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Electric Burn Injuries in Bangladesh: An Epidemiological Overview from A Tertiary Level Hospital

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Abstract | **Original Research Article**

Electrical burn injuries comprise a small fraction of the total burn admissions, but they are potentially a mutilating type. Electrical burns are one of the most important public health issues in industrial societies and can lead to serious outcomes and socioeconomic problems. This study was conducted to observe different epidemiological factors of electric burn patients attending at burn and plastic surgery department in Chittagong Medical College Hospital, Chattogram, Bangladesh. This retrospective study enrolled consecutive electrical burn patients admitted in Chittagong Medical College Hospital between 2020 to 2023. Demographics, clinical data and outcomes were recorded. Pearson's chi-squared test was used to examine differences between groups exposed to different voltages and Spearman's rank-order correlations were done to examine relationships between groups. We assessed 639 electric burn patients. There were 213 high voltage electric burn (HVEB) injuries and 426 low voltage electric burn (LVEB) injuries. Mean age of the patients was 27.81 ± 12.02 years (Mean ± SD) with a range of 1-55 years. Among them 84.8% patients were male, and 15.2% patients were female. The mean TBSA of burn in HVEB patients was 10.38 ± 4.91% (Mean ± SD) with a range of 5-30% whereas the mean TBSA of burn in LVEB patients was 4.5 ± 1.4% (Mean ± SD) with a range of 2-8% which is statistically significant. 351 patients (82.4%) in HVEB needed surgery and 75 patients (17.6%) were managed by conservative treatment, whereas 30 patients (14.1%) in LVEB needed surgery and 183 patients (85.9%) were managed by conservative treatment. There were positive and highly significant correlations between voltage of burns and duration of hospital stay and between voltage of burns and treatment needed. All patients in the LVEB group (213 patients, 100%) were discharged. In HVEB group 375 patients (88%) were discharged, 31 patients (7.3%) were referred to higher centers and 20 patients (4.7%) were death. The overall mortality rate in our series was 3.1%. Electrical burns are still a major problem in Bangladesh. Extensive injuries need to be managed in a tertiary care center.

Keywords: Epidemiology, Electric Burn, Morbidity, Mortality, Amputations.

INTRODUCTION

Electrical burns are one of the most important public health issues in industrial areas and it can lead to serious outcomes and socioeconomic problems. Electrical burns are classed into two categories: high-voltage electric burn (HVEB) and low-voltage electrical burns (LVEB). High-voltage electrical burns are caused by exposure to electrical currents above 1,000 voltages, while low-voltage electrical burns result from exposure to currents below 1,000 voltages [1,2]. According to World Health Organization, burn causes an estimated 265,000 deaths every year - majorities occur in third world countries. Nearly 3,000 people dies annually from burn related injuries in Bangladesh, an underdeveloped country in South Asia [3]. Electrical burn injury is now-a-days considered one of the most common causes of domestic and occupation-related injury in developing countries like Bangladesh. As the industrialization and education are increasing in our society, incidence of flame burn is decreasing, but electrical burns are increasing [4]. Electrical burns have a relatively low prevalence compared to other forms of burns, but their high morbidity and mortality make them one of the most fatal injuries [5]. Electrical arc flash burns are usually

considered a separate entity, in which no current passes through the body and cause superficial burns. By contrast, in electric burns, electrical current passes through the body. It may result in deeper and more extensive burns than electrical arc flash burns and can result in higher morbidity and mortality [6]. Electrical burn injuries often lead to disfigurement and limb loss of the victim hampering the ability of the individual to resume work. These injuries are very challenging to manage because of injury to the microvasculature causing progressive necrosis [7]. Patients with electrical burns also suffer mental disturbances like slower thinking, impaired concentration, language and memory problems, as well as emotional distress [8,9]. Therefore, patients have long-term residual sufferings which affects their quality of life. Electrical burns are characterized by varied mortality rates ranging from 2.35% to 26.7% [10]. Most electrical injuries are preventable by ensuring appropriate safety precautions. There are no published data regarding prevalence of electric burn in Bangladesh yet. Electrical infrastructures are inadequate, and safety measures are often overlooked in Bangladesh; therefore, the prevalence of electric burn injuries can be particularly high. Epidemiological data are necessary for establishing an effective prevention strategy [8,11]. By acquiring knowledge about epidemiology of electric burns in our area we can help establishing specific preventive strategies. Previous studies vary in reporting epidemiology for electrical burns in our area. Most studies focused on burn injuries in general, but detailed epidemiological data specific to electric burns are limited. There are only a few studies that analyzed the correlation between different types of electric burns (high-voltage vs. low-voltage) and treatment outcomes, including mortality and morbidity rates. A thorough understanding of the epidemiological profile of electric burns will help to the prevention and management of such type of injuries. This study will fill a crucial gap, providing baseline data that can be helpful in future research and helping to position Chattogram as a focal point for studies on electrical safety and burn management in Bangladesh. Therefore, this study aims to analyze the epidemiological characteristics of electric burn patients admitted at burn and plastic surgery department of Chittagong Medical College Hospital, Chattogram, Bangladesh over a 4-year period.

