ORIGINAL ARTICLE

Clinical predictors of mortality in earthquake victims with crush-related acute kidney injury requiring hemodialysis

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ABSTRACT

BACKGROUND: Major earthquakes frequently cause crush injuries that lead to acute kidney injury (AKI), posing significant challenges for medical teams. Understanding which patients are at the highest risk of mortality can help physicians make better treatment decisions during these disasters. This study examined earthquake victims who developed severe kidney problems requiring dialysis to identify factors that predict survival.

METHODS: A retrospective cohort study was conducted at a major tertiary hospital. Of the 5,338 earthquake victims treated, 1,416 adults developed AKI, of whom 159 required hemodialysis for crush-related injuries. Demographics, clinical features, laboratory parameters, and outcomes were analyzed during logistic regression to identify independent predictors of mortality.

RESULTS: The cohort's mean age was 38.3±14.6 years, with 62.9% male. Mortality was 30.8%. Independent predictors of mortality were septic shock (odds ratio [OR]: 52.148), elevated sodium levels (OR: 1.186), and hypoalbuminemia (OR: 0.877). Prolonged extrication time, systemic infections, and metabolic acidosis were significantly associated with mortality. Demand for hemodialysis peaked in the 1st week, with hyperkalemia and sepsis as major complications.

CONCLUSION: Mortality among earthquake victims with crush-related renal injury depends primarily on overall disease severity rather than renal function alone. Septic shock, blood chemistry imbalances, and prolonged entrapment were the main determinants of survival. Prompt rescue and aggressive treatment of infections and metabolic problems are essential to saving lives in future disasters.

Keywords: Acute kidney injury; Crush syndrome; earthquakes; mortality; renal dialysis.

INTRODUCTION

Natural disasters, such as earthquakes, are catastrophic events with profound human and infrastructural consequences. They often cause complex patterns of trauma, including crush injuries, metabolic disturbances, and multiorgan dysfunction.[1] Among these, acute kidney injury (AKI), particularly crush-related AKI, is a critical condition requiring urgent and specialized medical attention. AKI not only poses an immediate threat to survival but also contributes to long-term morbidity among survivors, underscoring the need for effective and timely interventions.

The pathophysiology of AKI in crush syndrome is well-documented and involves rhabdomyolysis-induced nephrotoxicity, hypovolemia, and systemic inflammation. These processes are further exacerbated by delays in rescue and medical intervention, which are common in disaster settings. Hemodialysis is a cornerstone of the management of crush-related AKI and has the potential to reduce mortality and improve recovery. However, its success depends on early diagnosis, efficient resource allocation, and coordination among multidisciplinary teams. Despite advances in disaster response systems, gaps remain in understanding the predictors of mortality in this vulnerable population.[2,3] Previous studies have focused

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on the epidemiology of AKI and the utility of dialysis during earthquakes, but data on specific clinical and laboratory markers that influence outcomes are limited. Furthermore, there is a need to evaluate how systemic complications, such as sepsis, hypoalbuminemia, and electrolyte imbalances, interact with AKI to determine mortality.[4,5] These insights are critical for optimizing disaster preparedness and improving care for earthquake victims, particularly in tertiary hospitals that serve as referral centers during such crises.

While previous studies have documented AKI patterns in the Marmara and Wenchuan earthquakes, they have primarily focused on epidemiological aspects and basic clinical outcomes. Our study addresses critical gaps by (1) providing a comprehensive multivariate analysis of mortality predictors, including metabolic markers rarely examined together, (2) analyzing the temporal evolution of renal function recovery stratified by pre-existing chronic kidney disease (CKD) status, and (3) examining the interaction between systemic complications and metabolic disturbances in a large contemporary cohort with modern management protocols. Limited data exist on the specific clinical and laboratory predictors of mortality in crush-related AKI, particularly the interplay between systemic complications and metabolic disturbances in determining patient outcomes. In this context, our study aimed to investigate the clinical, demographic, and laboratory characteristics of earthquake victims with AKI, focusing on crush-related injuries requiring hemodialysis (HD). We sought to identify key predictors of mortality to help clinicians manage similar scenarios more effectively. By analyzing a comprehensive dataset from a tertiary hospital, this study contributes to understanding predictors of mortality in earthquake-related crush syndrome.

