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Original Research Article

Prevalence of Cardiac Arrhythmias, Clinical Spectrum and Complications of Electrical Injury

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Abstract: ***Background:*** Electrical accidents (EA) are rare, but can cause serious and potentially life-threatening injuries to multiple organs. The majority of epidemiological data refers to workplace accidents which account for a significant share of such accidents in adults. Exposure to electric shock has been associated with an increased risk of developing immediate and delayed cardiac arrhythmias. ***Objective:*** To evaluate the prevalence of cardiac arrhythmias and different symptoms in patient with high voltage and low voltage electrical injury. ***Methods:*** This was observational prospective study was carried out at the Dept. of Cardiology, Bangabandhu Sheikh Mujib Medical College Hospital, Faridpur, Bangladesh from January to June 2021. 51 consecutive patients with electrical injury who were admitted. Admission criteria were age ≥15 years, loss of consciousness, cardiac arrest, electrocardiographic abnormalities, soft tissue damage and burns. Patients were categorized into high and low voltage injury group and their variables were compared. ***Results:*** The mean age of the patients was 32.3±10.4 years among them 41 (82.3%) were male. Patients who sustain high voltage electrical injury (>1000V) were 18 (35.2%) and low voltage injury (<1000V) were 33 (64.7%).Cardiac arrhythmias like sinus tachycardia (11.1% vs 6.0%, p=0.054), sinus bradycardia (11.1% vs 3.0% p=0.254), ventricular premature beats (5.6% vs3.0%, p=0.674), atrial fibrillation (11.1% vs 0%, p=0.054) were observed in high voltage and low voltage group. The commonest presenting symptoms in both groups were pain (77.8% vs 81.8% p=0.560) and fatigue (55.6% vs 39.3%, p=0.328). ***Conclusion:*** In this study few non-fatal cardiac arrhythmias were observed in both high and low voltage electrical injury group. Parameters considered to be risk factors such as known structural heart disease, loss of consciousness, high voltage electric shock, burn and soft tissue injuries were also not significant predictors of the occurrence of arrhythmias. There is no significant difference in the presenting symptoms and types of arrhythmias observed between low voltage and high voltage injury group.

Keywords: Prevalence, Cardiac Arrhythmias, Cardiac Monitoring, Electrical Injury.

INTRODUCTION

Electrical accidents (EA) are rare, but can cause serious and potentially life-threatening injuries to multiple organs. The majority of epidemiological data refers to workplace accidents which account for a significant share of such

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accidents in adults, although large regional variability exists between European countries in terms of incidence and mortality [1]. Electrical injury in the worldwide scenario is rare but has significant number of morbidity and mortality. It accounts around 0.05-4% of hospital admission in developed countries and 27% in developing countries [2]. Electrical injury are most often work-place related, seen in adult male population and are the 4th leading cause of traumatic work related death [3]. Classification of electrical injuries is typically divided into low-voltage (1000 volts), as well as by whether electrical current flows directly through the body versus a thermal injury caused by electrical flash. The severity of electrical burns and injuries to internal organs depends on voltage, resistance of the body, duration of current flow, type of current (direct or alternating) and the path of current through the body. Transthoracic current may lead to cardiac complications which manifest predominantly as arrhythmias, conduction disturbances, and myocardial tissue damage, depending mainly on the strength of current [4]. The electric current is not only confined to producing arrhythmias and varying degree of heart block but also damaging cardiac tissues and blood vessels. Arrhythmias are very common complications encountered in electrical accidents [5, 6]. Many small studies showed varying percentage of arrhythmias. Significant numbers of arrhythmias were observed in 3% of monitored patients [7]. Sinus tachycardia, sinus bradycardia, Premature Ventricular contraction (VPC) was most frequently encountered arrhythmias. Atrial fibrillation, ventricular tachycardia or fibrillations were also reported [8]. Varying degree of AV block and bundle branch block has also been observed in very few studies. Arrhythmias resulting from the proarrhythmic effect of electric shock usually occur immediately after the accident. If electric current reaches the heart within the vulnerable period it may also cause ventricular fibrillation (VF), which is the most common cause of death after EA [9]. In patients presenting at emergency units after EA, the most commonly diagnosed arrhythmias are sinus tachycardia, sinus bradycardia and isolated premature atrial and ventricular complexes (PACs and PVCs) [10-12]. If the conduction system of the heart is affected, bundle branch block, and various degrees of atrioventricular block may also occur [11-13], however, the exact frequency of these arrhythmias is unknown. Late-onset malignant arrhythmias are very rare after EA.

