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Original Research Article

A RETROSPECTIVE STUDY ON PATTERN OF ELECTROCUTION DEATH IN WESTERN ODISHA

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Abstract

Background: Due to the extensive use of electricity in homes and businesses, fatal electric injuries are relatively frequent. Consequently, each and every instance of electrocution needs to be thoroughly researched. **Materials and Methods:** The purpose of this study, which ran from January 2019 to December 2022, was to investigate the causes of deaths, seasonal fluctuations, places where they occurred, sources of contact that caused electrical injuries, lengths of survival, postmortem findings, and histological skin contact findings. A total of 6852 autopsy were performed throughout this time. **Result:** In all cases, petechial haemorrhages were seen over the heart (38 cases), lungs (56 cases), conjunctiva (07 cases), and brain matter (08 cases). Internal organs also shown congestion in all cases. Samples from the electrical injury's contact skin were always saved for histopathological analysis. Out of the total samples, 69.0% of the cases displayed every sign of electrical injury (infiltration of inflammatory cells, streaming of nuclei, coagulative necrosis, and epithelial separation), 8.3% of the cases displayed just these two signs, and 9.5% of the cases displayed none at all. **Conclusion:** A medico-legal case involving electrocution death necessitates thorough attention in order to accurately document the unfortunate victim's actual cause of death as well as to identify any flaws that should be fixed to avoid another electrocution at the same location in the future. Each of these deaths may have been prevented because they are all the result of either victim or equipment fault.

INTRODUCTION

Around the world, electrocution injuries play a significant role in morbidity and mortality. In India, electrocution-related injuries and fatalities are quite common. People are typically electrocuted by accidentally touching a current source, though this does happen occasionally, as does an electric flash arc that pounces on them from a low-voltage domestic supply or when they accidentally enter the magnetic field of a high tension electric supply. The primary effect of electricity is shock, which is caused by its current, and damage from electrocution rely on a variety of parameters, including the voltage and frequency of the current, the length of time it is in contact with the body, the ambient circumstances, and the path the current takes through the body.[1] Despite the fact that the human body is a poor conductor of electricity, damp surfaces like the ground enhance the risk of electrocution, which is a typical occurrence during rainy seasons. It is impossible to imagine modern society existing without electricity. The incidence of electrocution caused by electric current has increased as electricity has merged with humanity. Electrocution is the term used to describe any death brought on by an electrical shock to the body. The invention of electricity was hailed as a blessing for civilization, but its use in residential settings has continued to be associated with an increase in fatalities, either as a result of a lack of public awareness or blatant negligence on the part of the general population. Electric current is an essential component of modern human existence, both at home and at work. The exact extent of damage caused by electric current depends on the type of electric current, the strength of the electric current, and mostly the length of exposure to the electric current. Even though product safety has significantly improved and laws and regulations are properly implemented, electrical injuries still cause a significant amount of death and morbidity in affluent countries.[2] Because of a lack of understanding and inadequate safety measures,

electrocution-related deaths are becoming a public health concern, particularly in low-income nations.[3] According to official data on suicides and accidents in India for the years 2010 and 2011, there were 9059 and 8945 electrocution deaths, respectively, accounting for 2.4% of all unintentional deaths.[4] In India and internationally, electrocution deaths are practically never intentional and only a small number of incidents are documented in forensic work as such.[5] When compared to the national average, Western Odisha has the greatest rate of accidental deaths. The purpose of this study was to determine the frequency, victim profile, electrical injury pattern, and method of death in the studied population.

MATERIALS AND METHODS

This retrospective study was conducted in the Department of Forensic Medicine and Toxicology of VIMSAR, Burla, India. Total 6852 autopsies were conducted from January, 2019 to December, 2022 and of them, 84 cases in which death was alleged due to electrocution were selected for this study. All these cases were studied irrespective of their age and gender, and we also tried to find out the seasonal variations, if any, in cases of electrocution. Detailed and complete autopsy examination was conducted with the aim to find the area of body parts affected and types of electric injury, whether it is a contact injury or flash burns due to a spark. Information regarding the incidence of electrocution was collected from the police papers, and autopsy reports were taken into consideration to conclude the manner of death, whether it was suicidal, accidental, or homicidal in nature. Finally, the data were collected and analyzed after comparing with those of Indian and foreign authors.

RESULTS

Between January 2019 and December 2022, 6852 medico-legal autopsies were completed. A total of 84 of these involved electrocution brought on by electric current. Seventy of these 84 incidents included men, while fourteen involved women. They ranged in age from five to seventy-two (Fig. 1). Only one incidence was reported in the age bracket of children under 10 years, when the majority of electrocution deaths (33.3%) occurred. The cases were all accidental (100%) in nature. Table 2 and Fig. 2 demonstrate the seasonal occurrence of mortality from electrocution events. 39.2% of the instances were from the rainy season, 33.3% from the summer, and 27.3% from the winter. In fig.3, the majority of cases (61.9%) and rural regions (38.09%) were both urban.