MATERIALS AND METHODS

Study Design and Setting

This retrospective, cross-sectional study was conducted at a tertiary hospital that served as a major referral center following a devastating earthquake. The study included earthquake victims admitted to the hospital, with a focus on those diagnosed with AKI and requiring HD for crush-related injuries.

Patient Population

A total of 5338 individuals presented to the hospital following the earthquake, of whom 3313 were adults aged 18 years or older. Of these, 1416 patients were diagnosed with AKI, and 159 required HD for crush-related injuries. Demographic data, clinical parameters, laboratory results, and treatment outcomes were extracted from electronic hospital records.

Ethical Considerations

This study was approved by the Adana City Training and Research Hospital Scientific Research Ethics Committee (Date: 25.07.2025, Decision no: 72), and all procedures adhered to the ethical principles of the Declaration of Helsinki. Given the study's retrospective design, informed consent was waived. Patient anonymity and confidentiality were strictly maintained throughout the study.

Data Collection

Among the 3,313 adults, 1,416 were diagnosed with AKI, and 159 patients required hemodialysis for crush-related injuries. Due to the earthquake's impact on most hospitals in the region, many victims were admitted to our hospital within the 1st h after the disaster.

Data were collected retrospectively from patients' medical records. The data included demographic information (age, gender), clinical variables (intensive care unit [ICU] admission, mechanical ventilation, comorbidities), laboratory parameters (e.g., albumin, sodium, lactate, pH), and dialysis session details. Thirty-day mortality was defined as the primary outcome of the study. Mortality was assessed as death from any cause occurring within 30 days after hospital admission.

Disease severity was assessed using two validated scoring systems. The Acute Physiology and Chronic Health Evaluation II (APACHE II) score was calculated within the first 24 h of admission, using the worst values of 12 physiological variables, age, and chronic health status. The Sequential Organ Failure Assessment (SOFA) score was calculated to evaluate multi-organ dysfunction, incorporating assessments of the respiratory, cardiovascular, hepatic, coagulation, renal, and neurological systems. Higher scores indicate greater disease severity in both systems.

Statistical Analysis

Statistical analyses were performed using Statistical Package for the Social Sciences version 27.0 (IBM Corp., Armonk, NY, USA). Categorical variables were summarized as frequencies and percentages, and continuous variables as mean±standard deviation or, where appropriate, as median (minimum-maximum). The Chi-square test was used to compare categorical variables. Data-handling procedures included systematic checks for missing values and outliers. Missing data patterns were assessed, and cases with >20% missing key variables were excluded. Continuous variables were examined for normality using the Shapiro–Wilk test. Retrospective data collection followed a standardized protocol with two independent reviewers extracting data to ensure accuracy. Discrepancies were resolved through consensus or consultation with a third reviewer. For variables that did not follow a normal distribution, comparisons between two groups were conducted using the Mann–Whitney U-test. Factors influencing mortality were evaluated using multivariate logistic regression analysis. Model assumptions were checked, including linearity of continuous variables with log odds, and the final model's goodness-of-fit was assessed using the Hosmer–Lemeshow test. Sensitivity analyses were performed, excluding extreme outliers, to verify model stability. A $p<0.05$ was considered statistically significant for all tests.

RESULTS

A total of 5,338 patients were treated and followed up at our hospital, of whom 3,313 were adults aged 18 years or older. Among these, AKI developed in 1,416 patients, and 199 of them underwent HD treatment. Of these, 159 patients required HD due to AKI associated with crush syndrome.

A total of 159 earthquake victims were included in the study. The mean age of the patients was 38.3±14.6 years, with 100 (62.9%) male and 59 (37.1%) female. Comorbidities were observed in 19 (11.9%) patients: Diabetes mellitus in 5 (26.3%), hypertension in 7 (36.8%), and other comorbidities in 9 (47.4%). The mean time to extrication from the earthquake debris was 41.1±24.0 h. Signs of anuria were observed in 146 (91.8%) patients, with 55 (34.6%) having anuria and 91 (57.2%) oliguria. Amputations were performed in 43 (27%) patients, fasciotomy in 92 (57.9%), and additional complications were identified in 72 (45.3%). Among the amputations, 7 were performed on the upper extremities of 6 patients, while 40 were performed on the lower extremities of 36 patients. ICU admission was required for 92 (57.9%) patients, with a mean ICU stay of 11.8±13.2 days. Endotracheal intubation was performed in 46 (28.9%) patients. Hemodiafiltration (HDF) was applied to 24 (15.1%) patients. The need for HD continued for 72 (45.3%) patients during the 1st week, with a mean of 3.83±3.3 HD sessions per patient. CKD was developed in 8 (5%) patients during follow-up. Mortality was observed in 49 (30.8%) patients (Table 1).

