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Original Research Article

CLINICO-ETIOLOGICAL PROFILE AND OUTCOME OF ELECTRICAL BURN INJURY AT TERTIARY HEALTH CARE CENTRE

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ABSTRACT

Electrical burns are one of most devastating burn injury a patient has to bare. They are usually associated with less mortality rates as compared to those with thermal burns or other burn injuries, but they are associated with a higher incidence of morbidity. The proposed study entitled "Clinico-etiological profile and outcome of electrical burn injury at Tertiary Health Care Centre" was carried out on patients admitted in Burn Unit of Surgical wards of VSS Medical College and Hospital, Burla, Odisha during of May 2023 to April 2025. Forty-four patients (44.0%) were in the age group of >50 years and in 31 to 40 twenty-eight (28.0%), followed by 18 to 30 age group (16%) and 41 to 50 (12%). 64 patients (64%) were male and 36 (%) were female. 32 patients (32.0%) had electrical injury while working with irrigation pump motors and 22 (22.0%) by contact with domestic current in the kitchen, 14 (14.0%) due to contact with live wire, eight (8.0%) sustained electrical burns. Two patients (2.0%) of acute renal failure settled with dialysis, twenty-four patients developed septicemia and responded well to appropriate antibiotic therapy. Prevention is paramount. At the policy level, enforcement of occupational safety standards must be strengthened. Medical community must develop streamlined protocols for the management of electrical burn injuries, including early identification of systemic complications and coordinated post-operative care.

INTRODUCTION

Electrical burn is a unique form of trauma, in which mortality andn morbidity are very high when compared to thermal burns. The effects of electrical current depend on the type of current, voltage, tissue resistance, the pathway and the duration.[1]
Injuries caused by exposure to 1000 volts or greater are considered high tension electrical burns. High tension electrical current may cause 'flash' burns, 'True' electrical burns or secondary thermal burns.[2]
High-tension electrical burns results in cutaneous injuries, severe damage to underlying muscles, nerves, blood vessels and bones. Every organ system can be injured by the passage of current. Respiratory arrest, cardiac arrest, ventricular fibrillation, renal failure, gangrene of the extremities is some of the early life threatening complications.[3]
Burn injuries are a big health problem worldwide. Globally approximately 2,65,000 deaths occur annually due to burn injuries. Most of the burn injuries occur in people living in low and middle socioeconomic countries. Nearly fifty percent (50%) of these occur in the WHO SEAR (South East Asia Region) countries.[3] Burn injuries can occur due to different etiologies namely; thermal or flame burn injury, electric burn injury, scald burns, chemical burns or mixed injuries.[4,5]
Electrical burns are one of most devastating burn injury a patient has to bare. They are usually associated with less mortality rates as compared to those with thermal burns or other burn injuries, but they are associated with a higher incidence of the associated short – term and long – term morbidity, prolonged hospital stay, disability and disfigurement. Electrical burns are one of the leading causes of DALYs (Disability Adjusted Life Years) lost in low and middle income countries like India. Upper limb involvement is present in majority of the electrical burn injuries. Upper limbs may have entry point, exit point or both. Injury may range from simple flash burns or low voltage contact burns to devastating gangrene of the limbs.[6,7,8]

Electrical burns involving body part skin were treated by cleaning the wound. In high tension electrical burns involving body part specially upper limbs, where tissue destruction is massive with ischemic gangrene, amputation is performed to reduce the myoglobin and other toxic metabolite load and to reduce infective complications and the risk of secondary hemorrhage. All the efforts are taken to salvage the skin (limb) with adequate debridement and early flap cover using various distant flaps. Local flaps are avoided because of the unreliable vascularity due to extent of the electrical injury to the adjacent areas.[9,10,11]

Early split thickness skin grafts for remaining raw areas occurring due to flash burns are also gaining importance since repeated excision and early cover to prevent deepening of the wound following infection. Even third degree burns are excised starting from third post burn day and early split thickness skin graft is done to reduce the morbidity. In case of lightning, the commonest cause of death is respiratory arrest. So, if only artificial respiration is started immediately, patient can be revived. Since this should be done at the site of accident, which is more often remote, the mortality rate remains high.[12,13]

Aims and Objectives

The proposed study entitled "Clinico-etiological profile and outcome of electrical burn injury at tertiary health care centre" was carried out on patients admitted in Burn Unit of Surgical wards of VSS Medical College, Burla, Odisha, during of May 2023 to April 2025 with following aims and objectives: -

1. To evaluate various clinic-etiological profile and outcome of electric burn patients.
2. To detect early and late complication and their management.
3. To correlate post burn complication with percentage of electric burn.
4. To evaluate outcome according to their management.

