Epidemiology and Outcome in Electrical Burn Injury: Retrospective Study of 282 Patients in a Tertiary Care Hospital of Western Uttar Pradesh, India

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ABSTRACT
Electrical burns account for a small percentage of all burn injuries. However, in burn patients, they are a major source of disability. They put socioeconomic burden on the society. This is a retrospective epidemiological study of 282 electrical burn patients admitted in burn unit of a tertiary care hospital of North India. Majority of the electrical burn was due to accidental touching of uncovered wires and occupation-related burns in laborers and industrial workers who were mainly young males in the age group 20 to 40 years. Most of the cases were of high-voltage (≥1000 V) electrical burns. More severe burns, longer hospital stays, and more problems and operations were all linked to high-voltage burns. Amputation rates for high-voltage burns were significantly higher (37.3%) as compared to low-voltage burns (13.6%). Electrical burn injuries can be prevented by awareness programs, proper training, and safety measures both by public and government.

KEYWORDS: Electrical Burns Injuries; North India; High Voltage; Low Voltage; Industrial Worker; Epidemiology; Amputation.

1. INTRODUCTION

According to World Health Organization, an estimated 180,000 deaths every year are caused by burns—majorities occur in low-income nations; over two thirds occur in African and South-east Asian countries [1]. As a significant source of morbidity and disability, nonfatal burns can lead to extended hospitalizations, deformity, and rejection. Low- and middle-income nations suffer the most from burns, which are one of the main causes of disability-adjusted life years (DALYs). As the industrialization and education are increasing in our society, incidence of flame burn is decreasing, but electrical burn cases are increasing in our society [1]. Electrical burns have a relatively low prevalence compared to other forms of burns, but their high morbidity and death rates make them one of the most severe injuries [2]. The long-term hospitalization, the necessity for repeated surgical operations, and, finally, the functional sequelae that may arise from the original injury all add to the high expenses [3]. High-energy current flows through the body when it comes in touch with an electrical source. Injuries can be caused by arc flash, electricity flowing through the body, or clothes catching fire. It is crucial to remember that the look of an electrical burn isn't always indicative of its severity, as interior tissues or organs may be badly damaged. Fortunately, most of these injuries may be avoided. It is possible to improve the current situation with the help of public education and safety measures taken by our government and our citizens. Electrical burns are often classed as either high-voltage (≥1000 V) or low-voltage (<1000 V), depending on the voltage [4, 5]. In this retrospective study, we have analyzed the epidemiological profile of electrical burn patients admitted in our hospital and on the basis of that presented possible solutions to avoid these injuries.

2. METHOD(S)

From March 2018 to February 2021, 282 patients with electrical burns were hospitalized to our burn unit for this retrospective epidemiological investigation. Other forms of burn injuries (thermal, chemical, or scald), brought dead patients, insufficient data, patients who left the hospital against medical advice, and recovered electric burn patients who were hospitalized later for reconstructive surgery were excluded in the study. Each patient completed a detailed questionnaire, which included demographic information (such as age, gender, address, and education levels), mechanism of injury, voltage (high or low voltage), intensive care unit need, length of hospital stays and electrical burn severity (such as degree and total burn surface area: the Lund and Browder chart), as well as surgical interventions (such as skin grafts, flaps, fasciotomy, and amputation) and outcome. The study was approved by the ethics review committee of our medical college, and anonymized and deidentified patient

data and information were used in the analytic process. On admission, all patients managed according to standard treatment protocol comprising of intravenous fluid resuscitation, antibiotics and tetanus prophylaxis, burn severity assessment and surgical management, early diagnosis and treatment of life-threatening complications, proper diet, and rehabilitation.

Using conventional descriptive analysis and Mann–Whitney U tests or Pearson's chi-squared tests, we looked at differences in hospital stay time, total burn surface area (TBSA), complications, amputations, and mortality across groups exposed to different voltages. Statistical significance was determined by a value of $P < 0.05$. IBM SPSS Version 22.0 software was used to conduct all of the tests.