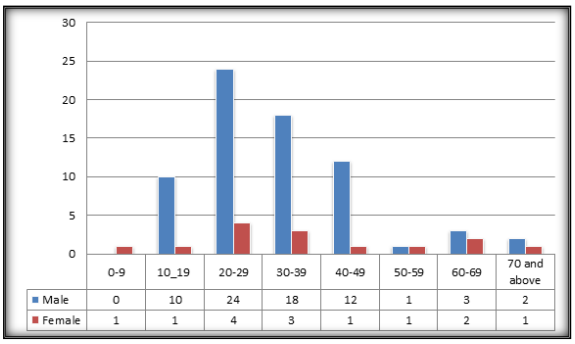

Figure 1: Shows the age and sex wise distribution of subjects

Table 1: Shows the distribution of subjects according to age and sex wise

Variables	Male	Female	Total (%)
Summer	22	06	28(33.3%)
Rainy	30	03	33(39.2%)
Winter	18	05	23(27.3%)
Total	70	14	84(100.0%)

Table 2: Shows the seasonal Variation of Electrocution deaths.

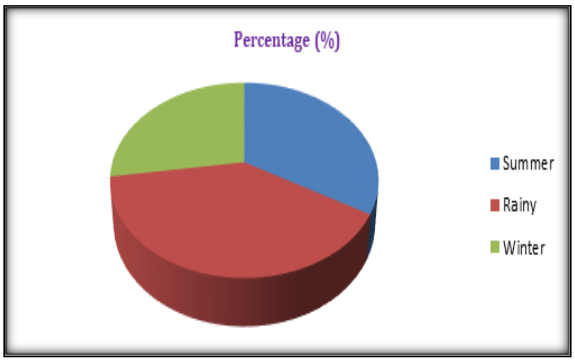

Figure 2: Shows the Seasonal Variation of Electrocution deaths

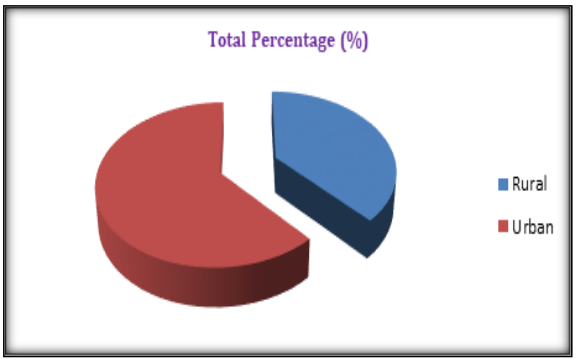

Figure 3: Shows the Rural versus urban wise distribution of cases

Table 3: Distribution of cases according to place of occurrence

Workplace	Male	Female	Total (%)
At work	20	02	22(26.1%)

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At home	30	12	42(50.0%)
Outside	20	02	22(26.1%)
Total	70	14	84(100.0%)

In terms of where the cases happened, 50.0% happened at home, 26.1% happened somewhere other than the workplace or home, and 26.1% happened at work (Fig. 3). Out of the total occurrences of electrocution, those that occurred outside of the house or place of employment were primarily caused by overhead railroad wires (10 cases), then by uninsulated wires on farms used to keep wild animals at bay or uninsulated wires in public spaces left accidentally open. According to Table-5's source of electrocutions, touching live electrical wires was the leading cause of death (35.7%), followed by handling electric rods for water heating improperly (23.8%), overhead wires (11.9%), evaporative water coolers (16.6%), and electric switchboards (11.9%) in table-4.

Table 4: Shows the distribution of cases according to source of electrocution

Source	Male	Female	Total (%)
Switch board	10	00	10(11.9%)
Evaporative water cooler	07	07	14(16.6%)
Electric rod for water heating	13	07	20(23.8%)
Overhead wire of train or electric pole	10	00	10(11.9%)
Live open uninsulated wire	30	00	30(35.7%)
Total	70	14	84(100.0%)

As opposed to lower extremities (7.1%), entrance wounds were more frequently found on the upper extremities (61.9%), particularly the palm and fingers. Multiple sites were included in 19.0% of patients (Table 5).

