therapy was performed in 21 of the 75 patients who underwent fasciotomy. It was used in five of these patients for isolated lower extremity fasciotomy, in 14 for isolated upper extremity fasciotomy, and in two patients for both lower and upper extremity fasciotomy.

Maxillofacial fractures occurred in nine patients due to rubble, and the most common fractures were occurred orbital floor fractures (Table III). Maxillofacial fracture fixation was performed and in 66.6% of these patients, while 33.3% were treated conservatively.

DISCUSSION

The main finding of our study is that, with proper systematical triage and collaboration of the trauma teams, proper fasciotomy, and appropriate surgical interventions, satisfactory results can be obtained. The data obtained due to the distance of our hospital from the earthquake areas show the late intervention data. One hundred-twenty patients could be treated in a short time owing to the hospital facilities and a sufficient number of employees. Although it is far from the earthquake area, the patients were saved from amputation by making the right decision. These findings indicate that the process of fasciotomy is well managed.

Earthquakes are among the most devastating disasters in terms of fatalities and, in addition to earthquake disaster, poor organization also increases the death rate from earthquakes. Working with the shift system of residents and physicians in the hospital during this process ensured that our team remained more dynamic and the likelihood of errors in procedures was low. This shift team only took care of earthquake patients.

Recently, researchers have begun to investigate the pattern of disaster-related injuries and, until recently, there are few studies examining the cause, outcome, and findings of earthquake-related injuries and deaths.[11] Uğurlu et al.[12] in the study of plastic surgery after the 1999 Marmara earthquake, reported 30 cases. In another study performed by Bulut et al.[13] after the Marmara earthquake, in the first hours after the earthquake, there were difficulties in registering patients, and a team was assigned to register patients to avoid this confusion in the following hours, and finally 62 patients were reported. In our study, the number of cases were 120. Articles published after the earthquake include patient demographics and types of injuries. Each earthquake should be evaluated on its own. We also share our own experience in this article.

In a study of earthquakes in China, the ratio of male-to-female was 48% and 52%, respectively, whereas in another study, 43.9% of the patients were male and 56.1% were female.[14,15] In our study, 47% (846/1,800) were male and 53% (954/1,800) were female. We obtained a similar male-to-female ratio with previous studies.

In the 2011 Van earthquake, the average time patients stayed under the rubble was 52.3 (range, 1 to 157) h.[16] In the Kahramanmaras earthquake, the mean time patients stayed under the rubble was 108.2±21.3 (range, 218 to 236) h. Although the data of plastic surgery patients do not the average of patients, the length of stay under the rubble was long. We believe that this is due to the fact that the Kahramanmaras earthquake was longer than the Van earthquake and 11 cities were affected simultaneously.

Uğurlu et al.[12] in their study after the 1999 Marmara earthquake reported that the lower extremity was injured in 70%, the upper extremity in 26.6%, and the maxillofacial area in 3.3% patients. In our study, most of the injuries were located in the upper extremities. We believe that it is due to the fact that the patient population consisted only of those treated in the plastic surgery clinic. In the current study, the rate of maxillofacial injury was 7.5%. As a tertiary referral hospital, we received many patients who had advanced injury from earthquake zones and we believe that this is the reason for the finding that maxillofacial injury was higher than the literature.

Injuries in earthquakes are usually caused by parts falling out of collapsed buildings and being under the rubble, resulting in compartment syndrome.[17] When fasciotomy is performed early in cases with compartment syndrome, the amputation rate decreases and patient survival is higher.[18] We believe that fasciotomy should be performed immediately, if clinically suspected. In our patients, compartment syndrome was diagnosed promptly, and fasciotomy was opened and limb amputation was prevented in 94.67% of cases.