3. RESULTS

A total of 2208 burn patients were admitted to our Burn Unit over the three-year study period, and out of them, 282 patients (12.77%) experienced electrical burns. A total of 217 (76.95%) of the 282 electrical burn patients had high-voltage burns, and 65 (23.04%) had low-voltage burns (Table 1). A total of 282 patients included 246 male patients (87.23%) and 36 female patients (12.77%). Males were more commonly affected in both groups of patients. Mean age in low-voltage group was 34.26 ± 17.33 year and 35.20 ± 11.67 year in high-voltage burn group. Most of the cases occurred in urban areas in the summer and rainy season.

Table 1: Comparison between the high-voltage and low-voltage groups.

Patient characteristics	Low-voltage	High-voltage
Number	65 (23.04%)	217 (76.95%)
Sex (Male : Female)	5:1	8:1
Age	34.26 ± 17.33	35.20 ± 11.67
Rural: Urban	1:6	1:4
TBSA	8.65 ± 14.32	18.97 ± 17.43
Length of hospital stay	17.63 ± 13.89	39.17 ± 31.22
ICU Need	8%	26%
No. of Surgical procedures done		
0	11%	0%
1	34.6%	23.4%
2 or More	35.9%	93.0%
Acute Complications (Arrhythmia, ARF, or Compartment syndrome)	8%	19%
Escharotomy/Fasciotomy	8.6%	41.2%
Flap cover	4.6%	34.8%
Amputation	13.6%	37.3%
Mortality	0	2

Most of the cases were between the age of 21 and 40 years age group which is the main working age group of our country (Figure 1). In all of the patients, upper limbs (84.60%) were found to be more often damaged than lower limbs (35.40%) (Figure 2). The mechanism of injury was occupational in 220 cases (78%), mainly in industrial workers, electricians, manual laborers working at construction sites, and farmers working bare foot in their fields in early morning times. Most of these cases are of high-voltage burn, while low-voltage burn group mainly consists of householders and children burn by household appliances at home (Figure 3).

Mean TBSA was 8.65% ± 14.32% in the low-voltage group and 18.97% ± 17.43% in the high-voltage group. In comparison to the low-voltage burn group, the high-voltage burn group's hospital stay was substantially longer ($P < 0.05$). Twenty-six percent of patients in the high-voltage group needed ICU support compared to only 8% cases in the low-voltage group. With regard to treatment, 2 or more surgical procedures were done in the high-voltage group (93%) as compared to only 35.9% in the low-voltage group which was statistically significant ($P < 0.05$).

Acute complications in the form of cardiac abnormalities, compartment syndrome, coma, or acute renal failure were seen more frequently in the high-voltage group. No mortality was seen in the low-voltage group, while 2 patients died in the high-voltage group which was statistically not significant. Note that 41.2% cases in the high-voltage group needed fasciotomy as compared to the low-voltage group (8.6%) which was statistically significant. Amputations were also performed in the high-voltage group in 37.3% cases, which was significantly more than the low-voltage group (13.6%). In the low-voltage group, only minor amputations in the form of finger or toe amputations were needed.

