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High Tension Electric Injuries in Western Rajasthan: A Review of 238 Patients

Prakash Chandra Kala

Burn Unit, Dr. S.N. Medical College, Jodhpur, Rajasthan 342001.

Correspondance: Dr. Prakash Chandra Kala, 342, Hanuwant-A, B.J.S. Colony, Jodhpur, Rajasthan.

Email: drpckala@gmail.com.

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IN BRIEF

Object: This is a retrospective and prospective study of clinical profiles of electric burn cases in Western Rajasthan during Jan. 2004 to Dec. 2007 admitted in burn ward of Dr. S. N. Medical College, Jodhpur, Rajasthan.

Methods: Patients data were examined in detail with reference to their age ,sex , mode of injury, part of the body affected, surface area involve, hospital stay, management (surgical as well non surgical), and ultimate outcome of the disease. After analyzing the cause of morbidity and mortality of these patients, discussing possible methods to reduce them were advised.

Results: This study comprised 238 cases of electric burn in the age group 21-30 years maximally affected with M:F ratio of 20.6:1. Of these 94.53%were Hindu and 5.47% were Muslim. Maximum hospital stay was of patients with Body Surface Area (BSA) 51-60%. Maximum no of deaths were 21-30% of BSA group. Body parts maximally affected were upper limb followed by lower limb, chest, abdomen, and lastly head and neck. In 238 patients total 182 surgeries were done among which 77 patients required amputation; debridment was second and skin grafting were the third commonly performed operations. Nine patients underwent subclavian artery ligation. Among amputations maximum were below elbow amputation. Fifty percent patients had revised amputation in upper limb converting below elbow to above elbow. In 10% patient above elbow amputation converted into shoulder disarticulation. Maximum no. of the patients was from 0-10% BSA. Mortality was maximum in patients having more than 80% burns and disability was maximum in 0-10% group. Total, 57 patients suffered from disability in which 37 patients lost their upper limb. Most common cause of death was septicemia.

Conclusion: Study shows that electric injury causes significant morbidity and mortality in all groups studied and is mainly due to high tension electric current. Electric injuries mostly occur in rural areas. It causes significant damage to general population as well as electricians. Mortality and morbidity make victims and family members of victims dependent on others. It can be prevented by educating the people about proper handling of electric circuit and devices. Proper communication is a must among electricians. Proper rehabilitation of handicapped persons and employment to family members may reduce social burden.

Key word: High tension electric current; Body surface area; amputation; mortality; morbidity.

INTRODUCTION

This was a retrospective & prospective study of clinical profile of electric burn patients admitted in the burn ward at Dr. S. N. Medical College during Jan.2004 to Dec. 2007 using their medical records.

A lot of patients in the burn ward come every year with high tension electric current burns so the aim of the study was to analyze the impact of electric injuries under the following points -

1. Age distribution
2. Sex distribution
3. Percentage of the body area involved
4. Part of the body involved
5. Place of burn
6. Urban/Rural area
7. Duration of hospital stay
8. Operative procedure applied
9. Complications
10. Morbidity & mortality
11. Electric burns as an occupational hazard

After discussing these points, we advised how these types of injuries can be managed and reduced in number and how to manage social impact of these types of injuries.

MATERIAL AND METHODS

Records of the patients admitted during the last three years from January 2004 to December 2007 were studied. Bed head tickets of the patients were evaluated in detail.

Patients data were examined in detail with references to their age, sex, mode of injury, part of the body affected, surface area involved, hospital stay, ultimate outcome of the disease. Management of these electrical injuries involved immediate cardiopulmonary resuscitation and administration of I.V. fluids. In the presence of myoglobin urea diuresis was induced by fusing adequate amount of Ringers lactate solution and mannitol (20%) with addition of sodium bicarbonate in order to obtain alkaline urine output. Silver sulphadizine was used locally to dress the wound. The required surgical procedure was carried out urgently or delayed after assessing the condition of the patient and selecting the appropriate procedure. Various factors related to the mortality were studied. In the study, the role of electricity as an occupation hazard was discussed.

