"BURNS CAUSED BY ELECTRICITY".

(A Review of one hundred cases)

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In the modern era, as a sequence of increased use of electricity, electrical burns have become very common. Though they form only a small proportion of all burns, they present special problems. It was in the year 1879 that the first fatal electrical accident occurred. The electric burn is an unique injury and the clinical problems presented by the patients result from both the effects of the peculiar thermal injury and from variable physiologic reponse of the specialised tissue to such trauma. Electrical burn attracts attention not only because of their severe effects but also on account of their characterestic behaviour which is quite different from thermal burn. The extreme heat generated by the resistance of the tissue to the passage of high voltage electrical current, the unpredictable course of the electricity through the body and the variation in the response of individual tissue separates these injuries from other type of thermal injury. Direct current is less hazardous than alternative current. Skin resistance is high so the current when it penetrates the skin produces greater degree of necrosis in the deeper tissue than on the surface. The current in passing through the skin chooses the path of least resistance and is conducted through the tissue fluid along the perivascular spaces and through the blood streams. Thus it leads to degeneration of the vessel wall and thrombosis often at some distance from the site of entry.

To facilitate treatment electrical burns have been classified as :–

(A) Low voltage injury :
  i. Flash
  ii. Contact

(B) High voltage injury :
  i. Flash
  ii. Arc and contact–
    (a) Punctate
      – small
      – large
    (b) Extensive
    (c) Extensive with vascular impairment.

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Management of these severe injuries require knowledgeble appreciation of the potential wide spread anatomic damage and destruction which may be immediately manifest or delayed in appearance. The resuscitative fluid administration is based on the urinary output as the damage involves the deeper structure including tendon and muscles and the ensuing disease state has been simulated more with crush injury The massive amount of muscle, which are often injured result in a release of large amount of myoglobin leading to myoglobinuria. (Boswick and Pandya, 1972). The incidence of renal failure in an electrical burn is all out of proportion to the total extent of skin involvement (Artz, 1974). The local wound management of electrical burns oscillate between late excision and early excision with immediate or delayed cover. The protogonists of the former believe that difficulty in determining tissue viability in the early post burn period dictates conservative debridement (Lewis, 1950). The followers of early excision believe that conservation of function in the area involve, decrease of morbidity and shortening of hospital stay, swings the balance in their favour (Donald B Well, 1929, Muir, 1957-58, Davis, 1958-59, Hunter, 1967).

Material and Method :

The material includes cases admitted in the Plastic Surgery unit of Patna Medical College Hospital in the children and Rajendra Surgical ward for the treatment of electrical burn injury. In all one hundred cases were studied in the present series.

Observation and Discussion :

The patients who were studied in the present series come from different age groups. Young adults (21 to 30 years) accounted for the maximum number of cases (32.5%). In persons above 40 years only few cases ware encountered (7.5%). Salisbury et al (1973) have reported the average age of their patients to be 24 years. Young children are also prone to the hazards of electricity. In the present series 15% of the cases were of the age group below 10 years. Giffords et al (1971) have found that majority of their cases were in the early toddlar age group (74%). In a series of 35 cases of Anderson and Sprensen (1966), 20 patients were below 1 to 2 years or age. Males predominate (80%) as compared to females. This is due to the fact that accident occurs mainly in the fields or on the poles and these sites are usually predominated by males.

Table I

Showing aetiological factors

Aetiological factor.	No. of cases	Percentage.
1. Domestic accidents	32	32%
2. High tension wire injury	45	45%
3. Contact with wire hanging around	13	13%
4. Industrial accidents	10	10%

Forty five cases were of high tension wire injury. Kragh and Erich (1961) and Peterson (1966) in their series also report a high incidence of high tension wire injury. Domestic accident accounted for 32 percent of the cases. Davies (1958-59) in her series of 70 patients reports 38 cases due to domestic accidents. Kragh and Erich (1961) have reported a moderately low percentage of cases due to domestic accidents. The most common cause of these domestic accidents were by touching

open live wire. In some cases the children burn their hands by grasping the heating elements of an electric wire. The high incidence of high tension wire injury may be due to the fact that electricity has penetrated the rural areas where the people are yet to be educated as regards to the consequences of this commodity. Hence ignorance (both on the part of the authority and of the people) accidents occur. Two cases in the present series were encountered where purposely the person touched the high tension wire with a view to commit suicide. Burn by electricity frequently occur in industrial places. Ten cases of the present series were of such nature. These are purely accidental and occured in the normal course of performing their duty.