Materials & Methods

This was a retrospective analysis of the medical records of 639 patients with electrical burn injuries admitted to the burn unit of Chittagong Medical College Hospital, Chattogram, Bangladesh between January 2020 to December 2023. All data were retrieved from hospital database. The diagnosis of electrical burn was made based on history, clinical examination, and electrocardiographic changes. Patients with electrical arc flash burns, patients with voltage not otherwise specified and those admitted for further reconstructive surgery were excluded. All patients received a standard management plan which comprises intravenous fluid resuscitation, burn wound assessment and management, infection control, nutritional support and rehabilitation. The following data were retrieved: electrical current voltage, age, gender, total body surface area (TBSA) burn percentages, types of management received, length of hospital stay and mortalities. The informed consent was not taken from the patients because of the retrospective nature of the study. Ethical clearance was taken from the ethical review committee of the institution. All data were analyzed by using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Mean ± SD was calculated for quantitative variables. Frequencies and percentages were calculated for categorical variables. Pearson's Chi square tests were done to examine the differences in TBSA of burn and treatment needed between groups exposed to different voltage of burn. Spearman's rank-order correlations were done to examine the relationship between groups exposed to different voltage of burn, treatment needed, and duration of hospital stay.

Results

639 patients with electric burns were enrolled in this study. Mean age of the patients was 27.81 ± 12.02 years (Mean ± SD) with a range of 1-55 years. In our study the highest number of patients were found in the fourth decades (244 patients, 38.2%) and third decades (148 patients, 23.2%). 542 patients (84.8%) were male, and 97 patients (15.2%) were female. Among them, 426 patients (66.7%) suffered from HVEB, and 213 patients (33.3%) suffered from LVEB. Among the 639 patients, the mean TBSA of burn was 8.42 ± 4.94% (Mean ± SD) with a range of 2-30% and the mean duration of hospital stay was 18.64 ± 13.78 days (Mean ± SD) with a range of 1-65 days. There is a positive linear relationship in scatter plot diagram between TBSA of burn and duration of hospital stay (figure 1).

