

# Electrical Burn and Amputations in a Burn Center in Addis Ababa, Ethiopia

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**Background:** Burn injuries are a global public health problem and continue to be one of the leading causes of unintentional death and injury. Electrical injuries, a relatively rare cause of burns, are increasingly being reported with higher rates of mortality in low and middle-income countries due to rapid industrialization in the absence of safety regulations. Electrical burn injuries can result in death, various organ system dysfunctions, or limb amputations.

**Methods:** A 5-year retrospective, cross-sectional study was conducted to assess the rate of amputation and associated risk factors in electrical burn injuries among burn patients at AaBET Hospital in Addis Ababa, Ethiopia.

**Results:** The rate of amputation among the 150 patients admitted with electrical burn in the study period was 33.3% (n = 50). A majority (62%; n = 31) of the patients were men (M:F 1.6:1) in the age range of 18–65 years. A fallen electrical wire coming in contact with the patients was the cause of the electrical burns in 50% of the cases. 65.3% of the patients had upper limb amputations, whereas 34.7% had lower limb amputations. Major amputations were more likely to occur when the entry site was the hand, whereas minor amputations were more likely to occur when the entry site was the scalp ( $P = 0.005$ ).

**Conclusions:** Younger male patients were identified as the main victims of electrical burns that resulted in amputations. Electrical burns showed substantial morbidity and mortality of patients. Total body surface area and entry site being the hand significantly affected the level and site of amputation. (*Plast Reconstr Surg Glob Open* 2024; 12:e5566; doi: [10.1097/GOX.0000000000005566](https://doi.org/10.1097/GOX.0000000000005566); Published online 2 February 2024.)

## INTRODUCTION

Burn injuries are a global public health problem and continue to be one of the leading causes of unintentional death and injury around the world. Annually, an estimated 6 million people seek medical treatment for burns, although the majority of them do not require admission or advanced care. The World Health Organization reports close to 180,000 deaths resulting from burns annually, and the majority of these occur in low- and middle-income countries (LMICs) such as Ethiopia.<sup>1</sup> Although there have been advances in burn care and reports of

decreased incidence as well as admissions due to burn in the developed world,<sup>2–4</sup> the situation in the LMICs is significantly different because of the scarcity of resources to care for patients with burns, the low socioeconomic status of the majority of the population, the high population density, and illiteracy, which are predisposing factors to sustaining burns.<sup>5,6</sup> Burns that do not result in death will cause significant morbidity, a longer length of stay in hospitals, and disabilities, with loss of almost 18 million disability-adjusted life years with approximately 94% of those in LMICs.<sup>1,7</sup>

Burns can occur as a result of thermal [scald (hot liquid/gas), contact (hot solid), flame], electrical, chemical, or radiation causes.<sup>1,4,6,8</sup> Electrical injuries are a relatively rare cause of burns accounting for nearly 4%–6% of cases in the developed nations, while figures as high as 27% have been reported in developing nations.<sup>9–12</sup> The incidence as well as mortality in electrical burns continues to increase

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with the rapid industrialization especially in LMICs.<sup>3,13–16</sup> There is also significantly increased morbidity and mortality in all age groups with electrical burns compared with other types of burns, with additional to long-lasting socioeconomic effects.<sup>17</sup>

Electrical burns are known to cause significant morbidity and mortality among those sustaining burns due to either direct contact with current, flash, or arc burns. The severity of tissue damage and organ dysfunction in electrical burns depends on the voltage passing through the body which can either be a low voltage (<1000 v) or high voltage (>1000 V) and the conversion of the electrical energy to thermal energy (heat).<sup>13,17–19</sup> Electrical burn injuries can result in the death of the patient in the acute phase due to cardiac arrest, organ failure, or shock,<sup>19</sup> whereas those who survive the initial physiologic disruption may end up with severe complications in the various organ systems as well as major limb amputations.<sup>12,16,17,20</sup>