MATERIALS AND METHODS

This was observational prospective study was carried out at the Dept. of Cardiology, Bangabandhu Sheikh Mujib Medical College Hospital, Faridpur, Bangladesh from January to June 2021. 51 consecutive patients with electrical injury who were admitted. Admission criteria were age ≥15 years, loss of consciousness, cardiac arrest, electrocardiographic abnormalities, soft tissue damage and burns. Immediate and delayed arrhythmias (up to 48hrs) were observed in cardiac monitoring unit. Medical history, presenting clinical symptoms, laboratory parameters like sodium, potassium, urea, creatinine and total creatinine kinase were recorded. Patients who suffered >1000 volt were categorized as high voltage injury and <1000 volt were low voltage injury. ECG monitoring was first done in emergency and then in cardiac monitoring unit for 48 hrs. Cardiac arrhythmias noted were also recorded in ECG paper and read by consultant cardiologist. Echocardiography was done by treating cardiologist and evaluated for ejection fraction and other cardiac abnormalities. Serum total creatinine kinase was done at the time of admission (day 0), day 1 and day 2. Normal total CK value is 24-190 units/L. Above this cut-off value is considered high. All the patients were given1500ml of 0.9% normal saline over 24 hours to avoid acute kidney injury. Cardiac arrhythmias, presenting symptoms and level of total creatinine kinase were compared in high and low voltage injury group.

Statistical Analysis

Methods Results Statistical analyses were performed using SPSS version 22.0 (SPSS Inc, Chicago, IL, USA).Continuous data was presented in mean mean±standard deviation (SD), median and range as appropriate. Categorical variables were expressed in frequency (%). Distribution of presenting complaints and cardiac arrhythmias between high voltage and low voltage group was done using Fisher's exact test. $P < 0.05$ was considered to be statistically significant.

RESULTS

The mean age of all electrical injury patients was 32.3±10.4 years, with 42 (82.3%) males and 9 (17.6%) females. When comparing with total number of patients high voltage injury was 18 (35.2%) and low voltage injury was 33 (64.7%) (Table1). Most of the patient sustaining electrical injury was work-place related. Among them 15 (29.4%) electrician, 15 (29.4%) farmer, 11 (21.5%) household worker, 4 (7.8%) factory worker and 6 (11.7%) labour (Table 1). we have observed mean heart rate 74±15.4 (b/min), systolic blood pressure 122.6±14.2 (mmHg), diastolic blood pressure 77.88±11.2 (mmHg) and ejection Fraction (%) 62.9±5.35 (Table 1). None of the patient had hypertension, diabetes and COPD. Similarly none of them were on beta blockers, salbutamol and theophylline.

Table 1: Baseline Clinical Characteristics (N=51)

Variables	Distribution
Age (years), mean±SD	32.36±10.4
Sex	
Male	42 (82.3%)
Female	9 (17.6%)
Types of Injury	
High voltage injury	18 (35.2%)
Low Voltage injury	33 (64.7%)
Clinical Parameters	
Heart Rate (b/min)	74±15.4
Systolic Blood pressure (mmHg) (mean±SD)	122.6±14.2
Diastolic Blood pressure (mmHg) (mean±SD)	77.88±11.2
Ejection Fraction (%) (mean±SD)	62.9±5.35
Occupation	
Electrician	15 (29.4%)
Farmer	15 (29.4%)
Household worker	11 (21.5%)
Factory worker	4 (7.8%)
Labour	6 (11.7%)

Patient admitted suffering from high voltage had more symptoms than low voltage injury with dizziness (33.3% vs 15.1%, p=0.147), tingling sensation (44.4% vs 39.3% p=0.793), fatigue (55.6% vs 39.3%, p=0.328), syncope (11.1% vs 0%, p=0.054), tinitus 5.6% vs3.0%, p=1.000), shortness of breath (5.6% vs 0% p=0.178), headache (11.1% vs 0%, p=0.054).