Table 1. Demographic data of patients with crush syndrome

Variables	Number of patients (Total, n=159)	%
Gender		
Male	100	62.9
Female	59	37.1
Comorbidities	19	11.9
Diabetes mellitus	5	26.3
Hypertension	7	36.8
Other	9	47.4
Anuria	55	34.6
Oliguria	91	57.2
Amputation	43	27.0
Lower extremity amputation	40	25.2
Upper extremity amputation	3	1.9
Fasciotomy	92	57.9
Infection complications	87	54.7
Wound infection	58	66.7
Urinary tract infection	14	16.1
Bloodstream infection	24	27.6
Aspiration-associated infection	4	4.6
Other infection	3	3.4
Culture positivity	77	48.4
Sepsis	78	49.1
Septic shock	37	23.3
Acute respiratory distress syndrome	6	3.8
Disseminated intravascular coagulation	13	8.2
Chronic kidney disease developed	8	5.0
Mortality	49	30.8

Patients may have more than one comorbidity or infection; subgroup percentages are calculated within the respective category.

Infection foci were detected in 87 (54.7%) patients. The most common infections were wound infections in 58 (66.7%), urinary tract infections in 14 (16.1%), bloodstream infections in 24 (27.6%), aspiration-associated infections in 4 (4.6%), and other infections in 3 (3.4%). Microorganisms were isolated in 77 (48.4%) patients. The most frequently isolated organisms were Acinetobacter baumannii in 44 (57.1%), Escherichia coli in 5 (6.5%), non-albicans Candida in 2 (2.6%), Candida albicans in 3 (3.9%), Klebsiella pneumoniae in 9 (11.7%), extended-spectrum beta-lactamase-producing E. coli in 3 (3.9%), coagulase-negative staphylococci in 4 (5.2%), and other microorganisms in 21 (27.3%).

No significant differences were found between groups in terms of gender or age ($p>0.05$). Non-survivors had higher rates of amputation, ICU admission, intubation, and HDF ($p=0.026$, $p<0.001$, $p<0.001$, $p<0.001$, respectively). Disease severity scores were calculated for all patients. The mean APACHE II score was 19.53±5.11 in survivors versus 21.31±7.22 in non-survivors ($p=0.254$), showing no significant difference. In contrast, SOFA scores were significantly higher in non-survivors (7.04±2.10) compared to survivors (5.74±1.40, $p=0.001$) (Table 2).

The average extrication time was significantly longer in patients who died ($p=0.019$). In addition, systolic and diastolic blood pressures, albumin, pH, and bicarbonate levels were significantly lower in non-survivors ($p<0.001$, $p<0.001$, $p=0.003$, $p=0.003$, $p=0.002$, respectively). In contrast, pulse rate, glucose, platelet count, sodium, lactate, ferritin, and international normalized ratio (INR) levels were significantly higher in these patients ($p=0.003$, $p=0.013$, $p=0.026$, $p=0.018$, $p<0.001$, $p=0.036$, $p=0.011$, respectively). No significant differences were observed in other laboratory parameters between groups, $p>0.05$ (Table 3).

Urinary infections were less common in non-survivors ($p=0.005$), while bloodstream infections were more frequent ($p=0.028$). Sepsis, septic shock, acute respiratory distress syndrome (ARDS), and disseminated intravascular coagulation (DIC) were significantly more prevalent in non-survivors ($p<0.001$, $p<0.001$, $p=0.005$, $p=0.012$, respectively) (Table 4).

