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Original Research Article

Retrospective study of lightning fatalities in Raigarh, Chhattisgarh

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ABSTRACT

Lightning is a massive electrostatic discharge caused by the circulation of warm moisture-filled air through unbalanced electric field in the atmosphere, accompanied by the loud sound of thunder.**Aims & Objectives:** The present study was conducted to ascertain the pattern of lightning cases along with distribution of cases based on age, sex, season, location, activity of the victim and injury pattern in the corpse.**Materials & Methods:** The present cross sectional retrospective study was carried out in the department of Forensic Medicine at Govt. Medical College, Raigarh, CG. All autopsy cases of lightning deaths from 2018 to 2019 (two years) were considered for the study.**Discussion:** Most of the deceased were in the age group of 31-40 years. All incidents happened in open field. High incidence of lightning deaths occurred during monsoon season and peak incidence in evening hours. In most cases arborescent mark was found as pathognomonic finding.**Conclusion:** Lightning incidents are always accidental in nature. They are fatal and need prompt resuscitative measures. Lightning injuries have bizarre presentation in the body, therefore the autopsy surgeon needs meticulous and detailed methodical approach during autopsy.This is an Open Access (OA) journal, and articles are distributed under the terms of the [Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License](https://creativecommons.org/licenses/by-nc-sa/4.0/), which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.For reprints contact: reprint@ipinnovative.com

1. Introduction

Lightning is a massive electrostatic discharge caused by the circulation of warm moisture-filled air through unbalanced electric field in the atmosphere, accompanied by the loud sound of thunder. A typical cloud to ground lightning strike can be over 5 km long.¹ A typical thunderstorm may have three or more strikes per minute at its peak.² Lightning strikes 40–50 times a second worldwide, for a total of nearly 1.4 billion flashes per year.³ Cloud-to-ground (CG) lightning accounts for 25% of lightning globally. Lightning is not distributed evenly around the planet.⁴ About 70% of lightning occurs on land in the tropics, where most thunderstorms occur. The north and south poles

and the areas over the oceans have the fewest lightning strikes. The place where lightning occurs most often is near the small village of Kifuka in the mountains of eastern Democratic Republic of the Congo⁵, where the elevation is around 975 meters (3,200 ft). On an average this region receives 158 lightning strikes per square kilometer a year.⁶ During thunderstorm the lightning flash/stroke discharge, many current peaks varying from 10,000-200,000 Amp occurring in fraction of a second affecting an area of about 30m distance.⁷ Because lightning can travel through air, plumbing systems, and land phone lines, it can struck people working in open fields or in their houses until 30 minutes after the final thunderclap is heard. Victims may present with minor injuries with no loss of consciousness to severe cardiopulmonary arrest or fatal injuries, however, the long-term effects on their lives and the lives of their family

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members can be devastating. Singh O. and Singh J. (2015)⁸ had concluded that Lightning is a common meteorological hazard in India.



Fig. 1: Appearance of lightning in air

2. Epidemiology

About 240,000 incidents regarding lightning strikes happen each year.⁹ According to National Geographic, annually about 2,000 people are killed worldwide by lightning.¹⁰ According to the National Oceanic and Atmospheric Administration, over the last 20 years, the United States averaged 51 annual lightning strike fatalities, placing it in the second position, just behind floods for deadly weather.¹¹ Singh O. and Singh J. (2015)⁸ had mentioned top 10 fatality incidents of lightning recorded in India during the period 1979–2011 are as follows-

Again Singh O. and Singh J. (2015)⁸ after consideration of records of Indian Meteorological Dept. (IMD), Pune had mentioned that 5259 persons have been killed by lightning strikes in India during 1979-2011 and at the same time maximum number of lightning fatalities was observed in the states of Maharashtra (29%), followed by West Bengal (12%) and Uttar Pradesh (9%).

2.1. Review of books and literatures

Indian authoritative figures like Reddy and Murty (2014)¹², Arurba Nandy (2013)¹³, Parikh (2014)¹⁴, Bardale (2011)¹⁵ and Pillay (2017)¹⁶ had discussed about the forensic aspect of death due to lightning. Apart from Indian authoritative figures foreign authors like- (a) Saukko P. and Knight B. (2016)¹⁷, (b) Gordon I., Shapiro H. A. and Berson S. D. (1991)¹⁸ had discussed about forensic aspect of death investigation in lightning cases. Apart from authoritative text books there are several researchers had published research work with respect to death due to lightning are appended below-

1. Study of Gadge SJ and Shrigiriwar MB (2013)¹⁹ at Yavatmal, Maharashtra had mentioned (1) Maximum

number of death due to lightning was found between the age group of 21-30 years, followed by 11-20 years and 31-40 years. (2) Females were predominant over males. (3) Married deceased were predominant over Unmarried deceased. (4) According to occupation of the victims farmers were maximum in number followed by labourers, (5) Maximum cases were brought dead, (6) With respect to autopsy findings, in most of the cases burns over the body was found.

