

# Cardiac Arrhythmias in Patients with Electrical Injury: Hospital Based Study.

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## Abstract

**Background:** Electrical injury and its consequences after exposure to electric shock has been associated with an increased risk of developing immediate and delayed cardiac arrhythmias. The aim of this study was to evaluate the prevalence of cardiac arrhythmias and different symptoms in patient with high voltage and low voltage electrical injury.

**Methods:** All 50 consecutive patients who were admitted in Chitwan Medical College from April 2018 to March 2020 were prospectively studied. 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%) were male. Patients who sustain high voltage electrical injury (>1000V) were 18 (36%) and low voltage injury (<1000V) were 32 (64%). Cardiac arrhythmias like sinus tachycardia (11.1% vs 6.2%, p=0.054), sinus bradycardia (11.1% vs 3.1% p=0.254), ventricular premature beats (5.6% vs 3.1%, 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 84.4% p=0.560) and fatigue (55.6% vs 40.6%, p=0.328).

**Conclusion:** In this study few non fatal cardiac arrhythmias were observed in both high and low voltage electrical injury group. There is no significant difference in the presenting symptoms and types of arrhythmias observed between low voltage and high voltage injury group.

**Keywords:** Cardiac Arrhythmias; Cardiac Monitoring; Electrical Injury.

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## Introduction

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.<sup>1</sup> Classification of electrical injuries are typically divided into low-voltage (<1000 volts) and high-voltage (>1000 volts), as well as by whether electrical current flows directly through the body versus a thermal injury caused by electrical flash. Electrical injury are most often work-place related, seen in adult male population and are the 4<sup>th</sup> leading cause of traumatic work-related death.<sup>2</sup> Extent of Injury to skin and internal organs is directly related to the voltage, resistance of the body, path of the current

though the body, type of current (direct or alternating) and the duration of current flow. The spectrum of electrical injury is broad, ranging from minimal injury to severe multiorgan involvement to death with life threatening cardiac arrhythmias. 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.<sup>3,4</sup> Many small studies showed varying percentage of arrhythmias. Significant numbers of arrhythmias were observed in 3% of monitored patients.<sup>5</sup> Sinus tachycardia, sinus bradycardia, Premature Ventricular contraction (VPC) were most

frequently encountered arrhythmias. Atrial fibrillation, ventricular tachycardia or fibrillations were also reported.<sup>6</sup> Varying degree of AV block and bundle branch block has also been observed in very few studies.

Even though European Resuscitation Council Guidelines for Resuscitation 2010 recommend that “all those who survive electrical injury should be monitored in hospital if they have had loss of consciousness; cardiac arrest; electrocardiographic abnormalities; soft tissue damage and burns.<sup>7</sup> Due to fear of cardiac arrhythmias (new onset or delayed), our practice is to admit and monitor all patient with electrical injury. The aim of our study was to observe the prevalence of cardiac arrhythmias, symptoms epidemiology, clinical spectrum and complications of electrical injury in our hospital.

## Methods

This was observational prospective study done during period of April 2018 to March 2020 at Chitwan Medical College. After approval of the study by the institutional ethical committee, informed consent was taken of all 50 consecutive patients with electrical injury who were admitted at this center. Admission criteria were age  $\geq$  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 cutoff value is considered high. All the patients were given 1500ml 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

Statistical analyses were performed using SPSS version 22.0 (SPSS Inc, Chicago, IL, USA). Continuous data was presented in mean mean $\pm$ 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 $\pm$ 10.4 years, with 41 (82%) males and 9 (18%) females. When comparing with total number of patients high voltage injury was 18 (36%) and low voltage injury was 32 (64%) (Table 1). Most of the patient sustaining electrical injury was work-place related. Among them 15 (30%) electrician, 15 (30%) farmer, 10 (20%) household worker, 4 (8%) factory worker and 6 (12%) labour (Table 1). we have observed mean heart rate 74 $\pm$ 15.4 (b/min), systolic blood pressure 122.6 $\pm$ 14.2 (mmHg), diastolic blood pressure 77.88 $\pm$ 11.2 (mmHg) and ejection Fraction (%) 62.9 $\pm$ 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.

Variables	Distribution
Age (years), mean $\pm$ SD	32.36 $\pm$ 10.4
Sex	
Male	41 (82%)
Female	9 (18%)
Types of Injury	
High voltage injury	18 (36%)
Low Voltage injury	32 (64%)
Clinical Parameters	
Heart Rate (b/min)	74 $\pm$ 15.4
Systolic Blood pressure (mmHg) (mean $\pm$ SD)	122.6 $\pm$ 14.2
Diastolic Blood pressure (mmHg) (mean $\pm$ SD)	77.88 $\pm$ 11.2
Ejection Fraction (%) (mean $\pm$ SD)	62.9 $\pm$ 5.35
Occupation	
Electrician	15 (30%)
Farmer	15 (30%)
Household worker	10 (20%)
Factory worker	4 (8%)
Labour	6 (12%)

Patient admitted suffering from high voltage had more symptoms than low voltage injury with dizziness (33.3% vs 15.6%,  $p=0.147$ ), tingling sensation (44.4% vs 40.6%  $p=0.793$ ), fatigue (55.6% vs 40.6%,  $p=0.328$ ), syncope (11.1% vs 0%,  $p=0.054$ ), tinnitus 5.6% vs 3.1%,  $p=1.000$ ), shortness of breath (5.6% vs 0%  $p=0.178$ ), headache (11.1% vs 0%,  $p=0.054$ ).