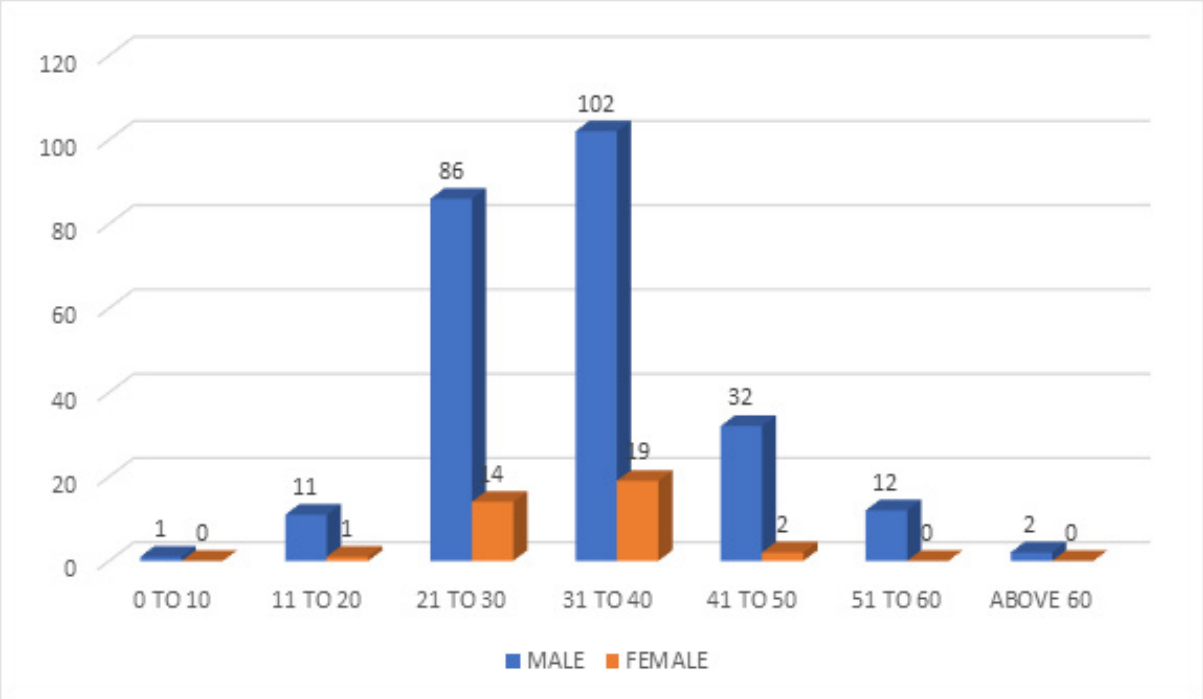

Figure 1: Age vs. sex distribution of cases.

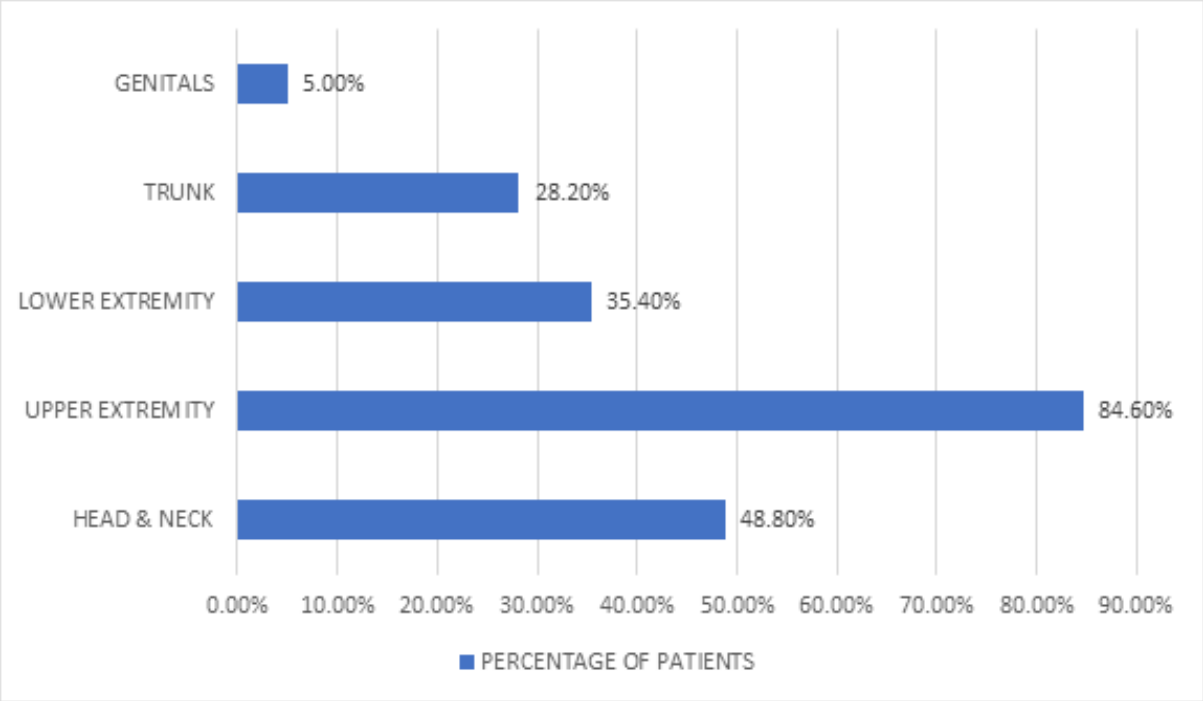

Figure 2: Distribution of burns according to body region.

