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Rhabdomyolysis in Earthquake Victims in Nepal

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Crush injury leading to rhabdomyolysis is one of the dreaded complications of natural catastrophes such as earthquakes.[1]

Rhabdomyolysis is a syndrome characterized by muscle necrosis and the release of intracellular muscle constituents, namely creatine phosphokinase, myoglobin, and various electrolytes into the circulation. Precipitation of myoglobin in the renal tubules with secondary obstruction and/or tubular toxicity constitutes one of the main causes of acute kidney injury (AKI).[2–5] Creatine phosphokinase (CPK), a widespread enzyme that catalyzes the phosphorylation of creatinine into creatinine phosphate, is an enzyme released into the bloodstream from injured muscle tissue. The skeletal muscle has a very high CPK content. It is present in the serum immediately following muscle injury, peaks at about 12 to 36 hours, and has a half-life of about 48 hours. However, every crush injury does not necessarily result in rhabdomyolysis, and not all instances of rhabdomyolysis lead to AKI.[6] Dehydration, sepsis, and use of nephrotoxic drugs also contribute to AKI following a crush injury.[7] The link between rhabdomyolysis and mortality is hyperkalemia at the beginning and acute oliguric renal failure and sepsis later.[3,5,8,9]

Compartment syndrome is a potential complication of severe rhabdomyolysis. Most striated muscles are contained within rigid compartments formed by fasciae, bones, and other structures. If the energy-dependent transcellular pump systems fail in the traumatized tissue, the muscle cells swell. As a result, intracompartmental pressure rises. High intracompartmental pressure provokes additional damage and necrosis.[6]

A devastating earthquake, registering 7.8 magnitude on the Richter scale, struck Nepal on April 25, 2015, at 11:56 AM Nepal Standard Time, with epicenter at Barpak, Gorkha, less than 50 miles northwest of Kathmandu. It was the worst natural disaster to strike Nepal since the 1934 Nepal–Bihar earthquake. It killed more than 8500 people and injured more than 22,000.

On the day of the earthquake, triage was set up in the emergency center at Tribhuvan University Teaching Hospital, Kathmandu, immediately after the earthquake. After primary and secondary surveys, immediate fluid resuscitation was done in accordance with the Recommendations for the Management of Crush Victims in Mass Disaster.[10]

Basic demographic data were collected from all the victims who needed admission, namely age, sex, date of admission, address, timing of arrival in emergency, degree and type of injury, type of surgical intervention, medical or surgical complication, need of dialysis, mode of dialysis, and outcome of each case during the course of hospitalization. Clinical parameters such as blood pressure, pulse rate, daily urine output, blood biochemistry (blood urea, serum creatinine, serum creatine phosphokinase, serum sodium, serum potassium), and blood cell count were also collected daily during the course of hospitalization. Those patients who developed AKI during the hospitalization were then analyzed.

AKI patients were defined as those with urine output of <0.5 ml/kg/h in 6 hours, despite fluid resuscitation according to the Recommendation for the Management of Crush Victims in Mass Disaster,[10] a rise in serum creatinine of ≥ 0.3 mg/dl (≥ 26.5 μmol/l) from baseline creatinine, an increase in serum creatinine of ≥ 4 mg/dl (≥ 353.6 μmol/l), or initiation of renal replacement therapy. Among these patients, a subgroup of patients who had CPK levels of >250 IU/L were further analyzed.

Descriptive statistics for all numeric variables were performed, and the mean ± SD were calculated. A 2-sample t test was performed to compare the mean of 2 independent groups, and a χ^2 test

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was applied to compare proportions of categorical variables, when appropriate. Data were analyzed with SPSS software version 20.0 for Mac (IBM SPSS, Armonk, NY). Statistical significance was accepted at a P value of <0.05.

A total of 1812 earthquake victims were received in the emergency department in Tribhuvan University Teaching Hospital during the earthquake period. Among them, 572 patients (31.56%) needed hospitalization. Altogether a total of 591 major operations were performed. The overall mortality in the patents who were admitted was 19 (3.32%).