Table II

Showing part of body involved

Part of anatomy	No. of cases	Percentage
Head and neck	22	22.0
Upper extremity	80	80.0
Chest and abdomen	20	20.0
Genitalia	3	3.0
Lower extremity	65	65.0

The maximum number of cases affected the upper extremity (80%). This finding is also coraborated by Davies (1958-59), Krag and Erich (1961), Robinson et al (1965), Peterson (1966). The frequent involvement of upper extremity is due to the fact that most of the accidents occur while working, and hence the hands are involved. The next common site involved was lower extremity. They are generally involved because it happened to be the site of wound exit as the electrical current is grounded over here. The mouth has not been involved in any of the cases in the present work. This is in contrast with the findings of the other workers, who have reported electrical burn in the region of mouth (Krag and Erich, Robinson et al). This difference may be due to the fact that the mouth is usually burnt by loose electr cal plugs which the children usually take into their mouth left carelessly by their parents, In this part of the country the use of electrical appliances are very remote and hence the chances of children taking the plugs into their mouth are less.

Table III

Showing immediate effects and associated injuries in electrical burns.

Effects	No. of cases	Percentage
1. Loss of consciousness	56	56.0
2. Confusion	20	20.0
3. Convulsion	12	12.0
4. Visual blurring	7	7.0
5. Hyposthesia	5	5.0
6. Fracture	9	9.0

Loss of consciousness has been found in 56% of the cases. This findings collaborated with the findings of other workers, Lewis (1950), Silverside, (1964). This is due the fact that unconsciousness supervenes with the high voltage of injury. As most of the cases of the present work belong to the high tension were injury group, hence this accounts for the high incidence of loss of consciousness. Fracture was associated in 9 cases of the present series. All the cases were due to the direct trauma sustained by fall from height. Burrow's (1936), Poticha et al (1962) have also reported cases of fracture in their series. Fracture in electrical burn cases occured due to two reasons : Firstly due to direct trauma when thrown from a height and secondarily due to violent muscular contraction (Burrow).

Table IV

Showing complications of electrical burn

Complication	No. of cases	Percentage
1. Renal shutdown	10	10.0
2. Infection	34	34.0
3. Secondary haemorrhage	12	12.0
4. Haematuria	5	5 0
5. Gangrene	40	40.0
6. Cataract in eye	8	8.0

In electrical burn although the percentage of burn may be quite low, likelihood of renal failure exists (Moore, Pearl and Nunn, Artz). Ten cases of the present series developed renal failure although the percentage of burn in all these cases were quite low. This was managed by administrating intravenous fluids and mannitol. Three of the cases died and rest managed to be revived. Renal damage is most likely caused by either initial severe shock or due to damage to the renal vessels or most likely by abnormal protein breakdown from the damaged muscles.

Infections were encountered in 34 cases of the present series. Necrosis of the deeper structure added by poor vascular supply is the main cause of high incidence of infection. Cross infection prevalant in the ward is the further factor for the incidence of infection. Robinson et al (1965) has reported about a case where septicemia of an unusual type had developed. Gangrene developed in 40 cases. This most commonly occur in case of high tension injury where the voltage is so high that it damages the blood vessels and the deeper structures. Few of the cases required an amputation. Occurence of cataract due to electrical injury is well established. (Bruner, 1924, Horton, 1926, Hollowway, 1930, Adam and Klein 1945, Robinson et al 1965. Peterson 1966). Cataract occurs in cases which have received injury in the region of scalp. Previous workers were of the view that the cataract occur only in high voltage injury, but in the present work two cases developed cataract where the injury was of low voltage. Horton has also reported a case where cataract developed with low voltage injury.

