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ORIGINAL ARTICLE

A Comprehensive Retrospective Evaluation of Autopsy Findings and Histopathological Changes in Cases of Fatal Electrocution in Western Ghats of Karnataka, India.

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ABSTRACT

Background: Aim of this study is to give an account on autopsy findings and histopathological changes in fatal electrocution cases. Secondary aim was to know the epidemiological profile, cause of death and its relation to survival period in fatal electrical injuries.

Study design: A retrospective study was undertaken of all fatal electrocution cases autopsied in mortuary of Dr. Prabhakar Kore Charitable Hospital of Belagavi, Karnataka, India between January 2011 to December 2021. Data was collected from autopsy reports, police information and hospital records. It was further analyzed and expressed in percentage.

Results: Cases represented 8.2% of all autopsy cases. Only 27% cases were due to low voltage electric current. Burn injury was seen in 81% of total cases. 43% cases showed both entry and exit mark. When skin of this area was sent for histopathological examination there was mononuclear infiltrate and subepidermal separation seen. There were interstitial hemorrhages on right atrium of heart and hemorrhagic foci were seen on kidneys and lungs too. Petechial hemorrhages were seen on heart, lungs, brain.

Conclusions: Histopathological findings can be used as evidence in determining cause of death. Deaths due to electrocution demands more closer awareness.

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keywords |Electrocution; Voltage; Burns; electric mark; autopsy; cause of death

INTRODUCTION

Death due to passage of electric current is defined as electrocution. There are numerous research and studies carried out all over the world on deaths due to electrical injuries. Most common causes of electrical deaths include careless behavior while using electrical equipments, improper maintenance of equipments and unawareness among public regarding safety techniques.[1]

Fatality also depends on person's characteristics, environmental factors, type

of electric current, source of electric current. These deaths are mostly accidental in nature, suicides and homicides from electrocution are very rare and If we rectify these common causes deaths are preventable and prevention is always better than cure.[2]

In today's world for smooth functioning of our day to day activities electricity plays very important role. We should not forget that human body is good conductor of electricity and hence when our body comes in contact with unprotected electrical source there are pretty high chances that electricity will flow through our tissues and may lead to fatal outcome.[2]

Year by year there have been constant rise in electric injuries and previously no such detailed study has been carried out on electrocution related deaths in this area which prompted to take up this study to evaluate various epidemiological aspects, pattern of injuries, cause of death, histopathological changes, survival period and to compare it with observations of other authors.

METHODS

This study is cross sectional retrospective investigation of fatal electrocution cases autopsied in mortuary of Dr. Prabhakar Kore Charitable Hospital of Belagavi, Karnataka, India between January 2011 to December 2021. This is a tertiary care hospital attached to Jawaharlal Nehru Medical College. Deaths due to lightening were excluded as current cannot be measured.

Detailed analysis was carried out on basis of hospital records and post mortem reports. Ethical approval was obtained from Institutional Ethics Committee of Jawaharlal Nehru Medical College, Belagavi to conduct the study.

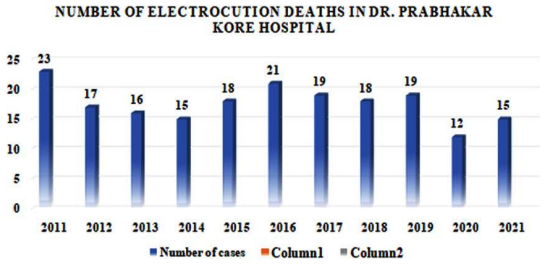
A diagnosis of electrocution fatality was made on basis of post mortem findings of electrocution, information furnished by police, hospital records and exclusion of other causes of death.

Data was analyzed with respect to age and sex of victim, season of year, time of day, place of occurrence, body region involved, voltage, type of electric mark, percentage of burns, cause of death, post mortem changes, histopathological changes, survival period.

The statistical analysis was done and data was analyzed and expressed in form of percentage in figures, tables and charts.

OBSERVATION AND RESULTS

In present study among autopsies which were carried out between 2011 to 2021 a total of 193 cases were of electrocution due to electric current out of total 2354 autopsies (8.2%) (Graph 1).



Graph 1: Total number of electrocution cases over 11 years

Out of these only 12(6%) were female while 181(94%) were male. There ages were ranging from 5 to 60 years. Most of the deaths due to electrocution were between age of 20-40 years (60%), there were 37 cases (19%) below 20 years. (Table 1).

