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Original Research

Forensic Analysis of Lightning Deaths – An Autopsy Based Study

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ABSTRACT

Background: Lightning related deaths are an uncommon occurrence in routine autopsy. Despite this, lightning-related deaths are more common in wet and mountainous regions. Rain is typically related to lightning, and electrocution is frequently observed as well, which must be distinguished from lightning-related injuries.

Aim and Objectives: Data on the victims' demographics, including age, gender, occupation, location, month, and time of the incident, as well as the presence of injuries, information from investigative agencies, visceral organ damage, and histopathological findings, were gathered for this retrospective study.

Methods: The total records of 25 lightning death autopsies conducted at the Government Medical College and Hospital in Villupuram, Tamil Nadu, India, between 2011 and 2020.

Results: The age range of the 25 patients was 17–65 years old, with an average age of 42. Eleven (44%) of the cases were female, while fourteen (56%) were male. While the fewest instances were reported in 2011, the number of cases surged in 2013 and 2015. May, October, and November saw the highest monthly case counts (24%, 28%, and 20%, respectively).

Conclusion: This study focuses on data that will help many stakeholders understand and make recommendations for reducing fatalities, addressing medicolegal issues, and developing policy in the wake of this terrible natural disaster.

Key-words: Autopsy, Demographics, Lightning,Medicolegal issues, Rain.

INTRODUCTION

Lightning is a naturally occurring phenomenon that kills and injures people all over the world.After tornadoes, flash floods, and hurricanes, lightning injuries are the most common weather-related cause of mortality worldwide. Since there is no referral and information centre where data are gathered and archived, the incidence rates of lightning injuries are most likely greater than those that are reported. Over 100 lightning strikes occur on Earth per second, for a daily total of 8 million lightning strikes. An estimated 50,000 thunderstorms occur each day, causing fires and injuries [1].

There are different types of lightning discharges: flashes to ground, ribbon lightning, beaded lightning, air discharges, cloud flashes or intra-cloud discharges and ball lightning[2]. There are three types of lightning: intracloud, intercloud, and cloud to earth. The most hazardous and destructive type of lightning is cloud-to-ground lightning. Cloud-to-ground lightning bolts frequently strike the tallest object, such as the top of a large tree or skyscraper. The most prevalent kind of lightning is intracloud lightning. Within the same cloud, this happens between centres that are oppositely charged. Intercloud lightning, which happens between clouds with opposing charges, is less frequent.

People's first objective during thunderstorms is to avoid the rain; therefore they seek cover beneath high-risk locations like large, tall trees, inside tiny shelters, or under metal roofs like bus stations and canteens. Five distinct processes are often responsible for lightning injuries: blunt trauma, ground current (step voltage), side flash (splash), direct impact, and contact damage [3, 4, 5].

Individuals involved in outdoor activities, such as builders, farmers, campers, climbers, hikers, golfers, hunters, and military people, are more vulnerable to lightning strikes than those who work indoors. First, meteorological information about the scene at the time of the occurrence may be gleaned from witness accounts and meteorological records when a lightning-related fatality is reported to a forensic investigator. Damage to neighbouring trees or keraunographic marks, such as the burning of the

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grass surrounding the body on the ground, were crucial hints in the scene inquiry.

Assam, Bihar, Chhattisgarh, Andhra Pradesh, and Arunachal Pradesh are the top 5 states with the highest illumination levels. However, when it comes to deaths caused by natural forces in 2022, lightning is the leading cause of death in the state of Tamil Nadu, accounting for 95% of all deaths (89 out of 93).

MATERIAL AND METHODS

The files of 25 autopsies of lightening deaths, which were performed between 2011 and 2020 at the Government Medical College and Hospital Villupuram, Tamil Nadu, India. In this retrospective study, the data were collected on demographic characteristics of the victims, such as age, gender, occupation, place of the event, month and event time, presence of the injuries, investigative agencies information report, presence of visceral organ damage, and histopathological findings.

