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To evaluate how early operative intervention will increase the chances of limb survival in electrical burns- At a tertiary Burn care centre

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Abstract
Background: Electrical burns incidence is increasing due to increased industrialization and increased use of electricity and electric domestic appliances. High morbidity and mortality associated with increasing incidence of electric injury may consume alarming is high amount of resources and healthcare budget.
Objective: To evaluate how early operative intervention will increase the chances of limb survival in electrical burns-at Safdarjung hospital burn unit over period of one year from January 2011 to December 2011 was reviewed and data about personal details, cause of burn, percentage of burn, treatment given, complication and final outcome were analyzed using descriptive statistics.
Results: Fasciotomies were done in 156 patients in 180 limbs. 1 patient had undergone laparotomy for ligation of RT external iliac artery. 58 out of the total 266 electric contact injured patients, represents that nearly 22% had to undergo amputations. Early flap cover after conservative debarment was done in 25 cases patients. Out of these 20 flap covers were done for upper limb defects. Minimal flap necrosis was noticed in 7 patients but the wounds healed without any further surgical intervention. In the 25 flaps done, 19 were distant flaps and 6 were local flaps. CT and MRI angiography was done in 24 patients during our study period. Out of these except for 2 CT angiography for lower limbs, all were for upper limbs. Out of 438 electric injury patients in our study, there was a mortality of 58 patients. 5 were brought dead and 53 patients expired while undergoing treatment in the hospital. This represents nearly 13% mortality rate from electrical related injuries.
Conclusion: Electric burn causes significant morbidity and mortality and can be prevented easily. It was emphasized that most of the electrical injuries can be prevented by education, policy implementation and use of safety. Patients survived with morbidity due to amputation. Initial management of electrical burn is imperative to optimize function and minimize long-term scarring. However, further studies are required regarding flap repair and microsurgery to minimize in electrical.

Keywords: Electrical injuries, burn, amputations, fasciotomy, flap covers

Introduction
Burns are one of the most devastating conditions encountered in medicine. The injury represents an assault on all aspects of the patient, from the physical to the psychological. It affects all ages, from babies to elderly people, and is a problem in both the developed and developing world. Electrical injuries are responsible for high morbidity and mortality. To decrease the high morbidity and mortality associated with burns, it is necessary to apply the principles of initial trauma resuscitation and the timely application of simple emergency measures. Burns are also a major problem in the developing world. Over two million burn injuries are thought to occur each year in India, but this may be a substantial underestimate. Mortality in the developing world is much higher than in the developed world [1-3].
Regarding the surgical approach, in a recent study `conservative debridement has been found beneficial. In this study partially damaged tendons, nerves and muscles were preserved and wound closure was achieved by immediate flap coverage. Patients treated in this manner with immediate soft tissue coverage had a significantly better outcome compared with a control group who underwent serial debridement procedures.
In this study, efficacy of fasciotomy in salvaging upper limbs, adequate debridement with early flap cover using flaps in healing of post electric burn wounds and amputation of gangrenous

parts of upper limbs were assessed.

Electrical burns involving upper limbs are treated by cleaning the wound. Fasciotomy is done in circumferential and deep burns to prevent increase in compartmental pressure. In high tension electrical burns involving 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 haemorrhage.

All the efforts are taken to salvage the 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.

Electrical burn injuries are a challenge to the reconstructive surgeons. Providing a stable skin cover and functioning limb is a great challenge to the burn surgeon [8, 9]. Electrical burns are the most devastating of all thermal injuries, usually involving skin and deeper tissues. They have multiple acute and chronic manifestations. They primarily affect young working males and are the most frequent cause of amputations in burns unit.

With the view of the above considerations, the main objective of the present study is to evaluate how early operative intervention will increase the chances of limb survival in an electrical burns-at Safdarjung hospital burn unit over period of one year.

Materials and Methods

This prospective study was conducted in department of Burns, Plastic and Maxillofacial Surgery, Safdarjung Hospital, New Delhi over a period of one year.

Inclusion criteria

1. All patients reporting to safdarjung hospital plastic surgery department due to acute electric burns were included in the study.

Exclusion criteria

1. Patients who presented more than 4 days after electric burns were excluded from early flap cover study.

All patients were evaluated clinically with detailed history, and physical examination. History specifically included.

1. The type of the current: (high voltage/low voltage)
2. Any treatment taken outside: Details of treatment:
3. Type of burn (contact/flash/arc)

The physical examination specifically included

1. Area of contact: entry point and exit point:
2. Extent of burns [TBSA]
3. Associated injuries [neurological/musculoskeletal/cardiac] The patients were followed throughout their hospital stay to assess the final outcome.

