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High Voltage Electrical Burns-Ten-Year Experience at A Tertiary Care Centre

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Abstract

Electrical injuries are particularly dangerous, as they can be instantaneously fatal and also put the rescuers in significant danger. Injury severity depends on the amperage of the current, the pathway of current through the victim's body, and the duration of contact with the source. **Material and Methods:** This study was conducted in the Department of Burns, Plastic and Reconstructive Surgery at, GMC Srinagar, India, from January 2009 to December 2018. **Results:** The study included 142 patients with high voltage injuries over a period of ten years. Males were predominantly affected. There were 127 males (88.9%) and females 23 females (13.07%). The age of patients ranged from 10 to 55 years. Most common age group involved was 20-40 years, comprising of 79% of patients. In the most of our patients (102 = 72 %) mode of injury was direct contact with live electric wire. Electrical injuries mostly affected the upper extremities followed by lower limbs. Compartment syndrome was found in 49 (34.5%) patients. Right upper limb was the most commonly involved, in 67 (46.9%) patients. Total body surface area burned ranged from 2 to 70%. Mortality was 4.2%. **Conclusion:** Emphasis must be laid on safety measures like wearing helmets, gloves, safety belts and insulated equipment. Improving the transmission system by opting to underground transmission lines may significantly reduce incidence of electric burns.

Keywords: High voltage, fasciotomy, electric workers, electrical injuries.

INTRODUCTION

Electrical injuries are particularly dangerous, as they can be instantaneously fatal and also put the rescuers in significant danger. Injury severity depends on the amperage of the current, the pathway of current through the victim's body, and the duration of contact with the source. Electrical current sources are typically classified as either low- or high-voltage, with 1000 volts (V) being the dividing line, and distinct injuries are associated with each type. Blood vessels, muscles and nerves are better conductors of electricity than bone, fat and skin.[1] An electrical burn potentially has three different components: (1) the true electrical injury from current flow, (2) an arc or flash flame injury produced by current arcing at a temperature of approximately 4000°C from its source to ground, and (3) a flame injury from the ignition of clothing or surroundings. Electrical injuries are potentially devastating injuries that result in injury to the skin as well as other tissues including nerve, vessels, muscle, tendons, and bone. Since its inception in 1849, electricity has been used widely in every sphere of life. Electricity use has increased manifold over the past few decades and so has the risk of injury. High voltage injuries are more common in developingountries.[2,3]About 0.8-1.0% of accidental deaths are due to electrical injury, and constitute 3-9% of all patients treated in burn centers. Electrical injuries cause around 1000 deaths in the United States each year with a mortality rate of 3-15%.[3,4]Electrical burn injury results may result in three ways: 1) direct contact; 2) flash (=thermal burn injury ± visual injury

related to lightning: no real current flow in the body); 3) and electric arc.

MATERIALS AND METHODS

This study was conducted in the Department of Burns, Plastic and Reconstructive Surgery at, GMC Srinagar, India, from January 2009 to December 2018. A retrospective analysis of medical records of all the patients admitted to our Unit with electrical burns, from 1st January 2009 to 31st December 2019, was undertaken. Demographic data, mechanism of injury, and amperage of current, total burn surface area (TBSA), site and depth of burns, surgical procedures and duration of hospital stay and complications were analysed. Statistical data were analysed with the Chi-square tests. A P value<0.05 was considered statistically significant.

RESULTS

The study included 142 patients with high voltage injuries over a period of ten years. Males were predominantly affected. There were 127 males (88.9%) and females 23 females (13.07%). The age of patients ranged from 10 to 55 years. Mean age was 28 years (Table 1). Most common age group involved was 21-40 years, comprising of 79% of patients.

In the most of our patients (102 = 72 %) mode of injury was direct contact with live electric wire. The second most common cause of injury was touching live electrical wire with a metallic object: iron rod in 11 (7.7%) cases. Live wire fell on 8 patients (5.6 %). 6 patients (4.2 %) got burns while entering water containing a live wire, 5 patients (3.5%) got injuries while their vehicles had a contact with live wire and 10 patients(7%) had flash burns. Table 2 demonstrates mode of injury.

Contact burns were seen in 83 patients (58.7 %) and a combination of contact with flash in 45 Electrical injuries mostly affected the upper extremities followed by lower limbs. In the upper extremities, most entrance wounds were due to grasping live wires. Most of the exit wounds were in the lower extremities because of the current grounding through the lower limbs. Compartment syndrome was found in 49 (34.5%) patients. Right upper limb was the most commonly involved, in 67 (46.9%) patients. Total body surface area burned ranged from 2 to 70% (Table 4).

