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Forensic-medical examination by the Van Forensic Medicine Group Directorate to deaths as a result of lightning strike

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Abstract

Lightning strikes may be a cause of death for farmers, sailors, and those engaged in outdoor sports. Death occurs due to damage to the cardiovascular and central nervous systems. In the autopsies performed in cases of lightning strikes, the information about the location of the incident, sociodemographic data, regions of burns and injuries on the body, histopathological findings, and cause of death are examined. In this study, a retrospective evaluation was made of 7 cases for which an autopsy was performed because of lightning strike in the city of Van in eastern Turkey. The deaths were seen to have occurred most often in spring, in the month of May. The 7 cases comprised 85.7% males and 14.3% females with a mean age of 28 years, and all were injured while shepherding. In 2 cases there was a witness, and in 6 cases, there were found to be burns and tears in the clothing. Singeing and flattening of the body hair was seen most often in the chest region. In addition to the findings of lightning strike, there were accompanying findings of blunt trauma (grazes, ecchymosis, lacerations) in 4 cases. There were first and second-degree burns in all the cases, with a mean 11.6% burned surface area. Histopathologically, focal subarachnoidal fresh bleeding was seen in 2 cases, subpleural and intra-alveolar fresh bleeding in the lungs in 2 cases, and interlobular rupture in the lungs in 2 cases. It must not be forgotten that lightning strikes are an uncommon natural catastrophe but have a high mortality rate. Together with the non-specific autopsy findings, examination of the scene of the incident and witness statements will be able to support the determination of the cause of death.

Keywords: Lightning strike, burns, autopsy findings

Introduction

Lightning can be defined as a temporary high-current electrical discharge, travelling many kilometres from the clouds to the ground. The electrical current in a lightning strike is 30,000-50,000 ampere direct current (DC) [1]. A lightning strike is formed from several consecutive processes occurring within microseconds [2].

Lightning is a natural phenomenon with fatal and destructive effects in the short term and significant climate effects in the longer term [2,3]. Lightning is known to threaten aircraft flight safety and the production of renewable energy from wind turbines, and has negative effects on electrical power stations

and transmission lines. Although it is difficult to estimate exactly how lightning will be distributed in the future, the combination of large metropolitan areas, increasing populations, and a warmer climate guarantees that people will be more intensely exposed to the danger of lightning [4].

While injuries and deaths due to lightning strikes are greater in some parts of the world, in other parts there are very few lightning-related injuries and deaths [5]. The majority of deaths due to lightning strikes occur in young people engaged in outdoor activities, and most lightning-related injuries occur in rural areas [6].

As deaths due to lightning strike are of accidental origin, they do

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not present a problem in respect of forensic medicine. However, occasionally, if a body is found in the open with no marks, the nature of the death may be uncertain. It is well known that lightning -related injuries cannot be predicted. Two people can be standing side by side during a lightning strike, and while one may not be injured, the other may be injured or die. The physical injuries in cases of fatal lightning strikes can vary from almost nothing to large burns, fractures and even tissue destruction [7]. In this study; It was aimed to examine the sociodemographic, crime scene and autopsy findings of death cases resulting from lightning strikes, which are rare in Van, which has the typical continental climate of eastern Türkiye.

Material and Methods

Approval for the study was granted by the Education and Scientific Research Commission of the Ministry of Justice Forensic Medicine Institute Directorate (decision no: 2023/112). A total of 2574 forensic autopsy cases performed in the Forensic Medicine Institute Van Group Directorate between 1 January 2015 and 1 January 2023 were examined. This study included 7 cases that were deaths resulting from lightning strike. These cases were evaluated from examination of the hospital documents, autopsy reports, autopsy photographs, scene of incident reports, witness statements, expert opinion reports, and histopathological examination reports.

The sociodemographic data, findings at the scene of the incident, injured areas on the body, burns findings on the body and rates, general body trauma findings, histopathological findings, and cause of death were examined for each case in the study.

Results

From 2574 forensic autopsies performed in the 8-year period in our centre, 7 (0.27%) cases were deaths due to lightning strike. The 7 cases comprised 6 (85.77%) males and 1 (14.3%) female with a mean age of 28 years (range, 16-50 years). It was determined that all the victims were injured in a lightning strike while shepherding. The lightning strikes occurred most frequently (n: 3) in spring, especially in May. In 2 cases, there was a witness who was also injured in the lightning strike. Medical intervention was made to 2 cases and 5 were determined to have died at the scene of the incident. When the lightning strike occurred, 4 of the victims were in an open area in a rural region, 2 were standing below a tree, and 1 was in front of a barn in an open field. In the scene of incident examination, it was reported that approximately 15 sheep had died next to the victim who died as a result of a lightning strike at the front of the barn while he was working as a shepherd. In the external examination, with the exception of one case, there were seen to be burns and tears in the clothes of the victims. No Lichtenberg figures were seen in any of the cases. Singeing and flattening of the body hair was seen most often in the chest region. In addition to the findings of lightning strike, there were accompanying findings of blunt trauma (grazes, ecchymosis, lacerations) in 4 cases. In the autopsy examinations, there were first and second-degree