After analysis of the records, the cause of mortality of these patients and possible method to reduce these were discussed.

Inclusion criteria: Patients who sustained electrical injuries by any mode (Direct current,

Table I. Age distribution in electric burn patients

Age	Male		Female		Total	
(In Years)	Total No.	%	Total No.	%	Total No.	%
0-10	7	3.2	2	8.7	9	3.8
11-20	52	24.1	10	43.5	62	26.05
21-30	62	28.8	3	13.04	65	27.31
31-40	45	20.9	5	21.8	50	21.0
41-50	29	13.5	3	13.04	32	13.5
51-60	14	6.5	0	0	14	5.9
61-70	5	2.3	0	0	5	2.11
>70	1	0.46	0	0	51	0.4
Total	215		23		288	

Study of 288 patients with electric burns shows that maximum patients having burns were in age group 21-30 years (27.31%) with M:F ratio of 20.6:1. As the age increases the incidence of electric burn accidents decreases. The age group more than 70 years had the least number of patients 0.4%. The mean age was 30.75 years.

Table II. Sex distribution in electric burn patients

Sex	Total	Percentage	Mortality	Percentage
Male	215	90.3	20	9.3
Female	23	9.67	1	4.3
Total	238			

Among the 238 victims of electric burns, 215 (90.3%) were males and 23 (9.67%) were females. Out of 215 male patients, 20(9.3%) expired. Only 1 (4.3%) female among total of 23 expired. This shows that males are more exposed to electric burns and also more prone to death.

Table III. Religious distribuation

Religion	Male	%	Female	%	Total	%
Hindu	208	96.75	17	73.91	225	94.53
Muslim	7	3.25	6	26.08	13	5.47
Total	215		23		238	

Out of the total population exposed to electric burn, 225(94.53%) were Hindu and 13 (5.47%) were Muslim.

Arch injuries, Lightning injuries, Hot elemental burn) included.

Exclusion criteria: Patients who were managed as outpatient were excluded from our study.

RESULTS

Study of 238 patients with electric burns shows that maximum number of patients who sustained electric burn injuries were in age group of 21-30 years (27.31%) and M:F ratio of 20:6:1. As the age increases the incidence of electric burn accidents increases up to 30 years after which the incidence decrease. The age group of more than 70 years has the least number of burn patients (0.4%). The mean age was 30.75 in this study.

It was found that among the 238 victims of electric burn 215, (90.3%) were male and remaining 23(9.67%) were females with a mortality of 9.3% (20) in males and 4.3% (1) in females. Majority of the patients (94.53%) were Hindu and rest (5.47%) were Muslim, none of the patients were of any other religion.

In this study, majority of patients (72.2%) were from the rural area; morbidity in electric burn patients was more in patients coming from the rural area which is around six times more than urban patients.

Study shows that the average hospital stay was 33.28 days and was maximum in the 41-50% BSA burn patient with average duration of 54.50 days. Minimum stays were among patients with more than 70% burns having an average stay of 14 days. Hospital stay of patients increased with the increase of percentage of burns up to 50%. Twenty one (6.4%) patients expired in this study and maximum number of deaths was from 21-30% burn patients.

Order of body parts involved by electric burn was: upper limb >lower limb >chest >abdomen >head and neck. Around 184 patients (77.32%) patients suffered from upper limb involvement. Head & neck was the least affected area, i.e, only 49 (20.59%) patients.

In 238 patients, 182 surgeries were performed among which 77 patients required amputation. Debridement (52 patients i.e. 21.8%) & skin grafting (38 patients, i.e. 15.9%) were the second & third most commonly performed operations. Fasciotomy was required in six (2.5%) patients and the subclavian artery ligation required in nine (3.7%) patients. One laparotomy was performed in blunt trauma of abdomen

associated with electric burn where duodenal perforation was found and repaired.

