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Upper Limb Amputations Following Electric Burn: Experience Sharing from Tertiary Hospitals in Bangladesh

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Abstract

Introduction: High voltage electrical burn is one of the most devastating burn injuries involving upper limbs in Bangladesh. It causes serious disfigurement and may lead to loss of the whole upper limb. The aim of this study was to see the severity of electric burn injury involving upper limbs pausing amputations at different levels in two tertiary level referral hospitals of Bangladesh.

Methods: A prospective observational study was designed to collect the data from Burn and Plastic Surgery Unit, Dhaka Medical College Hospital and Sheikh Hasina National Institute of Burn and Plastic Surgery from January 2019 to December 2019. One hundred and sixty-nine (169) patients with high voltage electrical burn injury involving upper limb underwent amputation were analyzed according to the severity based on clinical assessment.

Results: Male predominance (89%) was observed where right upper limb was involved in 49% of the cases and in 11% cases amputation was bilateral. The most alarming finding was 57.4% patients were below the age of 21 years. Below elbow amputation was done in 48.5% cases followed by above elbow amputations in 32.54% cases.

Conclusion: Male sex and younger age are the two most common association with electric burn and subsequent limb amputation. The incidence in higher in upper limbs. This study will help us to create the awareness and for prevention of electric burn.

Key words: Electric burn, Upper limb amputation

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Introduciton

High voltage electrical burn (HVEB) involving upper limb is the most disastrous burn injury experienced in Bangladesh. In a developing country like ours, electrical burn injury becomes one of the important health hazard. Unplanned and unsafe urbanization, lack of awareness among people and lack of monitoring increases the risk of burn incidence[1]. Large number of burn patients are admitted in our institute per year and about one third of them are due to electric burn. The incidence increases drastically in summer and almost in every case involves one or both upper limb and almost all cases are devastating. Even small burn to the hand can result in disfigurement and loss of function. Despite optimal management, full thickness circumferential burn and electrical injuries may require eventual amputation[2]. Even though they appear salvageable initially, in the long run condition deteriorates and ended up with amputation. Loss of the limb is the most serious complication of burn injuries and in a severe burn injury making decision of amputation is important to reduce morbidity and to enhance survival of the patient[1,2].

High voltage electrical injuries are caused by exposure to voltages equal to or greater than 1000V. Electrical burn injuries involve multiple systems of the body and

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may cause cardiac arrhythmias, rhabdomyolysis, renal impairment, and devastating soft tissue injury. In the limb, it may cause compartment syndrome due to deep muscle injury and tissue edema[3]. The upper extremities are involved in almost all cases of electrical burn injuries because they are the contact points to the voltage source. The amount of current that passes through a specific tissue is inversely proportional to the tissue's intrinsic resistance. In upper limb, electricity predominantly affects the skeletal muscle secondary to its large volume[4]. Visible cutaneous burn is often small, and the true extent of the injury cannot be estimated because most current passes through the deep tissues. Emergency surgical exploration is reserved for patients with compartment syndrome; otherwise, initial debridement can be delayed for 24 to 48 hours to allow tissue demarcation[5].

Standard management protocol for severe extremity electrical burn injury involving upper limb includes prompt resuscitation of the patient, elevation of the limb, strict monitoring and if needed early surgical exploration, fasciotomy, and debridement. Early fasciotomy releases the pressure within a compartment under tension and restores adequate perfusion to viable tissues and prevents further tissue necrosis[3,4]. Though fasciotomy is considered as a limb saving procedure, in severe cases of pre-existing irreversible extensive tissue injury, early fasciotomy will not reverse tissue necrosis rather fasciotomy and extensive wound debridement may expose them to the dangers of infection and sepsis. This necrosis may contribute to the decreased function or loss of the affected limb and even life-threatening complications such as renal failure and sepsis.[6] The limb cannot be salvaged, and amputation is needed to save the life[3].