Table 2: Presenting Complaints (N=51)

Symptoms	Total (n=51)	High Volt- age Injury (n=18)	Low Volt -age Injury (n=33)	p value
Dizziness	11 (21.5%)	6 (33.3%)	5 (15.1%)	0.147
Pain	41 (80.3%)	14 (77.8%)	27 (81.8%)	0.560
Tingling sensation	21 (41.1%)	8 (44.4%)	13 (39.3%)	0.793
Fatigue	23 (45.0%)	10 (55.6%)	13 (39.3%)	0.382
syncope	2 (3.9%)	2 (11.1%)	0 (0%)	0.054
Tinnitus	2 (3.9%)	1 (5.6%)	1 (3.0%)	1.000
Shortness of Breath	1 (1.9%)	1 (5.6%)	0 (0%)	0.178
Headache	2 (3.9%)	2 (11.1%)	0 (0%)	0.054

Pain was observed more in low voltage than high voltage group (81.8 vs 77.8%, p=0.560). No significant differences in presenting symptoms were observed between high voltage and low voltage injury group (Table-2). Palpitation, heart failure and death were not recorded after admission. Similarly none of the patient had loss of consciousness, cardiac arrest and high degree burns. Out of 51 patient, only 11 (21.5%) developed Cardiac arrhythmias. Patients who sustained high voltage electrical injury had more arrhythmias than low voltage injury with sinus tachycardia (11.1% vs 6.0%, p=0.054), sinus bradycardia (11.1% vs 3.0% p=0.254), ventricular premature beats (5.6% vs3.0%, p=0.674), atrial fibrillation (11.1% vs 0%, p=0.054). However no significant differences in cardiac arrhythmias were observed between high and low voltage injury group (Table-3). Arrhythmias like Left bundle branch block, Right bundle branch block, prolong QT, AV nodal block were not seen. No any life threatening arrhythmias like ventricular tachycardia, ventricular fibrillation were recorded.

Table 3: Cardiac Arrhythmias (N=51)

Symptoms	Total (n=51)	High Volt- age Injury (n=18)	Low Volt -age Injury (n=33)	p value
Sinus Tachycardia	4 (7.8%)	2 (11.1%)	2 (6.0%)	0.543
Sinus Bradycardia	3 (5.8%)	2 (11.1%)	1 (3.0%)	0.254
Atrial fibrillation (AF)	2 (3.9%)	1 (5.6%)	1 (3.0%)	0.674
Ventricular premature con- traction (VPC)	2 (3.9%)	2 (11.1%)	0 (0%)	0.054

Table 4: Laboratory Parameters (N=51)

Variables	Distribution
Sodium (mg/dl) (mean±SD)	136.74±3.4
Potassium (mg/dl) (mean±SD)	3.81±0.4
Urea (mg/dl) (mean±SD)	20.78±5.7
Creatinine (mg/dl) (mean±SD)	0.65±0.1
High voltage (n-18)	Median (Range)
Creatine Kinase (IU/L) Day 0	411 (112-1973)
Creatine Kinase (IU/L) Day 1	390.5 (20-2814)
Creatine Kinase (IU/L) Day 2	255.5 (80-2797)
Low voltage (n-32)	Median (Range)
Creatine Kinase (IU/L) Day 0	295.5 (50-1234)
Creatine Kinase (IU/L) Day 1	316.5 (42-2245)
Creatine Kinase (IU/L) Day 2	202.5 (21-1139

All patients who suffered electrical injury, renal function test was normal with mean Sodium 136.74±3.4 (mg/dl), Potassium 3.81±0.4 (mg/dl), Urea 20.78±5.7 (mg/dl), and creatinine 0.65±0.1 (mg/dl) (Table.4). Serial decrease in total CK seen in day day 0, day 1 and day 2 in high voltage group but rise in day 1 and decrease in day 2 seen in low voltage group (Table.4, Fig-1).

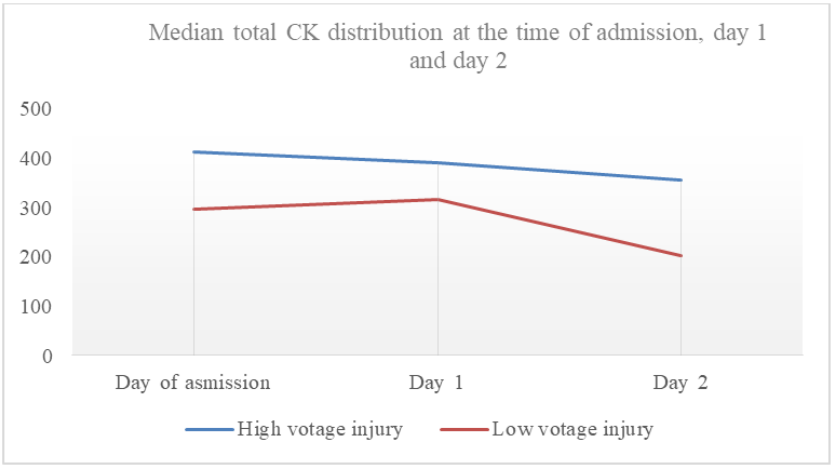

Fig-1: Median total CK distribution at the time of admission, day 1 and day 2.