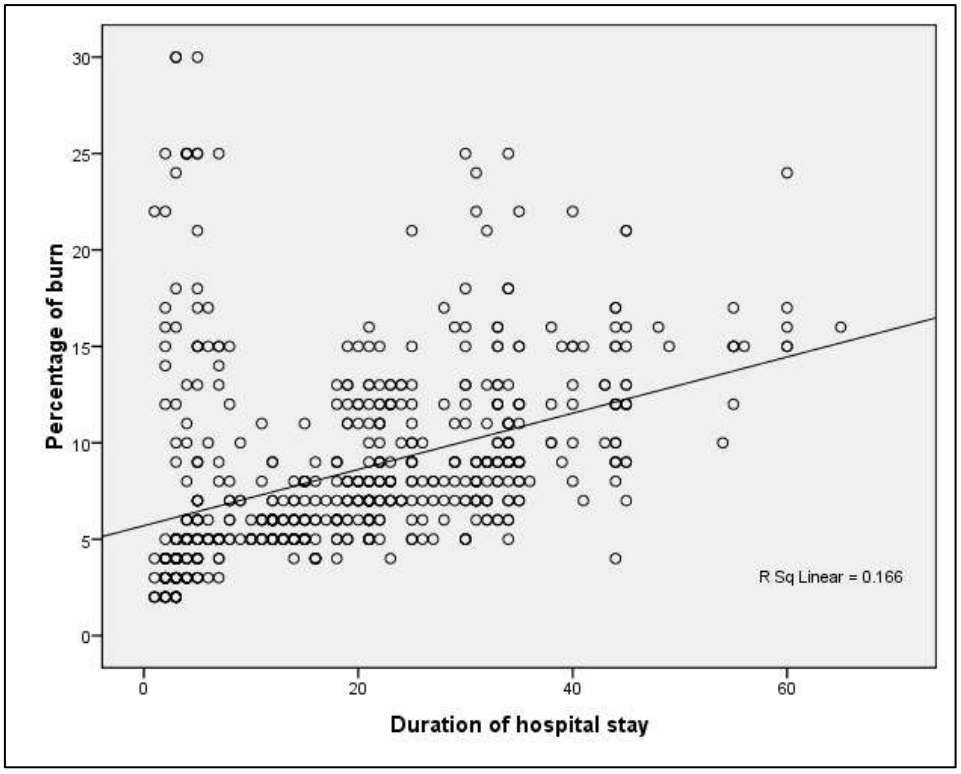

Figure 1: Relationship between TBSA of burn and duration of hospital stay

The mean TBSA of burn in HVEB patients was 10.38 ± 4.91% (Mean ± SD) with a range of 5-30% whereas the mean TBSA of burn in LVEB patients was 4.5 ± 1.4% (Mean ± SD) with a range of 2-8%. An independent sample t-test was done to compare the TBSA of burn between HVEB and LVEB. There were significant differences (t (639) = 17.1, p<0.01) in the scores with mean score for HVEB (M=10.38, SD=4.91) higher than LVEB (M=4.5, SD=1.4). the magnitude of the differences in the means (mean difference =5.9, 95% CI: 5.2 to 6.5) was significant (table 1).

Table 1: Differences in TBSA burn between HVEB and LVEB

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% CI of the Difference	
									Lower	Upper
Percentage of burn	**Equal variances assumed**	145.847	.000*	17.11	637	.000	5.878	.343	5.204	6.552
	Equal variances not assumed			22.91	545.3	.000	5.878	.257	5.374	6.382

* p-value is significant. p-value derived from independent sample t-test.

The mean duration of hospital stay in HVEB patients was 24.48 ± 12.76 days (Mean ± SD) with a range of 1-65 days whereas the mean duration of hospital stay in LVEB patients was 6.96 ± 6.26% (Mean ± SD) with a range of 1-44 days.

351 patients (82.4%) in HVEB needed surgery and 75 patients (17.6%) were managed by conservative treatment, whereas 30 patients (14.1%) in LVEB needed surgery and 183 patients (85.9%) were managed by conservative treatment which was statistically highly significant (Pearson Chi-square test done) (table 2).

Table 2: Type of Burn and treatment needed cross-tabulation

			Treatment needed			
			Conservative	**Surgical**	**Total**	**p-value**
Type of burn	**Low Voltage electric burn**	Count	183	30	213	0.000*
		% within Type of Burn	85.9%	14.1%	100.0%	
	High Voltage electric burn	Count	74	352	426	
		% within Type of Burn	17.4%	82.6%	100.0%	
Total		Count	257	382	639	
		% within Type of Burn	40.2%	59.8%	100.0%	

* p-value is significant. p-value derived from Pearson Chi-Square test (2 sided).

The most common surgery done in HVEB patients was split thickness skin grafting (124 patients, 29.1%) followed by flap (96 patients, 22.5%), disarticulation (44 patients, 10.3%), fasciotomy (40 patients, 9.4%), above elbow amputation (25 patients, 5.9%) and below elbow amputation (17 patients, 4%). The most common surgery done in LVEB patients was split thickness skin grafting (24 patients, 11.3%) followed by disarticulation (5 patients, 2.3%) and fasciotomy (1 patient, 0.5%) (table 3).