In univariate analysis, amputation, extrication time, albumin, sodium, pH, lactate, INR, sepsis, and septic shock were sig-

Table 2. Comparison of diagnostic features and clinical outcomes between mortality and survival groups among earthquake victims

Variables	Survivors (Total, n=110)	Non-survivors (Total, n=49)	p
Age (years)	36.7±11.9	41.9±18.9	0.325
Gender			
Male (n/%)	66 (60%)	34 (69.4)	0.258
Female (n/%)	40 (40%)	15 (30.6)	0.258
Comorbidity (n/%)	11 (10%)	8 (16.3%)	0.256
	Mean±SD	Mean±SD	p
Urinary output			
Anuria	33 (32.7)	22 (48.9)	0.175
Oliguria	68 (67.3)	23 (51,1)	0.115
Amputation	24 (21.8)	19 (38.8)	0.026*
Fasciotomy	66 (60)	26 (53.1)	0.413
Other problems	50 (45.5)	22 (44.9)	0.948
ICU admission	43 (39.1)	49 (100)	<0.001**
Intubation	6 (5.5)	40 (81.6)	<0.001**
Hemodiafiltration	102 (92.7)	33 (67.3)	<0.001**
1st week hemodialysis	48 (43.6)	24 (49)	0.532
Mean±SD	Mean±SD (Med)	p‡	
Duration under the rubble (hours)	38.5±24	46.9±23.2	0.019*
ICU duration (days)	10.5±10	12.9±15.4	0.770
Hemodialysis sessions	4.16±3.5	3.1±2.7	0.068
APACHE II score	19.53±5.11	21.31±7.22	0.254
SOFA score	5.74±1.40	7.04±2.10	0.001*

ICU: Intensive care unit; CKD: Chronic kidney disease; *p<0.05; †: Chi-square; ‡: Mann–Whitney U.

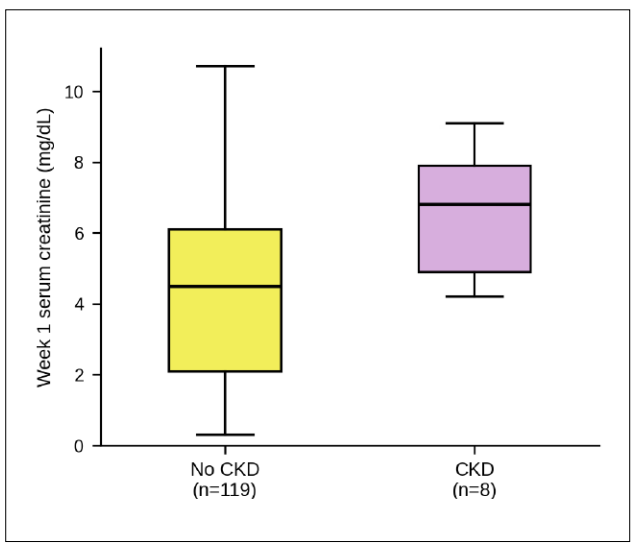

Figure 1. Comparison of week 1 serum creatinine levels between patients who did and did not develop chronic kidney disease (CKD).

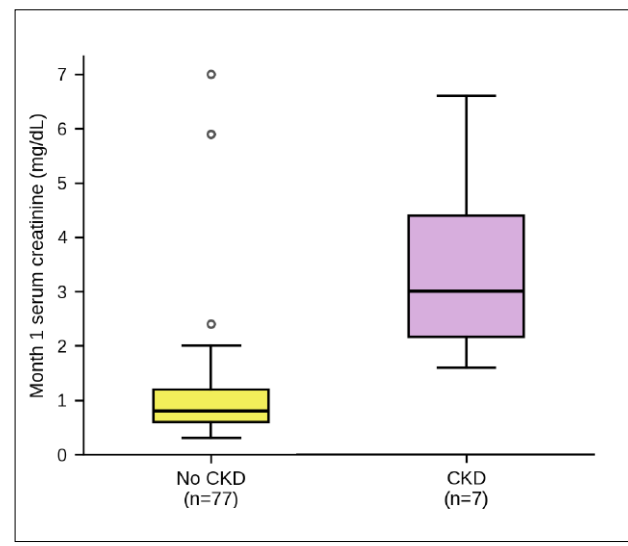

Figure 2. Comparison of month 1 serum creatinine levels between patients who did and did not develop chronic kidney disease (CKD).