STATISTICAL ANALYSIS: This study used Microsoft Excel to calculate frequencies and percentages of association of coronary changes with sudden death**.**

ETHICAL APPROVAL: This study was attained from the Institutional Ethics Committee (IEC) of the Government Coimbatore Medical College before starting the study.

RESULTS

Among the 25 cases the age range of the cases was 17-65, and the average was 42 years. Fourteen cases (56%) were male and eleven cases (44%) were female.The number of cases peaked in the years 2013 and 2015 while the least were recorded in 2011. The number of cases by month peaked in May, October and November with 24%, 28% and 20% respectively. Lightning accidents occurred on all days of the week with the majority on Monday [24%]. Off all the 25 cases majority of the cases occurred in the evening and it peaked between 3 pm to 6 pm [48%], while only 12% of cases occurred in the morning. The occupation of most of victim were farmers (72%) and they were stuck by lightening in the fields during the farming activity. Followed by the shepherds (20%)and the rest 8 % were involved in the leisure activities. Interesting 24% of the victims were struck while they were standing under the tree compared the other victims who were struck in open field. The lightening injuries were observedin all cases, with burns injuries was commonly seen 80% of the cases. The percentage of burns varied from 9% to 72% with average being 32%. The head, neck and chest were the most common areas for burns [60%] followed by the abdomen & thighs [20%] and foot & toes [15%]. Singeing of hairs [pubic and scalp hair] was present in the 35% of the cases associated with burns. In the rest of 5 non burns case fracture and bleeding of ears were noted. Tissue bits from the heart, kidneys and brain were taken for histopathology examinations. Congestions of the organs were seen on all the specimens and no other remarkable findings.