MATERIALS AND METHODS

The proposed study entitled "Clinico-etiological profile and outcome of electrical burn injury at Tertiary Health Care Centre" was carried out on patients admitted in Burn Unit of Surgical wards of VSS Medical College and Hospital, Burla, Odisha during of May 2023 to April 2025. The objective was to analyse the demographic characteristics and outcomes and patterns of electrical injuries.

Inclusion Criteria

- All patients (total 100 patients) admitted under the Department of Surgery, with a diagnosis of electrical burn injury from May 2023 to April 2025 were included in this study.
- age >18years and both sexes were included in this study.

Exclusion Criteria

- Severely ill / Terminally ill patient
- LAMA patients

Data Collection: The data recorded included age of the patient, gender, residence, place of injury, occupation of the patient, day of injury, month of injury, year of injury, time of reporting to hospital after injury, delay in reporting to out institute, voltage of the current (high or low), type of electrical injury (contact burns/ flash burns/ arc burns/ mixed burns), percentage of total body surface area involved, fall from height, history of head injury, unconsciousness, history of pre-existing comorbid conditions, ocular involvement, spine injury, intra-abdominal or intra-thoracic injury, upper limb fractures, lower limb fractures, cardiac abnormalities, serum CPK and creatinine levels (increased or normal) on the day of admission, within

normal range/ increased, urine myoglobin, treatment done, time interval between day of admission and first surgery, number of surgeries performed, total units of plasma transfused, total units of blood transfusions, whether patient required ICU admission, final outcome at discharge survived/ expired, total duration of hospital (in days).

Study Methods: Electrical burn injury is assessed at the time of admission. Extent of injury is marked in the case sheet. Photographs were taken for record purpose. Over the days, progression of the injury is observed and recorded. Fluid requirement is much greater than thermal burns. Ringer lactate is administered 2ml/kg body weight/% of electrical burns initially adjusted to maintain 1 – 1.5 ml/kg/hr urine output. Blood transfusions were given in cases of anemia due to red cell destruction. Intravenous administration of sodabicarbonate and large volumes of intra venous fluids are useful in methemoglobinuria cases. Keeping extremities level with the body increases tissue perfusion by decreasing limb mean arterial pressure without changing intracompartmental pressure. Tight compressive dressing is avoided.

Fasciotomy was done in circumferential deep burns to prevent increase in intra-compartmental pressure. Decompression was done in all muscle compartments. Nectrotic tissues were removed. Volar incision medical to biceps tendon down to carpal tunnel and dorsal incision from lateral epicondyle to midline of wrist is made to decompress flexor and extensor muscles respectively. In the hand, two longitudinal incisions were placed over the second and the fourth metacarpal bone, to release the dorsal and volar interosseous muscle compartments. Thenar and hypothenar muscle compartments were released by incisions over the radial and ulnar surface of the first and fifth metacarpals. Immediate decompression of tight muscle compartments with simultaneous radical debridement is done including immediate amputation of extremities that are clearly charred and non-salvageable. Deep muscle compartments adjacent to the bone are also released. Muscle with doubtful viability is left for reevaluation at 48 – 72 hrs intervals. After initial debridement, extension of tissue necrosis or gangrene is also recorded.

Wound debridement is done with skin cover either by split skin graft or flap. Nerves and tendons are preserved even if they appear devitalised. Repeated debridements are performed to excise all devitalised tissues. Definitive skin cover is given once the wound bed is healthy. Skin cover is achieved by means of split thickness skin graft if the wound bed is healthy or granulating without exposing vital structures. Exposed vessels, nerves, tendons and bone is covered with distant flaps. Groin flap, abdominal flaps either superiorly based or inferiorly based are commonly used distant flaps. Reverse radial forearm flaps and posterior interosseous artery flaps were also used in selected cases. Amputation of the gangrenous part is done in established cases, to reduce myoglobin load, to prevent infective complications and to reduce the risk of secondary hemorrhages.

Statistical methods used

1. Frequencies and percentages were used to describe for demographic data.
2. Categorical values were compared using Chi-Square test.
3. For continuous variables, mean with standard deviation and compared using independent sample t-test, if normal and Mann Whitney U test if not normal.

RESULTS

Table 1: Distribution of patients according to age

Sl No.	Age group in years	No. of patients	Percentage (%)
1	18-30	16	16
2	31-40	28	28
3	41-50	12	12
4	>50	44	44
T0TAL		100	100

The above [Table] shows that the forty-four patients (44.0%) were in the age group of >50 years and in 31 to 40 twenty-eight (28.0%), followed by 18 to 30 age group (16%) and 41 to 50 (12%). Majority of the participants were labour (40.0%) and hence are unemployed followed by Farmer (28.0%), driver (16.0%), student (8.0%) and teacher (4.0%), private job (4.0%).

