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Demographic and Clinical Profile of Amputees Aftermath of the 2023 Türkiye Kahramanmaraş Earthquake: Implications for Prosthetic Needs

2023 Kahramanmaraş Depremi Sonrası Ampute Olan Bireylerin Demografik ve Klinik Özellikleri: Protez İhtiyaçlarının Belirlenmesi

Emine Esra BİLİR[a], Filiz ESER[b], Fatmagül YURDAKUL[b], Burcu YANIK[a], Hatice BODUR[c], Ebru ALEMDAROĞLU[b], Bedriye MERMERCİ[b], Selami AKKUŞ[c], Emre ADIGÜZEL[b]

[a]Ankara Bilkent City Hospital, Clinic of Physical Medicine and Rehabilitation, Ankara, Türkiye

[b]University of Health Sciences Faculty of Medicine, Ankara City Hospital, Department of Physical Medicine and Rehabilitation, Ankara, Türkiye

[c]Yıldırım Beyazıt University Faculty of Medicine, Ankara Bilkent City Hospital, Department of Physical Medicine and Rehabilitation, Ankara, Türkiye

ABSTRACT Objectives: Amputation is considered one of the most catastrophic effects of an earthquake. This descriptive analysis examines the amputee victim's demographic, clinical characteristics, and prosthetic needs of February 6, 2023 earthquakes in Türkiye. **Material and Methods:** This retrospective study analyzed the records of 61 adult amputees who presented to our outpatient clinic for rehabilitation program and prosthetic prescription. Data collected included demographic information (gender, age, occupation, marital status, education level), clinical characteristics (time of extrication, affected extremity, amputation level, K activity level and accompanying pathologies), and the type of prosthesis prescribed. **Results:** The medical records of 61 patients with a combined total of 73 amputated limbs were retrospectively reviewed. The mean time to extrication from the rubble was 45.1±35.2 hours. Among the 61 amputees, concomitant injuries included crush and compartment syndrome in 8 (13.11%), brachial plexus injury in 7 (11.48%), peroneal nerve injury in 6 (9.84%), fracture in 3 (4.92%), femoral nerve injury in 2 (3.28%), and paraplegia in 1 (1.64%). Lower extremity amputations were the most frequently observed (71.2%). In addition, the most affected extremity type was the unilateral lower extremity (39.5%) and the unilateral upper extremity (20.5%). The most frequently affected amputation levels were transradial (13.6%) in the upper extremity and transfemoral (30.1%) in the lower extremity. **Conclusion:** Our study describes the demographic characteristics and clinical outcomes of patients with earthquake-related amputations. We believe that our findings will guide the development of preparedness, response, and recovery policies for potential future disasters.

Keywords: Amputation; earthquake; prothesis prescription; rehabilitation needs

ÖZET Amaç: Ampütasyon, bir depremin en yıkıcı etkilerinden biri olarak kabul edilir. Bu tanımlayıcı analiz, 6 Şubat 2023 Türkiye depremlerinde ampüte olanların demografik, klinik özelliklerini ve protez ihtiyaçlarını incelemektedir. **Gereç ve Yöntemler:** Bu retrospektif çalışma, rehabilitasyon programı ve protez reçetesi için polikliniğimize başvuran 61 yetişkin ampütenin kayıtlarını analiz etti. Toplanan veriler demografik bilgileri (cinsiyet, yaş, meslek, medeni durum, eğitim seviyesi), klinik özellikleri (enkazdan kurtarılma zamanı, etkilenen ekstremite, ampütasyon seviyesi, K aktivite seviyesi ve eşlik eden patolojiler) ve reçete edilen protez tipini içeriyordu. **Bulgular:** Toplam 73 ampüte uzvu olan 61 hastanın tıbbi kayıtları retrospektif olarak incelendi. Enkazdan kurtarılma ortalama süresi 45,1±35,2 saatti. 61 ampütede, eşlik eden yaralanmalar arasında 8 (%13,11) hastada ezilme ve kompartıman sendromu, 7 (%11,48) hastada brakial pleksus yaralanması, 6 (%9,84) hastada peroneal sinir yaralanması, 3 (%4,92) hastada kırık, 2 (%3,28) hastada femoral sinir yaralanması ve 1 (%1,64) hastada parapleji vardı. En sık gözlenen ampütasyonlar alt ekstremite ampütasyonlarıydı (%71,2). Ayrıca, en sık etkilenen ekstremite tipi tek taraflı alt ekstremite (%39,5) ve tek taraflı üst ekstremiteydi (%20,5). En sık etkilenen ampütasyon seviyeleri üst ekstremitede transradial (%13,6) ve alt ekstremitede transfemoraldi (%30,1). **Sonuç:** Çalışmamız, depremle ilişkili ampütasyonları olan hastaların demografik özelliklerini ve klinik sonuçlarını açıklamaktadır. Bulgularımızın, gelecekteki olası afetler için hazırlıklılık, müdahale ve iyileşme politikalarının geliştirilmesine rehberlik edeceğine inanıyoruz.