**Table 2:** Presenting Complaints.

Symptoms	Total (n=50)	High Voltage Injury (n=18)	Low Voltage injury (n=32)	p value
Dizziness	11 (22%)	6 (33.3%)	5 (15.6%)	0.147
Pain	41 (82%)	14 (77.8%)	27 (84.4%)	0.560
Tingling sensation	21 (42%)	8 (44.4%)	13 (40.6%)	0.793
Fatigue	23 (46%)	10 (55.6%)	13 (40.6%)	0.382
syncope	2 (4%)	2 (11.1%)	0 (0%)	0.054
Tinnitus	2 (4%)	1 (5.6%)	1 (3.1%)	1.000
Shortness of Breath	1 (2%)	1 (5.6%)	0 (0%)	0.178
Headache	2 (4%)	2 (11.1%)	0 (0%)	0.054

Pain was observed more in low voltage than high voltage group (84.4 vs 77.8%, p=0.560). No significant difference 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 50 patient, only 11 (22%) developed Cardiac arrhythmias. Patients who sustained high voltage electrical injury had more arrhythmias than low voltage injury with sinus tachycardia (11.1% vs 6.2%, p=0.054), sinus bradycardia (11.1% vs 3.1% p=0.254), ventricular premature beats (5.6% vs 3.1%, p=0.674), atrial fibrillation (11.1% vs 0%, p=0.054). However no significant difference 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.**

Arrhythmias	Total (n=50)	High Volt- age Injury (n=18)	Low Volt- age injury (n=32)	p value
Sinus Tachycardia	4 (8%)	2 (11.1%)	2 (6.2%)	0.543
Sinus Bradycardia	3 (6%)	2 (11.1%)	1 (3.1%)	0.254
Atrial fibrillation (AF)	2 (4%)	1 (5.6%)	1 (3.1%)	0.674
Ventricular premature contraction (VPC)	2 (4%)	2 (11.1%)	0 (0%)	0.054

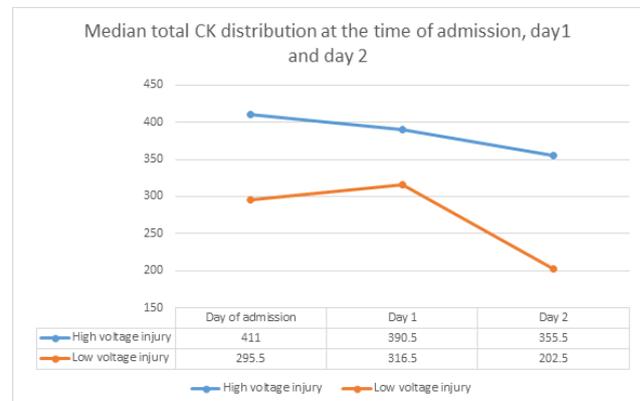
**Table 4: Laboratory Parameters.**

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, Figure.1).

**Figure.1:**



**Discussion**

In the present prospective study, we reviewed 50 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.<sup>8</sup> 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.<sup>9</sup> 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.

Most dreadful complication after electrical injury is ventricular tachycardia and fibrillation. In our study none of the patient had life threatening arrhythmias; only 11 patients develop nonfatal cardiac arrhythmias. 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.<sup>10</sup> 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.<sup>11</sup> All the arrhythmias like sinus tachycardia, sinus bradycardia, AF and VPC were transient and subsequently resolved. Around 40% electrical injuries are fatal with more morbidity and mortality,<sup>12</sup> but our study showed no any mortality after admission. This can be explained by less number of study population and high number of low voltage injury. 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.<sup>13</sup> The pathogenesis of cardiac arrhythmias is unclear and it is most likely multifactorial. Myocardial necrosis, alteration of sodium, potassium, adenosine triphosphate concentration and changes in the permeability of myocyte membrane 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.

There is high probability of acute renal failure in patient with electrical injury with rhabdomyolysis but in our scenario none of the patient suffered acute renal failure. It may be due to good hydration of the patient with normal saline. Total CK is the most reliable diagnostic indicator for rhabdomyolysis.<sup>14</sup> Serial decrease in CK seen in 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<sup>15</sup> 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.

There were few limitations in our study. First, sample size is small. Second, arrhythmias were only recorded in monitor and electrocardiogram, 24 hour Holter monitoring would be better for picking up arrhythmias. Third, we excluded patients aged <15 years, despite the fact that electrical injuries to children often occur in household. The outcomes likely would have been different if children been included in this study

### Conclusion

In this study, few non-fatal cardiac arrhythmias were observed in both high and low voltage electrical injury group. 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.

**Conflicts of interest:** None

**Acknowledgement:** None

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