Table 2: Distribution of patients according to Sex

Sl No.	Age group in years	No. of patients	Percentage (%)
1	Male	64	64
2	Female	36	36
	TOTAL	100	100

The above [Table] shows that 64 patients (64%) were male and 36 (%) were female. The educational background of the participants with persons who have not received any form of formal education recording 44.0% while Pre-school and primary both (16.0%) and Tertiary recorded, 4.0%.

Table 3: Distribution of various causes of electrical burn injuries

Sl No.	Various causes	No. of patients	Percentage (%)
1	Domestic current electric injuries (cooking, mixer grinder)	22	22
2	Contact with live wires	14	14
3	Climbing electrical poles for repair	08	08
4	Irrigation motor pump electric injuries	32	32
5	Earthing injuries during rains/lightening	12	12
6	Housing/lighting current	12	12
Total		100	100

The above [Table] shows that the various types of electrical burns were accidental in nature with extremity injuries. 32 patients (32.0%) had electrical injury while working with irrigation pump motors and 22 (22.0%) by contact with domestic current in the kitchen, 14 (14.0%) due to contact with live wire, eight (8.0%) sustained electrical burns, while working on electric pole, had a fall from height with multiple rib fractures and hemopneumothorax for which intercostal drainage was inserted and monitored for respiratory failure in the ICU, twelve each (12.0%) were due to earthing/rain and contact with housing current.

Table 4: Various surgical procedures performed

Sl No.	Various surgical procedures	No. of Patients
1	Fasciotomy	10
2	Debridement/Escharotomy and revision surgery	40
3	Superficial skin grafting	10
4	Fore foot amputation	02
5	Intercostal drainage	02
6	Flap rotation	01

7	Amputation/ Disarticulations	10

The above [Table] shows that the Skin grafting was done in 10 patients and ten underwent fasciotomy and all 40 patients settled well with local debridement and ten with disarticulations, two required fore foot amputations and one fore head flap rotation due to head injury with loss of scalp and two required intercostal drainage for rib fractures with pnueumothorax.

Table 5: Complications seen in electric burn patients

Sl No.	Complications	No. of patients	Percentage (%)
1	Acute renal failure	02	02
2	Septicemia	24	24
3	Respiratory failure	04	04
4	Severe anaemia	22	22
5	Atrial fibrillation	16	16
6	Wound infection	12	12
Total		100	100

The above [Table] shows that the two patients (2.0%) of acute renal failure settled with dialysis, twenty-four patients developed septicemia and responded well to appropriate antibiotic therapy. Four patients (4.0%) had respiratory failure and were managed with ventilator care, sixteen patients (16.0%) developed atrial fibrillation and were treated by physicians in the intensive care unit with metaprolol and reverted to normalcy. Twelve (12.0%) had wound infection and did well with conservative management.

Table 6: Amputations performed in electric burn patients

Sl No.	Type of Amputation	No. of patients
1	Fore foot amputation	03
2	Left below knee	0
3	Left above knee	0
4	Right below knee	0
5	Right above knee	0
6	Left below elbow	0
7	Left above elbow	0
8	Right below elbow	0
9	Right above elbow	0
10	Finger amputation/ Disarticulation	16
11	Toe amputation/ Disarticulation	10

DISCUSSION

Electrical burn injuries remain a significant public health concern, particularly in low-resource settings where occupational hazards are prevalent, and safety measures are inadequate. The present data reveals that the demographic most affected includes individuals above 50 years of age, a group that often remains in physically demanding roles well into later life, particularly in rural or informal sectors. These individuals may have limited access to safety training and resources, and their delayed response to electrical hazards may stem from physical limitations or lack of protective infrastructure.[14,15]

In this cohort, male patients constituted 64%, which may be attributed to gender roles within manual labor, farming, and electrical maintenance professions—fields where electrical exposure is common. This gender disparity is in line with findings from similar regional and international studies. Men in rural communities often assume more hazardous roles, leading to higher exposure rates and greater injury incidence.[16,17,18]

Education emerges as a significant protective factor. A substantial proportion of the study population was illiterate or had only attended preschool or primary school. Low education levels not only reduce the ability to understand and implement safety guidelines but also limit awareness of emergency protocols following electrical injury. Illiteracy restricts access to critical information about risks, first aid, and the importance of early medical intervention. It also contributes to the underutilization of safety tools and procedures, perpetuating cycles of vulnerability.[19,20,21]