Anahtar Kelimeler: Amputasyon; deprem; protez reçeteleme; rehabilitasyon ihtiyaçları

Correspondence: Emine Esra BİLİR
Ankara Bilkent City Hospital, Clinic of Physical Medicine and Rehabilitation, Ankara, Türkiye
E-mail: esrabilirftr@gmail.com

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An earthquake measuring 7.7 on the Richter scale struck eastern and southeastern Türkiye on Monday, February 6, 2023, centered in Kahramanmaraş. According to data from the Turkish Disaster and Emergency [Afet ve Acil Durum (AFAD)], it simultaneously affected 11 cities: Kahramanmaraş, Elazığ, Şanlıurfa, Diyarbakır, Gaziantep, Adıyaman, Hatay, Malatya, Adana, Osmaniye, and Kilis. On the same day, another earthquake with a magnitude of 7.6 struck Kahramanmaraş, Elbistan. Government data reports that at least 50,783 people lost their lives and more than 120,000 were injured due to the earthquakes.[1] The majority of the injured survivors suffered musculoskeletal trauma, often relating to crush injuries, resulting in unilateral, bilateral or even multiple limb amputation, fractures and spinal cord injuries.[2]

According to the recent earthquake records in the world, amputation surgery was performed on 112 of the 19,700 people injured in the Pakistan-Kashmir earthquake in 2005, 550 of the 28,000 people injured in the China-Sichuan earthquake in 2008, and 2,000 of the 300,000 patients injured in the Haiti earthquake in 2010.[3-5] In our country, approximately 1,000 amputation cases were encountered in the earthquake disaster centered in Kahramanmaraş in February 2023 according to data from the Turkish AFAD.[1]

Amputation is regarded as one of the most catastrophic effects of an earthquake, resulting in severe physical and psychological problems and can cause limitations in functional activities, mobility, and social adaptations.[6] Amputation can occur as a direct traumatic amputation of a limb during the event or because of complex fractures or limb loss following severe neurovascular injury. In addition to the crushing trauma caused by being buried under rubble, the prolonged stay of patients under rubble and the delay in transporting them to hospitals also increase the risk of soft tissue injuries resulting in amputation.[7] Long-term and well-planned rehabilitation after acute management is important to maximize their functional states and rebuild their lives. It has been established that in the management of natural disasters, coordination of services from short-term life-saving measures to long-term rehabilitation services and follow-up is very important to ensure the continuity of care and better outcomes. Early rehabilitation in disaster environments is important for preventing mobility and self-care problems, postural disorders, and decreased body endurance.[8]

Early rehabilitation for people who had limbs amputated because of an injury related to conflicts or disasters can be very challenging. Prosthetic applications should be started immediately after wound healing and stump tip shaping are completed. Earthquakes often cause serious injuries, including amputations. The subsequent process of wound healing and prosthetic fitting is complex and requires a multifaceted effort.[9] The decision and prescription stage for the prosthesis should be meticulously made by the team decision, which includes the patient and their family. Patients'' age, weight, amputation level, activity level, cognitive and psychosocial status, stump length and shaping, wound healing, muscle strength, presence of contracture, cardiopulmonary capacity, additional peripheral nerve injuries and accompanying comorbid conditions should be questioned in detail.[10]

The study described the demographic, clinical status, and prosthetic prescriptions of earthquake victims who underwent limb amputation due to the 2023 earthquake.

