

Case Series

Electric injury: a case series

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ABSTRACT

In the modern era, electricity acts as a vital zone for mankind. The most important external sign of electrocution is the electric mark. The internal findings of electrocution are usually unspecific. The electric mark can also be of postmortem origin and is therefore not a reliable proof that the electric shock occurred before death, unless the survival time was long enough for an inflammatory response of the affected tissue. Various cases of electrocution have been reported in literature but as per the best of authors knowledge none of them have been clearly explained for the establishment of complete electric circuit in reported cases; required for fatal electrocution. In the present case series, authors' report and discuss the three cases of electrocution under different circumstances with deviations in expectations. Because of the diagnostic problems authors also discuss the significance and careful evaluation of incident/death scene in all definitive as well as suspected cases of electrocution and emphasize on various components required for complete electric circuit for flow of current.

Keywords: Electrocution, Accident, Death scene visit, Burn

INTRODUCTION

Electric injury is commonly called 'electrocution'.¹ "Electrocution" is the term first coined in the late 1800s to describe the government's execution by electric chair to a criminal.² Some authors prefer to use the term electrocution if death occur due to electricity.¹ Three elements are required for fatal electrocution to occur: a charged electrical source, a current pathway through the victim, and a ground.³ Factors involved in electrocution are basically divided into two categories: factors related to the nature of electric supply like voltage, amperage and form of current; and factors related to the victim like resistance of the body tissues, area of contact of the body, duration of contact, earthing/insulation.⁴

In practice, a distinction is made among four voltage ranges: extra-low, low, high, and extra high voltage. In India, household voltage is usually 220 volts with a

frequency of 50 Hz. The low-voltage range goes up to 600 volts, while the high-voltage range is between 600 and 1,000 volts and higher.⁵ Due to highest litigation rate is well known in cases of electric injury deep knowledge of electric injury and mechanism of electric injury/death is important for forensic expert as well as for the clinicians to decide treatment protocol and prognosis. Therefore, complete history, correlation of circumstances with injuries over body, incident scene visits and complete autopsy is required to ascertain the cause and manner of death in the cases of electric injury. Electricity may also be involved in human rights cases and the forensic expert may be called upon to consult on electrical torture cases.⁶

In present case series, authors report and discuss the features of low voltage electrocution under different circumstances and highlights the gross, microscopic findings of electrocution and correlation of such injuries with scene of death. The reported cases are important for

the researchers as well as for the experts from different specialty to make policies and diagnosis in their practices.

CASE SERIES

Case 1

A 40-year, average built male farmer was brought to casualty department of tertiary health care center with alleged history of electric shock. At the time of admission, the patient was unconscious, pulse rate was 110 beats/minute and irregular. Blood pressure 90/60 mm of Hg. Suddenly, his condition deteriorated and he expired after few minutes. The police were informed and the dead body was shifted to mortuary for autopsy. Inquest report and death summary was submitted to autopsy surgeon. As per the history obtained from next of kin, the victim was wearing only an underwear and had a parna (a cotton towel which is used to clean the sweating) hanged over his shoulder region. He was watering his fields when some technical fault occurred in the water motor and it had stopped working. He discussed this matter with a co-farmer and he went to resolve the issue in a room where starter of water motor was installed. After a while, the co-farmer noticed some sort of smoke coming out from the respective room. He immediately reached there and observed that; the deceased was lying on the ground and he was not responding on call. The parna were ignited and electric wires were burning with sparking. During the incident, it was noticed that the deceased was bare feet and his feet were wet.

On external examination, the body was naked. An electrocution entry wound of size 6.5×4.5 cm was present over flexor aspect of right hand. On dissection, margins were hard, indurated and elevated. On dissection, base was pale, surrounded by a zone of pale area. A red line of demarcation was present. An electrocution exits wound of size 2.5×1 cm was present obliquely over flexor aspect of right foot with splitting of skin and charring (Figure 1).