Occupation data correlates strongly with injury causes. Laborers and farmers—representing 68% of the cohort—are more likely to interact with high-voltage equipment, especially in outdoor settings where safety protocols may not be enforced. Irrigation motor-related injuries, comprising 32% of the cases, highlight the dangers of handling electrically powered agricultural machinery without proper safety gear or knowledge.[22]

Contact with domestic currents and live wires further illustrates the diversity of exposure environments, from household to occupational settings. The clinical picture in these patients was severe. A considerable proportion (40%) required debridement or escharotomy, a finding indicative of deep, necrotic tissue damage. The presence of fasciotomy, amputations, and skin grafting underscores the degree of injury often sustained in electrical burns.

Many of these interventions are resourceintensive, requiring surgical expertise, wound care, and prolonged rehabilitation.[23]

Complications were common and ranged from localized infections to systemic conditions. Septicemia, seen in 24% of patients, represents a serious concern that reflects either delayed hospital presentation or suboptimal wound management in the pre-hospital phase. Anemia (22%) may be attributed to chronic blood loss from wound exudation and repeated surgical interventions. Atrial fibrillation (16%) and respiratory failure (4%) signify the multi-system involvement typical of high-voltage injuries, necessitating intensive monitoring and often multidisciplinary management.

Cardiac complications, in particular, deserve attention. Electrical currents passing through the thorax can induce arrhythmias or myocardial damage, even in the absence of visible skin burns. The presence of atrial fibrillation in 16% of patients in this study supports the need for routine ECG monitoring and potentially extended cardiac observation in the initial days following exposure. Amputations, particularly of the fingers and toes, were a frequent outcome. These injuries reflect the direct path of electrical current through the extremities, where entry and exit points typically lie. Timely debridement and early decision-making regarding amputation are critical for minimizing systemic complications, including infection and sepsis.[24]

From a psychosocial standpoint, the loss of digits or limbs significantly impacts the patient's quality of life, productivity, and mental health. Many affected individuals are breadwinners engaged in physically intensive occupations. Rehabilitation and prosthetic support systems must be prioritized to aid reintegration into work and society.[25]

Preventive strategies must be multifaceted. Education campaigns should be targeted at high-risk populations, especially farmers and manual laborers. These programs must be culturally sensitive and accessible, potentially incorporating visual aids, local languages, and community influencers to disseminate safety messages. The distribution of low-cost protective gear, such as insulated gloves and boots, could mitigate risk, especially during seasonal activities like monsoon irrigation, when electrocution risk increases. Legislation and policy enforcement are also crucial. Electrical safety codes in construction, agriculture, and domestic settings should be revised and rigorously implemented. Employers must be held accountable for the provision of a safe working environment. Meanwhile, healthcare systems must prepare for prompt triage and treatment of electrical injuries, with regional burn centers playing a pivotal role.[26]

Finally, community-level interventions can be transformative. Empowering local governance bodies to oversee electrical maintenance, monitor infrastructure, and respond to emergencies could significantly reduce incident rates. Public awareness days, school programs, and collaboration with NGOs and media can amplify outreach and education efforts.

CONCLUSION

This study paints a stark picture of the dangers posed by electrical burns in predominantly rural, under-resourced populations. The findings consistently highlight the disproportionate burden borne by older male individuals with low education levels engaged in high-risk occupations. The etiology of injuries, the severity of clinical presentations, and the spectrum of complications observed all point to a preventable, yet persistent public health issue.

Given the extent of surgical interventions required, from debridement to amputation, it is evident that electrical burns are not only a matter of immediate trauma but also long-term morbidity and economic loss. These injuries compromise productivity, contribute to disability, and require costly, prolonged care. In regions where healthcare infrastructure is already stretched, these cases present a compounding challenge.

Prevention is paramount. At the policy level, enforcement of occupational safety standards must be strengthened. Farmers and laborers should have access to equipment designed with safety in mind, and infrastructure must be updated to minimize accidental exposure. Training and education, especially among low-literacy populations, must form the backbone of community risk-reduction efforts.

Simultaneously, the medical community must develop streamlined protocols for the management of electrical burn injuries, including early identification of systemic complications and coordinated post-operative care. Integration of psychosocial support and vocational rehabilitation into recovery programs will also be vital in helping victims regain functionality and confidence. In conclusion, addressing electrical burn injuries requires a collaborative, cross-sectoral approach. By integrating preventive, clinical, educational, and policy-based strategies, it is possible to reduce incidence, improve outcomes, and restore quality of life for affected individuals.

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