burns in all the cases, with mean 11.6% (range, 1%-20%) burned surface area. In one case a burn on the left side of the abdomen was compatible in shape with a metal button on his clothes, and the burn was localised close to the button (Figure 1). There were entry and exit wounds in 3 cases; in one case the entry wound was in the face and in the other two, it was in the chest region. The exit wounds in all 3 cases were in the feet. In the histopathological examination, focal subarachnoid fresh bleeding was seen in 2 cases, subpleural and intra-alveolar fresh bleeding in the lungs in 2 cases, and interlobular rupture in the lungs in 2 cases. There was also congestion in tissues other than these. No alcohol or toxic substance was determined in the chemical analyses performed on the blood and other bodily fluids.



Figure 1. Signs of burns resulting from lightning strike

Discussion

It has been reported that there are 240,000 injuries and 24,000 deaths per year worldwide associated with lightning strikes. The mortality rate has been reported to be <0.3/1 million in developed countries, and higher in developing countries [8,9]. In previous studies conducted in Türkiye, the mortality rate due to lightning strikes was reported to be 0.4% of all forensic deaths by Oruç et al, and as 0.3% by Akkaya et al. [9,10]. In the current study, deaths related to lightning strikes were determined to constitute 0.27% of all forensic deaths. There is a continental climate in the east of Türkiye, where our autopsy center is located; In this study, the frequency of deaths due to lightning strikes was found to be consistent with studies conducted in centers with similar

climatic characteristics.

The majority of those injured as a result of a lightning strike are male, which has been attributed to males being outside more often [4-11]. In a study in Austria, the group at highest risk in lightning strike accidents was reported to be young male mountaineers and hunters [12]. Studies in Türkiye have reported that as males are more engaged in agriculture and animal husbandry, they are more often outside [9, 10]. The largest case series of lightning strike-related deaths in Türkiye stated that males were 7.5-fold more affected than females [10]. Similarly in the current study, 85.7% of the deaths were males. This was attributed to the fact that more males work with grazing animals in the geographic region where the study was conducted.

Previous studies have reported that deaths resulting from a lightning strike are seen most often in the second and third decades of life [5-9,11]. However, there are recent studies that have shown an increase in the mean age of victims [10,12]. Studies in Türkiye have shown the mean age of victims to be 22.7 years in western Anatolia, 25.6 years in central Anatolia, and 41.5 years in eastern Anatolia [9,10,13]. The mean age was similarly calculated to be 28 years in the current study. This can be explained by the widespread grazing animal husbandry in this region, and that shepherding is performed more by young adults and those in the early periods of old age.

In different geographical regions of the world, the times at which deaths due to lightning strikes occur can show variability. It has been reported that they occur most often in July in the USA and in the Austrian Alps, and in the period of June to September in India [11,12,14]. Previous studies in Türkiye have reported that the most deaths due to lightning strikes occur between May and September [9,13,15]. In a study conducted in a centre at an altitude of 954m, geographically close to the region of the current study location, it was reported that the most deaths due to lightning strike occurred in August [10]. However, in the current study, the most deaths occurred in May, which was thought to be due to the centre being at an altitude of 1730m.

In deaths resulting from a lightning strike showing geographic clustering, the rates of working in agriculture and construction sectors have been found to be high [6,10,11,16]. However, in a study from the Austrian Alps, it was seen that 98.4% of the deaths due to lightning strikes occurred during a leisure activity (walking, mountaineering, rock climbing, cycling, hunting), and 1.6% during timber cutting activities [12]. Previous studies in Türkiye have shown that deaths resulting from lightning strikes generally occur in open fields during agricultural and shepherding activities [9,10,13,15]. Consistent with the local literature, all the victims in the current study were determined to have died after injuries from a lightning strike while shepherding. This was an expected result for this area where outdoor sports are not greatly developed and the main source of income is agriculture and animal husbandry.

In a study of 64 patients, Ströhle et al. reported that two-thirds

of the cases recovered with mild injuries after a lightning strike [12]. In the most extensive autopsy series in Türkiye of deaths resulting from lightning strikes in the east of Türkiye, Oruç et al. reported that there were findings of blunt trauma (grazes and lacerations) on the bodies of all the victims [10]. In the current study, the external examinations performed in the autopsies found findings of blunt trauma, such as grazes, ecchymosis, and lacerations in 57.1% of the cases. This was thought to be due to stones, gravel and trees on the ground where the strike occurred.