Table 1: Cases as per age and sex

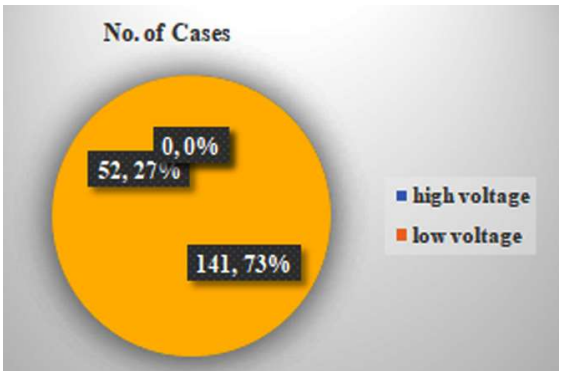
Age group (years)	Male	Female	Total
< 10	7	3	10
11- 20	25	2	27
21- 30	57	3	60
31- 40	58	1	59
41- 50	24	3	27
51- 60	10	0	10
Total	181	12	193

All (100%) cases were accidental in nature (Table 7). The rainy season comprised of 54% followed by summer 30%. Most deaths occurred between 12 noon to 6 pm (62%). 67% of total cases occurred in work place/ non domestic environment (Table 2).

Table 2: Seasonal and diurnal variation along with place of occurence

-	No. of cases	%
Season		
October – January (Winter)	35	18.9
February – may (Summer)	56	29.7
June – September (Monsoon)	102	54
Time		
6 am – 12 noon	53	27
12 noon - 6 pm	120	62.16
6 pm - 12 am	15	8.1
12am – 6 am	5	2.7
Place		
Domestic	63	32.4
Non domestic	130	67.56

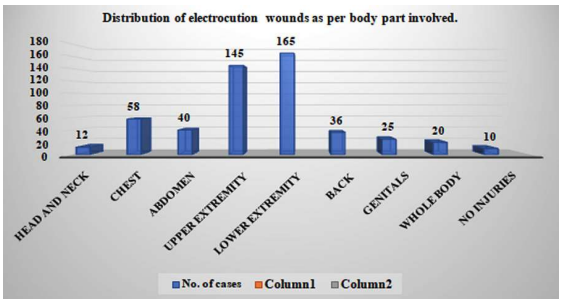
About 73% of cases were due to high voltage electric current (Pie 1).



Pie 1: Cases as per voltage of current

Burns were recorded in 81% of cases. Only entry mark was seen in 22% of cases. Both entry and exit mark were present in 43% of cases. No changes were seen in skin in 27% of cases. (Table 3)

Table 3: Distribution of cases as per body part involved



Lower extremity was involved in 85% of cases followed by upper extremity and chest (Table 3).

Table 3: Types of electrical injuries

Type of electrical injuries	No. of cases	Percentage
Only entry mark	42	22
Only exit mark	15	8
Both entry and exit mark	83	43
No mark	52	27
Burns	156	81
Other injuries (mechanical)	37	19

The survival period was less than 12 hours in 43% of cases whereas it was more than 7 days in 29% of cases. The cause of death was septicemia in 35% of cases followed by cardiac complications like arrythmias and ventricular fibrillation and burns shock. (Table 4)

Table 4: Survival period and Cause of Death

Survival period	No. of cases	Percentage
0-12 hours	83	43.2
12- 24 hours	11	5.4
1-3 days	16	8.1
3-7 days	26	13.5
>7 days	57	29.7
Total	193	100
Cause of death	**No. of cases**	**Percentage**
Septicemia	68	35.13
Burns shock	31	16.2
Ventricular fibrillation	21	10.8
Toxemia	5	2.7
Multiorgan failure	5	2.7
Hemorrhagic shock	16	8.1
Cardiac complications (arrythmias, Myocardial infarction)	47	24.3

Internal organs showed congestion in 64% of cases followed by edema in 51% of cases. Petechial hemorrhages were present over heart, lung, brain in 27% of cases. There was presence of fuild in abdominal and pleural cavity in 35% of cases. (Table 5)

Table 5: Manner of death

Manner of death	No. of cases	%
Accidental	193	100
Suicidal	0	–
Homicidal	0	–

Only 30% (58 cases) were sent for histopathological examination. Out of total samples which were sent for histopathological examination 89% were positive for mononuclear infiltrate and 72% subepidermal separation. Involvement of heart was seen in 74% of cases whereas lung involvement was seen in 66% of cases whereas brain was involved in 91% of cases. (Table 6)

Table 6: Autopsy findings of cases based on signs of electric current flow through body.

Signs of electric current flow	No. of cases	Percentage
Petechial hemorrhages	52	27
Edema	98	51
Congestion	124	64
Subdural, subarachnoid hemorrhages	19	10
Subcapsular hemorrhage	10	5
Fluid in pleura and abdominal cavity	68	35

Table 7: Histopathological changes in electrocution (58 cases were sent for histopathology)

Organ/Tissue	Histological finding	Frequency	Percentage
Skin	Mononuclear infiltrate	52	89
	Subepidermal separation	42	72
Heart	Rupture of pericardial vessels	43	74
	Interstitial hemorrhages on right atrium	19	33
Kidney	Congestion	36	62
	Acute tubular necrosis	34	59
	Hemorrhagic foci	41	71
Lung	Congestion of alveolar walls	35	60
	Interstitial edema	38	66
	Hemorrhage into alveolus	27	47
Spleen	Congestion	47	81
Brain	Edema	35	60
	Congestion	53	91
Liver	Edema	29	50

DISCUSSION

The widespread use of electricity in every phase of life is responsible for increase in both fatal and non fatal injuries.