Table 3. Comparison of diagnostic features and clinical outcomes between mortality and survival groups among earthquake victims

Variables	Survivors (n=110)	Non-survivors (n=49)	p
Systolic blood pres-sure (mmHg)	118.4±14.8	88.3±15.7	<0.001**
Diastolic blood pres-sure (mmHg)	72.6±8.4	54.3±11.9	<0.001**
Heart rate (beats/minute)	85.5±13.7	100.6±16.6	0.003**
Glucose (mg/dL)	132.3±62.9	170.1±100.3	0.013*
Urea (mg/dL)	116.2±80.7	121.6±78.5	0.600
Creatinine (mg/dL)	3.27±2.1	3.47±2.2	0.576
Albumin (g/L)	30.1±6.8	25.9±7.3	0.003**
Total protein(g/L)	58.3±10.8	54.3±11.6	0.263
C-reactive protein (mg/L)	176.5±84.9	169.1±102.9	0.433
Procalcitonin (ng/mL)	26.2±84.2	31.2±41.5	0.026*
Sodium (mmol/L)	133.1±10.2	135.9±6.3	0.018*
Potassium (mmol/L)	6.46±2.3	6.48±1.1	0.195
Uric acid (mg/dL)	11.7±3.2	12.5±3.2	0.169
Direct bilirubin (mg/dL)	0.14±0.12	0.16±0.16	0.718
Total bilirubin (mg/dL)	0.68±0.54	0.64±0.5	0.735
Alanine aminotrans-ferase (U/L)	419.6±268.5	603.7±564.8	0.346
Aspartate aminotrans-ferase (U/L)	1062.1±643.6	1244.8±929.8	0.426
Calcium (mg/dL)	7.54±0.9	7.22±1.2	0.097
Magnesium (mg/dL)	2.27±0.6	2.27±0.4	0.878
Phosphorus (mg/dL)	8.16±2.8	8.67±2.6	0.157
Creatine phosphoki-nase (U/L)	113471.3±16187.6	104047.7±98557.4	0.419
Amylase (U/L)	253.6±411.5	295.2±258.5	0.434
Myoglobin (ng/mL)	3745.9±743.7	907.4±3706.0	0.678
Leukocyte (×10^9/L)	24.52±27.69	24.58±25.06	0.684
Hemoglobin (g/dL)	15.3±3.6	3.16±15.2	0.595
Hemotocrit (%)	45.5±10.6	10.2±45.5	0.745
Platelets (×10^9/L)	263.25±93.04	260.15±102.70	0.357
pH 7.19±0.10	7.20±0.13	0.003**	
Bicarbonate (mmol/L)	16.1±3.2	15.5 ±3.59	0.002**
Lactate (mmol/L)	36.3±25.4	33.0±55.1	<0.001**
Ferritin (µg/L)	428.4±363.6	1897.6±345.7	0.036*
International normal-ized ratio	1.24±1.2	1.29±0.5	0.011*
1st week creatinine (mg/dL)	4.46±2.9	4.47±1.9	0.977
1st month Ürea (mg/dL)	38.7±27.8	91.3±51.1	<0.001**
1st month creatinine (mg/dL)	1.23±1.4	1.90±1.3	0.004**

*p<0.05; Mann–Whitney U.

nificant variables and included in a multivariate logistic regression model (Table 5). According to the model, albumin (odds ratio [OR]: 0.877), sodium (OR: 1.186), and septic shock (OR: 52.148) were identified as independent predictors of mortality (p<0.05).

Patients with CKD who developed group had significantly higher creatinine levels compared to those without CKD who did not develop at both week 1 and month 1 following the earthquake. These findings are illustrated in Figures 1 and 2, which demonstrate the prolonged recovery of renal function in patients with pre-existing CKD. At week 1, the mean

Table 4. Infection sites and complications in relation to mortality among earthquake victims

Variables	Survivors (n=110)	Non-survivors (n=49)	p
Infection complications	59 (53.6)	28 (57.1)	0.682
Wound infection	41 (69.5)	17 (60.7)	0.417
Urinary tract infection	14 (23.7)	-	0.005**
Blood infection	12 (20.3)	12 (42.9)	0.028*
Aspirate infection	1 (1.7)	3 (10.7)	0.061
Other infection	1 (1.7)	2 (7.1)	0.193
Sepsis	40 (36.4)	38 (77.6)	<0.001**
Septic shock	6 (5.5)	31 (63.3)	<0.001**
ARDS	1 (0.9)	5 (10.2)	0.005**
DIC	5 (4.5)	8 (16.3)	0.012*

ESBL+: Extended-spectrum beta-lactamase positive; ARDS: Acute respiratory distress syndrome; DIC: Disseminated intravascular coagulation.