Figure 1: Depicting oval shaped circumscribed electrocution wound with charring and surrounded by a pale zone.

On dissection, underlying soft tissues were pale with extravasation of blood in surrounded soft tissues. Multiple

other injuries were also present and superficial to deep burns were present over pinna of right ear, posterior aspect of neck, chest, abdomen and constitute about 18 percent antemortem burn. Hair over back of trunk were singed with wrinkling and blackening of skin at places (Figure 2).



Figure 2: Depicting first to four degree burns over posterior aspect of neck and trunk with singing of hairs at places.

Multiple stitched wounds of length varying from 2 cm to 6 cm which was surrounded by patterned abraded contusion was present over anterior aspect of chest wall. On dissection, underlying and surrounding soft tissues were found ecchymosed and ribs were found intact. On internal examination, all the organs were congested and stomach contained semi-digested food material and mucosa over lesser curvature of stomach was congested. All the injuries were antemortem in nature. Blood was negative poison including alcohol.

During autopsy, no clothes were present over body and pattern and distribution of injuries including burns were suspicious in this case. Later, autopsy surgeons along with investigating officer made a visit to scene of death and they noticed the following: The iron door of the room was opened. The motor starter was fixed on wall at the height of five feet from the ground and floor of the room was hard and made up of concrete. The wall near to circuit was blackened. The electricity wires attached to the starter were found blackened and uncovered. The broken pieces of circuit breakers/fuses were scattered on the ground. Wooden blocks of irregular surface were kept on ground. A slab of stone was present near the iron door of the room (Figure 3).

Case 2

A 30 years average built male electrician was brought to emergency with alleged history of fall from height while working on electric pole. At time of admission, he was in gasping state, vitals were un-recordable and oxygen saturation was 89 percent. Other investigations could not be done due to poor condition. Clinician made diagnosis of chest injury with electric shock. He remained unconscious till death then body was shifted to mortuary for autopsy. In inquest papers and history taken from his

coworkers, he was stand on iron ladder and repairing wire meter wire of complainant. Later he suddenly fallen on a stone over ground. The height of pole was about 20 feet and he had not taken any protective measures like thick rubber gloves.

On external examination, clothes were intact. The shirt was stained with reddish brown blood stains at places and sleeves were folded up to elbow joint. Blood-stained secretions were coming out from both nostrils and mouth. An electrocution entry wound of size 3.5×2 cm was present over extensor aspect of right hand. It was surrounded by multiple flash burns, blackening and wrinkling of skin (Figure 4).

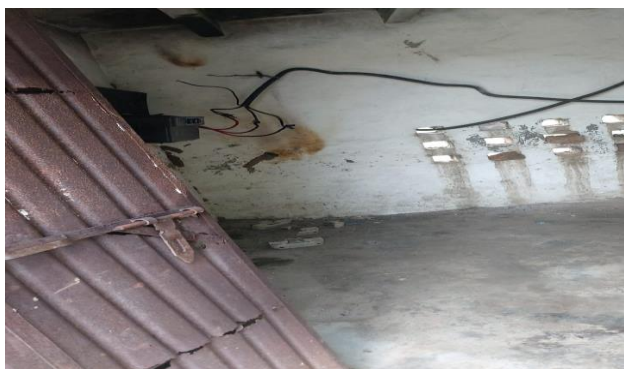


Figure 3: Depicting installed water motor starter on the wall with power input terminal wire is uncovered and blacking of wires, wall and floor in adjacent area where the victim was electrocuted.



Figure 4: Depicting electrocution wound with flash burns, charring of skin and wrinkling of skin over the forearm and hand due to electrocution.

The wound was centrally depressed and margins were hard, indurated and surrounded by a zone of hyperemia. On dissection, underlying soft tissue were found pale. On internal examination, diffuse reddish contusion was present over posterior aspect of right side of chest wall and multiple ribs of right side in paravertebral region were found fractured through and through with extravasation of blood in intercostal muscles. On exploration, pleura was torned and 750 ml liquid blood was present in right pleural

cavity. On dissection, posterior and lateral surface of right lung was found contused and lacerated (Figure 5).

