

Outcomes of Fasciotomy in Patients With Crush-induced Acute Kidney Injury After Bam Earthquake

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Introduction. Fasciotomy may increase the morbidity and mortality in patients with crush-induced acute kidney injury (AKI), by creating an open wound, increasing the risk of bleeding, coagulopathy, and potentially fatal sepsis. This study evaluates the outcomes of fasciotomy in these patients after Bam earthquake in Iran.

Materials and Methods. We reviewed medical records of victims of Bam earthquake complicated with crush-induced AKI. Demographic, biochemical, and clinical data of patients who underwent fasciotomy were evaluated and compared with other patients with AKI.

Results. Fasciotomy was performed for 70 of 200 patients with crush-induced AKI (35.0%). There were no significant differences regarding sex, age, time under the rubble, and muscle enzymes level between these patients and those without fasciotomy. They did not experience higher rates of disseminated intravascular coagulopathy, sepsis, adult respiratory distress syndrome, amputation, and dialysis session. Neither did they have a longer hospitalization period or higher death rate.

Conclusions. This study showed that fasciotomy did not have any deteriorating effect on morbidity and mortality of patients with crush-induced AKI after Bam earthquake.

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INTRODUCTION

Compartment syndrome is a limb-threatening condition characterized by increased intracompartmental pressure. Striated muscles are located in the spaces or compartments formed by rigid fascia. Normally, the inside pressure of these compartments is as low as zero to 20 mm Hg. When a limb is trapped under rubble, in response to mechanical pressure, myocytes become stretched and start leaking contents out of the cell.¹ Conversely, extracellular cations and fluid flow down the electromechanical gradient into sarcoplasm, leading to swelling of myocytes.² The increase in the amount of interstitial as well as intracellular fluid may lead to intracompartment pressure elevation. Once this pressure exceeds capillary perfusion

pressure (about 30 mm Hg), intramuscular veins start to collapse, and when it reaches the level of diastolic blood pressure, tissue perfusion becomes disrupted and ischemic injury will lead to necrosis of the muscles (rhabdomyolysis) and the nerves.³

Early treatment with fasciotomy is mandatory to reinstate perfusion to the affected tissues and prevents irreversible damage and subsequent disability.⁴ Impairment of renal perfusion due to hypovolemia as well as deposition of nephrotoxic casts "of muscle cellular debris, ie, uric acid and myoglobin casts" increases the risk of acute kidney injury (AKI) in crush victims.⁵ In this complicated situation, fasciotomy, by creating an open wound, may lead to profuse bleeding, aggravating coagulopathy and potentially fatal

sepsis. They all together will increase the risk of AKI and complicate the dialysis process in AKI patients. This study evaluated the outcomes of fasciotomy in patients with crush-induced AKI after Bam earthquake in Iran.

MATERIALS AND METHODS

Patients

In 2003, earthquake hit Bam, a city in Kerman province, Iran. In this cross-sectional study, we studied victims who were hospitalized and developed crush-induced AKI in 15 medical centers of 7 cities (Bandarabas, Bushehr, Esfahan, Kerman, Shiraz, Tehran, and Zahedan). Patients with a history of chronic kidney failure and AKI due to other causes were excluded.

Data Collection

The data were collected using a form designed by the Iranian Society of Nephrology, in collaboration with the International Society of Nephrology, including demographic, biochemical, and clinical items. A collaborator was assigned in each center to assure the completeness and accuracy of the responses in the questionnaires. These data, as well as the mortality and morbidity reports were compared between patients who underwent Fasciotomy and those who did not. Morbidities included disseminated intravascular coagulopathy

(DIC), sepsis, and adult respiratory distress syndrome (ARDS).

Rhabdomyolysis was defined as a creatine phosphokinase (CPK) level higher than 1000 IU/L in patients who were trapped under the rubble. Acute kidney injury was defined as an acute loss of kidney function with a persistent (at least 2 times in 2 different days) elevation of serum creatinine to a level of 1.6 mg/dL or higher (≥ 141 mmol/L). Rhabdomyolysis complicated with AKI was considered as crush-induced AKI.

Statistical Analyses

Descriptive analyses including were performed and mean \pm standard deviation values were calculated for interval variables. The Student *t* test was used to compare parameters between the fasciotomized patients and nonfasciotomized. The chi-square and the Fisher exact test were used to investigate the relationship between the outcomes (eg, DIC, sepsis, and ARDS) and the patient groups. A *P* value less than .05 was taken as statistically significant. All analyses were performed using the Stata (version 8.0, StataCorp LP, College Station, TX, USA).

RESULTS

Fasciotomy was performed for 70 of 200 patients with crush-induced AKI (35.0%), of whom 32

Table 1. Clinical, Biochemical, and Demographic Factors in Patients With Crush-induced Acute Kidney Injury With and Without Fasciotomy*

Variable	Acute Kidney Injury		P
	Fasciotomy (n = 70)	No Fasciotomy (n = 130)	
Age, y	27.4 \pm 1.3	28.7 \pm 2.5	.69
Male sex	38	60	.24
TUR	7.0 \pm 0.5	6.4 \pm 0.8	.60
Intravenous intake, L			
First 5 days	2.3 \pm 0.3	3.1 \pm 0.4	.64
First 24 hours	1.1 \pm 1.1	1.1 \pm 0.9	.58
CPK	24433 \pm 3969	28201 \pm 6129	.14
LDH	4189 \pm 1934	5501 \pm 4291	.17
AST	616 \pm 435	503 \pm 388	.45
BUN	86.9 \pm 44.7	90.5 \pm 43.1	.70
Creatinine	4.7 \pm 1.7	4.4 \pm 1.7	.35
Calcium	5.5 \pm 1.7	6.5 \pm 1.6	.04
Phosphorus	6.2 \pm 2	5.3 \pm 1.4	.11
Sodium	133 \pm 7.2	135 \pm 6.9	.27
Potassium	6.5 \pm 1.1	5.7 \pm 0.9	.001
Uric acid	8 \pm 2.1	9.6 \pm 3.2	.11

*TUR indicates time under the rubble; CPK, creatine phosphokinase; LDH, lactate dehydrogenase; AST, aspartate aminotransferase; and BUN, blood urea nitrogen.