Electrical burn, the major mechanism of injury pausing amputation, most commonly occurs at workplace (62.2%) and inexperienced young labor force represented the largest component[7]. Low-voltage injuries are usually more common in domestic settings and children are most affected. Adults are commonly affected at workplaces, accidentally; use of protective device reduces the severity of injury. But sometimes it is too fatal as they are exposed to high voltage even more than 12000V. One-third of electrical injuries and most of the high-voltage injuries are related to work. More than 50% of the work-related injuries arise from the contact with the power line and are in the 4th rank among the causes of death due to work accidents[8]. The aim of this study is to see the severity of electric burn injury involving upper limb pausing amputations and to establish appropriate management protocol, rehabilitation and prevention program.

Methods

A prospective observational study was performed in Burn and Plastic Surgery Unit, Dhaka Medical college Hospital and Sheikh Hasina National Institute of Burn and Plastic Surgery, Dhaka, Bangladesh between January 2019, and December 2019. Hundred and sixty-nine (169) patients with high voltage electric burn who were admitted with variable percentage or total body surface area (% TBSA) burn from different ages involving upper limbs underwent amputations were included in the study. Amputations were performed at different levels of upper limb according to the levels of injuries. Patients were followed-up for 3 months postoperatively and observed for development of any complications. They were studied for level of amputation according to severity of injury, which was assessed clinically.

Results

Male predominance (89% male. 11% female) was observed in the study. Right upper limb involved in 49% of the cases, left upper limb in 40% of the cases and 11% were bilateral. 57.4% of the patients were children and adolescents (age <21 years) and 42.6% were adult (age >21 years). Most of the incidents occurred at workplace (71%), followed by at home (14.79%) and outside home (14.2%). Below elbow amputations were performed in 82 cases (48.5%), above elbow amputations in 55 patients (32.54%), ray amputation in 16 patients (9.46%), amputation of multiple fingers in 12 patients (7.01%) followed by at the level of shoulder joint was done in 3 patients (1.77%) and trans-metacarpal amputation done in one patient.

Fig 01: *Pre-operative picture of electric burn injury at different level of upper limb. A: Upper limb involved up to middle of forearm, charred. B: Whole limb is involved. C: Limb involvement up to distal arm. D: Index and middle finger E: Only little finger. F: Limb involvement up to mid-forearm, fasciotomy done. G& H: Bilateral involvement.*

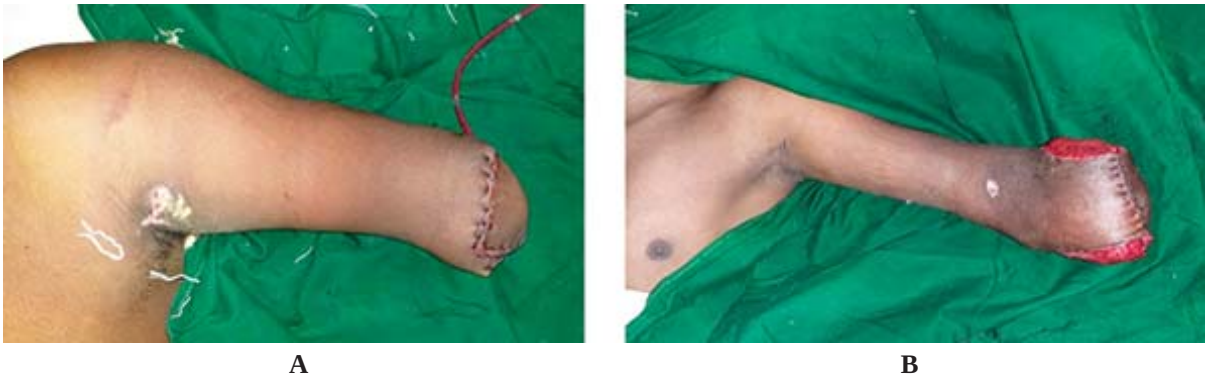

Fig 02: Per-operative picture of different level of amputation of upper limb. A: Above elbow amputation. B: Below elbow amputation.