MATERIAL AND METHODS

This single-center, retrospective study included earthquake victims who were followed up in our physical therapy clinic between March 2023-June 2024 and who applied to our outpatient clinics for prosthesis prescription. The files of 61 adult amputees were retrospectively reviewed. Demographic information (gender, age, occupation, marital status, education level, location at the time of the earthquake), clinical information (time of extrication from debris, affected extremity status, amputation level, K activity level) and the type of prosthesis applied were recorded.

Ethics committee approval was obtained from our Ankara Bilkent City Hospital No. 1 Medical Research Scientific and Ethical Evaluation Board (TABED) (date: November 6, 2024, no: TABED 1-24-729). The study was conducted in accordance with the guidelines regarding the Declaration of Helsinki.

Inclusion criteria for the study: patients over the age of 18 years who suffered limb loss after the 2023 Maraş earthquake. The exclusion criteria for the study were: (1) being under the age of 18, (2) having congenital limb deficiency, (3) having incomplete information in the file.

Demographic information (gender, current age, age at the time of the event, status, occupation, marital status, education level), clinical information (body mass index, duration of stay under debris, affected extremity status, amputation level, stump length, K activity level), and the type of prosthesis considered to be applied were recorded in accordance with the chart created by one of the authors.

The affected extremity status was grouped as unilateral/bilateral and lower/upper. The upper extremity amputation levels were classified as shoulder disarticulation, translumenal, elbow disarticulation, transradial, wrist disarticulation, and fingers. Lower extremity amputation levels were determined as hip disarticulation, transfemoral (or above the knee), knee disarticulation, transtibial, Chopart, Boyd, Syme, and toes.

The K activity level, which is used to determine the activity levels of patients, is a measurement tool that evaluates and classifies the patient's ambulation with the prosthesis, functional capacity, and transfer ability. The amputee individual is evaluated with 21 items in the Amputee Mobility Scale (sitting balance, reaching grasping while sitting, transferring from chair to chair, getting up from chair, standing balance, going up and down stairs, etc.) and a score is obtained by adding the points given to each item.[11]

The upper extremity prostheses prescribed to the patients were grouped into 3 categories: myoelectrically controlled arm prostheses, mechanical prostheses, and cosmetic prostheses. Lower extremity prostheses were evaluated in 10 categories: modular prostheses (hip, transfemoral, knee, transtibial), Chopart/Boyd/Pirogoff prosthesis, and partial foot prosthesis.

STATISTICAL ANALYSIS

"Data were analyzed using SPSS, version 25.0 (IBM, the USA). The Shapiro-Wilk test was used to assess the normality of the distribution of the numerical data. Continuous variables with normal distributions were reported as the median and standard deviation. Those without normal distributions were presented as the median and interquartile range (inter quantile range; 25th-75th percentiles). Qualitative data are expressed as frequency and percentage. A 95% confidence interval and a 5% margin of error were used. A p value less than 0.05 were considered statistically significant."

RESULTS

The mean age of the 61 (female/male: 35/26) patients included in the study was 38.9±14.3. The sociodemographic characteristics and earthquake-related information of patients who' sought amputation rehabilitation and prosthesis prescription at our hospital following the earthquake are shown in Table 1. The clinical data are given in Table 2. Affected extremity (n=73) were 52 (71.2%) lower extremity and 21 (28.7%) upper extremity. These extremity ampu-

TABLE 1: Sociodemographic characteristics of patients and earthquake-related information (n=61)

Age ($\bar{X}$±SD)	38.9±14.3
Gender	
Female	35 (57.4)
Male	26 (42.6)
Education status (n/%)	
Primary school	9 (14.8)
Middle school	4 (6.6)
High school	27 (44.3)
University	21 (34.4)
Marital status (n/%)	
Married	40 (65.6)
Single	21 (34.4)
Occupation (n/%)	
Not working	27 (44.3)
Officer	19 (31.1)
Employee	4 (6.6)
Student	11 (18.0)
Location at time of earthquake (n/%)	
Province	34 (55.7)
District	24 (39.3)
Village	3 (4.9)
Time to extricate from the debris ($\bar{X}$±SD)	45.1±35.2