Table 5. Multivariate analysis of mortality predictors in patients with crush-related acute kidney injury

Variables	p	OR	%95 CI	
			Lower	Upper
Amputation	0.417	1.675	0.482	5.817
Duration under the rubble (hours)	0.146	1.017	0.994	1.040
Albumin	0.004**	0.877	0.803	0.958
Sodium	0.002**	1.186	1.063	1.323
pH	0.158	77.262	0.184	32432.7
Lactate	0.063	1.025	0.999	1.053
International normalized ratio	0.154	0.753	0.511	1.111
Sepsis	0.479	1.676	0.401	6.997
Septic shock	<0.001**	52.148	8.704	312.419

CI: Confidence interval; OR: Odds ratio. *p<0.05; **p<0.01.

creatinine level was 6.59±1.8 mg/dL in the CKD developed group and 4.32±2.7 mg/dL in the non-CKD group (p=0.020). By month 1, the CKD developed group's mean creatinine level remained elevated at 3.47±1.8 mg/dL, while the non-CKD group's mean creatinine level had decreased to 1.09±1.1 mg/dL (p<0.001). These findings highlight the slower recovery of renal function in patients who developed CKD.

DISCUSSION

The devastating earthquakes that struck Türkiye highlighted the critical importance of timely medical interventions in disaster scenarios. In this study, we analyzed one of the largest cohorts of earthquake victims with crush-related AKI, revealing that mortality was influenced by a combination of systemic complications and metabolic disturbances.

AKI in the patients included in this study was predominantly attributed to acute tubular necrosis resulting from rhabdomyolysis, as evidenced by markedly elevated mean levels of creatine kinase and myoglobin. The severity of renal impairment was further underscored by the high proportion of patients (91.8%) presenting with either anuria or oliguria. Among the interventions, fasciotomy was performed on 92 patients (57.9%), a rate lower than the 67.7% reported among HD-treated patients during the 1999 Marmara earthquake.[6] The lower rate of fasciotomy observed in our study compared with the Marmara earthquake may be explained by increased clinical awareness in the diagnosis and monitoring of rhabdomyolysis and compartment syndrome, the implementation of

more selective and indication-based surgical decision-making, and a greater emphasis on limb-sparing approaches. Notably, fasciotomy in our cohort did not demonstrate a significant impact on mortality. In addition, amputations were required in 43 patients (27%), with the majority involving the lower extremities (86.1%) compared to 13.9% in the upper extremities. These findings highlight the vulnerability of the lower extremities to trauma in earthquakes.[7] Larger muscle groups in these regions contribute to extensive rhabdomyolysis and an increased risk of AKI.

For such patients, close monitoring for rhabdomyolysis is critical, and simple measures like urine dipstick tests for hematuria or patient observation of urine color and output can aid in early detection.

A significant relationship was observed between the time to extrication from debris and mortality. These findings emphasize the critical importance of rapid rescue efforts in improving survival outcomes, as delayed extrication increases the risk of systemic complications and mortality.

Our findings align with previous studies that emphasize the profound impact of AKI and electrolyte imbalances on the prognosis of disaster victims, particularly those with crush syndrome. Similar to the Wenchuan earthquake study, where hyponatremia was prevalent in over half of the patients and significantly associated with poor outcomes, our study also identified electrolyte disturbances, such as hypernatremia, as critical predictors of mortality among earthquake victims.[8] In our study, sodium levels in the survivor group were found to be lower compared to the non-survivor group. This finding can be explained by the provision of better hydration to the survivor group. Furthermore, the interplay of systemic complications such as sepsis and septic shock underscores the necessity for early and aggressive interventions to stabilize patients. The consistent association of AKI with crush-related injuries in both studies reinforces the critical role of timely renal replacement therapy and multidisciplinary disaster response strategies in improving survival outcomes. These findings collectively highlight the importance of robust nephrology expertise and resource planning in disaster medicine to mitigate morbidity and mortality in future large-scale emergencies.

