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Original Article

An Epidemiological Study on Cases of Electrocution Referred to the Autopsy Hall of Tehran Province Legal Medicine Office

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ABSTRACT

Objective: Annually, a significant number of electricity-induced deaths (electrocution) occurs throughout the world. According to the report by the Iranian Legal Medicine Organization (LMO), 6750 cases of electrocution were referred to the autopsy halls of LMO during 2004–2014. In addition to death, a large number of non-fatal electrical accidents are associated with severe and sometimes irreparable injuries such as extensive burns, skeletal fractures, loss of vision and hearing, brain damages and paralytic dysfunctions. **Methods:** This study was carried out on 124 cases of electrocution referred to the autopsy hall of Tehran Office of LMO. Clinical and autopsy findings entered in related forms and analysed by statistic methods. **Results:** The victims were mostly low educated, young (21–30 years old) male workers, who were electrocuted by accidental exposure to electricity through urban power lines. In most cases the accident had occurred in residential settings and an electric mark was evident in 88.7% of cases and frequently on the victims' hands. The most common findings in autopsy were bleeding and pulmonary congestion. Conclusion**:** Preventive measures such as educational programs on the usage of electrical instruments, sufficient safety measures in dangerous environments like industrial plants, workshops, power transfer stations, and high-voltage posts, and increasing the level of awareness in this regard among industrial workers, electricians and others who deal with electrical current.

Keywords: Electrocution, Electrical injury, Autopsy findings, Electric mark, Electricity Induced Death, Electrical Accidents, Trauma

INTRODUCTION

As human societies move toward industrialisation, electrical shocks are being seen as one of the common hazards, which sometimes result in serious harms and even death, and considering their medical aspects as well as social and psychological consequences is equally important from a legal point of view[1].

The passage of electrical current has various effects on body organs and tissues, depending on the course of the current through the body, and sometimes threatens one's life. This injury is commonly called electrocution, though some authors use this term only if death occurs[2,3].

Various mechanisms are involved in causing injury and death by electrical current, including cardiac arrest, electricity-induced spasm of respiratory muscles leading to asphyxiation, extensive burns resulting in infection and septicemia, different types of bone fractures following muscular spasm or traumas secondary to collision with objects or falling, dysrythmia and cardiac shock subsequent to cessation of vital cerebral functions[3-5].

The severity of damage is directly related to a number of factors, which include type of current, potential difference, amperage, tissue resistance, course of current and its duration[6,7].

In the present study, cases of sudden death due to electrocution referred to the autopsy hall of Tehran Office of LMO were included in order to carry out an

epidemiological survey on them in terms of age distribution, gender distribution, education level, mechanism of death, autopsy findings, location of death, final cause of death, etc.

MATERIALS AND METHODS

This has been a cross-sectional descriptive study aimed to present epidemiological aspects of electrocution in cases referred to the autopsy hall of Tehran Office of LMO. The studied population consisted of proven cases of electrocution and those cases in which there was a doubt about electrocution as the definite cause of death were excluded from the study. Confirmation in each case was obtained through evaluation of the scene, eyewitness testimonies and autopsy findings. Anonymous questionnaires with burial certificate number, containing items like personal, social and educational characteristics, location of the scene, causes of the accident, final cause of death, presence of electric mark and its location and autopsy findings, were prepared and given to our colleagues in the autopsy hall. These questionnaires were completed within the study period for all cases of electrocution referred to the autopsy hall of Tehran Office of LMO. In order to ascertain the diagnosis of electrocution, hospital medical records (if available), results of laboratory evaluations and the death scene report were also studied in each case.

In cases with incomplete information or documents, family members of the victim were contacted to elicit further information and those cases that remained incomplete or those where there were doubts about electrocution as the final cause of death were excluded from the study. Thereafter, the data were gathered and statistically analysed.

RESULTS AND DISCUSSION

From among the 124 cases of deaths due to electrocution in the study period, 117 (94.4%) were male and 7 (5.6%) were female, which is consistent with results of other similar studies (e.g. 96% male and 4% female in one study)[1,8,9].