Table 2. Outcomes in Patients With Crush-induced Acute Kidney Injury With and Without Fasciotomy*

Outcome	Acute Kidney Injury		P
	Fasciotomy (n = 70)	No Fasciotomy (n = 130)	
DIC	3 (4.5)	8 (6.5)	.33
ARDS	5 (6.9)	12 (10.1)	.31
Sepsis	8 (7.9)	11 (2.2)	.94
Amputation	5 (4.7)	3 (3.3)	.84
Hospitalization, d	18.4 ± 17.0	16.2 ± 10.7	.39
Dialysis sessions	6.6 ± 3.9	5.8 ± 3.6	.89
Dialysis hours	20.6 ± 11.46	21.0 ± 14.8	.89
Death	8 (8.1)	12 (11.9)	.44

*Values in parentheses are percents. DIC indicates disseminated intravascular coagulopathy and ARDS, adult respiratory distress syndrome.

(45.7%) were women. The mean age of the patients in the fasciotomy group was 27.4 ± 1.28 years (range, 10 to 65 years). The mean duration of their entrapment was 7.0 ± 0.5 hours (range, 1 to 15 hours). Fasciotomy had been done with 1 incision in 47 patients (67.1%), 2 incisions in 18 (25.7%), 3 incisions in 4 (5.6%), and 5 incisions in 1 (1.4%). These patients were hospitalized for 18.4 ± 17 days and received 1.14 ± 1.08 L of intravenous fluid during the first 24 hours after the rescue.

The mean serum levels of muscle enzymes in the Fasciotomy group were as follows: CPK, 24433 ± 3969 IU/L; lactate dehydrogenase, 4189 ± 1934 IU/L; and aspartate aminotransferase, 616 ± 435 IU/L. Among the 70 patients with fasciotomy, sepsis occurred in 8 (7.9%), DIC in 3 (4.5%), ARDS in 5 (6.9%), and death in 8 (8.1%). Amputation was performed in 5 patients (4.7%), postfasciotomy.

Table 1 shows comparisons of clinical, biochemical, and demographic factors in the Fasciotomy and nonfasciotomy groups. There were no significant differences, except for the mean serum levels of calcium and potassium. Also comparison of outcomes between the two groups did not show any negative effect of fasciotomy (Table 2). Fasciotomy did not increase the rate of sepsis, DIC, ARDS, amputation, dialysis sessions, or hospitalization period in these patients.

DISCUSSION

After Bam earthquake, fasciotomy was performed by surgeons if clinically and classically indicated, at the second-line hospitals. Over one-third of the patients with crush-induced AKI underwent fasciotomy. The mean CPK level of 24433 ± 3969 IU/L confirms severe rhabdomyolysis in this subset of patients. Comparisons of clinical, biochemical, and demographic factors of the patients with

fasciotomy and the other patients with crush-induced AKI did not show any significant difference in the clinical course. There were no significant differences regarding the time under the rubble and muscle enzymes levels, as clinical and biochemical surrogates of trauma severity. Comparisons did not show any negative effect of fasciotomy in the final outcomes.

Regarding the management of compartment syndrome, there are 2 main viewpoints. While one group offers surgical methods as the treatment of choice, others emphasize the role of mannitol in decompressing the compartments, without any invasive intervention which increases the risk of infection and bleeding complications.⁶⁻⁹ Kang and colleagues believe that immediate intensive care therapy improves the survival rate.¹⁰ Bradley reported only a 13% recovery for patients with lower extremity compartment syndrome and foot drop who underwent Fasciotomy.¹¹ Matsuoka and colleagues showed that there was no evidence that fasciotomy improved the outcome in crushed patients.¹² Haung and colleagues reported high infection and amputation rates in their series.¹³ In Turkey earthquake in 2003, routine fasciotomy was performed in almost 70% of patients with compartment syndrome, of whom 81% subsequently developed sepsis from wound infection.¹⁴ Similar studies in Iran, Japan, and Turkey did not favor immediate fasciotomy for casualties suffering from crush injury in earthquakes and recommend conservative treatments.¹⁵⁻¹⁷ In contrast, some investigators recommend immediate surgical intervention as the treatment of choice in order to decrease intracompartment pressure.¹⁷⁻²²

Taking all the comparisons in to account no unfavorable outcome was witnessed with fasciotomy in our study. The rate of sepsis, DIC, ARDS,

amputation, dialysis, and death did not increase in fasciotomized patients. In the other words, fasciotomy would increase neither the morbidity nor mortality rates in our patients affected with crush-induced AKI after Bam earthquake. We do not have enough relevant data regarding the probable patients with compartment syndrome which were managed conservatively during Bam earthquake. Due to this lack of data, we did not focus to compare fasciotomy with conservative method, which needs setting up some randomized controlled trials in the future.

CONCLUSIONS

This study showed that final outcomes of patients with crush-induced AKI were not affected by fasciotomy during Bam earthquake.

CONFLICT OF INTEREST

None declared.

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