Amputations are one of the devastating yet necessary procedures done in burns to reduce morbidity and increase the survival of patients.<sup>21,22</sup> Although the amputation rates are generally lower in burns with an estimated incidence of around 2%–4%, the majority of the amputations occur as a result of electrical burns, which account for about 20%–40% of the amputations.<sup>4,13,15,17,18,20,21,23</sup> Amputations require longer durations of admission and rehabilitation, which may result in deleterious effects on the psychological well-being of the burn patients who end up with a loss of limb or part of it.<sup>15,18,22</sup> The type of amputations done can be either minor or major depending on the level of amputation. Major amputations are proximal amputations passing through the forearm bones, humerus, tibia, or femur, whereas minor amputations are those done distal to the wrist and ankle joints.<sup>11,21</sup>

Electrical burns, as well as amputations, mainly affect male individuals in the younger age groups, which will have a significant socioeconomic impact.<sup>4,15,20,22,24</sup> with the burden of a disabled family member in the most productive age group of any given society.<sup>16,24</sup>

## Methods

### Study Setting

The study was conducted at Addis Ababa Burn, Emergency and Trauma center (AaBET), an affiliate institution of Saint Paul Hospital Millennium Medical College in the capital city of Ethiopia, Addis Ababa. The hospital is one of the largest government trauma centers with a burn unit in the country, accepting referrals from different parts of the country. It is one of three governmental hospitals with a burn unit for a country with a population of more than 120 million. The burn unit has a dedicated 19 beds and a single operation theater. The study was conducted after receiving ethical clearance from the institutional review board of the research directorate of Saint Paul Hospital Millennium Medical College.

### Study Design

A single-facility-based, retrospective study was conducted by reviewing 401 burn patient charts over a 5-year

## Takeaways

**Question:** What is the rate of amputation in electrical burns, and what factors affect the site and level of amputation?

**Findings:** A 5-year retrospective review of burn cases showed that one-third (33.3%, n = 50) of the 150 electrical burn patients ended up with some level of amputation. Level and site of amputation varied with entry sites.

**Meaning:** Electrical burns resulted in substantial morbidity and mortality. Total body surface area and entry site being the hand significantly affected the level and site of amputation.

period from September 1, 2016, to August 31, 2021 to assess the clinical profile and outcome of electrical burn injuries among burn patients at AaBET Hospital. All patients who sustained electrical burns and ended up with amputation over the study period were included in the study.

### Data Collection and Procedures

Data were collected from patients' medical records using a structured questionnaire. The questionnaire collected sociodemographic data, length of hospital stay, total body surface area (TBSA), anatomic location and depth of burn, level of amputation, number of amputations, and number of procedures from the medical records.

### Operational Definitions

#### Major Limb Amputations

Amputations done proximal to the wrist or ankle joints including those passing through the forearm, arm, leg or thigh.

#### Minor Limb Amputations

Amputations done through or distal to the wrist and ankle joints.