Among the patients who needed hospitalization, 23 patients (4.02%) developed AKI. In the patients with AKI, the mean age was 35.57 ± 17.92 years (range 6−84 years). Of the patients, 26.08% were in the age group between 20 and 29 years, and 56.52% of them were male. The mean CPK level was 18144.39 ± 18589.76, mean creatinine was 495.26 ± 319.92, mean potassium was 5.09 ± 1.31, and mean hemoglobin level was 8.74 ± 1.88. Ten patients (43.47%) developed sepsis, 8 patients (34.78%) had compartment syndrome, and 2 patients (8.6%) died (Supplementary Table S1). Regarding surgical procedures, fasciotomy was performed in 7 patients, open reduction and internal fixation in 2 patients, and craniotomy in 1 patient.

Of the 23 patients, 20 (86.9%) with AKI needed dialysis support. All underwent hemodialysis. The mean hemodialysis session was 3.7 ± 2.34. In all, 69 (12.06%) patients had CPK levels of >250 IU/L. Their mean age was 35.8 ± 20.08, and 24.6% were in the age group between 20 and 29 years. A total of 49.3% were male. In all, 49 patients had lower extremity injury, 13 had trunk injury, and 7 had upper extremity injury (Supplementary Table S2). Of these patients, 23 patients (33.33%) developed AKI. The incidence of sepsis, compartment syndrome, and mortality were found to be greater in patients who had AKI ($P < 0.05$) (Supplementary Table S1).

Eleven patients (1.92%) had a CPK level of >18,000 IU/L. Ten (90.9%) of them developed AKI, and all of those with AKI required dialysis support ($P < 0.05$). In these patients, the mean CPK level was 34,071.91 ± 15,431.11, mean creatinine was 486.64 ± 252.70, mean potassium was 5.37 ± 1.20, and mean hemoglobin level was 8.45 ± 2.06. Three patients (27.27%) developed sepsis, 8 patients (72.72%) had compartment syndrome and 2 patients (18.18%) died (Supplementary Table S2). So, the arbitrary CPK cut-off level of >18,000 IU/l was associated with a higher incidence of AKI and need for dialysis support, suggesting that we have to be more vigilant in taking preemptive measures such as more aggressive fluid resuscitation and frequent monitoring in these high-risk victims.

Comparatively, in an earthquake that occurred in Marmara, Turkey, in 1999 (7.4 magnitude on the Richter Scale), 5302 patients were hospitalized and 639 (12.0%) developed renal problems, of whom 477 (74.6%) were treated by dialysis.[1,11] Furthermore, in a report on the Bam, Iran, earthquake in 2003 (6.7 magnitude on the Richter Scale),[12] 2283 patients needed hospitalization. Dialysis was required in 6.5% of all patients and in 64.24% in patients with AKI.[13] In regard to the Bam earthquake, Hatamizadeh *et al*. reported sepsis in 19 of 164 patients (11.6%) with AKI and mortality in 21 of 165 patents (12.7%).[13] Similarly, in an earthquake in Kobe, Japan, in 1995, the need for dialysis correlated directly with serum CPK levels. Dialysis was required in 84% of patients with a CPK level of >75,000 IU/l and only 39% in patients with a CPK level of >75,000 IU/L.[14] In a separate study, researchers at Massachusetts General Hospital in the United States looked at the risk prediction score for kidney failure or mortality in rhabdomyolysis. McMahon *et al*. found that patients with CPK levels of >40,000 IU/l were at an increased risk for death or requiring renal replacement therapy.[15]

By contrast, we found an increased incidence of AKI even in patients with lower CPK levels than those reported in other analyses of earthquake victims. This finding could be caused by a delay in the arrival of patients to the hospital due to difficulty in transport and rescue operations.

When combined with the findings of additional studies, our analysis from a central hospital in Nepal shows that rhabdomyolysis and AKI are common in earthquake victims. As patients with high levels of CPK are more likely to develop AKI and other complications, we should be vigilant about managing these patients more aggressively to prevent complications and mortality.

DISCLOSURE

All the authors declared no competing interests.

SUPPLEMENTARY MATERIAL

Table S1. Comparison of complications between patients with AKI and without AKI in patients with CPK of >250 IU/L.

Table S2. Data for patients with CPK levels of >250 IU/L and >18,000 IU/L.

Supplementary material is linked to the online version of the paper at http://www.kireports.org.

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