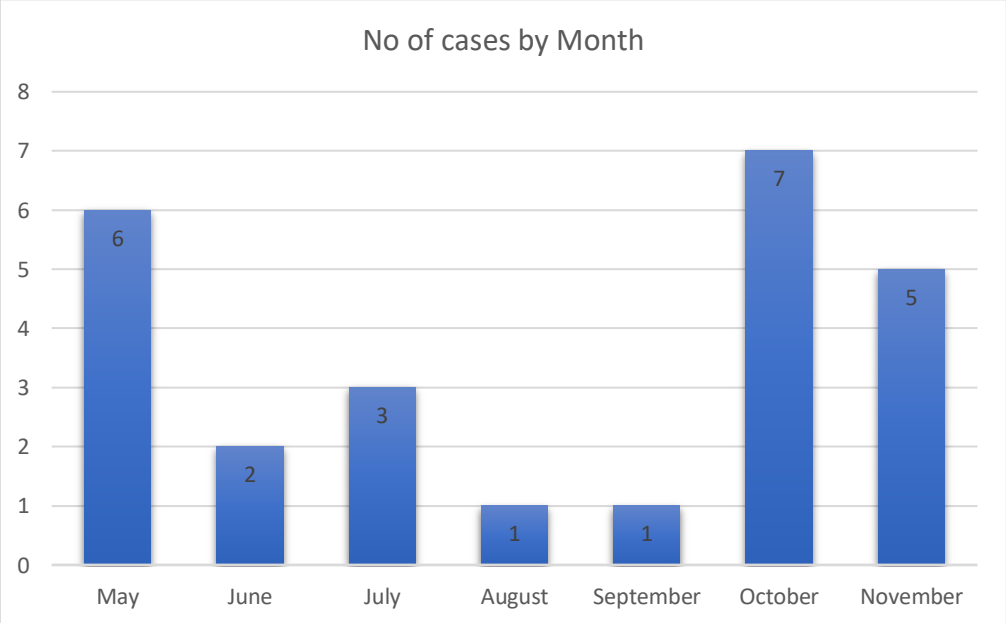

Figure 1: Month wise Distribution of Lightning Deaths

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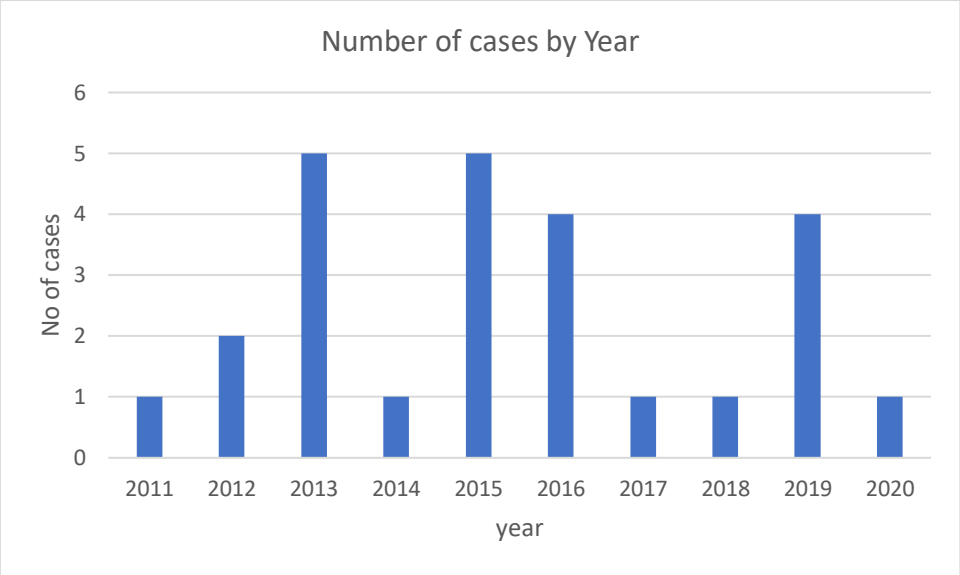

Figure 2:Year wise Distribution of Lightning Deaths

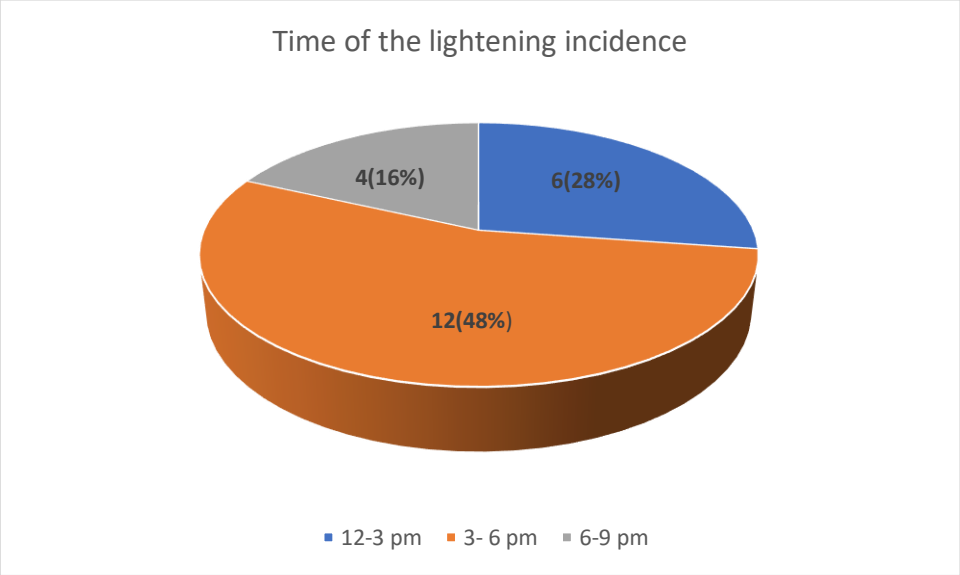

Figure 3: Time of Occurrence of Lightning Deaths

DISCUSSION

With an estimated 50 lightning strikes every second and 20% of those resulting in ground strikes, lightning is a common occurrence throughout the planet. Although the precise number is impossible to determine, it is estimated that lighting causes about 24,000 deaths and ten times as many injuries globally each year.Extreme occurrences brought on by the climate are trending upward globally. Out of all of these incidents, lightning has killed more people than any other calamity. In terms of lightning strikes and the deaths they cause, especially the Indian subcontinent has become one of the world's most vulnerable areas.