DISCUSSION

To the best of our knowledge, the present analysis is the largest study thus far published to focus on arrhythmias and cardiac biomarker changes following EA. We found that all arrhythmias with possible relation to EA in patients presenting after EA could be diagnosed by ECG on admission. In the present study, we reviewed 51 patients with electrical injury and found that adult males were commonly affected. Low voltage rather than high voltage injury were more commonly encountered in our study. Work place injury was common in electrician and farmer. Aggarwal S, *et al.,* showed work related injury were common in nine years of experience study [14]. We have observed commonest presenting symptoms like pain and tingling sensation of extremities, dizziness and fatigue in this study. All the symptoms except pain were seen more in high voltage injury group. This kind symptomatology also has been demonstrated in the other study [15]. Pain is common and difficult complaint after electrical injury and in our study low voltage injury group complained more pain than high voltage injury. All the symptoms except pain were subsided before discharge. In our study palpitation, heart failure and death were not recorded after admission. Similarly none of the patient had loss of consciousness, cardiac arrest and high degree burns. Out of 51 patient, only 11 (21.5%) developed Cardiac arrhythmias. Patients who sustained high voltage electrical injury had more arrhythmias than low voltage injury with sinus tachycardia (11.1% vs 6.0%, p=0.054), sinus bradycardia (11.1% vs 3.0% p=0.254), ventricular premature beats (5.6% vs3.0%, p=0.674), atrial fibrillation (11.1% vs 0%, p=0.054). Most of the arrhythmias were seen in high voltage than low voltage injury group. Cardiac complications and arrhythmias are frequently seen in patients with high voltage electrical injury [16]. It has been observed sinus tachycardia and bradycardia was common arrhythmias in our study. This has been

supported by another study, which showed sinus tachycardia, nonspecific ST- and T-wave changes, AV nodal blocks, and QT interval prolongation were common ECG changes in patient with electrical injury [17]. There was no any significant difference in type of arrhythmias between low voltage and high voltage group. One of the studies done in Germany has shown similar kind of findings [18]. The pathogenesis of cardiac arrythmias is unclear and it is most likely multifactorial. Myocardial necrosis, alteration of sodium, potassium, adenosine triphosphate concentration and changes in the permeability of myocyte memebrane are thought to be the genesis of lethal and nonlethal cardiac arrhythmias after electrical injury. So further pathological and clinical studies are needed to elaborate cardiac arrhythmias in these patients. Serial decrease in CK seen in day day 0, day 1 and day 2 in high voltage group but there was slight rise in day 1 and rapid fall day 2 seen in low voltage group. It has been seen that CK levels peak within 24–36 h post injury [19], and its excretion is slow and steady in high voltage injury group. Further studies are needed to elaborate the pathophysiology of kidney handling total CK in patients with electrical accidents. In our analysis some patients with high-voltage accident and/or severe burn injuries showed a massive elevation of CK level suggesting rhabdomyolysis, however, none of the patients developed an acute renal failure. Significant elevation of cTnI was only detected in one patient who was resuscitated for 25 min due to ventricular fibrillation. TnI elevation is considered to be due to long-term myocardial low perfusion. Sinus tachycardia was seen on the patient's admission ECG recording without repolarization abnormalities, while control laboratory tests showed no further increase in cTnI levels.

CONCLUSION

In concluded, few non-fatal cardiac arrhythmias were observed in both high and low voltage electrical injury group. Parameters considered to be risk factors such as known structural heart disease, loss of consciousness, high voltage electric shock, burn and soft tissue injuries were also not significant predictors of the occurrence of arrhythmias. There is no significant difference in the presenting symptoms and types of arrhythmias observed between two groups. There should be an evidence-based, standardized procedure for the treatment of patients with electrical injuries so that these patients can be cared safely.

CONFLICT OF INTEREST:
None.

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None.

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