ORIGINAL ARTICLE

PATTERN AND PROFILE OF ELECTRIC BURN INJURY CASES AT A BURN CENTRE

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Background: Electrical burns are quite different from thermal and chemical burns. This study is from a centre which deals with job related electric burn injuries alone and thus can give a pure account of the electric burns and discuss the related peculiarities. Study aims to highlight the differences in the mechanism of electric burn injury, its mode of presentation, morbidity, complications and thus the treatment strategies as compared to rest of the burn injuries. **Methods:** This is a descriptive case series study of first consecutive 61 electric burn victims treated at a Burn Unit and Plastic Surgery centre. Cases were admitted and resuscitated at the emergency, and further treated at burn unit. Thorough history, examination findings and operative procedures were recorded. Patients were photographed for record as well. Emergency operative procedures, wound management, soft tissue coverage procedures and complications during the hospital stay were recorded and studied. **Results:** Twenty cases (33%) were in the fifth decade of life. High voltage electric burn injury was seen in 42 (69%) of the cases. Whereas only 9 cases were treated conservatively, other 52 cases had 24 fasciotomies and 71 debridements. Series witnessed 10 expiries, and 22 amputations and all these were result of high voltage electric burns. Twenty eight soft tissue coverage procedures were carried out. **Conclusions:** Electric burn injuries are altogether different from rest of the burn injuries and must be treated accordingly. These injuries are peculiar for ongoing damage, extensive trauma, complications and prolonged morbidity. Treatment requires a high degree of suspicion, more aggressive management to unfold and minimize the deep seated insult.

Keyword: Electric burns; Electrical injuries; Job related injuries; Electric current injuries

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INTRODUCTION

With advances in technologies, electrical injuries are getting more common. These injuries are known for their devastating complications and long lasting socioeconomic impact.[1]

Whereas children are more prone to these injuries at household environment, in adults most of these injuries occur at workplace.[2–5] One third of the electrical injuries and majority of the high voltage injuries are job related.[6] Another study found that 75% of the high voltage burns were work related.[7] More than 50% of the electrical injuries result from contact with the power line. These are also reported fourth leading cause of work related traumatic death.[6] An epidemiological study of 383 cases in China underscored the need for stronger preventive measures.[8]

Electrical burns are quite different from injuries sustained due to thermal or chemical burns. Although primary electrical injury is burns, secondary blunt trauma may result from falls or being thrown from the electrical source by an intense contraction of muscles. Therefore, these patients need to be initially evaluated as a trauma patient as well.[9,10] Although they can exclusively cause surface damage, but more commonly deeper tissues underneath the skin have been more severely damaged. This makes the electrical burns difficult to be accurately diagnosed at their presentation, and hence their severity is underestimated. At time of presentation, the mechanism of injury may be difficult to be established. Electro thermal heating remains the main factor in muscle damage exclusively seen in high voltage electric injuries.[11]

Servicemen of water and power development authority (WAPDA), due to the nature of their job, remain more vulnerable to this injury. Very first burn unit for the treatment of electric burn injuries sustained by these servicemen was established at WAPDA Teaching Hospital, Lahore. Importance of the present study lies in the fact that study analyzes initial consecutive 61 cases of purely job related electrical injuries treated in a period of two and half years and compares it with similar studies.

MATERIAL AND METHODS

This case series study was carried out at The Department of Plastic Surgery and Burn Unit, WAPDA Teaching Hospital Complex, Lahore, Pakistan, from Feb 2011 to Sep 2013. All the victims of electrical burn injuries who were brought to hospital and were admitted in the unit for treatment of electrical burn injuries were included in study. All victims were first admitted in emergency, history was recorded and they were examined. Fluid resuscitation was started and necessary fasciotomies were carried out. Only when the patients were stable, they were shifted to the burn unit. All these

patients were then treated at burn unit. All these patients were photographed for record. Necessary debridement procedures, amputations, soft tissue coverage and reconstructive procedures carried out were recorded. These patients were then followed up during the rehabilitation phase. All the available records were studied retrospectively to see the frequencies and percentages of injuries, amputations, number of various procedures carried out.