Table 3: Treatments given to the patients

			Type of Burn		Total
			High Voltage electric burn	**Low Voltage electric burn**	
Treatment	**Conservative**	Count	75	183	258
		% within Type of Burn	17.6%	85.9%	40.4%
	Fasciotomy	Count	40	1	41
		% within Type of Burn	9.4%	0.5%	6.4%
	STSG	Count	124	24	148
		% within Type of Burn	29.1%	11.3%	23.2%
	Flap	Count	96	0	96
		% within Type of Burn	22.5%	0.0%	15.0%
	Below elbow amputation	Count	17	0	17
		% within Type of Burn	4.0%	0.0%	2.7%
	Above elbow amputation	Count	25	0	25
		% within Type of Burn	5.9%	0.0%	3.9%
	Disarticulation	Count	44	5	49
		% within Type of Burn	10.3%	2.3%	7.7%
	Below Knee amputation	Count	3	0	3
		% within Type of Burn	0.7%	0.0%	0.5%
	Trans shoulder amputation	Count	1	0	1
		% within Type of Burn	0.2%	0.0%	0.2%
	Bilateral above elbow amputation	Count	1	0	1
		% within Type of Burn	0.2%	0.0%	0.2%
Total		Count	426	213	639
		% within Type of Burn	100.0%	100.0%	100.0%

Sperman's rank-order correlations were done to examine the relationship between voltage of burn, treatment needed, and duration of hospital stay. There were positive and highly significant correlations between voltage of burn and duration of hospital stay, r_s=0.65, n=639, p<0.001 (table 4) and voltage of burn and treatment needed, r_s=0.66, n=639, p<0.001 (table 5).

Table 4: Correlations between voltage of burn and duration of hospital stay

			Velocity of Burn	Duration of hospital stay
Spearman's rho	**Voltage of burn**	Correlation Coefficient	1.000	.648**
		Sig. (2-tailed)		.000
		N	639	639
	Duration of hospital stay	Correlation Coefficient	.648**	1.000
		Sig. (2-tailed)	.000	
		N	639	639

**. Correlation is significant at the 0.05 level (2-tailed).

Table 5: Correlations between voltage of burn and treatment needed

			Voltage of burn	Treatment needed
Spearman's rho	**Voltage of burn**	Correlation Coefficient	1.000	.659**
		Sig. (2-tailed)	.	.000
		N	639	639
	Treatment needed	Correlation Coefficient	.659**	1.000
		Sig. (2-tailed)	.000	.
		N	639	639

** Correlation is significant at the 0.01 level (2-tailed).

In our study all patients in the LVEB group (213 patients, 100%) were discharged. In HVEB group 375 patients (88%) were discharged, 31 patients (7.3%) were referred to higher centers and 20 patients (4.7%) were death. The overall mortality rate in our series was 3.1% (table 6).

Table 6: Outcome of the patients

			Type of Burn		Total
			Low voltage electric burn	High voltage electric burn	
Outcome	**Discharge**	Count	213	375	588
		% within Type of Burn	100.0%	88.0%	92.0%
	Referred	Count	0	31	31
		% within Type of Burn	0.0%	7.3%	4.9%
	Death	Count	0	20	20
		% within Type of Burn	0.0%	4.7%	3.1%
Total		Count	213	426	639
		% within Type of Burn	100.0%	100.0%	100.0%

DISCUSSION

Electrical burns are devastating injuries and can cause deep burns with significant morbidity, leading to prolonged hospital admission and multiple surgeries to achieve complete wound healing. These injuries are also responsible for amputation of limbs making the patient dependent on caregivers even for basic activities of daily living if multiple limbs are involved. Even after limb salvage surgery, the patient may have to undergo multiple admissions for reconstruction of tendons and nerves in the affected limb before adequate functionality of the limb is achieved [12]. In the present study we attempted to examine the epidemiology of electric burn injury in the burn and plastic surgery department in Chittagong Medical College Hospital, one of the busiest tertiary hospitals in Chattogram. Electrical burns injuries are not common, but they deserve special attention. Electric burn injuries comprise approximately 27% of all admissions to burn centres in developing countries and approximately 0.04 - 5% in developed countries [13].

In the present study a total of 639 admitted electric burn patients were enrolled. The number of high-voltage electrical burns (66.7%) was higher than low-voltage electric burns (33.3%). Our findings are similar to previous study findings [7,14,15]. In contrast, other researches have shown that low-voltage electric burn injuries is higher in percentage [16-19]. This discrepancy may be due to differences in population behaviours and occupational hazards.

