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ORIGINAL ARTICLE

ACUTE KIDNEY INJURY IN CRUSH SYNDROME AND RENAL DISASTER-EXPERIENCE IN BANGLADESH AFTER GARMENT FACTORY COLLAPSE

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Abstract:

Background: *Crush-syndrome usually resulting from earthquake and other natural disaster causes mortality and morbidity. A multistoried garment factory collapsed in Savar, Dhaka, Bangladesh on 24th April 2013 with about 4000 workers. Among the rescued victims, many of them develop crush – syndrome and AKI that led to a man-made renal disaster in Bangladesh. We analyzed outcome of severe AKI patient who required renal replacement therapy.* ***Methods:*** *Victims from accident site were first treated in primarily local hospital and primary care center. Suspected crush syndrome patients were rapidly transferred to tertiary hospital for dialysis and ICU support. We collect data of severe AKI patient by a standard questionnairebased onrenal disaster relief force – crush syndrome patient questionnaire.* ***Results:*** *We had experienced many AKI and crush syndrome after collapsed garment factory with 3500 workers which created a manmade renal disaster. We observed 27 severe AKI due to crush syndrome of Rana plaza with mean age 25.12 years, most of them were female (51.85%). Victims rescued as early as possible, average rescue time was 20.30 hours, 62.96% developed compartment syndrome and required fasciotomy. All of them got dialysis treatment; some of them required ICU support. Among all, 67% recovered completely and 26% died. Main causes of death were infection and DIC with MOF.* ***Conclusions:*** *Crush injury victims who developed severe AKI, required dialysis. Severe AKI patients who required dialysis had high mortality and morbidity. Early intervention to prevent AKI and complications may reduce mortality and morbidity.*

Key words*: AKI, Crush Injury, Renal Disaster*

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Introduction:

Crush syndrome refer to systemic manifestations of muscle crush injury by direct trauma or ischemic reperfusion injujry[1]. Crush injury means compression injury between opposing elements leading tissue damage. Compression injuries associated with renal failure was first described in 1909 after Messenia earthquake [2] and association between renal failure and crush injury completely describe in 1941 Bywaters and Beall[3]. Crush syndrome refers to muscle injury with systemic manifestations that include tense, edematous and muscle pain, hypovolemic shock, acute kidney injury, hyperkalemia, acidosis, cardiac failure, respiratory failure and infection.[4]

Crush syndrome is second cause of mortality and morbidity after direct traumatic death.Disintegration of skeletal muscle after prolonged pressure on the limbs due to stretch insult, ischemicinsult, and ischemic reperfusion injury lead to rhabdomyolysis[5]. Increased permeability of sarcolemma occurs in compressed muscles, so calcium, sodium and water move to intercellular milieu while potassium and myoglobin efflux to extracellular environment[6]. After collapse of building, 80% of the entrapped victims instantly died

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by the direct trauma, 10% survived with minor injuries and 10% injured badly.Seven out of tenseverely injured develop crush syndrome and acute renal failure.[7]

AKI after rhabdomyolysisdue to (1).Third space fluid loss in necrosed muscle leading intravascular volume depletion, renal hypo-perfusion and ischemia.(2). Myoglobincauses intra-tubular cast formation and obstruction, (3). Myoglobin scavenges nitric oxide that aggravates renal hypo perfusioninjury (4). Endotoxin and cytokines from injured muscle leads renal vasoconstriction.(5). Hyper-uricemia may contribute cast formation and tubular obstruction, (6). Free iron from myoglobin which catalyzes. free radical formation, enhance ischemic injury to renal tubules(7). Hyperkalemia, hyperphosphatemia and hypocalcaemia may depress cardiac output and potentiate renal hypo-perfusion (8). Inflammation of kidney tissue by precipitation of CaPO4 salts. (9). Release of tissue thromboplastin from damage tissue tigers DIC and acute kidney injury[8]

Rhabdomyolysis may present with asymptomatic elevation of creatinine kinase or AKI due to oliguric ATN and multi -organ failure. Localizes features includes pain, pressure, pulselessness, paresthesia, paresis or paralysis and pallor. Systemic features include hypovolemic shock, hyperkalemia, heart failure, respiratory failure, infection and AKI. Urine become dirty brownish discoloration due to myoglobinuria, biochemical features includeincreased muscle enzymes, urea, creatinine, phosphate, potassium and acidosis.[9]

Initial treatment of crush syndrome includes volume resuscitation, correction of hypovolemic shock and dehydration and prevention of AKI, lactic acidosis and hyperkalemia. Isotonic saline administration 1L/hour stat initially and monitor volume status, urine output for further fluid requirement. Victim may needupto 6L fluid.

