VOLUME - 13, ISSUE - 11, NOVEMBER - 2024 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Plastic Surgery

ELECTRICAL INJURIES IN CHILDREN- A PREVENTABLE CAUSE OF SHOCKING CONSEQUENCES

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ABSTRACT This study aims to share our Institutional knowledge on electrical injuries in paediatric patients and investigate the causatory and preventive measures. A retrospective review of files of electric burn victims from 2019 to 2023 admitted in our Tertiary burns care centre under 16 yrs of age was done. A total of 138 patients were treated during this period. The following data were retrieved: Patient Demographics, nature of injury (high or low voltage), duration of Hospital stay, total burnt surface area, procedures performed were considered and data was analysed statistically. Paediatric electric burns comprise around 24.2% of total Electric burns cases. Boys were more commonly injured than girls (70.2% vs 29.7%). Children were affected with High voltage burns more than low voltage group. (83.3% vs 16.6%). High voltage burns was more prevalent in older age group (11.8 yrs) than low voltage burns (3.8 yrs) with significant p value (<0.01). 66.9% of the high voltage burns group were due to contact with damaged high-tension wires. Mean hospital stay was significantly longer in patients with high voltage injuries (16.36 days) than in those with low voltage injuries (3.17 days). Amputations were needed in 44 patients (31.8%). 74 patients (53.6%) underwent fasciotomies, Flap cover was needed in 52 patients (37.6%). 20 patients (17.39%) succumbed to their burn injuries. Although entirely preventable, Significant morbidity and mortality is associated with Paediatric electric burn injuries. Public awareness campaigns, Strict Safety norms by the Government, good housekeeping and General public cooperation are in dire need.

KEYWORDS : Electric Burns, Paediatric electric burns, High voltage burns, low voltage burns

INTRODUCTION

The Playfulness and curiosity of innocent children seek for magic in their daily adventures. However, the unfortunate handful of them may get victimized by fire hazards. Electric burn injuries hold a significant share in leading causes of morbidity and mortality among burn victims. Paediatric electric burn victims account for a notable size in them.

Electrical burns are arbitrarily divided into high voltage (R1000 V) and low voltage (< 1000 V). The Indian domestic power grids operate on alternating current (AC) at 220 V, thus injuries that occur indoors in India are almost exclusively low-voltage AC. The extent of damage by Electrical injury is determined by the magnitude of voltage and current (amperage; I), current type (alternating or direct), path of current flow, duration of contact, tissue resistance at the point of contact, and individual susceptibility.[2]

Paediatric burn victims are affected not just at Individual level but as a whole family. The physical pain of Burns, separation from the family, Hospital environment, financial burden and need for prolonged physiotherapy results in psychosocial distress of the entire family. The post traumatic stress disorder associated with the accident leads to a devastating sequela through the child's adulthood.

The only effective management of burn injury is its prevention altogether. Hence the aim of our study is to evaluate the various aspects of electric burn injuries in the paediatric age group in our region and provide data to help formulate more effective preventive measures.

MATERIALS AND METHODS

Medical records were retrospectively reviewed for all patients under the age of 16 years who were admitted in our Burns unit for evaluation and management of paediatric electrical burn injuries over a period of 5 years (January 2019 to December 2023).

Details of demographic data, mode of injury including voltage and time interval from injury to presentation, body regions involved, associated injuries, length of hospital stay, details of surgical procedures and outcome were collected retrospectively from the registers. Baseline demographics and clinical data of patients was analysed by descriptive statistics such as mean, median, standard deviation with interquartile range for continuous variables, frequencies with percentages for categorical variables. The difference in proportion was analysed by Chi-square test and the difference in means by student t-test. All statistical analyses were performed using commercially available software- Statistics Package for the Social Sciences (SPSS)- 20th version. A p-value of <0.05 was considered to be significant.

RESULTS

There were 4749 admissions to our Burns Unit over the period of 5 years from 2019-2023. A total of 570 patients had suffered electrical burn injuries of which 138 (24.2%) were in the paediatric age group. Boys (n=97; 70.2%) were more commonly injured than girls (n=41; 29.71%) with an overall male:female ratio of 2.3:1. There were 23 (16.6%) low voltage (LV) burns and 115 (83.3%) high voltage (HV) burns. The youngest patient was aged 6 months and the oldest was aged 16 years. (mean = 10.52 years).

