Original Article

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A Retrospective Study of Histopathological Changes in Electrocution in Tertiary Hospital

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Abstract

Background: Injury and death from the passage of electric current through the body is common in both industrial and domestic circumstances. The study has been conducted to find out the incidence of electrocution deaths in tertiary center, common source of electrocution and the study of the pattern of injuries sustained by the victims. Histopathological study of skin lesions and other organs of the electrically injured victims are received for microscopic examination. *Methods and Material:* In the present study, 30 cases of electrocution have been considered. Case details including history are retrieved from records during the period of 2011 to 2016 and have been analyzed. The findings are recorded in proforma and evaluated histomorphologically. *Results*: 30 cases (6.6%) of electrocution deaths, all are males. The highest number of autopsy cases are observed in the age group of 21-30 years, followed by 31-40 years. Most of the victims are electrocuted at work places and very few victims electrocuted in their houses. The most common causative agent is high voltage electricity (93.3%) followed by the home appliances (6.7%). 90% of the cases died on the spot. All the electrocution deaths in the present series are accidental cases and no homicidal or suicidal cases observed. *Conclusions:* The risk of getting electrocuted from the haphazardly installed electric wires without proper maintenance in most parts of the place is indeed a matter of concern. The spread of awareness and adoption of safety measures are important factors required for prevention of fatal electrocution and the study is to look for the consistency in the frequency of these histopathological findings.

Keywords: Accidental; Electrocution; Entry Wound; Exit Wound; High Tension Wire; Skin Lesions; Myocardial Fibers.

Introduction

Electrocution is defined as death caused by the passage of electrical energy through the body [1]. Electrocution is the passage of a substantial electrical current through the tissue, which can cause skin lesions, organ damage, and death. Injury and death from the passage of electric current through the body are common in both industrial and domestic circumstances. The incidence of electrocution deaths in the developed country like the united states during the year of 2002-2008 is 432 (consumer product associated electrocution) [2] and in a developing country like India during 2013 and 2014 are 10218 and 9606 respectively, i.e., 2.1% of all accidental deaths (National Crime Reports Bureau) 2. Electrical injuries commonly involve multiple organ systems. The body injury due to electricity may include burns in the skin and deeper tissues, cardiac rhythm disturbances and other associated secondary injuries due to fall. The current pathway through the body will determine the type and extent of injury and flow through the heart are associated with worse injuries and outcome. Death may be due to ventricular fibrillation, respiratory paralysis, blunt trauma or drowning. These are collectively referred to as electrocution injuries. The electrocuted person may lose consciousness and die due to fall from height or drowned in a bath tub whichever may be the circumstance. Among these, ventricular fibrillation is the most common cause of death. Fatalities are

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almost always accidental.

Hence, the present study has been carried out to assess the incidence of electrocution deaths in tertiary center and to find out the common source of electrocution, and study the pattern of injuries sustained by the victims along with histopathological changes.

Materials and Methods

A retrospective study of 452 deaths during 2011 to 2016 were carried out in the Department of pathology, vydhei Institute of Medical Sciences and Research Centre Bangalore. Analysis of the autopsy cases of electrocution deaths brought to our Centre, have been carried out as regards the history of the cases and post-mortem examination findings are retrieved from case records. The material received are entry and exist wound of skin tissue bits, heart, kidney, lungs and brain for histopathological study. Microscopic details gave clue to the cause of death, findings are recorded in Proforma and analysis done.

Results

In the present study, 452 cases analyzed, 30 cases (6.6%) are of electrocution. The year 2015 had the highest number of electrocution deaths (Table 1), and male victims outnumbered females. The highest number of cases is observed in the age group of 21-30 years followed by 31-40 years as shown in (Table 2). Most of the victims are electrocuted in the work place (90%) and the remaining victims are electrocuted in their houses with common causative agent is high voltage electricity (93.3%) followed by the home appliances (6.7%). Entry and exit wounds caused by the electrical injuries are observed in 40% of the cases but no entry or exit wounds are observed in 6.7% of the cases (Table 3). As shown in (Table 4 a and b), the upper extremity is the most frequently involved site of entry wound (60%) followed by the chest, flank and abdomen 6.7%; while exit wounds are mostly observed in the lower extremities (30%). 90% of the cases died on the spot and the majority of these victims are electrocuted by high tension wire. All the electrocution deaths in the present series are accidental cases and no homicidal or suicidal cases are observed.