Systemic alkalization by administration of sodium bicarbonate required to reduce acidosis and hyperkalemia. Sometimes mannitol may require forcing diuresis. Dialysisand, ICU support may berequired in critically ill patients.[10]

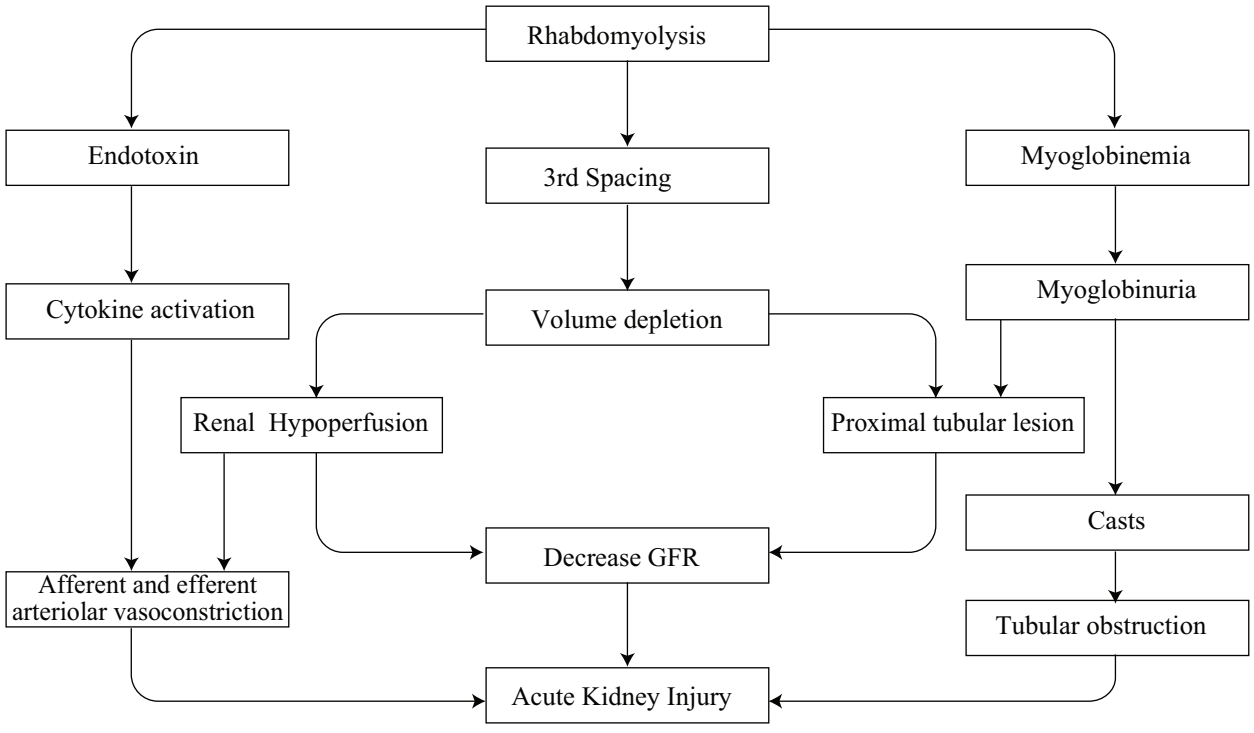

Fig.-1 *Pathophysiology of Acute Kidney Injury in Rabdomyolysis*

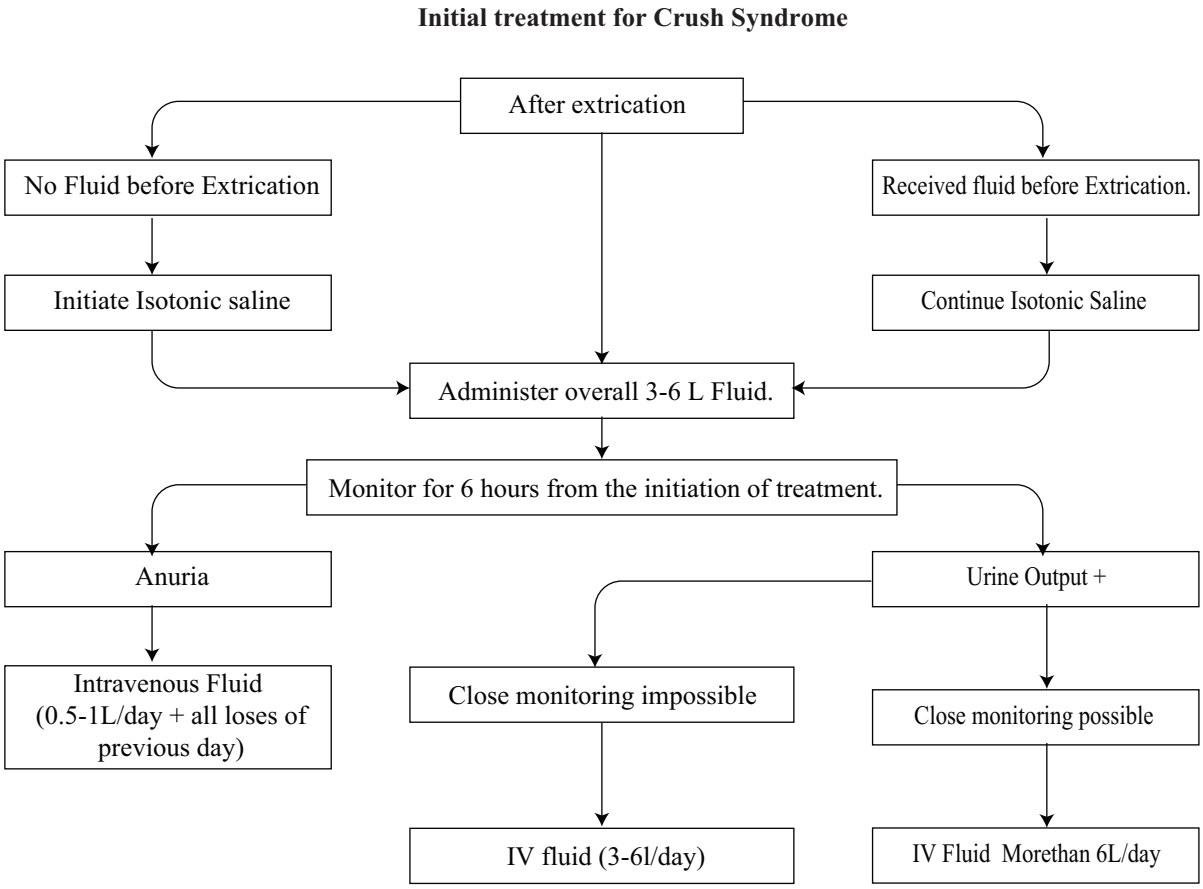

Fig.-2 *Algorithm for Fluid resuscitation to prevent Crush related AKI*

The concept of renal disaster developing after earthquake in December 1988, Armenia, where 25000 people died, and 600 cases of acute renal failure developed. Of which 225 victims required dialysis. But due to no organized support structure with appropriate training and deployment strategies response was ineffective. Poorly organized relief worsens the chaos and creates a second disaster, interfering with other global rescue activities. After disappointing experiences in Armenian earthquake, the international society of Nephrology (ISN) install the Renal Disaster Relief Task Force (RDRTF). RDRTF is a logistic organization provides organized effort to combat renal disaster and save life. ISN-RDRTF effectively participates in Marmara, Turkey earthquake in 1999 where 639 victims develop AKI related to crush syndrome[11].

April24 at 9am 2013, multistoried garment factory (Rana Plaza) collapsed in Savar, 50 kilometers from Dhaka, the capital city of Bangladesh, with 3500 unfortunate workers inside. The incident caused more than 1139 deaths and 2500injury. Severely crush injured victims developed crush syndrome and acute kidney injury. 27 crush syndrome and AKI victims were transferred to Dhaka medical college and National Institute of Kidney Disease and Urology (NIKDU) for dialysis, ICU support and specialized treatment. We observed these severe crush syndrome and AKI patients for outcome and complications.