Data for quantitative variables are expressed as $\bar{X}$±SD; data for qualitative variables are expressed as n (%). SD: Standard deviation

TABLE 2: Affected extremities, amputation levels and K-levels of the patients (n=73)

Affected extremity (n/%)	
Unilateral lower extremity	29 (39.7)
Bilateral lower extremity	11 (15.0)
Unilateral upper extremity	15 (20.5)
Bilateral upper extremity	1 (1.4)
Unilateral lower and upper extremity	4 (5.5)
Bilateral lower and unilateral upper extremity	1 (1.4)
Amputation level (n/%)	
Upper extremity	
Transradial	10 (13,6)
Transhumeral	9 (12.3)
Shoulder disarticulation	2 (2.7)
Lower extremity	
Transfemoral	22 (30.1)
Transtibial	18 (24.6)
Hip disarticulation	5 (6.8)
Knee disarticulation	3 (2.7)
Chopart/Boyd/Pirogoff	4 (5.5)
K level (n/%)	
K1	1 (2.2)
K2	11 (25.0)
K3	28 (63.6)
K4	2 (4.5)

Data for qualitative variables are expressed as n (%).

TABLE 3: Distribution of accompanying damages in amputee patients (n=61)

Accompanying damage type (n/%)	
Brachial plexus injury	7 (11.48)
Peroneal nerve injury	6 (9.84)
Crush and compartment syndrome	8 (13.11)
Fracture	3 (4.92)
Femoral nerve injury	2 (3.28)
Paraplegia	1 (1.64)

Data for qualitative variables are expressed as n (%).

tation statuses were unilateral lower extremity 29 (39.7%), bilateral lower extremity 11 (15.0%), unilateral upper extremity 15 (20.5%), bilateral upper extremity 1 (1.4%), unilateral lower and upper extremity 4 (5.5%), and bilateral lower and unilateral upper extremity 1 (1.4%).

Among the 61 amputees, concomitant injuries included crush and compartment syndrome in 8 (13.11%), brachial plexus injury in 7 (11.48%), peroneal nerve injury in 6 (9.84%), fracture in 3 (4.92%), femoral nerve injury in 2 (3.28%), and paraplegia in 1 (1.64%) patient. The distribution of accompanying damages in amputee patients is given in Table 3.

When the types of prosthesis prescribed to earthquake victims who applied to our hospital were examined, it was determined that the most frequently prescribed upper extremity prostheses were myoelectrically controlled arm prostheses (n=17, 23.3%), and the most frequently prescribed lower extremity prostheses were modular transfemoral prostheses (n=22, 30.1%). The types of prosthesis applied are listed in Table 4.

Activity level assessment revealed that 35.3% of transfemoral amputees were classified as K2, while 64.7% were classified as K3. Among the transtibial amputees, the distribution was as follows: 7.7% at K2, 76.9% at K3, and 15.4% at K4. For the hip disarticulation patients, 1 was classified as K2, and 4 were classified as K3. Knee disarticulation patients demonstrated activity levels of K2 and K3, respectively. There was no significant difference between the K activity level and the group with knee disarticulation, above-knee amputation, and below-knee amputation (chi-square: p=0.507). The K-levels of the patients according to their lower extremity amputation level are shown in Tables 5.

Among the 44 patients who underwent prosthesis due to lower limb amputation and affected ex-

TABLE 4: Types of prosthesis applied for upper and lower extremities (n=73)

Prothesis type	**n/%**
Upper extremity	
Unilateral myoelectric control arm prosthesis	16 (21.9)
Mechanical prosthesis	1 (1.4)
Bilateral myoelectric control arm prosthesis	1 (1.4)
Cosmetic prosthesis	3 (4.1)
Lower extremity	
Modular hip prosthesis	5 (6.8)
Modular transfemoral prosthesis	22(30.1)
Modular knee disarticulation prosthesis	3 (4.1)
Modular transtibial prosthesis	18 (24.7)
Chopart/Boyd/Pirogoff prosthesis	4 (5.5)

Data for qualitative variables are expressed as n (%).