The study shows that maximum number of the amputations were below elbow which was 33.8% (22 patients). Some of these were converted into mid arm amputation 55.47% (10 patients). Shoulder disarticulation occurred in two (3.07%) patients.

In this study, nine patients underwent subcalvian artery ligation; among these therapeutic subcalvian arteries ligation was done in two (22%) patients for radial artery bleeding.

In 50% of cases, below elbow amputation, was converted into mid arm amputation, and in 10 % of cases, mid arm amputation was converted to shoulder disarticulation.

In this study, 46.2% (110) of patients had burn percentage area less than 10% and only 2% (5) patients had burn area of more than 80%. The overall morbidity was 36.1% (86) and maximum number of patients were from less than 10% burn surface area (51.8%). Mortality was 8.8% (21), which was maximum in burn percentage area more than 80%, where three out of five patients expired. Fifty-seven patients were left with late disabilities, in which 37 patients (42.92%) lost partial upper limb followed by partial lower limb and finger loss. Least common disability was great toe loss. One patient had exit wound on anterior abdominal wall who sustained blunt injury. He was explored and duodenal perforation was found and repaired.

Table IV. Habitat & morbidity

Habitat	Incidence		Morbidity	
	Total	%	Total	%
Rural	172	72.27	49	85.97
Urban	66	27.74	8	14.03
Total	238		57	

In this study of 238 patients, majority of patients (72.2%) were from the rural area. Morbidity in electric burn patients was more in patients coming from the rural area which is around six more than urban patients.

Table V. Hospital stays according to percentage BSA involved

Percentage BSA involved	No. of patients	%	Average hospital stay in days
0-10	110	46.22	20.46
11-20	63	26.48	28.62
21-30	35	14.71	37.6
31-40	11	4.63	43.66
41-50	6	2.52	42.8
51-60	3	1.26	51.67
61-70	4	1.68	11.67
71-80	1	0.42	13.0
> 80	5	2.11	14.8
Total	238		

Present study shows that the hospital stay was maximum in the BSA group of 51-60% which comprises the average duration of 51.67 days. Minimum stay was among the BSA group of >70%, having average stay of 14 days.

Table VI. Hospitals stay of survived patient

BSA	MALE	FEMALE	No. of patient survived	Average stay in hospital
0-10	92	14	106	20.77
11-20	55	5	60	29.18
21-30	29	1	30	41.63
31-40	9	1	10	50.8
41-50	4	0	4	54.5
51-60	3	0	3	51.67
61-70	1	0	1	27.0
71-80	0	1	1	13.0
> 80	2	0	2	11.0
Total	195	22	217	33.28

The average duration of hospital stay was maximum in the BSA group of 41-50% among survived patients which comprises 54.5 days. As the BSA increases the duration of hospital stay increases, but after 50 % BSA the duration of hospital stay decreases due to early deaths.

Table VII. Average stay of electric burn victims in hospital

BSA	Death	Average stay in days
0-10	4	12.25
11-20	3	17.33
21-30	5	13.4
31-40	2	8.0
41-50	2	19.5
51-60	0	0
61-70	2	4
71-80	0	0
> 80	3	17.33
Total	21	10.20

The maximum number of deaths was in from 21-30% BSA group and the average duration of hospital stay was maximum in BSA group 51-60%. This is because the chances of patient survival is less with increasing BSA.

In the study it was found that septicemia contributes maximum (23.81%) as the cause of mortality. Respiratory complication and renal failure are the least common cause of death in burn patient and contribute 9.53% each.

In this study, 31 patients were from electricity department they sustained injury while working at the high voltage 33kv GSS lines. Ten of these patients later died during their management in the burn unit of hospital, remaining 16 (51.6%) patients of this groupsuffered from late disabilities like limb loss, paraplegia , toe loss, which is a significant number.