Methods:

All Injured victims initially were admitted in local hospital. Among the in injured patients, those with severe injury, crush syndrome, compartmental syndrome or decrease urine volume, were transferred to Dhaka medical college, NIKDU for specialized treatment especially dialysis and ICU support. All selected patients were clinically assessed by pulse, blood pressure, urine output, temperature, injury nature and other parameters. All patients investigated for complete blood count, CPK, Serum creatinine, blood urea, serum electrolytes, chest X-ray and other investigations. Crush injury diagnosed based on the presence of swollen limbs and history of limb compression[12]. Crush syndrome includes muscle injury with systemic symptoms of hypovolemic shock, AKI, hyperkalemia, heart failure, respiratory failure, and infection[13-14]. Compartmental syndrome includes

traumatic injury of limb with pain, pressure, paresthesia, paresis or paralysis, pallor and pulse-lessness. Patient with compartmental syndrome underwent fasciotomy as decided by expert clinician and surgeon[14].AKI diagnosed by decrease urine output ,5ml/kg/hour for 6 hours or increase serum creatinine>0.3 mg/dl to baseline.[15,16]Severe AKI includes serum creatinine>4mg/dl, GFR less than 25 mi/min or on RRT or urine volume less than 0.3ml/kg/hour for 12 hours [15,16]Hyperkalemia diagnosed by presence of serum potassium >5.5 mmol/l.All patients with crush syndrome initially treated with adequate fluid replacement and bicarbonate infusion. Oliguric patients were hydrated with mannitol infusion given for diuresis. Hyperkalemia treated with insulin &glucose infusion and dialysis. Patient with serum creatinine>6mg/dl, acidosis, persistent hyperkalemia and volume overload were selected for dialysis through central venous catheter.Outcome of recovery, death, duration of hospital stay and requirement of ICU support were observed. Partial recovery defined as serum creatinine remain above normal but not dependent on diakysis. Complete recovery defined as serum creatinine within normal range. Dialysis dependent defined aswho require regular dialysis. Data collected by questionnaireson the basis of renal disaster relief force – crush syndrome patient questionnaire.

Results:

After collapse multistoried garment factory,1136 victim died before extrication, 1762were rescued with different types of injury which was minor to severe. 27 severely injured victims develop crush syndrome and acute kidney injury, diagnosed by reduce urine output or rise of serum creatinine, transferred to referral center for dialysis and ICU support. All victims were young adult working people with mean age was 25.12 (range of 14-35) years, male13 (48.15%) and female 14(51.85%). Seven victims (25.93%)died during treatment. Victims who were extricated for five to forty-sevenhours,(mean 20. 30 hours) after building collapse had multiple injury. 62.96% (17) developed compartment syndrome and required fasciotomy. 24 hours Urine output decreased about 0-400 ml (mean 107.5 ml) and blood pressure reduced systolic 90-150mm of Hg, mean 106.66 mm of Hg and diastolic pressure 40-90 mm of Hg, mean 72.66 mm of Hg. All patients required dialysis,average 11 session /patient (2-24 sessions/pt) and blood transfusion required 2.5 unit / patient (1-6units/pt). 62.96% of patients required ICU support with or without ventilator support. (**Table I** baseline characteristic of patient)

Table -I

Baseline characteristic

	N	Range	mean	Percentage(%)
Male	13			48.15
Female	14			51.85
Age (years)		14-35	25.12	
Extrication time (hours)		5-47 hours	20.30 hours	
Compartment syndrome	17			62.96
Number of injury		1-5	2.53	
Urine output ml /24 hours		0-400	111.48	
Fasciotomy	17			62.96
Blood transfusion		1-6 unit	2.59 unit	
Dialysis session		2-24	11.66	
ICU and ventilation	17			62.96
Ventilation	15			55.56
Blood pressureMm of Hg	Systolic		90-150	110.61
	Diastolic		40-90	75.35
Death	7			25.93

Table-II
Biochemical profile

Value	Mean	Range
Haemoglobingm/dl	8.6	6.4-12.5
Serum creatinine mg/dl	7.25	4.6-9.2
Blood urea mg/dl	146	84-280
CPK unit/L	41124.3	3054-125754
Serum potassium mmol/L	5.7	4.2 -8.3

In Table-II serum creatinine is high 7.25 mg/dl, CPK is 41124.3 unit/L and serum potassium is 5.7 mmol/L.