Investigations will specifically include

1. Imaging investigations like CT scan, MRI were done as and when required.
2. Informed consent was taken from all the patients.
3. Statistical analysis was done using data analysis software with the help of the statistician.

Results

Total number of patients treated for electrical burns during this period is 438 (7.86%) out of. total number of patients treated for burns of all kinds during the same period is 5569.

Surgical Intervention

Our study showed that multiple procedures were done in electrical burn victims from day one to the last day in the hospital starting from fasciotomy to skin grafting or flap cover.

Fasciotomies were done in 156 patients in 180 limbs. In our institute, fasciotomy was done regularly if there was suspicion of vascular compromise of limb and even in cases of established vascular compromise of distal parts of limb, fasciotomy was done proximally. Out of these only 9 limbs which were having prior doubtful vascularity survived and did not require amputation later.

Laparotomy

1. Patient had undergone laparotomy for ligation of rt external iliac artery.

Amputations

Electric contact injuries resulted in significant loss of limbs and life.

Table 1: Amputations

Amputations	Right side	Left side	Bilateral
Below elbow	10 patients	9 patients	5 patients
Above elbow	11 patients	8 patients	6 patients
Below knee	1 patient	2 patients	0
Above knee	2 patients	2 patients	1 patient

A total of 58 patients had to go undergo amputation due to gangrene of limbs. Other than the 57 patients described in the table above one patient had to undergo bilateral below knee amputation and right above elbow amputation. Out of the total 266 electric contact injured patients this represents that nearly 22% had to undergo amputations.

Early flap cover

In the present study, 25 flaps were done, 19 were distant flaps and 6 were local flaps.

Table 2: Early flap cover

Early flap cover	Number of patients
Distant flap cover	19
Local flap cover	06

Table 3: Site operated

Site operated	Number of patients
Upper Limb	20
Lower limb	05

Mortality

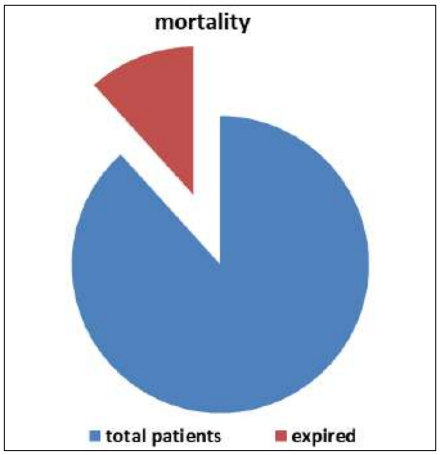

Fig 1: Mortality rate in burn cases

Out of 438 electric injury patients in our study, there was a mortality of 58 patients.5 were brought dead and 53 patients expired while undergoing treatment in the hospital. This represents nearly 13% mortality rate from electrical related injuries.

Discussion

One of the major complications of high tension electrical injury is acute renal failure. Circulating haemoglobin is toxic to kidney and may lead to acute tubular nephropathy. Prompt fluid resuscitation is the key to prevent complications [1]. The use of IV fluids to increase renal perfusion and sodium bicarbonate to achieve urine alkalinity has been utilized in our burns unit. Blood transfusions were given to correct anaemia, which was due to massive red blood cells destruction due to electrical burns.

Fasciotomies were done in 156 patients in 180 limbs. In our institute, fasciotomy was done regularly if there was suspicion of vascular compromise of limb and even in cases of established vascular compromise of distal parts of limb, fasciotomy was done proximally. Out of these only 9 limbs which were having prior doubtful vascularity survived and did not require amputation later. This may be because of the delayed presentation of patients to our centre and also could be due to the severe primary injury of the direct electric current itself. Though without comparative study it cannot be proven we opine that even in cases of established loss of vascularity (gangrene) distally by doing fasciotomy proximally some length (1 to 5 cms) of the future stump being saved.

Tight compressive dressing was avoided. Fasciotomy was done in all circumferential deep burns without waiting for any signs of increased compartmental pressure. Decompressions of all muscle compartments were done. Necrotic tissues were removed. This is done usually on the day of admission. Chen (2013) [2] in their study have reported fasciotomy as most common procedure as opposed to our study where eschorotomy/fasciotomy was the second most common surgical procedure after debridement.