DISCUSSION

These patients were evaluated with reference to age, sex, religion, habitat, body surface involved, part of the body affected, duration of hospital stay, various operations performed, morbidity, mortality & their causes along with various complications. Study of 238 patients of electric burn shows that maximum number of patients who sustained electric

Table VIII. Part of the body affected

Part Of the Body	Number	Percentage
Head/ Neck	49	20.59
Upper Limb	184	77.32
Chest	78	32.78
Abdomen	57	23.95
Lower Limb	108	45.38

Out of 238 patients, the order of body parts involved was upper limb>lower limb>chest>abdomen>head/neck. Around 184 (77.32%) patients suffered upper limb involvement. Head & neck was the least affected area, i.e, only 49 (20.59%) patients.

Table IX. Various operations performed in electric burn patients

Name of operation	No. of patients	%
Fasciotomy	6	2.5
S.C. Ligation	9	3.7
Amputation	77	32.3
Debridment	52	21.8
Skin grafting	38	15.9
Total surgery	182	76.2

In 238 patients, total 182 surgeries were performed among which 77 patients required amputation. Debridment & skin grafting were second & third commonly performed operations.

Table X. Subclavian artery ligation

Number of patients	Prophylactic		Therapeutic	
	No.	%	No.	%
09	07	78%	02	22%

In this study, 9 patients underwent subclavian artery ligation; among these therapeutic subclavian artery ligation was done in two (22%) patients for radial artery bleeding.

Table XI. Distribution of patients according to level of amputation in upper limb

Level of amputation / disarticulation	Number	%
Interphalangeal	9	13.8
Metacarpophalangeal	5	07.7%
Wrist	6	0.9%
Below Elbow	22	33.8%
Above Elbow	20	30.7%
Shoulder	02	03.07%
Total	64	100 %

Maximum numbers of amputations were below elbow (33.8%). Some of these were converted to above elbow amputations (30.7%). Shoulder disarticulation occurred in two (03.07%).

Table XII. Revised amputations in upper limb electric injury

Revised Amputation	Number	%
Below wrist to above wrist	08	40%
Below elbow to mid arm Elbow	10	50%
Mid arm elbow to shoulder	02	10%
Total	20	100%

Twenty patients had revised amputation in upper limb of which maximum (50%) were below elbow to above elbow. In 10% cases above elbow amputations are converted to shoulder disarticulation.

Table XIII. Distribution according to body surface area involved & mortality/morbidity

Percentage BSA involved	Male		Female		Total		Disability		Mortality	
	No.	%	No.	%	No.	%	No.	%	No.	%
0-10	96	44.8	14	58	110	46.2	57	51.8	4	3.6
11-20	58	27	5	20.8	63	26.4	17	26.9	3	4.7
21-30	34	15.8	1	4.1	35	14.7	6	17	5	14.2
31-40	10	4.6	1	4.1	11	4.6	4	36.3	2	18
41-50	6	2.8	0	0.0	6	2.5	0	0.0	2	33
51-60	3	1.4	0	0.0	3	1.2	1	33.3	0	0.0
61-70	3	1.4	1	4.1	4	1.7	0	0.0	2	50
71-80	0	0	1	4.1	1	0.4	0	0.0	0	0.0
> 80	4	1.86	1	4.1	5	2	1	20	3	60
Total	214	100	24	100	238	100	86	36.1	21	8.8

Most patients in this study had BSA (Body Surface Area) 0-10% involvement between. Mortality was maximum in BSA group of >80% but disability was higher in BSA group of 0-10%.

burn injury were in age group of 21-30 years (27.31%) and M:F ratio of 20.6:1. As the age increases the incidence of electric burn accidents increases up to 30 years, after which incidence decreases. The age group more than 70 years has the least number of burn patients (0.4%). The average age was 30.75 in this study. According to the study of Kid M et al[1] the average age of electric burn patients was 34.9. The cause of more incidence of electric burn in 21-50 age group is due to more exposure to external environment particularly in agriculture field and jobs concerned to electricity handling, like line man etc. In Indian setup, geriatric & pediatric age groups most of the time stay at home with good supervision from all family members. That may be the reason for low incidence of electric burn injury in these age groups. In this study it was found that among the 238 victims of electric burn, 215 (90.3%) were males and remaining 23(9.67%) were females, with a mortality of 9.3% (20) in males and 4.3% (1) in females. Khan N et al[3] studied 111 patients which were admitted at Pakistan Ordinance Factory Hospital and found that 55 % were males and 45% were females. In our study, the majority of affected persons were male because of their involvement in this work and in our setup females are hardly exposed to works where high voltage electricity is used.