Table 1: Year wise distribution

Year wise	No. of cases	Percentage
2011	2	06.7
2012	3	10
2013	7	23.3
2014	7	23.3
2015	8	26.7
2016	3	10

Table 2: Age Wise Distribution of Electrocution Deaths

Age Group (Years)	Frequency	Percentage %
11- 20	4	13.3
21-30	15	50
31-40	5	20
41-50	6	16.4
Total	30	

Table 3: Distribution of entry and exit wounds

Characteristics	Number	Percentage%
Entry only	16	53.3
Entry and exist	12	40
No entry or exist	02	6.7
total	30	

Table 4: Distribution of lesions, site of entry and exist wound

Part of body	Number Entry wound(a)	Percentage %	Number Exist only(b)	Percentage %
Upper extremity	18	60	6	20
Lower extremity	7	23.3	9	30
Abdomen and flank	3	6.7	0	0
No exist	3	10	15	50
Total	30		30	

Table 5: Distribution of histopathological changes occur in different organs and skin

Organ/Tissue	Histological finding	Frequency&Percentage
Skin	Sub-epidermal separation& Epidermal coagulation	28(93%)
Number-30	necrosis Nuclear streaming	25(83%)
Heart	Separation of Myofibers	4(29%)
Number- 4	Alternating hyper contracted hyper distended myocytes	4(29%)
	Square Nucleus expression in myocytes	4(29%)
Kidney	Tubular Necrosis of renal cortex	5(45.45%)
Number -11	Parenchymal breach	3(27.3%)
	Foci of hemorrhage	3(27.3%)
Lung	Congestion of alveolar walls	8(57.1%)
Number- 8	Interstitial and intra alveolar edema	2(14.3%)
	Hemorrhage in to alveolar space	2(14.3%)
Spleen	Rupture	3(100%)
Number 3	Congestion and hemorrhage	
Brain	Edema and Congestion	6(85.7%).
Number-3		

Fig. 1: Microscopy of skin showing nuclear streaming in Electrocution

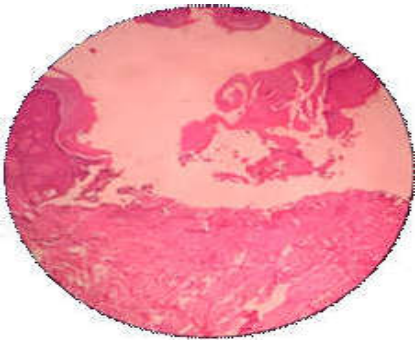

Fig. 2: Microscopy of skin showing epidermal coagulation necrosis

Fig. 3: Microscopy of heart showing bundles of elongation myofibrils

Fig. 4: Microscopy of heart showing square expression of Nucleus within myocytes

Discussion

The wide-spread commercial utilization of electrical power has been associated with a rapid increase in both fatal and non-fatal injuries. In the present study, death of male accounted for 100% of the cases, which is in concordance with the findings of other workers [3,4,5]. The male predominance is attributed to association of men with electrical work and repair of electrical appliances handling more than the women. The peak age group of deaths is between 21-30 years (50%), is very rare in both extremes of ages. This age group is the most active phase in life with higher chances of occupational exposure to risk. Ragui S [3] Bharath *et al.* [5], Gupta *et al.* [6] and Shah and Joe [7] observed similar findings in different parts of the country.

The high rate of indoor deaths (78.06%) is due to accidental electrocution is observed by Dokov [8] in Varna. Similar findings were observed by Byard *et al.* [9] in South Australia, Bharath *et al* [5]. in Andhra Pradesh, and Gupta *et al.* [6] in Gujarat, India. The

findings in the above mentioned groups are not in concordance with that of the present study where most of the cases occurred outdoors (93.3%). The low incidence of electrocution indoors (household) death in the present study could be attributed to the erratic power supply in that place.

In a study by Tirasci et al [10] 42.3% and 18.7% of the cases of electrocuted deaths are caused by electric wires and electric cables at work place. However, in the present study, 93.3% of the cases were electrocuted due to high voltage electricity. This is because of poor maintenance of the electric cables, using of bad quality wires, breakage, which may remain unattended on the road side may be the causes of outdoor accidental electrocution.

Study by Ragui S [3] observed 72 of the cases had only entry wounds while 20% had no entry or exit wounds, similar findings were observed by Tirasci [11]. This is in contrast to the findings of the present study where 53.3% had entry and corresponding exit wounds 40% [Table 3]. In the present study 6.7% of cases does not show any entry or exit wounds, can be due to wet body surfaces at the time of electrocution.