The outcomes of our study are consistent with those of previous research emphasizing the critical impact of timely intervention and comprehensive management in earthquake victims, particularly those suffering from crush syndrome and AKI. Similar to the findings in the Kahramanmaraş earthquake study, our data highlight the prevalence of AKI and systemic complications such as sepsis and septic shock among victims.[9] The correlation between the duration of entrapment under rubble and metabolic derangements, including elevated serum lactate, uric acid, and myoglobin levels, underscores the importance of early fluid resuscitation to mitigate ischemia-reperfusion injuries.

The cornerstone of treatment for crush-related AKI is undoubtedly fluid replacement and HD.[10] The indications for HD is these patients are no different from other causes of AKI. Patients underwent HD for hyperkalemia, metabolic acidosis unresponsive to medical treatment, hypervolemia, and uremic symptoms. No prophylactic HD was performed.

In our study, similar to the Kahramanmaraş earthquake study, hyperkalemia was the most common indication.[11] Other HD indications included hypervolemia, medically refractory metabolic acidosis, and uremic symptoms.

In addition, trauma characteristics, such as crush injuries below the knee and the presence of compartment syndrome, were more strongly associated with mortality in the Kahramanmaraş cohort. These differences underscore the importance of context-specific approaches to disaster nephrology, with an emphasis on rapid diagnosis and management of metabolic derangements, compartment syndrome, and systemic complications like sepsis.

The findings of our study contrast with those from the Marmara earthquake, highlighting important advancements in disaster management and nephrology care. The Marmara earthquake reported a significantly higher dialysis need (74.6%) and mortality rates among renal victims compared to our cohort, where improvements in fluid resuscitation strategies and better disaster preparedness likely played a critical role.[12] The Marmara study identified extensive rhabdomyolysis and systemic complications such as DIC and ARDS as key predictors of mortality, emphasizing the severity of crush syndrome complications. While our study also observed high rates of AKI and systemic infections, the streamlined management protocols in the recent disaster, including early fluid administration and potassium-free fluids, likely contributed to improved survival outcomes. Furthermore, surgical interventions such as fasciotomies were performed more frequently in the Marmara cohort, correlating strongly with sepsis and higher mortality rates. This underscores the importance of balancing invasive procedures with medical management strategies like mannitol therapy to mitigate compartment syndrome while minimizing the risk of infections. Variations in patient management between earthquakes reflect evolving disaster response protocols. The implementation of early fluid resuscitation protocols and improved coordination of dialysis resources since the Marmara earthquake likely contributed to the observed differences in outcomes. Regional factors, including proximity to tertiary care centers and speed of international aid response, also influence mortality patterns across different disasters.

Both our study and the analysis of mortality factors in crush syndrome identify low systolic blood pressure upon admission as a significant predictor of mortality among earthquake victims.[13] This shared finding emphasizes the critical importance of early fluid resuscitation in managing crush syndrome patients, as hypotension often indicates delayed or inad-

equate pre-hospital care. In addition, hypotension increases HD complications and the need for vasopressors during HD, which also increases mortality. Another reason may be the addition of hypotension to be complications of crush-related AKI such as sepsis and septic shock. However, while our study primarily focuses on hypervolemia and systemic complications like sepsis as additional contributors to mortality, the other study highlights the role of elevated serum potassium and creatinine levels alongside severe acidosis as key determinants of poor outcomes. Furthermore, while both studies report a significant association between AKI severity and mortality, the frequency of HD was higher in their cohort, likely reflecting differences in rescue and treatment protocols or patient demographics.

In our study, 49 patients (30.8%) died. This mortality rate is comparable to those reported in other major earthquakes. For example, the mortality rate was 23.7% in the Marmara earthquake and 15.1% among AKI patients on HD in the Wenchuan earthquake.[14,15] The high mortality rate observed in our study may be associated with differences in demographic and clinical characteristics of the patients and with the severity of the earthquake.

Although crush-related injuries are associated with significant mortality and morbidity, studies have shown that the risk of developing CKD is relatively low.[16] In our study, CKD developed in 8 patients, and none of them required long-term HD.