In the study majority of the patients (94.53%) were Hindu and rest (5.47%) were Muslim while none of the patients was of any other religion. This is because of more Hindu population in western Rajasthan who are exposed to high voltage electric injury in agriculture field owned by them.

In this study majority of patients (72.2%) were from the rural area. Morbidity in electric

Table XIV. Electric burn & morbidity

Morbidity	Number of patients	%
Upper Limb Loss	37	64.92
Lower Limb Loss	6	10.53
Finger Loss	6	10.53
Toe Loss	2	3.51
Paraplegia / Quadriplegia	5	8.78
Other	3	5.27
Total	59	

Total of 59 patients suffered the disability in which 37 patients (64.92%) lost their upper limb. Second most common disabilities were lower limb loss & digital loss.

Table XV. Cause of mortality

Causes	Total Death	%
Spinal Shock/ Head injury	4	19.05
Septicemia	5	23.81
Respiratory Complication	2	9.53
Renal Failure	2	9.53
Other	8	38.09
Total	21	

Septicemia contributed maximum (23.81%) in the cause of mortality. Respiratory complication & renal failure were the least causes of death in burn patients.

burn patients was more in patients coming from the rural area which is around six times more than urban patients, as the majority of cases of electric burn were referred from peripheral hospital to burn unit of this hospital. It is quite possible that the causes of high incidence of morbidity among the patients from the rural area are because of unavailability of proper treatment in rural areas, lack of general awareness, inadequate precaution and protective measures taken while working in presence of high voltage current.

The present study shows that the average hospital stay was 33.28 days. It was maximum in the 41-50% burn patients with average duration of 54.50 days, and minimum among patients with more than 70% burns (average stay of 14 days). Hospital stay of patients is increases with the increase of percentage of burn up to 50%, thereafter stay increases because these patients had fatal termination as a result of extensive electric burn injury. Twenty-one (6.4%) patients expired in this study and maximum number of deaths were from 21-30% burn patients.

Order of body parts involved by electric burn were: upper limb >lower limb >chest>abdomen >head and neck. Around 184 patients (77.32%) patients suffered from upper limb involvement. Head & neck was the least affected area, i.e, only 49 (20.59%) patients.

Subrahmanayam M et al[7] studied 40 patients admitted in General Hospital, Sungai, India. In the study, extremities were affected in 52.5% patients, head and neck in 2.5% patients, trunk in 2.5% patients, and a combination of these in 42.5% patients.

In 238 patients, 182 surgeries were performed of which 77 patients required amputation. Debridement (52 patients i.e. 21.8%) & skin grafting (38 patients, i.e. 15.9%) were the second & third most commonly performed operations. Fasciotomy was required in six (2.5%) patients and the subclavian artery ligation required in nine (3.7%) patients. One laparotomy was

performed in blunt trauma of abdomen associated with electric burn where duodenal perforation was found and repaired.

The study shows that maximum number of the amputations were below elbow which was 33.8% (22 patients). Some of these were converted into the mid arm amputation 55.47% (10 patients). Shoulder disarticulation occurred in two (3.07%) patients. As the live wires usually come in contact with upper limb effect of electric current is maximum in distal part of the upper limb, hence, the morbidity in form of mid arm amputation was seen in maximum number of patients. Deep tissue injury caused by electricity is much more than it looked from outside. That's why in some of the patients below elbow amputation was converted into mid arm amputation and in some cases shoulder joints had to be sacrificed. In this study ten patients subsequently underwent revised amputation.