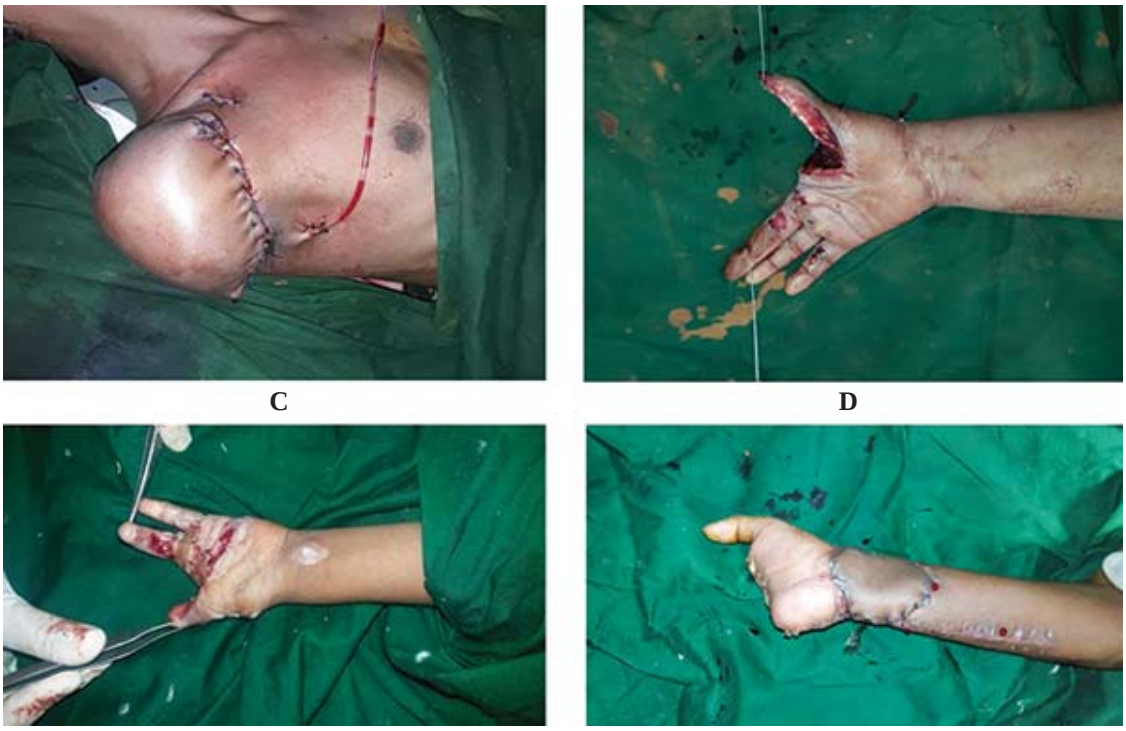

Fig 02: *C: Amputation at the level of shoulder. D: Ray amputation of index finger. E: Amputation of index and middle finger. F: Trans-metacarpal amputation.*

Fig 03: *Follow up pictures. A: Below elbow amputation. B & D: Bilateral above elbow. C: At the level of shoulder joint. E: Above elbow. F: Bilateral below elbow. (Consent was taken for photographic presentation)*

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Table-I

Primary level of amputation (n=169)

Level of Amputations	No of Patients	%
Ray amputations	16	09.46%
Index	6	
little	2	
Middle	5	
Ring	3	
Multiple fingers	12	07.01%
Index, Middle, Ring	2	
Index, Middle, Ring, Little	3	
Index, Middle	1	
Middle , Ring	1	
Middle, Ring, Little	2	
Middle, Ring	2	
Thumb, Index	1	
Trans-metacarpal	1	
Below elbow	82	48.50%
Above elbow	55	32.54%
Shoulder joint	3	01.77%
Grand Total	169	100.00%

Table-II

Management of stump complication

Stump Revision	No of patients	Percentage of total
Revision amputation	30	17.75%
STSG over stump	09	5.32%
Flap coverage	01	0.6%
Total	40	23.66%

Out of 169 cases, complication occurred in 40 cases (23.66%). Revision amputations were performed in 30 cases (17.75%).