The average age of the high- voltage group is 11.86 yrs and low voltage group is 3.86 yrs. p value is significant (<0.01). Age group distribution of paediatric electric burns is depicted in figure 1. Table 1 shows comparison of data according to magnitude of Voltage.

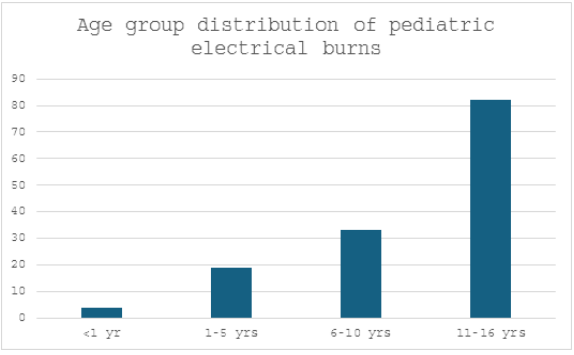

Figure 1: Distribution of age group in paediatric electric burns

TABLE 1: Table of comparison of data according to magnitude of Voltage (High voltage vs Low voltage):

Mechanism of Injury	Mean age (Years)	Gender Male Female	Mean Length of Hospital stay (Days)	Mean TBSA (%)	No. Of Deaths	Associated injuries
High voltage injuries (n=115)	11.86	84(73%) 31(26.9%)	16.36	25.18	20	*Head injury -9 *Long bone fractures -4 *ECG abnormalities- 19
Low voltage injuries (n=23)	3.86	13 (56.5%) 10(43.4%)	3.17	2.52	0	*Long bone fracture- 1 *ECG abnormalities- 5
p- value	<0.01	0.14	<0.0001	<0.0001		

High-voltage Electric injuries were more common in boys than in girls (84(73%) vs 31(26.9%)). In the low-voltage group, 13 of 23 patients (56.5%) were boys and 10 (43.4%) were girls. Boys were commonly involved in both groups but however, p- value is not statistically significant (0.14). Patients mainly belonged to urban areas (n=93; 67%) than rural areas (n=45; 32.6%).

No. Of paediatric burn accidents were relatively higher during the months of April to July. (n=68) figure 2 depicts month wise distribution of patients. The time interval between injury and presentation ranged from 1 to 10 hours with a mean of 4.54 hours.

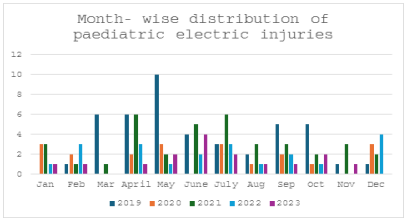

Figure 2: Month- wise distribution of paediatric electric injuries from 2019 to 2023

The length of hospital stay ranged from 1 to 67 days. Mean hospital stay was significantly longer in patients with high voltage injuries (16.36 days) than in those with low voltage injuries (3.17 days) (p<0.0001). Figure 3 describes mechanism of Injuries.

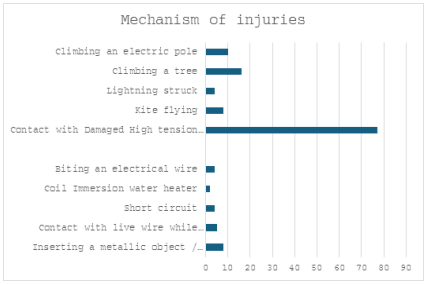

Figure 3: Mechanism of Injuries in High and low voltage group:

Extent of injury (TBSA) was determined by using Lund and Browder charts. Table 2 shows distribution of no. of patients and the length of hospital stay against Total Burnt surface area (TBSA).

TABLE 2: Table showing distribution of no. of patients and the length of hospital stay against Total Burnt surface area (TBSA):

TBSA (%)	No.of patients	Mean length of hospital stay (days)
<10%	57	5.8
10-19%	26	20.6
20-49%	37	27.8
>50%	18	3.2

Upper extremity was most frequently involved followed by lower extremity, trunk, face and scalp. Involvement of multiple regions was seen mainly in High voltage injuries.