Table 5: Shows the case distribution according to primary contact site

Site of contact	Male	Female	Total (%)
Upper extremity	46	06	52(61.9%)
Lower extremity	06	00	06(7.1%)
Trunk	00	05	05(5.9%)
Whole body involvement (multiple sites)	16	00	16(19.0%)
No injury	02	03	05(5.9%)
Total	70	14	84(100.0%)

Table 6: Shows the distribution of cases according to type of electric injury

Site of contact	Male	Female	Total (%)
Only entry wound	42	05	47(55.9%)
Entry + exit wound	05	03	08(9.5%)
Flash burns	06	00	06(7.1%)
Electric burns	15	03	18(21.4%)
No injury	02	03	05(5.9%)
Total	70	14	84(100.0%)

In 80% of all cases, there was direct contact with electricity. 55.9% of these instances only had entry wounds, while 9.5% had both entry and exit wounds. 5.9% of instances, however, did not exhibit any electric harm (Table 7).

Table 7: Shows the survival period of victims of electrocution

Survival period	Male	Female	Total (%)
Brought dead	51	13	64(76.8%)
0–6 h	02	01	03(3.5%)
7–12 h	00	00	00(00.0%)
13–24 h	03	00	03(3.5%)
25–48 h	02	00	02(2.3%)
48–72 h	00	00	00(00.0%)
> 3 day	10	00	10(11.9%)
Total	70	14	84(100.0%)

According to the medical care received, 21.4% of patients were alive and receiving hospital care when they passed away, compared to 76.8% of patients who were certified dead upon arrival (Table 7).

Table 8: Shows the histological findings of contact skin in electrocution

Histological features	No. of cases (84)
Coagulative necrosis + baseline streaming of nuclei	02(2.3%)
Coagulative necrosis + epithelial separation	07(8.3%)
Streaming of nuclei	05(5.9%)
Only infiltration of inflammatory cells	04(4.7%)

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All of the above findings	58(69.0%)
Negative	08(9.5%)

In all cases, petechial haemorrhages were seen over the heart (38 cases), lungs (56 cases), conjunctiva (07 cases), and brain matter (08 cases). Internal organs also shown congestion in all cases. Samples from the electrical injury's contact skin were always saved for histopathological analysis. Out of the total samples, 69.0% of the cases displayed every sign of electrical injury (infiltration of inflammatory cells, streaming of nuclei, coagulative necrosis, and epithelial separation), 8.3% of the cases displayed just these two signs, and 9.5% of the cases displayed none at all (Table-8).

DISCUSSION

The death rate associated with electricity also began to increase after it was invented and used commercially. A sharp rise in both fatal and non-fatal injuries has been linked to the increasing usage of electricity.[6,7] Electric current-related deaths in India are caused by voltages of 220-240 V alternate current, while reports of deaths from lower voltages of 15 V AC have also been made.[8,9] Males made up 86.4% of all fatalities, or the majority. This might be because men are exposed to electrical risks more often. This is comparable to the Lindstroo et al. study.[10] The age range of 20-29 years saw the highest percentage of fatalities (33.3%), followed by that of 30-39 years (25.0%); the combined number for both age ranges was 58.3%. The reason could be that a person who is between the ages of 21 and 40 is the one who earns a living. People in their second to fourth decades actively engage in electricity-dependent tasks more frequently, whether at work or at home, making them more susceptible to electrocution risks. These outcomes matched the findings presented by Kumar et al.[11,12] Since electrocution is a rare cause of death and typically occurs accidentally, all deaths in this study were accidental in nature. The examination of the literature confirms the rarity of electrocution-related suicide or homicide.[13,14] However, Karger et al.[15] observed a greater rate of electrocuted suicides. The rainy season (39.2%) (July-October) and summer (33.3%) were the seasons with the most fatalities. The findings of Kumar et al.[11,16,17] were similar to those of the rainy season's high rate. Due to fluctuations in humidity, wetness, and individual behaviour, electrocution-related deaths vary seasonally. Increased humidity and heavy use of electric appliances like coolers, air conditioners, and refrigerators during the summer may be to blame for an increase in electrocution-related fatalities.[18] Additionally, excessive sweating brought on by the hot and humid weather reduces the skin's resistance to electric current, which might result in electrocution. In the current investigation, it was discovered that there were more cases and incidences of electrocution among urban residents than among rural residents. Surprisingly, there were no female victims of electrocution out of the total 38.09% instances in the rural population. In the urban population, female cases were also substantially lower than male ones. There are fewer electrical connections in homes and workplaces in rural India, and particularly in our region, than there are in urban areas. Additionally, it is rare for rural areas to receive energy, and some of them experience load shedding, which is the periodic halting of the power supply by the government. As a result, people interact with electric equipment less frequently and with less intensity. This may be one of the causes of the rural areas' low case rates. Similar to how "Early to bed and early to rise" is more common in rural than urban regions, early evening meals are followed by rest (sleep). As a result, users interact with electrical devices and electronic newspapers less frequently. In the current study, electrocution incidents at homes were more frequent than those at work or other locations. At work or elsewhere, there were no female cases. The majority of female electrocution cases were observed in domestic electrocution occurrences. This was significantly different from studies conducted by other researchers, who discovered that fatalities at work were more common than those at home.[18] The increased use of electrical appliances at home may be to blame for this. Such equipment might provide an electrical hazard if improperly placed or operated. Such incidents might be caused by improper earthing, overloaded circuits, malfunctioning equipment, and other factors. Out of all the incidents of electrocution, those that occurred outside of the house or place of employment were primarily caused by overhead railroad wires, followed by uninsulated wires on farms used to keep wild animals at bay or uninsulated wires in public areas left accidentally open. In this investigation, inadvertent contact with electricity that is typically available for home use caused more than half of the fatalities. All other occurrences involved low-voltage electric current sources, with the exception of those in which victims were electrocuted after catching the overhead wire of a train. In contrast to domestic accidents, which are frequently caused by defective household equipment, frayed or broken electrical cables, and poor earthing, workplace mishaps are often caused by carelessness and an underestimation of the danger of live circuits.[19,20] As a traditional external indicator of electrocution, the distinct damage marks created at the site of electrical current contact (entrance mark) and joule burns can be evaluated. In nearly half of the autopsied cases, just the entry mark was observed, whereas roughly 9.8% of cases revealed both the entry and exit marks. The conclusions agreed with Di Maio's.[21] findings. Voltage, current flow, contact area, and contact time all affect whether an