CT and MRI angiography was done in 24 patients during our study period. Out of these except for 2 CT angiography for lower limbs, all were for upper limbs. We found that CT angiography under estimated the length of the gangrenous part in three cases. In one case of clinically frank gangrene of hand. CT angiography reported complete viability of hand. One case of radial artery pseudo aneurysm was identified at the point of contact injury. This is contrast to Vedung *et al.* [14]. Who have concluded that early angiography is valuable for the detection of deep injury, and often indicates the level of adequate amputation or the need for immediate exploration.

Amputations

A total of 58 patients had to go undergo amputation due to gangrene of limbs. Many patients had to undergo amputation of more than one limb.

The high number of amputations performed by us could be due to the delay in presentation of the cases to our centre and due to the extensiveness of the injury seen in our study. The more bothering aspect of losing limb or life in electrical injuries is that the patient is most probably young (31% patients were between 21 to 30 years) and the working bread earner of the family.

Repeated debridements were performed in order to excise all devitalized tissues and to reduce infective complications. Definite skin cover was provided after proper wound debridement in the form of split thickness skin grafts or flaps. Chen (2013) [2] in their study have reported debridement as second most common procedure as opposed to our study where debridement was the most common surgical procedure. This may be due to the fact that during period of our study, early excisional surgery and skin grafting was not being done at our unit.

Early flap cover after conservative debridement was done in 25 cases patients. By conservative debridement we mean no removing the tendon's and nerves of doubtful viability. We opine that between local flaps, distant flaps and free flaps for early flap cover distant flaps are better. Since local flaps are raised from the surrounding area of electric contact point defect there is a chance that gangrene may progress to the area from where we are using local flap since we are doing the flap cover in a very early period in this study. The same problem persists with free flap because they have to be demonstrated to the donor vessels in the area of electric contact and there chance of thrombus. In contrast distant flaps have little chance of necrosis because they have a different blood supply and so they increase the blood flow to the area of defect though only for short period.

The ages ranged from 14 years to 48 years. 19 were done in male patients and 6 in female patients. Out of these 20 flap covers were done for upper limb defects. Minimal flap necrosis was noticed in 7 patients but the wounds healed without any further surgical intervention. Pus discharge was noticed for 2 to 3 weeks in 4 patients. We suspect that pus discharge for a long duration could be due to leaving nonviable tissue in the process of conservative debridement. Spontaneous detachment of one side groin flap (twice) was noticed in the patient in whom bilateral groin flap was done. This could be due to the uncomfortable position of upper limbs in the patient but could also be due to leaving nonviable tissue due to our plan of conservative debridement and flap not adhering to the wound bed. In the 25 flaps done, 19 were distant flaps and 6 were local flaps. Our results accordance with that of previous findings reported by Jeffry *et al.*, [8] who has reported early flap cover in 6 patients.

Holliman *et al.*, [3] pointed that early and repeated direct inspection of the damaged tissues is the most reliable method of assessing viability.

Parshley *et al.*, [4] stressed the importance of immediate decompression of tight muscle compartments, to prevent further damage to the tissues and simultaneous radical debridement, including immediate amputation of the extremities that are clearly non-salvageable.

Fig 2: Burn at upper limb

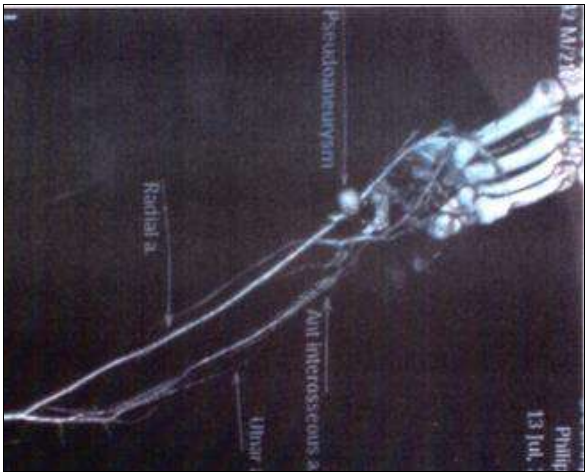

Fig 3: CT Angiography showing radial artery pseudo aneurysm at electric contact site