In order to overcome the atmospheric electrical resistance and produce currents ranging from 30,000 to 100,000 Amperes, which last between 0.1 and 0.001 seconds, lightning strikes between clouds and ground objects happen when the electrical potential difference is greater than 30,000 Volts [6,7]. In the United States, lightning may heat the air it strikes by up to 50,000 degrees Fahrenheit, or around 27,800 degrees Celsius, according to the National Weather Service. The sun is over five times hotter than that [8].

Six distinct mechanisms can cause injury in lightning strikes: 1) direct strike effect; 2) contact effect when lightning strikes an object while the victim touches it; 3) side flash effect from a nearby lightning-stricken object; 4) step voltage or ground current effect from a lightning strike several meters away; 5) upward streamers effect associated with injury by low energy; and 6) the more recent "sixth mechanism" which can be considered a "electro-blast effect."

Let's say that odd injury patterns or ripped clothing raise suspicions of foul play. In that instance, the cause of death must be carefully ascertained by assessing the local thunderstorm history, observing the effects of lightning in the vicinity of the death

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scene, and noting any signs of damage to clothing and accessories, skin injury, or singed hair. Additionally, the pattern and distribution of burns must be noted, as they are typically superficial due to the lightning flash's short duration. The local history of thunderstorms, the characteristic burns on the deceased body, and the fusion or magnetization of metal objects on or near the deceased can all be used to identify whether a death was due to lightning.

All autopsies showed a lightning strike fatality rate of 0.22%, which is in line with the national literature. In the study by Akkaya et al. [9] in Eskişehir, this rate was 0.3%, while in the research by Tıraşçıet al. [10] in Diyarbakır, it was 0.7%. We have found that males are most affected by lighting injuries. The majority of victims are from rural communities and were hit in thesummertime, in the afternoon. These results correlate with previous studies [11, 12, 13].

In addition to direct lightning strikes, lightning can also be transferred from a nearby object, such a building or tree, through a telephone wire, or even from another person as a contact injury. Because of the potential difference between the two legs, the electric current may enter one and escape via the other, making even transmission by ground current conceivable [14]. There are wide variations in the frequency of lightning incidents that have been documented in the literature. According to Hinkelbein et al., lightning causes injuries to over 1000 individuals in Germany annually [15, 16, 17].

This study is important because it has demonstrated that the team conducting the autopsy in lightning strike cases needs to gather information about the scene, the weather at the time of the incident, whether any other living things were hurt there, and the characteristics of the victims' clothing prior to the autopsy. The team must also obtain samples from the entrance and exit wounds and conduct a thorough exterior inspection, paying particular attention to the Lichtenberg figure and fumigated hairs.

CONCLUSION

A common high-voltage electrical injury that causes significant rates of morbidity and fatality is lightning. The physical harm could go away entirely or it might have long-term consequences. Although the mechanism of harm infliction is complicated, medical professionals and investigative agencies must comprehend it. After a lightning strike, most victims pass away right away, but in rare instances, those who survive require emergency medical attention. Better rural healthcare facilities, citizen education about safety precautions, and government policies about thunderstorm warnings through the media might all help prevent these deaths. During a storm, people are encouraged to stay inside. Risks may rise if you seek cover in a shed or tree. Water, metal, cables, and electrical fixtures must be avoided even inside. Electrical equipment should not be used indoors, and the phone cord should be unplugged. This study highlights information that will give different stakeholders knowledge and suggestions for preventing deaths, resolving medicolegal problems, and formulating policies in this dreadful natural disaster.

CONTRIBUTION OF AUTHORS

Research concept- Peranantham S, Shanmugam K
Research design- Peranantham S, Shanmugam K
Supervision- Gerard Pradeep Devnath
Materials- Peranantham S, Shanmugam K
Data collection- Peranantham S, Shanmugam K
Data analysis and Interpretation- Peranantham S
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Writing article- Gerard Pradeep Devnath, Peranantham S
Critical review- Gerard Pradeep Devnath
Article editing- Peranantham S, Shanmugam K
Final approval- Peranantham S, Shanmugam K

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