More than one-third of the victims were between 21 and 30 years old, followed by 31 to 40 and 41 to 50 year olds (Figure 1). It should be mentioned that similar studies have revealed that electrocution was more common in

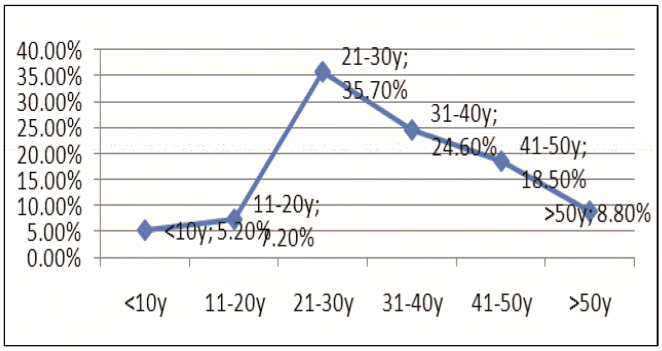

Figure 1: Age distribution of victims of electrocution referred to the autopsy hall of Tehran Office of LMO in 2009–10

the second and third decades of life and in one study the mean age of victims was reported as 24, which is similar to our results[1,10].

In most cases, the level of education of the victims was below high school diploma (45.9%), followed by high school diploma (10.4%), B.A or B.S (8.8%), occupational and technical diploma (7.2%), M.A or M.S (3.2%) and doctorate or higher (1.6%).

In terms of marital status, 50.8% of the victims were single and 45.9% of them were married. It should be mentioned that 4 victims (3.2%) were unidentified and their marital status, occupation, and level of education, as well as the source of electricity, the cause of electrocution and its place of occurrence were unknown.

Most of these victims were blue collar workers (38.7%), followed by those who were unemployed (27.4%), had non-governmental jobs (18.6%), were government employees (7.3%), housekeepers (4.8%) or their occupation was unknown (3.2%). Similar studies have shown that most cases of electrocution are seen among workers (ironsmiths, welding and electrical industries)[11,12].

In 82.2% of cases urban usage power lines were the source of electricity and in 14.6% of cases a high voltage source was involved and in 3.2% of cases the source was unknown. In another study on cases of electrocution in Towhid Hospital (a specialised burn and trauma centre in Tehran) 75% of cases were reported to be caused by low voltage sources and another study reported as 50[1,13].

In the present study, 92% of deaths were due to accidental

exposure to electrical current, 3.2% were suicide and 1.6% homicide cases that is consistent with other studies reporting most cases due to accidents (sometimes occupational accidents) followed by suicide and homicide[1].

The final cause of death in a majority (70.2%) of cases was electrocution and then skull fracture due to fall after exposure to electrical current (Figure 2).

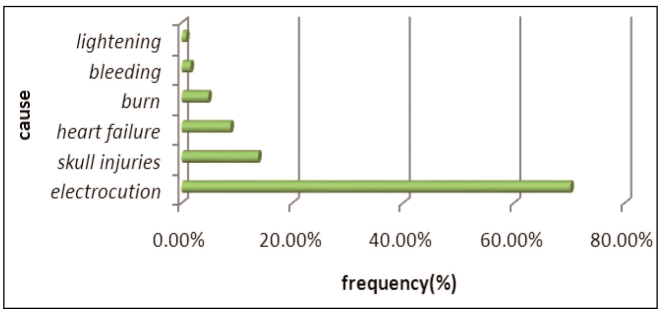

Figure 2: Distribution of frequency of the final cause of death among victims of electrocution referred to the autopsy hall of Tehran Office of LMO in 2009–10

In the present study, it was revealed that most cases (41.2%) had occurred at home, followed by workplace (33.8%), street (16.9%), other places (such as swimming pool) (4.9%) and unknown (3.2%). These results are in complete agreement with a similar study that has given the figure for workplace accidents as 30%. In 110 cases (88.7%) there were clearly visible electric marks and in 14 cases (11.3%) no electric marks were observed. In most of these cases (46.7%) the electric mark was seen on hands of the victims, while the least observed place of electric mark (3.2%) was neck (Figure 3).

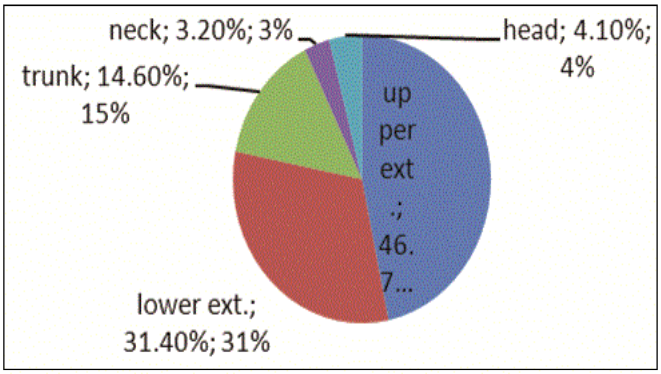

Figure 3: Distribution of frequency of the place of electric mark among victims of electrocution referred to the autopsy hall of Tehran Office of LMO in 2009–2010

These results are more or less similar to those of other studies[3,7].