2. Study of Gunethi BK and Singh UP (2015)²⁰ at Khammam, Telengana had mentioned — (1) Males were predominant over females, (2) Maximum cases were brought dead, (3) Maximum cases were found in the age group of 31-40 years, followed by 21-30 years of age group. (3) Maximum number of deceased belongs to agricultural workers, (4) The pattern of injuries is noted as burns over body in 94.73% cases with maximum cases having Lichtenberg figures 68.42%.
3. Study of Shrigiriwar MB, Gadhari RK, Jadhao VT, Tingne CV, Kumar NB (2014)²¹ at IGGMC, Nagpur had revealed that- (1) Maximum victims were farmers and farm labourers, (2) Males were predominant over females, (3) In most of the cases victims were standing /sitting under tree, followed by working in field, (4) In most cases of deaths bodies of deceased persons were found in remote areas with torn clothes and burn injuries.
4. Study of Manukonda R.V., Debash E., Tsegaye S., Ingale D. (2018)²² had mentioned the following findings- (1) Majority of the victims are farmers (87%) in the age group of 31-50 years (78.2%) with a male predominance ratio of 7:1, (b) Majority of the cases (74%) showed no specific findings internally, (c) Twenty six percent of the cases which showed specific internal findings ranged from petechial hemorrhages on the heart, lungs and brain to fractures of bones.
5. Study of Prakash C. and Tayal I. (2013)²³ had informed about (1) death due to direct lightning strike, (2) death due to indirect lightning strike.

3. Aims & Objectives

1. Study of pattern of lightning cases
2. Study of year and season wise distribution of cases
3. Frequency of cases based on age, sex etc
4. Distribution of cases based on location of incident, activity of the victim and injury pattern

3.1. Justification for the study

1. Academic- Study of findings of lightning cases
2. Helping investigating agencies in correct identification of cases as well as correlation with circumstantial findings.

Sl. No	Date	Year	Place	No of Victims
1	18 th July	1996	Hazaribagh (Jharkhand)	39
2	6 th July	2000	Balia (Uttar Pradesh)	27
3	6 th June	2004	Basti and Gonda (Uttar Pradesh)	25
4	28 th Sept.	2004	Nashik (Maharashtra)	31
5	19 th June	2006	Hingoli (Maharashtra)	24
6	25 th June	2006	Gwalior (Madhya Pradesh)	30
7	13 th Mar	2007	Balia and Basti (Uttar Pradesh)	28
8	30 th June	2007	Raigad (Maharashtra)	25
9	27 th June	2010	Yavatmal (Maharashtra)	24
10	11 th Aug	2010	Sapaul (Bihar)	52

4. Materials and Methods

The present cross sectional retrospective study was conducted in the department of Forensic Medicine & Toxicology at Late Shri Lakhiram Agrawal Memorial Govt. Medical College, Raigarh (CG). All the post-mortem records of lightning cases conducted at mortuary of KGH, Raigarh (CG) were considered for the research study. All cases other than lightning were excluded from the study. People of all age groups from both sexes were included in the study. The study was conducted from 1st Jan 2018 to 31st Dec 2019 (Two Years). All the data were collected and subjected to statistical analysis.

4.1. Photographs



Fig. 2: Arborescent burn mark over chest



Fig. 3: Singeing of scalp hair in lightning

5. Data Analysis

Table 1 During the study period out of 1109 autopsy cases, only 06 cases were death due to lightning, i.e. 0.54% of total autopsy cases.

The Table 2 shows that maximum cases were found in the age group of 31-40 years. The victims from both sexes were equally affected.

Table 3 According to the data all the cases were found in open spaces.

Table 4 It had been observed that maximum number of death cases occurred while working in farm land and while taken shelter under a tree or alike. Apart from that death of one victim was also reported when the victim was communicating in mobile phone and returning to home from market.

The Table 5 shows that maximum incidents had occurred during monsoon season (05 cases, 83.33%) and during evening hours. One case was also reported in afternoon.

Table 6 It had been observed that burn injuries due to lightning were found in different parts of the body of the victims. This suggests that almost all parts of body can be affected in lightning.