14 patients (10.14%) had concomitant injuries. 9 patients had closed head injury who had sustained fall from height: 4 underwent surgical evacuation and 1 underwent decompressive craniectomy. Rest was managed conservatively. 5 patients had associated long bone fractures and were managed by Orthopaedicians. 24 patients presented with ECG changes ranging from sinus tachycardia, ectopic beats and 2 patients had bundle branch blocks.

74 patients (53.6%) underwent fasciotomies –52 in the upper extremities, 11 in the lower extremities and 11 in both. All patients who required fasciotomy had suffered high voltage burns. Flap cover was required in 52 patients (37.6%). 24 patients needed more than one flap cover. A total of 44 patients (31.8%) underwent major amputations. A summary of all surgical procedures performed is shown in Table 3 and figure 4 shows graphical representation of the same. 20 patients (17.39%) succumbed to their burn injuries who sustained high voltage induced burns involving >50% TBSA.

TABLE 3: Table showing Surgical procedures performed

Fasciotomy	74
Split skin grafting	76

Local flap procedures	
Transposition flap	12
Rotation flap	5
Cross finger flap	9
Temporalis fascia flap	2
Pedicled lattismus dorsi	2
Pedicled Trapezius flap	1
Distant flap procedures	
Groin flap	12
Abdominal flap	7
Free flap cover	
Anterolateral thigh flap	2
Amputations	
Fingers	32
Toes	21
Below elbow	22
Above elbow	23
Below knee	9
Above knee	10

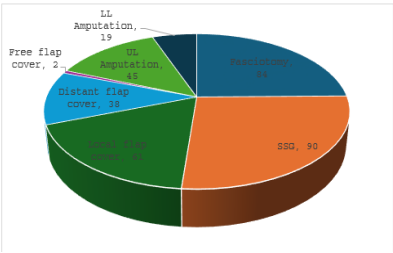

Figure 4: Various procedures performed in electric Burn reconstruction:

DISCUSSION

Electrical burns in the paediatric age group constitute from 2% to as high as 10% of all burn admissions in India.[1] Thickness and moisture content of the skin determines electrical current resistance at the point of contact.[2] Children with thin skin and a high water and fat content will likely sustain serious injuries from the same exposure as an adult. Even a seemingly benign skin burn can have serious impacts, and the depth of the damage is not usually immediately apparent.

Tissue resistance from lowest to highest is nerve, blood vessels, muscle, skin, tendon, fat, and bone. The pathway of the current through the body (Vertical or horizontal) determines the number of organs that are affected and severity of the injury.[3]

Injuries due to alternating current causes tetanic muscle contractions and commonly keeps the victim grasped to the electrical source due to strong forearm flexors compared to extensors (no-let-go phenomenon) leading to associated injuries.[2] 14 of our patients had such injuries; 9 had head injury and 5 had long bone fractures.

Depamphilis et al[4] reported the high- voltage paediatric electric injury rate as 19% in children in the United States, while Srivastava et al[5] reported that 80% of paediatric electric injuries in India occurred with high-voltage. Demir et al[6] reported that 50.6% of the cases occurred with high-voltage electricity. In our study, 83.3% cases were due to High voltage accidents.

Many studies show that high-voltage Electric injuries are more common in children older than 12 years of age and Boys are frequently affected [7,14,16] as they are inclined to more outdoor activities. Our study showed the average age of the high-voltage group is 11.86 yrs and low voltage group is 3.86 yrs with significant p value (<0.01). In our study, 70.2% cases were boys and the male: female ratio was found to be 2.3

While many studies showed peak occurrence of burn injuries during summer and thermal injuries in winter 7 our study showed peak of cases during the months from April to July. This could be attributed to summer holidays with children indulging in playful outdoor activities.