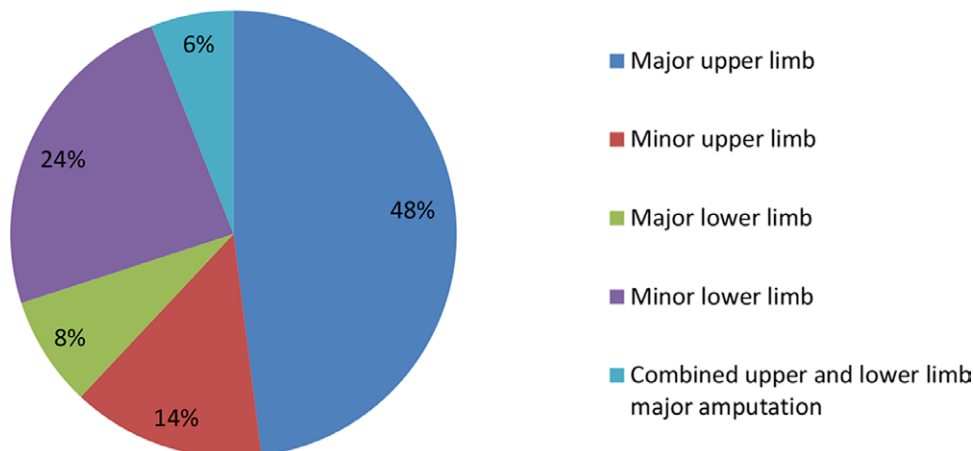
### Data Analysis

Data were analyzed using SPSS for Windows, version 28.0. Descriptive statistics were computed to evaluate characteristics of those who presented with an electrical burn (ie, mean, SD, and frequencies). Independent samples *t* tests (for continuous predictors) and chi-square analyses (for categorical predictors) were used to evaluate risk factors for amputation (major versus minor amputation and upper limb versus lower limb amputation). Results with a *P* value less than 0.05 were considered statistically significant.

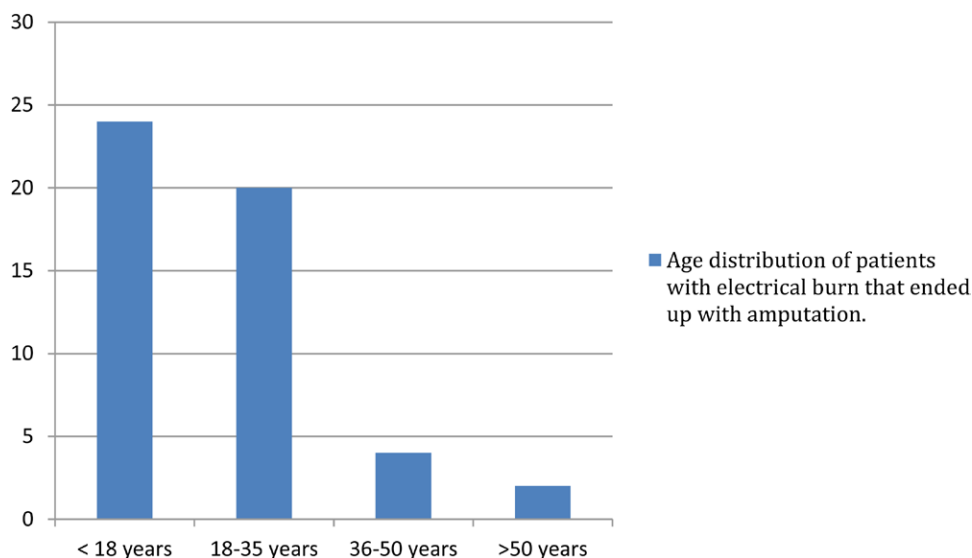
## RESULTS

A total of 401 patients' medical records were reviewed, which revealed that 37.4% (150 patients) were admitted with a diagnosis of electrical burns over the 5-year study period. (See figure, Supplemental Digital Content 1, which shows a flow chart showing the total number of burns, electrical burns, and amputations over a 5-year

## Amputation levels



**Fig. 1.** The levels of amputation of the electrical burn patients who ended up with an amputation.



**Fig. 2.** Age distribution of patients with electrical burn who ended up with amputation.

period in a burn unit in Addis Ababa, Ethiopia. <http://links.lww.com/PRSGO/D43>.) One-third (33.3%) (n = 50) of the patients with electrical burns ended up with different levels of amputation (Fig. 1). From the 50 patients with an amputation due to electrical burns, a majority were in the younger age group [88% (n = 44), with 48% (n = 24) in the age range of 19–35 years and 40% (n = 20) under the age of 18 years]. The mean age of study participants was 23 years (Fig. 2). Male participants were the primarily affected population (62%) with electrical burns, which ended up with amputations. A fallen electrical wire coming in contact with the patients was the cause of the electrical burns in 50% of the cases, while the remaining half of the patients sustained the injuries in their household and workplaces. Only 35% of