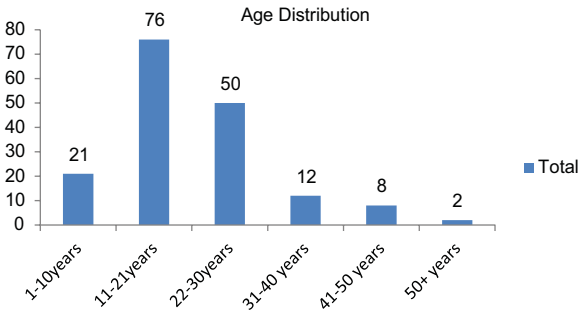

Fig.-4: *Distribution of patient according to the age(n=169)*

Out of 169, maximum age range was between 11to 30 years. Mean age was 21.22yrs, minimum age 2 yrs and maximum 65yrs.

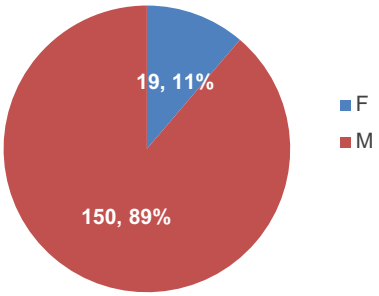

Fig.-5: *Distribution of patient according to sex (n=169)*

Male and female ratio was 7.9:1

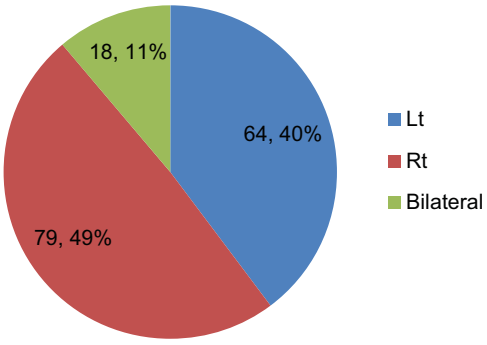

Fig.-6: *Upper Limb involvement (n-169)*

Right upper limb involved in 49% cases. Left upper limb in 40% cases and bilateral in 11% cases.

Discussion

The high voltage electrical burns injuries are the most serious form of burn injury and related to life threatening complications, loss of limb and longer hospital stay[1,5]. High voltage electrical injuries are caused by exposure to voltages equal to or greater than 1000 V. Passage of current through tissues leads to electro-thermal heating, generating temperatures of up to 4000°C and more and result in extensive tissue damage along the path of current flow. The extent of cutaneous injuries is often just the tip of the iceberg compared to the depth and extent of underlying tissue damage.[4]. Mortality is usually high due to cardiac and respiratory arrest, shock, renal failure from myoglobinuria and sepsis[3]. Treatment must be prompt and consist of aggressive resuscitation, cardiac monitoring, organ support, wound care and supportive care. Early rehabilitation, wound coverage, and delayed deformity reconstruction are important concepts in treating electrical injuries[5]. Survivors often end up with amputations.

Male predominance was found in our study with male and female ratio was about 7.9:1. A large portion of the patients were children and adolescents (44.79%), age between 11 to 21 years. Children were more affected by unsafe household connection and electrical lines passing through their houses. A common finding was the unsafe proximity of the residential buildings to the overhead high voltage electrical lines and transformers. They were affected while playing in the rooftop with unsafe electric wires and at workplace. Though child labor is prohibited in our country, due to poverty, sometimes they are the only earning member of their family and are bound to work in unsafe workplace without any protective devices.

Adult were mostly affected due to lack of safety devices at workplace and most of them were construction workers and electricians. Children below the age of five years are vulnerable for household accidents. Bigger children are mostly affected while playing in balcony, terrace or in the playground with overhanging electric wires. Very often they come in contact with these wires accidentally and devastating electric burn injury takes place in adulthood, burn injuries occurred mostly in the fourth and fifth decades of males as labor injuries[1].