RESULTS

A total of 61 cases, all males, of acute electric burn injuries were treated over a period of two and half years. The average age of the patients was 43.5 years, whereas 46 was the median age. Majority of the patients, i.e., 20 (33%) were in the fifth decade and other 18 (30%) in sixth decade of their life. (Table-1). In 42 (69%) patients the injury was a high voltage electric burn injury and in 14 (23%) patients it was caused by low voltage. In four patients it was due to flash burn caused by the malfunction of the electrical equipment. In one case it was spillage of the hot oil from the electrical equipment that caused the burn injury. Five of the cases had history of fall during the accident. (Table-2).

A total of 24 fasciotomies were carried out in 19 cases. A total of 71 debridements were carried out in 23 cases. Nine cases were treated conservatively. Nineteen sessions of split thickness skin grafting were carried out in seventeen cases. In eight cases different flaps were utilised for soft tissue coverage of the defects. (Table-3). A total of 22 amputations were carried out in 18 cases. Three of the cases had bilateral amputations of both upper limbs while another had amputations of both lower limbs. Total of nine thumbs were amputated in eight cases. Amputations carried out during this study are depicted in (Table-4)

Table-1: Age range distribution

Age Range	No. of Patients	Percentage
20–30	07	11
31–40	16	26
41–50	20	33
51–60	18	30
Total	61	100

Table-2: Mode of injury

Mode	No of patient	Percentage
11 KV	42	69
220v	14	23
Flash	4	7
Others	1	1

Table-3: Various surgical interventions

Procedures	No of procedures	No of Patients
Fasiotomies	24	19
Debridements	71	23
Amputations	22	18
Split Thickness Skin Grafting	19	17
Full Thickness Skin Grafting	1	1
Flap Coverage	8	8

Table-4: Amputations status of the patients

		No of patients	No of Amputations
Upper Limb	Rt Arm	-	-
	Lt Arm	2	2
	Both arms	3	6
Lower Limb	Leg	1	1
	Both legs	1	2
Thumb	Rt Thumb	7	7
	Lt Thumb	2	2
Finger	One	2	2
	Two	-	-
	Three	-	-
Total		18	22

DISCUSSION

Electrical burn injuries are quite different from thermal and chemical burn accidents. Whereas in thermal and chemical injuries heat wave travels from hot object or liquid on body surface to the deeper tissues, it is in reverse direction in electrical burn injuries, and mechanism of injury involves passage of current through the body. The apparent damage at the surface may be quite trivial at presentation but it gradually unfolds itself in coming days, both in depth and breadth of the tissues involved. This progressive tissue death (necrosis) further complicates the treatment of these injuries.[12,13]

Resistance to current flow varies in different tissues. Highest resistance is found at bone, tendon and fat due to their high content of inert matrix. During electric injury accidents, this high resistance causes the tissues to heat up and coagulate on flow of current through them.[14,15] Thus tissue damage spreads from deeper sitting non conductor tissues to the surrounding tissues. Joule heating has been described as mechanism of tissue damage in electrical burn injuries.[16] However, recently electroporation has been described as the mechanism for tissue damage in these injuries. According to this suggested mechanism, cell membrane permeabilization and direct denaturation of macromolecules, such as proteins, mediates skeletal muscle necrosis which brings progressive internal damage even with insignificant external injury.[17–19]

Severity of the electrical injury depends on lot of factors including the current strength, duration of current flow, resistance, and moisture at the skin, component of flash and ignition of the clothing. Depending on these features, electrical injuries may, at times, generate such a high amount of energy at the interface that they may literally char the tissue due high energy contained. All these facts make the electrical injuries a separate entity which has its unique presentation, mode of progression of the wound, the morbidity and mortality.