Ragui S. [3], observed 77.77% of entry wounds are observed in the upper limb and 43.75% of exit wounds in the lower limb. Similar findings are observed by Sheikhazadi *et al* [4], Bharath *et al* [5]. and Tirasci [10].

In the present study most of the entry wounds are on the upper extremities while exit wounds are located in the lower extremities as shown in Table 4 (a and b) which are correlated with the above studies.

Ragui S from Manipur India [3] (100%) and Dokov [8](78.06%), electrocution cases were accidental. whereas similar study done by Shah and Joe [7] (61.86%) in Tamil Nadu, Interestingly, in the present series, all the cases are accidental in nature which is correlated with above studies.

In all the cases of electrocution deaths, the histopathological findings of electrically injured wounds are attempted to identify the point of entry and exist.

Microscopy of the Skin

Stefan Jellinek (1871-1968) Austrian scientist [11] studied histopathology of skin changes in several cases on electrocution deaths in the earlier part of 20thcentury. In his work, proved microscopic changes due to electrical injury are consistent. The common microscopic features in the skin are the *streaming of the nuclei, the basal epithelial layers show nuclear elongation, pyknotic nuclei and are tightly packed.* The nuclear elongation is attributable to an electric polarization effect.

The similar changes is corroborated by another scientist Heinlein in 1962. However these nuclear changes are also seen in many other types of injuries such as in blunt dermal injuries, cauterization, blisters following barbiturate poisoning and freezing. Nuclear changes are therefore not specific evidence of electrocution by themselves. The nuclear changes with circumstantial evidence and other corroborative findings, gave a clue towards the conclusive evidence of electrical injury [12].

Bharath *et al.* [6] in his 2 studies and Viswakanth et al [12] observed microscopic findings of the skin due to electrical injury including nuclear streaming, sub-epidermal separation and epidermal coagulative necrosis were 100% and 67%.

Manish *et al.* [13] studied 86 cases of which 15(17.44%) deaths are due to electrical injury. Their microscopic findings of skin which are mentioned above, observed by same group includes 49% and 37% respectively.

In our study, majority of electrocution deaths, shows nuclear streaming (93%), sub-epidermal separation and epidermal coagulative necrosis constitute 83% (Figure 1&2, Table 5). This is in concordance with the above study.

Microscopy of the Heart

Electrical injury seen in the heart as dysrhythmias or coagulative necrosis of the myocardium [13]. The commonest cause of death in electrocution related injury is due to a disturbance in cardiac conduction system causing ventricular fibrillation. Though ventricular fibrillation is considered as the main cause of death following electric shock, electric injury sometimes can cause patchy necrosis of the myocardium [14].

A study was conducted by Vittorio Fineschi *et al.* [15] and by Viswakanth et al [12] observed instantaneous death due to electrocution characterize the morphologic changes. They observed the frequency of myocardial fiber breakup in cases of electrocution accounting for 90% and 100% respectively.

In the present study, a total of 14 heart specimens out of that 4 (29%)(Table 5) cases showing myocardial fiber breaks with squaring of nuclei, areas of thinning, elongation of myocardial fibers (Figure 3 & 4), along with foci of sub endocardial micro infarction. Majority of them are unaccompanied by

inflammatory reaction, which is suggestive of sudden death.

In our study microscopic features of 11 kidney specimens, show acute tubular necrosis with foci of hemorrhage. The organs sent along with skin are heart, lung, spleen which shows congestion, edema. Laceration of parenchyma of the above mentioned organs are due to electrocution or fall from height.

Conclusion

The final diagnosis of death due to electrical injury is based on electrical marks along with the light microscopic changes of the skin and other organs. Following observations, the present light microscopic of skin and other organs show epidermal nuclear streaming, epidermal separation, coagulative necrosis and myocardial fibers breakup in heart, acute tubular necrosis in kidney, congestion, edema, hemorrhage and necrosis present in the other organs gave a clue to death.

The risk of electrical injury due to haphazardly installed electric wires without proper maintenance in most parts of the places is indeed a matter of concern. In addition, the electric power supply system has to be improved with the installation of underground cables for the prevention of unnatural deaths. The important factors required for prevention of fatal electrocution are by upgrading the electrical transmission lines, adoption of safety measures and spread of awareness.

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Conflict of Interest: Nil

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