Highest number of patients belonged to the 31-40 years age-group (38.2%) in our study. The results also indicated that most of the electric burn injuries occurred in young people. Most of them may be the sole earners in their family. Losing the ability to work due to electric burn injuries is a great loss to the family as well as society in general [20]. In our study, 84.8% cases were male, and 15.2% cases were female. Male to female ratio was 5.5:1. These results may be due to male predominance in relevant electrical appliances-based occupations. This is similar to previous data regarding the sex distribution of electrical burns [21,22].

High voltage burns had more percentages of TBSA burns and thus experienced longer hospital stays in our study. High voltage burns are characterized by greater energy release, thus causing deeper and more extensive tissue damage; resulting in longer hospital stays. These factors are related to increased morbidity and mortality [23]. In HVEB patients, the mean TBSA was 10.38% and mean hospital stay was 25 days whereas in LVEB patients, the mean TBSA was 4.5% and mean hospital stay was 7 days. Our findings are almost similar to a meta-analysis done by Shih *et al*. [13]. They reported that in high voltage injuries mean TBSA was 17.6% and mean hospital stay was 31 days. In low voltage injuries mean TBSA was 10.6% and mean hospital stay was 11 days.

In the current study, surgical procedures involved in managing the electrical burns included wound debridement, fasciotomies, split thickness skin graft, flap coverage, amputations, and disarticulations. The high voltage electric burn injuries were deeper and required multiple surgeries. 50 patients (7.8%) in our

study required multiple surgeries. Our observations are similar to the study done by Gajbhiye *et al*. [14]. Procedures done for managing burn cases reported in their study were debridement, surgical excision, split skin grafting, fasciotomy, amputations and flap. In another study conducted by Srivastava *et al*. the reconstructive procedures performed were early excision and skin grafting, distant flaps, micro vascular free flaps, rhinoplasty, ear reconstruction, tendon reconstruction and scalp reconstruction [24]. Most of the procedures noted in our study are similar.

In our study, the mortality rate in HVEB patients was 3.1% and no mortality observed in LVEB patients. Shih *et al*. performed an extensive literature search on electrical burn injuries between 1946-2015 and they reported mortality in high voltage injuries was 5.2% and low voltage injury was 2.6% [13]. In another study it was found that mortality in HVEB was 0.46% and it was 0% in LVEB [7]. However, this study was conducted in a specialized burn center in southern China and their transport system was very improved. Our study was conducted in a tertiary care hospital, which is the only specialized center in this region. The transport system is not modern in this area. Moreover, there is a scarcity of intensive care unit beds in this facility. Hence, mortality is relatively higher in our study.

Electrical burn injuries are still a major risk factor for limb amputations. In HVEB direct damage happens in muscles, nerves and tendons, causing gradual ischemia. Thrombus formation in the small arteries and vasoconstriction causes slowing the blood flow and gradual tissue necrosis. These are the contributing factors for limb amputations [25]. Amputation rates in electrical burn injuries varies from 10% to 68% [7]. Amputation rates for electrical injuries in our study were 15%. The amputation rates were 21.3% for high voltage burns and 2.3% for low voltage burns. Aghakhani al reported similar results [26]. The study by Kym *et al* in South Korea reported that 74.7% in their series underwent amputation, but most of those were minor [25]. They reported an amputation rate of 15.6% in the low voltage group. High voltage electric burns involved more amputations of the upper limb, because upper limb is the most common current entry point. Mazzetto-Betti *et al*. reported that hand was the entry point of electrical current in 94% cases and lower limb was the exit point in 78% cases [27]. Amputation of limbs causes physical, as well as psychological disability. They also need long-term rehabilitation.

Electric burn injuries is a major health concern in this modern and industrialized age. Prevention of such type of injury should be emphasized. This study was conducted in a tertiary care centre where burn management ward is overburden and modern treatment facilities are not available. Future multicentre studies with long-term follow up should be conducted in this region to understand the epidemiology of electric burns and thus developing strategies to prevent it.

Conclusion

This retrospective study provides valuable insights into the epidemiology of electrical burns in Bangladesh. High voltage injuries need to be managed in a tertiary care centre using a multidisciplinary approach. The quality of life in patients with limb amputation is poor. Thus, steps should be taken to create awareness as well as planning a good preventive strategy for electrical burns. We recommend policy makers make a priority action plan on prevention of electrical burns focusing on the safety of workers.

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