In our study death of male attributed to around 94% of total cases with most common age group as 20-40 years. This is mainly due to association of men in repair of electrical appliances and other electrical work as compared to women and more occupational exposure in age of 20-40 years. A study by sachingiri in Nagpur, Radha kabbur in Banglore, B. Mukheerjee in Loni showed similar findings.[3-5]

In present study rainy season attracted maximum fatalities (54%), this may be attributed to humid and warm environment and less resistance of wet skin to electric current in rainy season. Similar findings were seen in study by Shaikh Moinuddin in Telangana, Beemshetty Rajesh study in Vishakhapattanam, Kusa Kumar study in Coimbatore, B. Mukheerjee in Loni showed similar findings.[5-8]

Domestic place of incident includes residential areas and non domestic places include electric poles, industries, factories. In our study place of incident was non domestic in 67% of cases, findings were similar in B. Mukheerjee in Loni, kumar study in lucknow, contrast findings were seen in Rautjiet al study in delhi.[5,6,9]

Lower extremity was most commonly involved in our study whereas upper extremity was most commonly involved in Mukheerjee in Loni, kumar study in lucknow and Rautaji et al. study in South Delhi.[5,6,9]

International Electrotechnical Commission defines high voltage as more than 1000 volts of alternating current and above 1500 volts of direct current and low voltage as upto 1000 volts of alternating current and upto 1500 volts of direct current. High voltage current was responsible for 73% of cases in our study whereas in shaikh Moinuddin study at Telangana high voltage current was responsible in 56% of cases. Incontrast to this low voltage was responsible for 61% of cases in study by AkcanRamazan in Ankara.[7,10]

In our study presence of entry and exit wound was seen in 43% of cases whereas in Mukherjee study at Loni only 17% cases showed entry and exit mark and in Mohd. Khan study at Aligarh showed only 29% cases with both entry and exit mark.[5,11]

Present study showed that survival period was less than 12 hours in 43% of cases similar findings were seen in Pathak study at Jaipur, Reddy study at Puducherry.[12,13]

All cases in our study were accidental in nature, similar findings were seen in Rautaji et al. study of South Delhi, kumar study in lucknow, Ankan Study at Ankara, shaha study at Coimbatore.[6,9,10,14]

Commonest cause of death in present study was septicemia followed by cardiac complications like arrythmias, ventricular fibrillations, myocardial infarction and burns shock. Whereas septicemia was cause of death in only 25% cases in shaikh Moinuddin study of Telangana.[7] Electrocution associated burns was responsible for death in 7% cases in study by beemshetty at Telangana[8] in contrast to our study where burns shock was responsible for death in 17% cases.

In present study Internal organs were edematous (51%) and congested (64%) in maximum cases. Similar findings were seen in beemsetty study at Telangana and Pate study at Thane, saha Study at Coimbatore.[8,14,15]

Out of total cases which were sent for histopathological examination 89% showed skin involvement (mononuclear infiltrate, subepidermal separation) whereas in a study by shaikh Moinuddin all 100% cases showed skin involvement and 93% cases showed skin involvement in a study by kabbur at el study at Bangalore, present study findings were in contrast to study by Sachin Giri at Nagpur where 67% cases showed skin involvement.[7,3,4]

CONCLUSIONS

The overall findings of our present study are in accordance with other similar studies carried out in different parts of India.

Majority of electrocution fatalities are occupational and accidental in nature. Therefore deaths due to electrocution demands more closer awareness and are preventable. Hence safety campaigns should be implemented to minimize fatalities due to electrocution. Damaged electrical appliances should be repaired at earliest at home or workplace and electrical transmission lines should be routinely upgraded.

Most of cases of present study were due to contact with high tension electric cable. People who are working in electrical department should first be given proper training before doing any electrical repairs.

In our study on 40% cases showed entry and exit wounds. Hence proper crime scene investigation and detailed history with accurate autopsy should be undertaken as it becomes difficult for autopsy surgeon to diagnose electrocution as cause of death, suspected cases should be confirmed by histopathology and electron microscopy.

Our study showed diurnal and seasonal variation. Maximum cases were reported in rainy season, precautionary measures should be undertaken like not walking in waterlogged

or flooded areas as electrical lines may be snapped due to wind and water.

STRENGTHS AND LIMITATIONS

The strength of this study is that we have addressed and stressed on parameters like histopathological changes in skin and other organs, autopsy findings of cases based on signs of electric current flow through body, cause of death, survival period which are often missed in majority of similar studies. No such study considering all these parameters was conducted so far in state of Karnataka.

Limitation of the study is that even after conducting 11 year study sample size was less due to low incidence of deaths due to electrocution. As study is retrospective so we had to rely on data collected by others and not all cases with skin changes were sent for histopathological examination as diagnosis of death due to electrocution is based on electric contact wound marks and light microscopic changes in skin and other organs.

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