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electrical injury may occur. An electrical burn only happens when the skin's temperature is elevated for long enough to cause damage.[22] On the other side, a passing bump or fall on a conductor causes a circuit break; in situations involving high-tension supply, the victim is typically violently expelled. However, there may be sufficient current to make it challenging for someone to remove their body parts.[23] Four of the instances had no signs of an electric burn. The victims in each of these incidents came into touch with water. Wet skin provides less resistance to the flow of electricity than dry skin, hence there are no apparent electric burn marks at the point of contact. In these situations, factors including the presence of eyewitnesses and improper earthing of electrical devices or circuits aid in formulating a conclusion regarding electrocution. Because extremities are the most frequent sites of contact with the source of electric current, the hands and fingers of the upper extremities are the most common sites for electrical injuries (entry marks), whereas exit wounds were typically seen on the soles and toes of the lower extremities. The results agreed with those of Erkol'sstudies.[24] Out of everyone, 80.95% were brought in dead, while 19.04% passed away while receiving treatment. Since the upper extremities was engaged in 61.9% of instances in this study, it is well known that the electric current is particularly harmful when it uses a circuit that involves the heart muscle. Due to the spread of low-voltage AC current (220–240 V) utilised in Indian homes and small-scale industries, there were a high number of electrocutions at the site. When low- or medium-voltage current is used, the joule burn and electric markings on the body are crucial indicators of electrocution. In situations of electrocution, electric markings are frequently absent. To support the conclusion that the death was caused by electrocution in such circumstances, a histological study of the skin from the electric wound was carried out. As seen in 90.47% of instances that showed evidence of electrical damage, it has been noted that histological analysis may play a significant role in the diagnosis of electrocution. In 69.0% of these modifications, all indications of electrical damage were identified. In many cases, electrical injuries result in high temperature burns, which yield characteristic collagen findings of severe thermal denaturation that stain the collagen blue with haematoxylin. It was possible to see the epidermis separating along with the development of microblisters both in the horny layer and the squamous epithelium. At the site of an electrical burn, the nuclei of epidermal cells stretch and constrict, giving the area a palisade-like appearance. The streaming of the nuclei is a common name for this transformation.[25]

CONCLUSION

The unlucky victim's actual cause of death must be documented, and any conditions that should have prevented the victim's death from electrocution must be identified in order to prevent similar deaths in the future. These deaths are typically unintentional and preventable if appropriate safety measures are taken. Use caution when working with broken or malfunctioning appliances, uninsulated wiring, etc. Use of electrical devices or gadgets that children cannot handle should be discouraged. Children should never have access to an electric switchboard. According to our investigation, water coolers pose an increasing electrical hazard. By introducing correct earthing to it, this is easily avoidable. Additionally, one should take out the plugs and leave the water cooler in the off position when filling it with water. Residents who live close to high-tension wires or individuals who climb on the railway bogie's roof are particularly at risk of electrocution. So, it is best to avoid such interaction. In the end, staying safe is possible if you follow safety procedures when using electrical equipment.

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