TABLE 5: K-levels for lower extremity amputation level					
Amputation level	K1	K2	K3	K4	p value
Transfemoral	-	6 (35.3)	11 (64.7)	-	0.507
Transtibial	-	1 (7.7)	10 (76.9)	2 (15.4)	
Hip disarticulation	-	1 (20.0)	4 (80.0)	-	
Knee disarticulation	-	1 (50.0)	1 (50.0)	-	
Chopart/Boyd/Pirogoff	-	-	1 (100.0)	-	
Transtibial and transfemoral	1 (33.3)	2 (66.7)	-	-	
Transtibial and Chopart/Boyd/Pirogoff	-		2 (100.0)	-	
Transfemoral and Chopart/Boyd/Pirogoff	-		1 (100.0)	-	

Data for qualitative variables are expressed as n (%).

tremity were 52, 4 (9.1%) were fitted with mechanical knee joints, while 23 (52.3%) were fitted with hydraulic knee joints. In the majority of the transtibial amputees 18 patients, 16 (88.89%) received modular below-knee prostheses equipped with an active vacuum system, whereas 1 (5.56%) were prescribed a modular below-knee prosthesis with a silicone liner pin system and 1 (5.56%) was provided with a modular below-knee prosthesis with a passive vacuum system.

DISCUSSION

Our study investigated the sociodemographic and clinical characteristics of patients who experienced earthquake-related amputations and sought treatment at our institution. The average age of the patient was 38.9±14.3 years, with a preponderance of female patients. Most patients were located in provincial urban centers during the earthquake. The mean time to extrication from the rubble was 45.1±35.2 hours. Among the 61 patients, 47.5% presented with unilateral lower extremity amputations. Transfemoral, transtibial, and transradial amputations were the most frequent amputation levels. There were amputations in 79 extremities of 61 patients, and prostheses could be prescribed for 73 of these extremities. This finding underscores the significant need for prosthetic care in this patient group.

Following an earthquake, the prompt initiation of comprehensive rehabilitation is crucial for amputees to achieve optimal functional outcomes once they are clinically stable.[12] A multidisciplinary team, including physical therapists, prosthetists, and orthotists, should assess each patient and develop a tailored rehabilitation plan to manage any complications that may arise. In the aftermath of major earthquakes, the availability of prosthetic devices and rehabilitation services has been reported to be insufficient, primarily due to limited healthcare access, resource scarcity, and financial constraints, particularly in developing nations.[13,14] Our hospital swiftly established a multidisciplinary team to evaluate amputee patients from various regions affected by the widespread Kahramanmaraş earthquake. These patients often present with multiple injuries. In their study evaluating musculoskeletal system injuries following the 2023 Maraş earthquake, Özdemir et al. reported a 16.4% incidence of crush syndrome and a 25.9% incidence of nerve injuries. Lower extremity nerve injuries, predominantly affecting the peroneal and sciatic nerves, were more prevalent (75%) than upper extremity nerve injuries, which primarily involved the radial, ulnar, median, and brachial plexus nerves (25%). Transtibial amputation was the most common discharge diagnosis, accounting for 47% of cases.[15] The most common pathologies accompanying our amputee patients in our study were compartment syndrome, brachial plexus injury, and peroneal nerve lesion. Our study revealed that a substantial proportion of our patients exhibited polytrauma, a hallmark of victims in large-scale disasters like earthquakes. The high incidence of brachial plexus, peroneal nerve, and femoral nerve injuries underscores the neurological sequelae of the compressive and crushing forces experienced during such events. Moreover, the significant prevalence of fractures and crush syndrome, encompassing both bone and soft tissue injuries, corroborates the mechanical trauma associated with earthquakes.