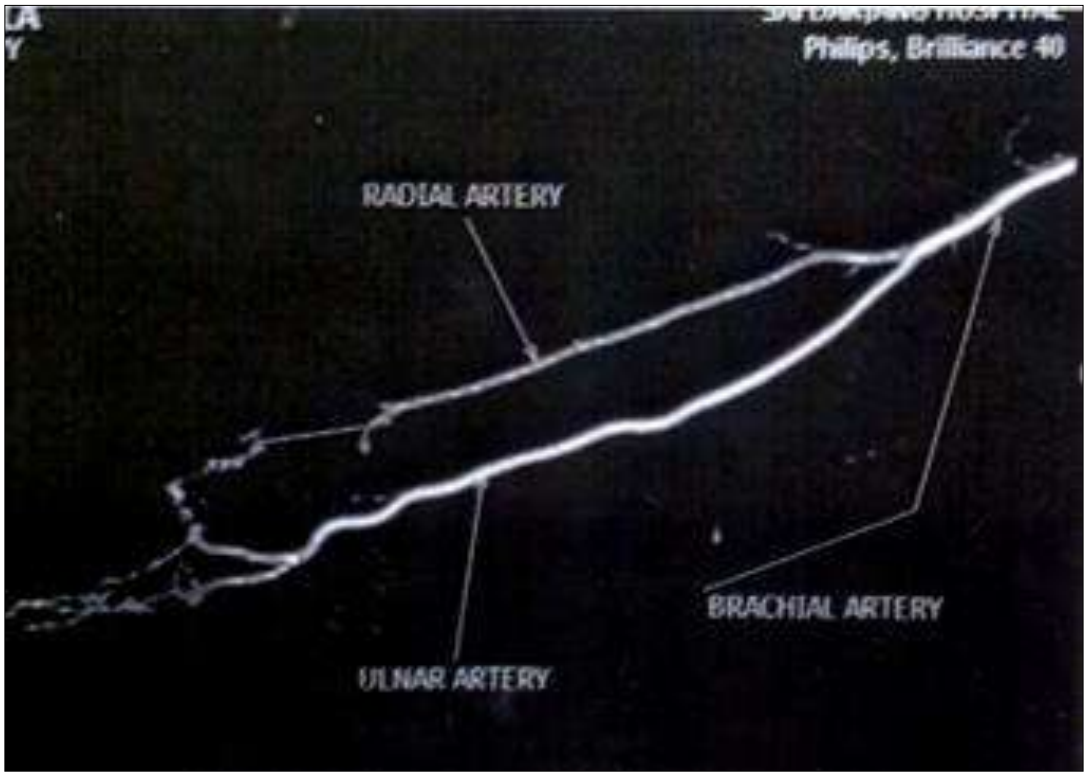

Fig 4: CT Angiogram showing narrowing of the distal part of radial artery

Fig 5: Superiorly based abdominal flap for contact burn forearm and wrist

Fig 6: Escharotomy

Fig 7: Fasciotomy

Fig 8: Electric contact burn of wrist and fingers

Fig 9: After debridement and amputation of ring finger exposed tendons of wrist, little and middle fingers

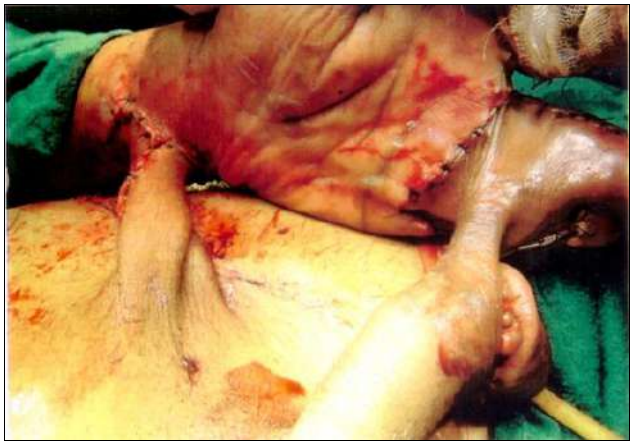

Fig 10: Groin flap for wrist defect and Prepucial flap for middle and little fingers defect and amputated ring finger site

Fig 11: Post op after 6 months

Early fasciotomy, eschorotomy, early excision and skin grafting, flap repair and microsurgery seem to reduce amputation is appropriate cases. However further studies are required regarding role of flap repair and microsurgery to in electric burns [5-7].

Complications during the course of treatment following electric burn were gangrene, psychiatric illness, acute kidney injury, secondary hemorrhage and rhabdomyolysis [8-10].

In our study, Early wound debridement and skin cover has helped in reduction in the rate of amputations and faster wound healing. However reconstruction by flap cover has been delayed in some cases because of the poor general condition of the patients and the presence of extensive injuries over various regions of the body.

Conclusion

Incidence of electric burn is increasing due to increasing use of electricity and industrialization. Electric burn causes significant morbidity and mortality and can be prevented easily. It was perceived that most of the electrical injuries can be prevented by education, policy implementation, use of better quality equipment, safe handling of electric appliances and use of safety. Need for early surgical intervention and better rehabilitation program was emphasized to improve the outcome.

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