In recent years, electricity transfer lines have been brought underground in Tier 1 large cities, but in other areas, transmission lines are still overhead passing through houses and close to balconies and roads. Adolescents get injured mostly when they climb on trees and electricity poles and transformers, touching the overhead wires of electric transmission lines with metal rods. Such injuries are almost often associated with fall from heights and contribute to additional trauma.[9,15] In our study, a total of 23 victims were injured as a result of climbing electricity poles and trees. A total of 66.9% cases were due to contact with damaged high-tension wires lying in fields/rooftops while walking/ playing.

Kite flying being a popular recreational activity among adolescents in India is known to cause High tension injuries when the wet kite strings come in contact with the high-tension wires in their residential vicinity.[10] In our study such injuries were seen in 8 patients (6.95%).

Garcia et al [11] reported that all low voltage induced electric burns (n = 61) involved less than 1% of the body surface area. Gokdemir et al[8] showed burns involved less than 1% of the body surface in 52% of patients. In our study only 10% (n=14) had burns less than 1%.

Electric shock induced cardiac damage is caused by thermal injury and ischemic injury to the myocardium leading arrhythmias, Bundle branch blocks and myocardial infarction.[12] 24 of our patients presented with ECG changes ranging from sinus tachycardia, ectopic beats and 2 patients had bundle branch blocks.

The heat generated by high voltage electric current cause damage to bones and muscle results in compartment syndrome in the extremities. Timely intervention by early escharotomy/ fasciotomy for decompression is the need of hour. However, amputations are inevitable in many due to the severity of injury to present with.[13] In our study, 64 patients (46.3%) underwent major amputations.

Few known causes of Electrical accidents are Poor design of the electrical installations, lack of maintenance, improper earthing to electrical equipment's, Insulation failure, Improper stringing of the overhead lines without adequate clearance between phases and between phase and earth, No provision for anti- climbing devices on towers/ poles, improper location and fencing of the transformers and careless attitude of the public.

According to Indian Electricity act 2003, all apparatus, cables and supply lines are to be maintained in healthy conditions by periodic inspection and tests as per the relevant standards by the designated Electrical Inspector. Fixing danger/ caution boards on conspicuous positions, good insulation and colour coding of wires, good housekeeping, adequate ground clearance of overhead high-tension lines and regular maintenance with periodic inspectory visits are mandatory. Every child must be educated at a tender age about the basic precautions before handling any electrical equipment. Parents and caretakers also need to be educated well regarding the same and encouraged to keep vigilant around children. While the recommendations for low voltage burn admissions have progressively changed from a need for admission to a more individualised strategy, Immediate first aid and medical attention to be sought for even trivial accidents. Targeted community based electric burn prevention programmes and campaigns educating about safety and hazard-prevention, Prompt referral and

transportation are crucial.

LIMITATIONS

Being a retrospective study and data being retrieved from a single tertiary referral centre, the complete data regarding the incidence of paediatric electric burns could not be extrapolated. The mortality rate where certain victims are deceased at the site of injury or during transportation were not taken into account. In addition, we could not assess the long-term morbidity, rehabilitatory measures, learning disabilities and the psycho-social impact of the accident on the affected children. A well-designed multicenter study with long-term follow up can improve the limitations of the current study.

CONCLUSION

Electrical accidents are preventable altogether, if necessary, precautions are taken at the personal level and if we bind by the rules. Need of the hour precautionary measures by the Government are establishing underground electric transmission lines and regular maintenance inspections by the officers. Good house holding by eliminating bare uninsulated wire and faulty appliances, using safety cover sockets, adequate earthing, educating children and keeping dangerous electrical equipments out of reach from children are few measures to avoid domestic electric accidents.

Nevertheless, Public awareness campaigns regarding Basic First aid measures to be followed in case an electric shock does happen are mandatory. Swift referral and transportation from primary health care centres to tertiary hospitals with dedicated Burns unit is obligatory. The treating Surgeon is expected to follow the basic tenets of burn reconstruction with an individualised strategy: the reconstructive elevator approach. Regular follow ups with multi disciplinary team involving physiotherapist, psychiatrist and occupational therapists cannot be stressed enough.

ACKNOWLEDGEMENTS: Nil

DECLARATION OF CONFLICTING INTERESTS: The authors declare that there is no conflict of interests regarding the publication of this case report.

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