patients arrived to the hospital within 24 hours of injury, and an even lower percentage of patients (30%) had fasciotomy done. The hand was identified as the commonest entry site, whereas the feet were the commonest exit site. Upper limb amputations were done for 65.3% of the patients, whereas 34.7% had lower limb amputations. As indicators of morbidity among electrical burn patients that ended up with amputations, 89% of patients stayed in the hospital for more than 30 days and had an average of three procedures during their stay (SD = 1.2). The mortality in these series of patients was 8%. In the identification of significant risk factors for level of amputation, TBSA was larger for major amputations (M = 25.04, SD = 14.18) than for minor amputations (M = 11.82, SD = 8.42),  $t(45) = 3.64$ , ( $P < 0.001$ ). Major amputations were

more likely to occur when the entry site was through the hand, whereas minor amputations were more likely to occur when the entry site was through the scalp [ $\chi^2$  (4, N = 41) = 15.04,  $P$  = 0.005]. Upper limb amputations were more likely to occur when the entry site was through the hand, whereas lower limb amputations were more likely to occur when the entry site was through the scalp [ $\chi^2$  (4, N = 41) = 15.77,  $P$  = 0.005].

## DISCUSSION

Electrical burns accounted for a little more than one-third (37.5%) of all burn patients admitted to our burn unit over the 5-year study period, this figure is very high compared with institution-based data from Turkey, Portugal, and China,<sup>11,12,15</sup> which can be explained by the fact that our center is one of three burn units for the whole country with a population of more than 120 million, making it a referral center for the most severe forms of burns. Younger patients under the age 35 years were mainly affected with electrical burns and ended up with some level of amputation, which was also demonstrated in other countries such as Turkey, China, the USA, and Albania.<sup>13,14,17,20</sup> These devastating and debilitating injuries destine these young patients to long years of life with disability in a country with limited availability of prosthesis and rehabilitation. A fallen electrical wire coming in contact with the patients was the cause of the electrical burns in 50% of the cases, which is indicative of the need for community level preventive health education and awareness campaigns to prevent these severe injuries in addition to better safety protocols being developed for the high tension wires being installed throughout the country. The rate of amputation in our series was 33.3%. Most of the patients who ended up with an amputation also had a significant level of morbidity with longer in-hospital stay and repeated procedures, while 8% died during their period of treatment, reflecting the severity of injury. This figure is higher than the worldwide mortality rate of 4.1%,<sup>12</sup> which can be explained by the lack of prehospital care, burn intensive care unit, and advanced early excision and coverage options in the burn unit in Ethiopia. In the absence of uniformly available employer or government-based resources available for patients in Ethiopia, even those patients who survive these severe injuries incur huge treatment costs within the hospital and after being discharged with their various levels of disability. Electrical burns are unique injuries that may cause a flash (external burn) in addition to the internal burns from the current. All 50 patients that ended up with an amputation had associated flash burn with a mean TBSA of 20%. Larger TBSA burns and those in which the initial contact point was the hand were associated with major amputations above the level of the wrist. This is explained by the commonly present associated flash burns and the severity of injury requiring an amputation through the forearm or arm bones (Fig. 3). When the entry site was the scalp, the most likely scenario was someone in a standing position accidentally coming in contact with an overhead wire, where the initial contact point will be the scalp and the current will go through the



**Fig. 3.** An example of high voltage electrical burn with an initial contact point on the right hand that presented with the right hand and forearm clenched and mummified.

body and ground through the feet, which will end up with foot or toe amputations.

## CONCLUSIONS

Younger male patients were identified as victims of electrical burns that resulted in amputations. Electrical burns resulted in substantial morbidity and mortality of patients. Larger TBSA burns and entry site being the hand significantly affected the level and site of amputation in patients with electrical burns.

### Limitations of the Study

The authors recognize that categorizing amputations as minor in the presence of thumb or multiple digit involvement does not represent the severe functional disability incurred by the loss of these digits.

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**DISCLOSURE**

The authors have no financial interest to declare in relation to the content of this article.

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