The management of electrical burn follows on a principle simulating to that of crush injury. High quantity of fluid is administered in comparison to the low percentage of burn involved, which is monitored on the basis of the urinary output. An early proper debridement of the wound is done to prevent renal damage. Three cases of the present series died due to renal shut down, as an early amputation or debridement could not be carried out. Various types of treatment carried out in the present series is given in the chart below.

Table V

Treatment carried out.

Treatment	No. of cases	Percentage
1. Exposure and dressing	32	32.0
2. Excision & skin grafting	62	62.0
3. Excision & cover by flap	8	8.0
4. Skin grafting & later replacement by flap.	4	4.0
5. Amputation	26	26.0

Wells (1929) was the first surgeon to hold the view that early excision in electrical burn provides better result. This view was later on also held by Artz, Bowe, Brown and Fryer, Davies, Gatewood and McCarthy Muir. In the present series 32 cases were treated by exposure and dressing of the wound by applying local antibiotic cream. Sixty Two cases required an excision and skin grafts. Of these in 15

cases the graft had to be repeated as the initial take was not satisfactory. This may be due to the poor vascularity and infection which is common in electrical burn. In 4 cases the skin graft had to be replaced by flap as further necrosis of the tissue occured leading to exposure of bone. Eight cases required cover by flap. These cases were mostly of the upper extremity and involved the hand. The direct abdominal flap was applied and in 2 cases groin flap was attached. Pedicle flap bearing its own blood supply can close the wound and protect this abnormal tissue from the harmful effects of bacterial infection by providing an additional blood supply. Twenty six cases of the present series required an amputation. These were mostly of the upper limb. Smith and Rank (45-46) reported a case where triple amputation of limbs was done for severe electrical burn. Poticha et al (1962) have reported amputation in 12 cases out of his series of 31 cases. Almost similar are the finding of Robinson et al (1965), Gunn, (1967) and Salisbury (1973). Amputation is a life saving measure. In the present series, most of the amputations were done after 72 hours, when a clear line of demarcation is established indicating the level of amputation. In case of burn of the scalp barrier to infection are well sealed and conservative approach is the desired treatment (Gatewood and McCarthy, 1957; Robinson et al, 1965; Sturim, 1969). This principle has also been followed in treating the scalp burn. In 2 cases the necrosed bone completely sloughed out exposing the duramater. Skin graft was applied on the duramater and the result was satisfactory. Gatewood and McCarthy also reports about a case where split thickness skin graft was given on the dura. In 6 cases decortication was done to enable granulation tissue to grow up and delayed skin graft was done. Some of the workers recommend conservative therapy in electrical burn because of initial examination it is difficult to determine the extent of injury. The damage to tissue is progressive, so that it is imperetive to wait till a line of demarcation forms (Lewis, (1950), Dale (1954), Skoog 1963, Robison et al 1965). Muir (1957-58), has explained that local progressive necrosis found in electrical burn is not the direct result of the electrical injury but is due to the bacterial infection of tissue which is viable but whose vitality and power of resistance to infection have been depressed by the specific action of the electrical current. Hence early excision eliminates infection thu conserving and regenerating the less viable tissue.

Summary :

Hundred cases of electrical burn have been studied. Young males adults were found to be more affected and the percentage of burn in most of the cases were rather low. High tension injury was the cause in majority of the cases. The upper extremity was involved in 80% of cases. Cataract in the eye developed in 8 percent of the cases in which the injury was in the region of the scalp. In the region of the hand to restore function an early excision was the treatment of choice. Cases requiring amputation were delayed till a line of demarcation developed. The region of scalp was treated conservatively. As electrical injury simulates crush injury proper and adequate intravenous fluid were administered irrespective of their low percentage of burn.

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