In our study, there were suspected electric mark in 17 cases (13.7%), for which skin samples were taken and sent to pathology laboratory. The reports included 11 positive and 6 negative results. The number of suspected samples in a similar study (1999-2000) was reported as 25% of all samples[1].

Figure 4: Electric mark in a 32-year-old man's foot

Figure 5: Electric mark in a 32-year-old man's foot

Figure 6: **Electric mark in a 22-year-old man's hand who was an electrical industry worker**

The most frequent finding in autopsies pulmonary congestion and bleeding (64.3%) and the least frequent one was amputation of limbs (2.5%) (Table 1). All of these are non-pathognomonic for electrocution and have been referred to in reference books and various papers[14–17].

Table 1: Distribution of frequency of autopsy findings among victims of electrocutionreferred to the autopsy hall of Tehran Office of LMO in 2009–10

Autopsy finding	Frequency (%)
Intra cranial haemorrhage	34.2
Pulmonary edema	12.1
Brain edema	37.3
Pulmonary haemorrhage	64.3
Bone fracture	9.1
Amputation	2.5
Cyanosis	34.4
Facial petecia	39.1
Brain injury	24.6
Visceral petecia	51.7

CONCLUSION

There is no doubt regarding the importance of electrocution and its mortality in relation with the issue of its causes, both legally and medically. In the present study, no electric mark was observed during the autopsy (in 11.3% of cases) and the expressed opinions were based only on the evidence found through criminal investigation and statements of eyewitnesses of the scene, since in many cases no sign or sequel is seen on the body of the victim or within it and autopsy helps to rule out other factors that may be involved in each case. The similarity of the results (regarding distribution of frequency by age, gender, occupation and level of education) of the present study with other studies on the same issue reveal the fact that most cases of electrocution have occurred in young, under-educated, male blue collar workers, especially in industrial plants, and most of them were caused by urban electrical current during an accident. All of these indicate the necessity of preventive measures in this regard. Adherence to safety regulations at home (the most common place of electrocution in our study and workplace as the most common place of electrocution in some other studies) and ensuring the proper usage and functioning of electrical appliances and instruments, especially in places like bathrooms, and to avoid using defective and non-standard instruments (e.g. hair -dryers and heaters) as well as using proper clothing in hazardous locations to prevent electrocution are some of the most essential points to be mentioned[18,20,21].

The present study and other similar ones show that in less than one-fourth of cases there has been a need for pathological evaluation to confirm the diagnosis of electrocution, and this indicates that although autopsy findings in victims of electrocution are, in very rare instances, used to confirm this diagnosis, determining the final cause of death is mostly done through noting the presence of electric mark, careful investigation of the scene of death, criminal records (if available) and statements of eyewitnesses. Given the course of the current that usually enters through hands and exits through feet, the statistics regarding the place of electric mark (hands and feet) are evidently similar to other studies that emphasises the point about the necessity of care in using safe clothing) i.e. thick plastic gantlets and standard insulating jackboots)by industrial workers, electricians and others who deal with electrical current, during their work[19,21]. As mentioned earlier, autopsy findings are non-specific and may be seen in various other conditions (e.g. drowning, frostbite, various kinds of suffocation, etc.). Finally, the most important point about electrocution is to provide preventive approaches, since, apart from its mortality, physical and/or mental morbidities may result from it, which are mentioned in reference books to be as high as 10% in cases of electrocution[5,7,20]. These may include amputation, need for skin grafts, complications of falling (e.g. fractures, bleeding and other injuries) that cause pain and suffering for the individual and impose

high costs both on the individual and the society. Hence, preventive measures such as educational programs on usage of electrical instruments, sufficient safety measures in dangerous environments like industrial plants, workshops, power transfer stations, and high-voltage posts, and increasing the level of awareness in this regard among industrial workers, electricians and others who deal with electrical current.

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