Sinha et al[8] (1977) in a study of 80 cases of electric burns from Varanasi, India, reported amputation in patients 45% where as in this study amputation was under-taken in 32% cases. In this study nine patients underwent subclavian artery ligation; among these therapeutic subclavian artery ligation was done in two (22%) patients for radial artery bleeding. In the rest of the cases, subclavian artery ligation was done prophylactically in the patients who had deep wound in axilla as one of the steps in shoulder disarticulation and to prevent bleeding from severely charred upper limb.

In 50% of cases, below elbow amputations were converted into mid arm amputation and in 10 % of cases, mid arm amputations were converted to shoulder disarticulation because of deep tissue injury, which was much more severe in the form of coagulative necrosis of muscle, much beyond the amputation level which was very difficult to assess at first surgery.

In this study, 46.2% (110) of patients had burn percentage area less than 10%. Only 2% (5) patients had burn area of more than 80%. The overall morbidity was 36.1% (86) and maximum number of patients were those with less than 10% burn surface area (51.8%). Mortality was 8.8% (21), which was maximum in burn percentage area more than 80%, where three out of five patients expired. It shows that three / five mortality is directly related to severity of burn. The prolonged survival in patients having less burn surface area is associated with more morbidity as compared to patients with extensive burns with short survival and high mortality.

Sinha et al[8] (1977) in a study of 80 cases of electric burns from Varanasi, India, reported mortality in 3.7% of the patients. However, in our study mortality rate was 8.8%. Clark and Luaser[10] reported direct relationship between the percentage of burn surface area affected and mortality in burn injuries. In another study, Clavdfe[11], 1970, high rate of complications in extensive electric burn areas attributed to body surface area exposed to exterior environment. Fifty-seven

Table XVI. Electric burn & morbidity/mortality in electric department

Years	Number of patients			
	Mortality		Morbidity	
	No.	%	No.	%
2004	1	10.0	9	42.86
2005	2	20.0	7	33.34
2006	2	20.0	5	23.81
2007	5	50.0	0	0.0
Total	10		21	

In this study of last four years, around 31 electric burn patients were from electricity department. Most patients were working in rural areas. Out of 31 electricians, 10 expired which comprises around 47.6% and which is a significant number.

patients resulted in late disabilities, in which 37 patients (42.92%) lost partial upper limb followed by partial lower limb and finger loss and least common disability was great toe loss as the exit wound in these cases was in the sole near the finger because of moist foot but sparing the great toe. One patient had exit wound on anterior abdominal wall who sustained blunt injury. He was explored and duodenal perforation was found and repaired. The incidence of loss of upper limb of upper extremity was high because of direct manipulation of electric devices with bare hands and, in most; the lower limb disability resulted due to exit of electric current through the lower limb. In the study, it was found that septicemia is a major (23.81%) cause of mortality. Respiratory complications and renal failure make up the least common causes of death in burn patients (9.53% each).

Luce and Gottlieb[9] found the overall mortality from renal failure and sepsis to be in the range of 3-14%. This study showed it to be 23.81%. Babik J et al[6] carried outa study at Kosica Saca Burn Centre, Slovakiya, described 96 patients treated for burn caused by electricity in between the period of 1987-1994. In the study of 12355 burn patients, they reported that infection was most important complication with an incidence of 21.3%, which is close to this study.

In this study, 31 patients were from electricity department who sustained burn injuries while working at the high voltage 33kv gss lines. Ten of these patients later died during their management in the burn unit of our hospital; remaining 16 (51.6%) patients of this group suffered from late disabilities like limb loss, paraplegia, and toe loss, which is a significant number.

Fig I. Shoulder disarticulation in electric burn patient with SSG of surrounding area

Fig II. Eixit wound at ABD wall

Fig III. Gangrene if right upper arm and hand

Fig IV. Faciotomy of burn hand

Fig V. Disarticulation of fingers with fasciotomy in high tension electric burn

Fig VI. Disarticulation of great toe at exit wound

Fig VII. Entry wound at hand

Fig VIII. Exit wound at footof same patient's in Fig VII

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