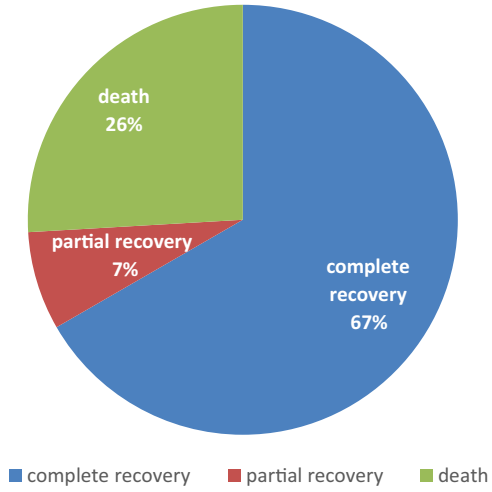

Fig -1: *Outcome of the dialysis patient*

Outcome of the patient shows in Fig.-1: 67.86 %(19) patients had complete renal recovery whose creatinine became normal with normal urine output. 7.14 % (2) patients had partial renal recovery with serum creatinine not normal but not dialysis dependent. Total 26% (7) patients died and 27 became dialysis dependent.42.9% (3) died due to septicemia and DIC,

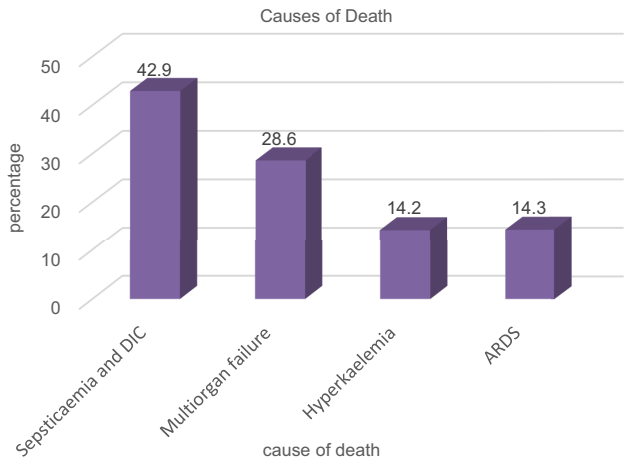

Fig-2: *Causes of Death*

28.6 %(2) develop multiorgan failure and died, 14.2 % (1) develop ARDS and 14.2% (1) died due to hyperkalemia before starting dialysis (Fig.-2). In most of cases, cause of death was septicemia and multi organ failure. One patient died before stating dialysis due to severe hyperkalemia and one patient died due to ARDS.

Discussion:

Crush-syndrome and Acute Kidney Injury cases are seen in after earthquake and others natural calamities, also seen in war. We had experienced many AKI and crush syndrome after collapsed garment factory with 3500 workers which created a manmade renal disaster. We observed 27 severe AKI due to crush syndrome of Rana plaza with mean age 25.12 years, most of them were female (51.85%) (Table I). Victims rescued as early as possible, average rescue time was 20.30 hours, 62.96% developed compartment syndrome and required fasciotomy. All of them got dialysis treatment; some of them required ICU support. Among all 67% completely recovered and 26% died. Main causes of death were infection and DIC with MOF.

Most of the victim was young adult with mean age 25 years. Female were more victimized than male as most of the workers in the factory were female. Maximum injured rescued within 30 hours of incidence and mean rescue time was 20.30 hours and minimum 5 hours. Most of earthquake extrication time were similar, in Marmara earthquake rescue time was 24 hours.[17] 17 (29) victims developed compartment syndrome and underwent fasciotomy and 2 patient required amputation were similar to earthquake victim.[5] CPK (creatinine phosphokinase) was elevated in most of the cases and highest level was 125754u/l and potassium level was also increased in every case Table II. This finding is also similar in crush injury patient in earthquake victims[17]. 26% of crush injured died and 67% were recovered well. Other study in earthquake victim showed 13-25% died in renal failure related complications[17].

Causes of death were septicemia and DIC, multiorgan failure, hyperkalemia and ARDS in our study (Fig. 2). Septicemia was most common cause of death as infection prevention was difficult in our setting.Most of crush injured in Marmara died due to multiorgan failure and hyperkalemia[6,17].

Mortality in AKI of crush injury is extremely high. Early intervention and prevention of infection and multiorgan failure may improve the outcome.

Conclusions:

After garment factory collapse a significant part of victim develop crush syndrome and complications

along with acute kidney injury. One fourth of patient with severe AKI required dialysis. Patient with crush-syndrome with severe AKI required dialysis and have high mortality and morbidity. Early intervention to prevent AKI and complications may reduce mortality and morbidity.

Conflict of Interest:

The author stated that there is no conflict of interest in this study

Funding:

No specific funding was received for this study.

Ethical consideration:

The study was conducted after approval from the ethical review committee. The confidentiality and anonymity of the study participants were maintained.

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