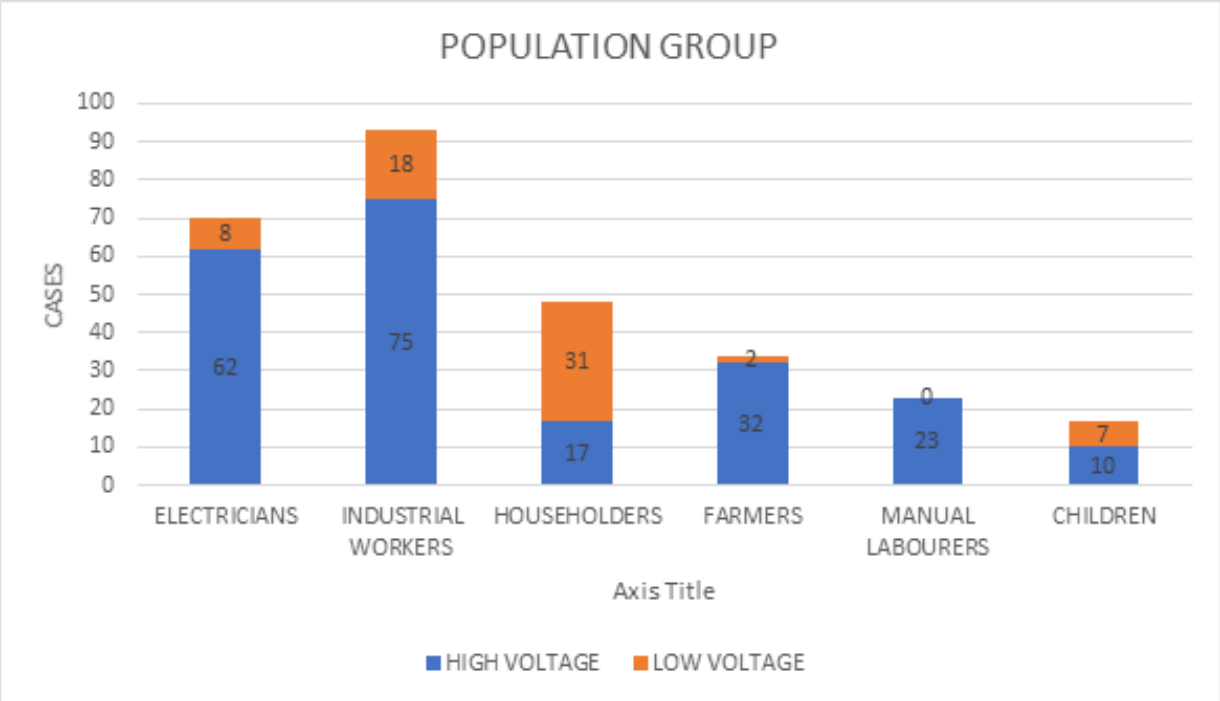

Figure 3: Distribution of cases according to population groups.

4. DISCUSSION

Although less frequent than scald and flame burns, electrical burn deserves special attention. In industrialized nations, they account for around 0.04% to 5% of all burn cases, but in underdeveloped countries, they can account for up to 27% [5]. In our study, electrical burn injuries accounted for 12.77% of total burns admitted in our hospital, considerably significant compared to developed nations.

Approximately 76.95% of electrical burns were caused by high-voltage currents, whereas only 23.04% were caused by low-voltage currents in our study, comparable to prior studies [4, 6]. In the present study, majority of electrical burn injuries were more frequent in summer and rainy seasons [7]. This may be due to the high levels of industrial activity, and residential electricity consumption (refrigerator and air coolers usage) in north India during this time of year temperatures reaches above 45^0C.