This study has several limitations. First, the retrospective design may introduce recall bias and limit the control over data collection, potentially leading to missing or incomplete records. Second, the single-center nature of the study restricts the generalizability of the findings to other regions or populations affected by similar disasters. Third, the lack of certain laboratory and clinical parameters in the dataset constrained the scope of our analyses. Finally, the study cohort was limited to patients who presented to our hospital, potentially excluding victims who either did not reach healthcare facilities or were treated elsewhere. These limitations should be considered when interpreting the findings of this study. Formal collinearity diagnostics were not included in our original analysis protocol; however, the stability of the model was assessed through sensitivity analyses. The high odds ratio for septic shock should be interpreted cautiously, given the wide confidence interval, which may reflect the relatively small number of events in this category.

CONCLUSION

This study highlights the multifactorial determinants of mortality among earthquake victims with crush-related AKI requiring HD. Key findings indicate that prolonged extrication times, systemic complications such as septic shock, and metabolic disturbances, including hypoalbuminemia and elevated sodium levels, were significant predictors of mortality. The high prevalence of complications such as sepsis, amputations, and intensive care admissions underscores the critical importance of early and aggressive interventions. These findings reinforce the need for robust disaster preparedness plans, specialized nephrology expertise, and streamlined protocols for managing crush syndrome and AKI in disaster settings. By addressing these factors, future disaster responses may achieve better survival outcomes and mitigate the long-term impact on affected populations.

Ethics Committee Approval: This study was approved by the Adana City Training and Research Hospital Scientific Research Ethics Committee (Date: 25.07.2025, Decision No: 72).

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ORİJİNAL ÇALIŞMA - *ÖZ*

Hemodiyaliz gerektiren ezilmeye bağlı akut böbrek yaralanması olan deprem mağdurlarında ölümün klinik tahmin edicileri

AMAÇ: Büyük depremler sıklıkla akut böbrek hasarına (ABH) yol açan ezilme yaralanmalarına neden olur ve bu durum sağlık ekipleri için önemli zorluklar oluşturur. Hangi hastaların ölüm riski açısından daha yüksek olduğunu anlamak, afet sırasında hekimlerin daha doğru tedavi kararları vermesine yardımcı olabilir. Bu çalışma, diyaliz gerektiren ağır böbrek hasarı gelişen deprem mağdurlarında sağkalımı öngören faktörleri belirlemeyi amaçlamıştır.

GEREÇ VE YÖNTEM: Bu retrospektif kohort çalışma, bir üçüncü basamak merkezde gerçekleştirilmiştir. Tedavi edilen 5.338 deprem mağdurunun 1.416'sında ABH gelişmiş olup, bunların 159'unda ezilmeye bağlı olarak hemodiyaliz gereksinimi doğmuştur. Demografik özellikler, klinik bulgular, laboratuvar parametreleri ve sonuçlara ilişkin veriler, mortalitenin bağımsız belirleyicilerini tanımlamak için lojistik regresyon kullanılarak analiz edilmiştir.

BULGULAR: Kohortun ortalama yaşı 38.3±14.6 olup, %62.9'u erkektir. Mortalite oranı %30.8 olarak saptanmıştır. Septik şok (OR: 52.148), yüksek sodyum düzeyleri (OR: 1.186) ve hipoalbüminemi (OR: 0.877) mortalitenin bağımsız belirleyicileri olarak tanımlanmıştır. Uzamış kurtarılma süresi, sistemik enfeksiyonlar ve metabolik asidoz mortalite ile anlamlı şekilde ilişkili bulunmuştur. Hemodiyaliz gereksinimi ilk hafta içinde en yüksek seviyedeydi; hiperkalemi ve sepsis başlıca komplikasyonlardı.

SONUÇ: Ezilme ilişkili böbrek hasarı olan deprem mağdurlarında mortalite oranları, yalnızca böbrek fonksiyonundan ziyade genel hastalık ağırlığı ile ilişkilidir. Septik şok, biyokimyasal dengesizlikler ve uzun süreli enkazda kalma süresi sağkalımı belirleyen temel faktörlerdir. Hızlı kurtarma çalışmaları ile enfeksiyon ve metabolik sorunların agresif tedavisi, gelecekteki felaketlerde hayat kurtarmak için kritik öneme sahiptir.

Anahtar sözcükler: Akut böbrek hasarı; depremler; ezilme sendromu; mortalite; renal diyaliz.

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