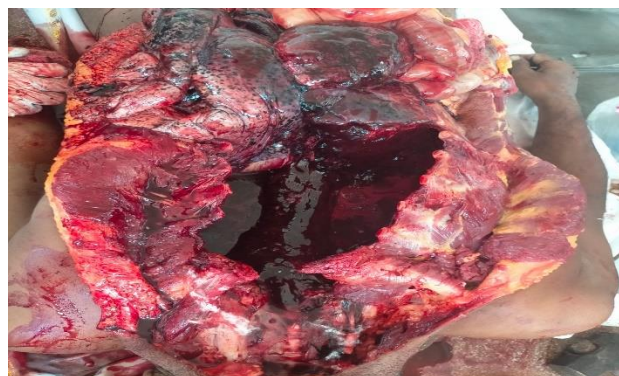


Figure 5: Depicting liquid blood in right pleural cavity with contusion and collapsed lower lobe of right lung due to fall from pole.

Other organs were congested. Viscera was negative for alcohol and poison. Cause of death was opined thoracic injury due to fall consequent to electrocution, which is accidental in manner.

Case 3

A 26 years old average built male worker was brought dead in accident and emergency department with history of fall from table while he was changing fused bulb at the home. Dead body was sent for autopsy. After receiving inquest report from investigating police and history obtained from his spouse, he fallen on ground due to slipping of foot. The height of bulb holder from ground was approximately 10 feet and his feet were naked during incident. At prima facie it was a case of fall from height.

On external examination, all the clothes were intact. A reddish abraded contusion of size 6×3.5 cm was present horizontally over left supra clavicular region. On dissection underlying and surrounding soft were found ecchymosed. A reddish abrasion of size 2×1 cm was present over left lateral malleolus. A reddish abrasion of size 3.5×2 cm was present vertically over lateral aspect of upper part of left arm and it was raising suspicion of electrocution wound but no exit wound of electrocution was noticed over body (Figure 6).

To rule out electrocution, skin sample was sent for microscopic examination to confirm the diagnosis and make sure the flow of current. On internal examination, all the organs were found congested and stomach contained semi-digested food material with hyperemic mucosa at places. After complete autopsy cause of death was kept pending for preserved samples. Later pathologist reports the sent sample showed changes of electrocution (Figure 7). After considering the relevant reports cause of death was opined as “accidental electrocution”.



Figure 6: A suspected electrocution wound over lateral aspect of right arm with a zone of hyperemia and pale base on dissection.

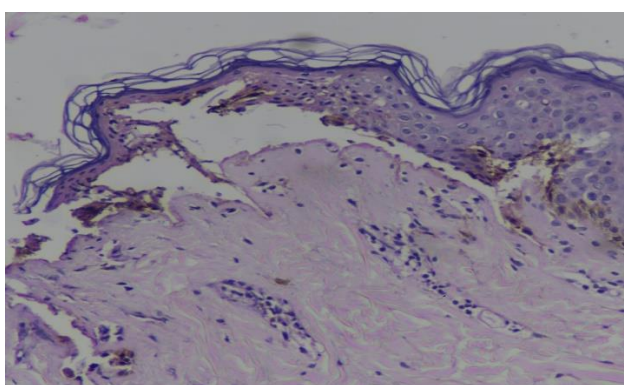


Figure 7: Depicting suprabasal bullae, infiltration of inflammatory cells in basal layer, nuclear or cellular elongation, necrosis and epithelial separation at places due to electrocution.