Of the 282 patients studied, men were the more affected, a finding that is similar to previous studies [2, 8–10]. This may .be because in our country most of the industrial as well as electricity-related works are done by males. More than 75% of all electric burn incidents occurred in young and middle-aged adults, similar to earlier findings [8], i.e., working age group of our country. Children and housewives suffered a large number of low-voltage burns. There is no doubt that children are less capable of assessing danger and protecting themselves.

Like earlier studies, we found that industrial employees, electricians, manual laborers, and house makers were the most likely to suffer burns at work and at home, respectively [3, 6, 11, 12]. Main reasons for this finding as told by patients themselves were handling electricity wires without proper safety gears and operating heavy machinery without proper training; in manual laborers, it was mainly due to the working at construction sites close to the high-tension lines; and in our house makers, it was mainly due to improper use of electric appliances used in our daily life. Thus, in order to minimize the occurrence of electrical burns, it is essential to raise public awareness, educate people, and implement prevention methods in our day-to-day life. Use of outlet covers for connecting elements, electric-fault circuit interrupters, guidelines to regulate the production of electrical equipment, warning signs, and other precautions may be standardized in all the states and applied uniformly. In addition, public education initiatives in schools, workplaces, and communities might improve understanding about electrical injuries and correct use of electricity, as well as self-protection.

There were lengthier hospital stays for patients with high-voltage deep burns and more TBSA burns than those with low-voltage burns, which is consistent with earlier studies [6, 8, 13]. Our study showed most electrical current enters the body through upper and lower extremities, followed by scalp. As a result of the higher-energy release and more severe tissue damage, high-voltage burns result in longer hospital stays, more disability, and higher mortality in these patients [14].

In present study, mortality rates were 0.92% for high-voltage burns and 0% for low-voltage burn, which was very low in comparison to previous studies (range 2.4% to 26.7%) [5, 12, 14, 15]. Large number of electrical burn patients can be saved by just following the basic treatment protocol of proper fluid, electrolyte and vital monitoring in ICU, and prompt diagnosis

and treatment of any life-threatening conditions. In our setup, once the patient general condition gets better, we shift them to general Burn ward and mobilize them as early as possible following enhanced recovery protocols. In recent years, due to the improvement in transportation infrastructure in our nation, many patients have been able to visit large centers and obtain adequate treatment in the previous few years, which is a great thing.

Approximately 37.3% of patients with high-voltage burns underwent major and minor amputations, while 13.6% of patients with low-voltage burns underwent minor amputations. Ten percent to 68% of electrical injuries result in amputations [16]. The amputation of one upper limb was also more prevalent in high-voltage burns, possibly because it was the most common entrance point for current [8, 17]. The functional and psychosocial impacts of amputated limb leave a stigma in the patient's life forever. Most of the patients are electrician or industrial workers and are not able to resume their occupation. Rehabilitation of such patients is another issue which is beyond the scope of this study [3].

However, there were a few drawbacks to this research. As due to the retrospective nature of this investigation, we were unable to examine long-term morbidity, learning impairments, rehabilitation patterns, or societal costs. This sample excluded persons who may have died from electrical burns, on their way to our center or at other hospitals as well as those who did not seek medical care for some other reasons. Lastly, it was done in a single hospital. To circumvent the limitations of the current study, more well-designed multicenter studies with long-term follow-up are needed.

5. CONCLUSION

In addition to affecting public health, electrical burns have a high morbidity rate, which can result in a significant economic cost to the patient as well as country. Electrocution among young men and industrial employees is on the rise, underscoring the need to reassess occupational safety standards by concerned authority. At our homes, we can protect electrical injuries by using properly insulated electric devices and keeping our children away from electrical appliances. Government should reinforce strict safety guidelines for industries as well as stop illegal housing constructions near the high-tension lines. Electricity may be dangerous, and educating people about the dangers and enforcing safety precautions are vital to preventing these accidents.

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AUTHOR CONTRIBUTIONS

All authors contributed equally in the study.

CONFLICT OF INTEREST

There is no conflict of interest.

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