In the current study, we had 75 fasciotomy patients, 30 of whom underwent fasciotomy in our plastic surgery department. Totally 45 patients

were admitted for defect closure after fasciotomy performed in external clinics, and 12 patients underwent extension due to incomplete fasciotomy that did not reach the deep compartments. Uğurlu et al.[12] evaluated 163 patients and reported a fasciotomy rate of 3%. On the other hand, Bulut et al.[13] reported a fasciotomy rate of 9.6% in a total of 645 plastic surgery patients. In the current study, we found a fasciotomy rate of 4.1% in a total of 120 patients. In our study, we found no statistically significant difference between the patients who underwent fasciotomy and those who did not, in terms of the mean time to stay under the rubble. This may be due to the fact that the severity of the trauma is a more determinant condition for the development of compartment syndrome rather than the duration of being under the rubble. This result may also be due to the small number of patients.

The study by Gormeli et al.[16] reported that amputation was performed in seven (33.3%) of 21 patients. Sever et al.[19] reported that amputation was performed in 121 (15.2%) of 790 patients. In our study, 5.3% of patients who underwent fasciotomy underwent amputation. Although the number of patients in our study was limited, our amputation rate was low, as we performed fasciotomy in the early period. Furthermore, this rate may seem to be low, as amputations performed in the orthopedic clinic were not included in the study.

In the meta-analysis by Kranke et al.[20] HBOT was found to reduce amputation rates. In our study, the rate of patients with fasciotomy undergoing HBOT was 28%. In the study performed by Duman et al.[21] after the 1999 Marmara earthquake that limb amputation was prevented in 75% of cases. In our study, this rate was 94.7% in plastic surgery patients, as we decided immediately fasciotomy and limited number of patients were applied to our hospital. Another factor to reduce the amputation rate is HBOT which was used in 21 of our patients with fasciotomy.

Negative pressure wound therapy is even more useful for severe soft tissue injuries and infections.[22] Zhang et al.[23] reported on the Wechuam earthquake that soft tissue infection rate was 5.88%. In the current study, we found similar results with literature.

In our study, the free flap was used in nine patients at the early stage. However, no initial treatment results can be presented for this disease. A prospective long-term study is planned.

In the study performed by Li et al.[24] in 419 patients affected by the Wenchuan and Yushu earthquakes, 119 had maxillofacial fractures of which 58.6% were fractures of the orbital region, 51.7% were of the zygomatic bone, 24.1% of the maxilla, and 63.8% of the mandible. In our study, orbital fractures were seen in 44.4%, zygoma fractures in 11.1%, maxillary fractures in 11.1%, and mandibular fractures in 33.3%. This can be explained by the fact that our hospital is located far from the earthquake zone and the number of patients was limited.

Furthermore, rhabdomyolysis is a common complication in patients with crush injuries, and a serum CK value more than five times normal or a value of about 1,000 U/L is used to diagnose this condition.[9] Accordingly, rhabdomyolysis was diagnosed in 61.7% of our patients. In a meta-analysis performed by Safari et al.,[25] a correlation between serum CK levels and acute renal failure due to crush syndrome was found. The fact that hemodialysis was performed in 14 (11.6%) patients with high CK values and crush injuries in our study supports these data. In the meta-analysis by Liu and He[26] crush syndrome, brain damage, multiple organ failure, and old age were among the causes of death. In our study, multiple organ failure and pulmonary thromboembolism were the causes of death, and they were similar to those in the literature.

Nonetheless, there are some limitations to this study. Some patients who discontinued treatment after they were intervened with first aid in our emergency service and plastic surgery service were excluded from the study. There were 120 earthquake patients evaluated referred to plastic surgery, as the Ankara City Hospital was far from the earthquake area. Considering the general earthquake, we believe that the number of patients is small. Exclusion of other clinical data, particularly from the orthopedic clinic, is one of the limitations to this study.

In conclusion, earthquake patients were successfully treated in the plastic surgery clinic with rapid systematical triage and appropriate surgical intervention. Based on our study findings, satisfactory clinical results can be obtained after a proper fasciotomy.

Ethics Committee Approval: The study protocol was approved by the Ankara City Hospital Ethics Committee (date: 09.03.2023, no: E1-23-3366). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Idea/concept, writing the article, analysis and/or interpretation, other: H.M.E.; Design, literature review, materials: H.M.E., Ö.Ö.; Control/supervision: R.E.Ü.; Data collection and/or processing: R.Ç., F.Y.; Critical review, references and fundings: H.M.E., B.Y., Ö.Ö.

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