DISCUSSION

In general, electric current flow is directly proportional to water content of tissue. For example, heart and blood give allow more flow i.e. give less resistance than skin.⁷ The effect of passage of an electrical current through the tissue can cause merely cause skin lesions to death.¹ For death occur due to electrocution, the human body must become a part of an active electrical circuit.⁸

Electric current takes the path of least resistance and cause endogenous thermal damage. Most of the deaths occurred due to electricity by ventricular fibrillation due to passage of current affect the physiological conduction.⁹

In cases of electrocution, electric mark (Joule burn) is specific and diagnostic of contact with electricity.¹⁰ Tyagi et al reported electric marks and joule burns are often seen only with low or medium voltage current and also both entry and exit marks are seen together only in 20% of cases.⁷ In present series first case showed both entry and exit marks of electrocution but second case showed only entry wound of electrocution. Third case had a suspected electrocution wound.

In 2020, electrocution constitute 3.6 percent (13446) of total reported mortality but this was 3.3 (13432) percent during 2019, which clearly indicate significant increase in incident rate of electrocution.¹¹ In western world, cases of suicides, homicide are common as compared to accident but in developing countries like India majority of electrocution fatalities are accidental in manner.¹²

Giri et al conducted a study under different facets of electrocution deaths. He found that 47.7% cases in his study were electrocuted at home and all cases (100%) were electrocuted accidentally. Most of cases in his study were came in contact with uninsulated wire and histopathological examination of skin in 67.04% cases showed electric injury.¹³ In present case series, three victims were electrocuted at different places but manner of death in present three cases is similar to his study i.e. accidental. In the discussed case series, all cases were coming in contact with electric wire and third discussed case showed significant changes on histopathology.

Referring to the three cases presented above, the following points can be reported.

In case 1, the injuries other than electrocution were also present. After incident scene visit, authors were able to conclude that non-electrical injuries like burn injuries over back were due to ignition of clothes and injuries over chest from being thrown by electricity on wooden blocks and strike on slab. After considering the autopsy findings and incident visit, authors opined the cause of death is electrocution and its complications which is accidental in manner. A circuit was complete in this case as: an electric source i.e. uninsulated wire, pathway for flow of current i.e. body of victim, and a ground i.e. victim was stand on ground with bare feet.

In case 2, the injuries other than electrocution were also present. After complete autopsy and incident scene visit report, authors are able to conclude that the inflicted chest injury was due to fall on a stone over ground consequent to electrocution. Later, authors opined the cause of death is thoracic injury consequent to electrocution, which is accidental in manner. A circuit was complete in this case: electric source i.e. uninsulated wire on pole, pathway for flow of current i.e. body of victim, and a ground i.e. victim was stand on iron ladder; which is sufficient to act as a ground for flow of current.

In case 3, at prima facie this was a case of fall from height. But during autopsy, no fatal injuries were noticed except a suspected wound of electrocution over body. After complete autopsy, death scene visits and histopathological examination of skin, authors were able to conclude that, this was a case of electrocution. Later authors opined the cause of death is electrocution, which is accidental in manner. A circuit was complete in this case: active electric source i.e. broken bulb holder, pathway for flow of current i.e. body of victim, and a ground i.e. victim accidentally touched his arm with iron pipe which was connected to

underground pipeline which is sufficient to flow of current.

In view of the above, all cases behaved differently, this presentation is a deviate to expectations but it gives a significant contribution on electric conduction through the body.

The possibility of having no exit marks of electrocution may be because the body was not on its weight or erect posture directly touching the ground hence offer zero resistance to flow of current.

CONCLUSION

Mere autopsy findings were not confirmatory of electrocution and authors were able to ascertain the cause and manner of death in all the cases after incident scene visit. Electrical injuries in adults are work-related. This is another addition to reported cases of fatal electrocution.

Recommendations

Although all household and industrial appliances are thoroughly tested and certified still electricity cause significant mortality. Authors emphasizes that proper education, awareness and training to general as well as those who deals with electricity may reduce the fatal electrocution. made the work friendly environment by providing the protective measures and emergency services at work place.

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