Table 7 In most of the cases (05 out of 06 cases) typical arborescent mark of lightning was observed in the body of victims. In 50% of the cases singeing of hair was present and in most of the cases, effects of lightning on clothing was absent. In one case SAH (Sub arachnoid haemorrhage) was also found.

6. Discussion

In our study maximum number of victims were in the age group of 31-40 years, which matches with the study of Gunethi BK, Singh UP (2015)²⁰ and Manukonda Rajeev Varma et al (2018).²² It was found in one study that the female victims were predominant over male¹⁹ but reverse finding²¹ was also recorded in another study from the same state therefore finding of equal number of male and female deceased in our study is quite possible. In our study most of the cases occurred in open field, which matches with the study of Chao TC et al (1981).²⁴ Since there was no structural barrier to protect the victim from the aggression

Table 1: Year wise distribution of cases

Sl. No	Year	Total No. of Autopsy cases	Total No. of Lightning cases	% of case
1	2018	551	01	0.18%
2	2019	558	05	0.90%
Total		1109	06	0.54%

Table 2: Age wise distribution of cases

Sl. No	Age group (in years)	No. of victims
1	0-10	01 (M= 01)
2	11-20	01 (F= 01)
3	21-30	01 (M= 01)
4	31-40	03(M= 01, F= 02)
5	41-50	00
6	51-60	00
7	60 & Above	00
Total		06 (M= 03, F= 03)

Table 3: Distribution according to place of incident

Sl. No	Place of incident	No. of victim
1	Road	02
2	Below a tree	02
3	Agricultural Field	02
Total		06

Table 4: Distribution according to activity of the deceased

Sl. No	Activity of the deceased	No. of Victim
1	Communication in Mobile	01
2	Shelter (beneath a tree)	02
3	Farming	02
4	Returning from market	01
Total		06

Table 5: Distribution according to season & time of incident

Sl.No	Season	No. of Victim	Time of Incident	No. of Victim
1	Nov- Feb	00	Morning (4AM-11.59 AM)	00
2	March - June	01	Afternoon (12 PM- 3.59 PM)	01
3	July- Oct	05	Evening (4PM- 7.59 PM)	05
Total		06	Night (8 PM- 3.59 AM)	06

Table 6: Distribution of burn injury

Sl. No	Site of Body	No. of Cases
1	Head	02
2	Face	05
3	Neck	03
4	Upper Limbs	01
5	Chest	03
6	Abdomen including pubic region	04
7	Lower limbs	02

Table 7: Misc. Information based on autopsy findings

Arborescent Mark		Other injuries over different parts of body		SAH*		Singeing of Hair		Effect on Clothing	
Present	Absent	Present	Absent	Present	Absent	Present	Absent	Present	Absent
05	01	06	00	01	05	03	03	01	05

of lightning at open field, therefore all death occurred in partially sheltered and open areas. Again Chao TC et al (1981)²⁴ had mentioned that no death due to lightning occurred in well protected places. Communicating through mobile phone is working under the principle of electromagnetic wave therefore while a person is communicating through mobile during lightning may bring dangerous episode for himself.

Most of the cases happened during monsoon season, which matches with the study of Gunethi BK, Singh UP (2015)²⁰ and Gadge SJ and Shrigiriwar MB (2013).¹⁹ All cases in our study occurred between 12-6 PM, which is consistent with the findings of Gadge SJ and Shrigiriwar MB (2013)¹⁹ at Yavatmal, Maharashtra, therefore it is evident that lightning deaths are more common during working hours in day time. Arborescent mark is one of the critical finding in death due to lightning, which differentiates these cases from suspicious homicidal and other cases involving foul play. In majority of the cases no any specific internal finding was observed during post mortem examination. In only one case SAH was found.

7. Conclusion

Lightning is a naturally occurring global phenomenon and the incidents are always accidental in nature. Cardiopulmonary arrest is most common cause of death in such cases followed by ventricular fibrillation and thermal injuries. Although lightning injuries have a unique presentation in the form of arborescent mark on the body, but it can have unusual presentation in the body ranging from very specific finding to very little or no external or internal finding. In most cases victims die immediately after lightning effect, but in some cases person survives, which needs prompt resuscitative measures. Our study involves very little number of cases, which doesn't clearly depict the actual picture of lightning deaths. Therefore it needs more sample size with meticulous and methodical approach in lightning related deaths. We are in concurrence with respect to safety measures pointed out in the study of Manukonda Rajeev Varma et al. (2018)²² and Chao TC et al. (1981).²⁴

8. Confidentiality

Non disclosure of identity of the deceased and autopsy surgeon.

9. Source of Funding

None.

10. Conflict of Interest

None.

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