Despite significant progress in the fields of medicine, industry, and technology, post-earthquake amputations continue to occur with alarming frequency. Amputations constitute the primary cause of disability following seismic events. Statistical data are indispensable for the formulation, planning, and execution of policies designed to prevent disability, mitigate the progression of existing disabilities or injuries into impairments, and guarantee equal opportunities for individuals with disabilities. In a study of 439 earthquake victims conducted by Özdemir and colleagues, an amputation rate of 10.6% was reported. Transtibial amputation was identified as the most prevalent type of extremity amputation, accounting for 47% of all amputations. Transfemoral and transradial amputations followed, comprising 31-8%, respectively.[15] Bingol et al. reported that among 65 patients, 87 amputations were performed in the upper extremity (12.6%) and in the lower extremity (87.4%). The most common type of amputation was transtibial (41.3%), followed by transfemoral, translumenal, and toe amputations.[16] Similar to the trends observed in the 2010 Haiti earthquake, the lower extremity was the most common site of amputation.[17] In our study, consistent with the general population data in the literature, most amputations (69.8%) were in the lower extremity. Transfemoral amputation was the most common type of amputation, accounting for 27.8% of all amputations. This was followed by transtibial amputation (22.7%) and transradial amputation (12.6%). This order matches observations from the Pakistan earthquake, however, it contrasts with reports by Randolph et al. and Kundakçı et al. who found a higher incidence of transtibial than transfemoral amputations, yet still underscored the predominance of lower limb amputations.[3,17,18]

A strong correlation exists between the level of amputation and functional capacity. Patients with transfemoral or higher-level amputations typically experience more difficulties with functional tasks, such as standing balance, single-leg stance, and transfers, as measured by the Amputee Mobility Scale. These difficulties are likely attributable to the substantial loss of body mass.[19,20] Patients with transfemoral or higher-level amputations are predicted to demonstrate reduced K activity levels compared with individuals with transtibial amputations. In contrast to Esfandiari et al. study of 587 lower extremity amputees, which yielded results aligned with previous research, our study did not reveal a significant correlation between K activity level and amputation level.[21] We propose that the multiple injuries sustained by our earthquake-related amputee population may account for this discrepancy.

In most lower limb amputees, 52.3% received hydraulic knee joints, whereas 9.1% were prescribed mechanical knee joints. Prosthetic prescriptions were influenced by factors including patient age, comorbidities, and mobility levels. Mechanical knee joints were preferentially selected for older individuals and those prioritizing safe ambulation, particularly those at a heightened risk of falls.

In order to minimize functional losses in upper extremity amputees, (21.9%) patients were prescribed myoelectric controlled arm prostheses, one patient (1.4%) was prescribed a mechanical arm prosthesis, and 3 patients (4.1%) were given cosmetic prostheses due to their high level of amputation (shoulder disarticulation) and concomitant lower limb amputation. Considering the patient's' geriatric age and ipsilateral transfemoral amputation, we opted for a mechanical arm prosthesis as it offered a lighter and more user-friendly solution.

Amputee patients in our wards received a comprehensive rehabilitation program. This holistic approach aimed to preserve the joint range of motion, improve soft tissue flexibility, and strengthen muscles in both the affected and unaffected limbs. Additionally, training in posture, balance, coordination, endurance, weight transfer, standing, walking, and trunk stability was provided. Cardiac and pulmonary rehabilitation were also integral parts of the program.

Furthermore, the program addressed pain management, wound care, and the prevention and management of complications such as nerve injuries, infections, urinary tract issues, and deep vein thrombosis. Psychological and educational support was provided to help patients cope with their emotional and practical needs. The goal was to empower amputees to achieve independence in daily living, work, and leisure activities and prepare them for prosthetic use.

The literature on the types of prostheses prescribed to amputees following earthquakes is notably limited. The substantial increase in the amputee population in our country after the devastating Maraş earthquake necessitated the rapid provision of several prostheses. Our hospital prioritized prostheses that would ensure both safety and functional sufficiency for our patients. We anticipate that the data presented in this study will contribute significantly to the current body of knowledge.

Due to the retrospective nature of our study, there were limitations in obtaining additional crucial data, including the development of new complications, patient satisfaction with the prosthesis, frequency of prosthesis use, and the need for replacement prostheses. The exclusion of participants with incomplete data from the study introduces a high likelihood of missing data.

CONCLUSION

Our study describes the demographic characteristics and clinical outcomes of patients with earthquake-related amputations. We believe that our findings will guide the development of preparedness, response, and recovery policies for potential future disasters.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any

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