Among adults, majority of these injuries result from high voltage lines. Studies have shown that high voltage injuries may cause extensive muscle

necrosis even at sites distant from the skin injuries. And, as it may lead to compartment syndrome, rate of decompression fasciotomies is high in these injuries.[20,21] The extensive damage often leads to frequent debridements and even amputations in these high voltage injuries.[22] Studies have been reported where 100% of the high voltage electrical burn cases had debridements and necrotomies.[7] Same study reported an amputation rate of 18%. These cases are also prone to myoglobinuria renal failure due to massive release of myoglobin from the damaged muscles.[22]

Majority of the cases in present series were in 5th and 6th decades of life, 33% and 30% respectively. Impact of these injuries are double fold as on one side these injuries are extensive, devastating and complex requiring a prolonged treatment and on other hand department gets deprived of its valuable manpower who are in the mid of their service. As seen in earlier studies, series noted that majority of these injuries resulted from contact with the power line. Series had 42 cases (69%) as a result of high voltage injuries, while 14 cases (23%) were low voltage injuries.

As suggested in previous studies, all the amputations carried out in this study were seen in high voltage injuries.[22] Total of 22 amputations were carried out in 18 patients, i.e., 30% of the study cases. Three of the patients lost both their upper limbs and another lost both his legs. Eight of the patients lost one of their thumbs each. Study also witnessed 10 (16%) expiries which all occurred in high voltage electric burn cases. Whereas other 9 cases had superficial injuries and were treated conservatively, rest of the series had total of 71 debridements, 24 fasciotomies, 20 sessions of grafting and 8 flap surgeries for soft tissue coverage and 22 amputation stump surgeries. Such a high number of fasciotomies, debridements, and amputations shows the extensive nature of the disease, an ongoing damage and, also, post traumatic impact on the social life of these cases.

High voltage electric injuries usually occurred while these line men were working on high tension lines. At times throw away effect caused secondary injuries as well. Three of the cases had fracture neck of femur, two had fractures at vertebral column and two other had fractures of ribs.

Another important observation was a minor injury and burn area at presentation which then progressed to a bigger wound. It was due to this peculiar mechanism of the wounds that some of the studies recommended that true extent of actual injury was unlikely to strongly correlate with the extent of cutaneous burns.[23] Therefore, treatments based on calculation of the body surface area involved in the injury might lead to under treatment of the insult. This is gross contradiction to the management plan of the other forms of burn injuries where the treatment is planned on the basis of the burn area as % of total body surface area. So, electric burn cases require a high degree of suspicion, more aggressive management to unfold and minimize the deep seated insult. One of the initial steps to achieve this goal may be extensive use of fasiotomies to lay open the involved and suspected areas so that, in case of involvement, the rising pressure of the compartments may not lead to ischemia and a greater damage. Timely and judicious fasciotomies may save the limbs in such cases. Although a lot of indicators and diagnostic tests may be used to estimate the extent of underlying tissue damage,[24] recent studies have demonstrated a strong relation between elevated serum creatinine phosphokinase (CPK) and the extent of deep tissue damage in electrical burns[23,25,26].

Studies have already stressed on the preventive measures for these injuries.[8] Present study had four cases of flash burn due to faulty equipment while one case had splash of hot oil due to malfunction of the equipment. However, majority of the cases had element of negligence and occurred due to overlooking the preventive measures. Long departmental enquiries were held in these cases. The heavy loss of lives, an amputation rate of different parts of body of 30% in these patients, heavy number of surgeries which the patients had to go through, prolonged rehabilitation programmes for the survivors all speak of the burden that patient, department, the society and the hospital related resources had to bear due to this trauma. It also speaks of the importance of laying down and observance of the strict precautionary measures by the department. This one overlooked step resulted in loss of valuable lives, prolonged morbidity, shortage of the manpower and economic burden on department and the country.

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