Different surgical procedures were done in 121 (84.7%) patients. They underwent a total of 470 procedures, with 1 to 7 procedures per patient. Debridement was the most common procedure. Multiple serial debridements, with an average of 2.7 per patient, were needed in 73.5% of cases. A total of 64 fasciotomies were required in 49(34.5%).

Associated injuries were seen in 27 (18.9%) patients, fractures being the most common injury, followed by haemothrax.

Mortality was 4.2% (6 patients).Three had acute renal failure secondary to myoglobinuria, two deaths were due to sepsis and one patient died from inhalational burn associated with an electrical burn injury.

DISCUSSION

Electrical injuries are becoming a more common form of trauma with high morbidity and mortality. The overall mortality reported in literature ranges between 2-15% [5]which correlates well with our study.

Males were affected more than females with a ratio of 5.5:1, the reasons for male preponderance are; males are commonly involved in outdoor activities, electricians, construction workers and manual labourers are usually male in our society. Similar findings of this male predominance has been reported in the literature[6,7,8].

The subgroup of people most commonly associated with electrical injuries was electrical worker (electricians), accounting for 80 (56%) patients. This is similar to the results of many studies in the literature[9,10]. Reasons could be recruitment of inexperienced and inadequately trained daily wagers. Most of them had not observed any safety measures, like wearing a helmet, using safety belts, gloves, properly insulated tools.

Another subgroup was farmers. They are commonly injured during attempts to steal electricity for agricultural activities in summers, and household members while stealing electricity during winter months. Labourers received injuries while operating machines requiring high voltage current and also while carrying metallic bars at construction sites, which develop contact with overhead high-tension lines. Similar observations were made by other authors[11].

Younger adults were most commonly affected, with an overall mean age of 27 years: most of the patients

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(48.1%) were in the 21-40 years age group. Garcia-Sanchez reported that 60% of patients with electrical injuries were in this age group[8]. Many authors have identified a mean age ranging from 26 to 30 years[6,7]. This age group also includes inexperienced and inadequately trained electrical workers which are hired as daily wagers in electric department.

An average of 2.7 procedures per patient were required, similar to studies by others[12,13]. Fasciotomies were required in 34.5% of patients to salvage the limb by relieving any compartment syndrome, as mentioned by many researchers[13,14]. Amputations were required in 26.3% of patients when fasciotomy failed to save the limb or if the limb was severely charred. This corresponds well to many studies in the literature[14,15,16].

Right upper limb was most common entry site. Right hand is usually used for working activities, so this is the limb that is most commonly involved. Exit site was mostly seen on the lower limbs as grounding is through them. Similar observations were made others[1,17]

Overall mortality in high tension electric burns is estimated to be 2-15%[18,19] which correlates well with our study. Morbidity and mortality are largely affected by the type of electrical contact, extent of burns, amount of muscle necrosis. The development of multi-organ dysfunction in severe cases determine mortality and long-term prognosis.[20]

Conclusion

High voltage injuries are common in our society, and electrical daily wager workers are at a greater risk of exposure to them. Emphasis must be laid on safety measures like wearing helmets, gloves, safety belts and insulated equipment. Improving the transmission system by opting to underground transmission lines may significantly reduce incidence of electric burns. General public should be made aware about electricity hazards and preventive measures.

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TABLE 1: Age distribution

Age Group	No of Patients	Percentage
1-10 Years	5	3.5 %
11-20 Years	15	10.5 %
21-30 Years	70	49.6 %
31-40 Years	42	29.4 %
41-50 Years	7	4.9 %
> 50 Years	3	2.1 %
Total	142	100 %

TABLE 2: Mode of injury

Mode of injury	No of patients	Percentage
Direct contact with wire	102	72%
Contact with metallic rod	11	7.7 %
Flash	10	7 %
Falling of live wire	8	5.6 %
Entering water containing live wire	6	4.2 %
Wire touching vehicle	5	3.5 %
Total	142	100 %

TABLE3: Type of Burn

Type	No of patients	Percentage
Contact Burn	83	58.7 %
Flash	45	31.5 %
Contact + Flash	14	9.8 %
Total	142	100 %

TABLE 4: Percentage body surface area burnt

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Body surface area burnt	No of patients	Percentage
< 10	26	18.2%
10-19	23	16.1%
20-29	55	39%
30-39	13	9.1%
40-49	9	6.3%
50-59	10	7%
60-69	2	1.4%
> 70	4	2.9%
Total	142	100%

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