In another study from India [9], out of 110 patients, 103 were males; most of them were from 2nd, 3rd, 4th decade of life. Maximum patients (43.63%) belonged to the age group between 21 to 30 y. This shows that the people from the most productive period of life are commonly affected. Similar figures were shown in other studies. There was a complete male preponderance in the number of victims of electric burn. Only 7 out of 110 were females (6.36%). Males are prone to get injured because of occupational exposure[8]. Forty-eight patients (43.63%) of electric burn belonged to the age group of 21-30 years. Occupational exposure can be attributed as the reason for high incidence in this age group. Involvement of upper extremities is seen in most of the cases of electric burns. Amputations at the level of forearms (15 cases) and digits (10 cases) were at the top of the list. Few unfortunate victims had multiple amputations like one patient in this study had amputations of both upper limbs at mid-forearm level and the right lower limb at mid-thigh level[9].

The amputation rate was highest in the electrical burn in all other available studies. In the study conducted by Jang, amputation rate was19.2% in electric burn followed by11.8% in the radiation burn, 2.5% in the contact burn, 1.1% in the flame burns, 0.7% in chemical burn, 0.7% in steam burn, and 0.2% in scald burn. Among burned patients, the most common amputation level was finger amputation (42.0%), the 2nd was toe amputation (16.9%), the third was trans humeral amputation(15%) followed by trans radial (5.5%), wrist or partial hand amputation(2.9%)[1]. Another study shows that about 49.4% of victims of high voltage injuries need amputations with the majority in the upper extremities because the hand is the usual primary point of contact[4].

In our study, electric burn involving upper limb, most common amputation level was below elbow (48.5%), the 2nd was above elbow (32.54%), ray amputation was 9.46%, amputation of multiple fingers was 7.01% and shoulder joint disarticulation was done in 1.77% cases. Right upper limb was involved in 49%, left upper limb in 40% and bilateral involvement was in 11% cases.

In our study, revision surgery was done in 40 cases (23.66%). Stump revision was done in 30 cases (17.75%). STSG for coverage of exposed stump was done in 9 cases and axillary flap coverage in one case. Stump revision rate is quite higher observed in our study but there were several reasons behind it. Very often, we need to do amputation on emergency basis to save patient life and definite amputation is not possible.

Patients are not ready to give consent for amputation and they want to keep the limb at any cost. So, there is increased risk of infection and wound dehiscence and needs secondary procedure.

The cost of treatment and rehabilitation remains a heavy burden. Most of the electric burn patients are daily labor. Those who survived such injuries, the long-term sequalae's are devastating. Prolonged hospital stays, multiple surgeries, long rehabilitation processes and heavy financial involvements are attendant issues and most of them can't bear it[3]. The victims are the main earning member of their family. As they become jobless, without saving and health insurance coverage, it is very hard to survive. Also, huge treatment cost and development of long-term disability make their life miserable.

Most of the accident occurs at workplace, it was reported in another study by Noble et al. that 91% of the subjects may suffer electric burn injury while working with high voltage electric power source. More than 50% of the work-related injuries arise from the contact with the power line and are in the 4th rank among the causes of death due to work accidents[10].

Electric burns are devastating. Even a small burn can cause loss of the limb. Very often after limb salvage surgery, the patient may need to undergo multiple admissions for reconstruction of tendons and nerves and it is very difficult to restore function of the limb[11].

An electric burn is a burden not only on the patient, relatives, and managing team but also on the entire community. Collaboration of different specialties is the key to successful management[12,13]. But this is preventable through program for educating people regarding safe habits and use of equipment in workplace and at house[14].

Conclusion

The loss of limb is the most severe complication of electrical burn injury involving upper limb. Patients with electric burn are generally due to labor accidents and unsafe household connections where children and adolescent are mostly affected. Victims are ended up with major disabilities and lifelong sufferings. However, most of the injuries are preventable with proper education and knowledge. Therefore, effort must be given at national level. Information obtained from this study is expected to be helpful to support prevention program, awareness, developing management protocol and introducing rehabilitation program for burned amputees for their welfare.

Conflict of Interest:

No conflict of interest was reported

Patient consent:

Informed written consent for the publication and use of their image was taken.

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Author Contribution to the article:

Conceptualization: Nurunnahar Begum & Tanveer Ahmed. Data collection: Nurunnahar Begum, & Zahangir Alom Moni. Methodology: All authors. Writing, Review & Editing: Nurunnahar Begum, Tanveer Ahmed & Md. Abul Kalam.

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