Due to the high temperature created by a lightning strike, there are burns and the smell of burning on the body and clothes of victims. Depending on the material of the clothes, they sometimes burn and sometimes there can be findings of synthetic material having melted [6]. An autopsy study reported findings of burns on the clothes of 15 of 17 cases [10]. With the exception of one case in the current study, there were findings of burns on the clothes of all the other cases, consistent with the reports in literature.

Occasionally as a result of a lightning strike, there can be seen to be burns in the skin and hair and findings of singeing and flattening of body hair. As the electric current in lightning strikes has a short-term effect, first and second-degree burns may develop [10,12,17]. Just as in electric shock injuries, there may be entry and exit wounds in lightning strike injuries [17]. Generally, the developing burns affect a small part of the body surface area and it has been reported that they do not significantly contribute to death [10]. In a previous study, it was reported that first and second-degree skin burns developed on mean 7.6% of the body surface area in the victims of a lightning strike [10]. Consistent with the literature, in the autopsies of the cases in this study, there were seen to be entry and exit wounds in 42.9% of the victims of lightning strikes, and there were first and second-degree burns on mean 11.6% of the whole body surface area.

Lichtenberg figures form with the appearance of fern leaves as a result of blood extravasation in the skin and subcutaneous tissues, and these are a pathognomic finding of a lightning strike. Lichtenberg figures play an important role in autopsies in determining the cause of death. However, as they disappear a few hours after death, they may not always be seen [10,11]. Studies in literature have reported great differences in respect of the frequency of Lichtenberg figures, ranging from 0% to 64.7% [9,10,13,17]. Consistent with these great differences in literature, no Lichtenberg figures were determined in any of the current study cases. Van is the 6th largest city in Türkiye in terms of area, and the deaths related to lightning strikes in this study were determined to have occurred in rural areas at a great distance from our centre. Therefore, the autopsy procedures were performed hours after death, and so this was thought to be the reason that Lichtenberg figures were not observed in the examinations.

Following a lightning strike, the victims generally die as a result of paralysis in the cardiovascular system associated with depolarisation [7,11]. Contusion and bleeding in the internal organs can usually be seen in the autopsy findings. In addition,

occasionally aspiration pneumonia, pulmonary oedema, and widespread alveolar bleeding in the lungs can be seen [7,10, 11]. Similarly in the current study, congestion was seen to have developed in all the organs, and focal subarachnoid fresh bleeding in the brain was determined in 2 cases, interlobular rupture in the lungs in 2 cases, and subpleural fresh bleeding and intra-alveolar fresh bleeding in the lungs in 2 cases.

Conclusion

This study can be considered to contribute to the limited literature that has examined deaths related to lightning strikes. A lightning strike is a natural phenomenon, which is rarely seen in the east of Türkiye, but has high mortality rates. Especially in the spring months in our region, lightning strike must be kept in mind in cases of suspicious death of farmers and shepherds found in open rural areas with burns on the body and clothes. In the autopsy procedures performed in the victims of lightning strikes, non-specific findings may be seen, usually burns, traumatic lesions, etc. In addition, examination of the scene of the incident and witness statements can be supportive in determining the cause of death.

Conflict of Interests

The authors declare that there is no conflict of interest in the study.

Financial Disclosure

The authors declare that they have received no financial support for the study.

Ethical Approval

Approval for the study was granted by the Education and Scientific Research Commission of the Ministry of Justice Forensic Medicine Institute Directorate (decision no:2023/112).

References

1. Uman MA. Lightning. McGraw-Hill book company, USA, 1969;1-13.
2. Rakov VA, Uman MA. Lightning physics and effects. Cambridge University Press, Cambridge, 2003;4-6.
3. Cooray V, ed. The lightning flash. 2nd edition. London, United Kingdom: Institution of Engineering and Technology, 2014;819-78.
4. Yair Y. Lightning hazards to human societies in a changing climate. Environ Res Lett. 2018;13:123002.
5. Sleiwah A, Baker J, Gowers C, et al. Lightning injuries in Northern Ireland. Ulster Med J. 2018;87:168-72.
6. Blumenthal R. Injuries and deaths from lightning. J Clin Pathol. 2020 Aug 12. doi: 10.1136/jclinpath-2020-206492. [Epub ahead of print].
7. Saukko P, Knight B. Knight's Forensic Pathology. 3rd edition. Arnold Publishers, London, 2004;336-7.
8. Holle RL. Annual rates of lightning fatalities by country. 20th International Lightning Detection Conference. 21-23 April 2008. 2th International Lightning Meteorology Conference. 24-25 April 2008. Tucson, Arizona, USA, 21-3.
9. Akkaya H, Karbeyaz K, Kökçüoğlu MA, Urazel B. Lightning associated deaths during 1997-2011 in Eskişehir. J For Med. 2013;27:94-9.
10. Oruç M, Dündar AS, Şamdancı ET, Celbiş O. A 9-year retrospective review of lightning deaths from the Eastern Anatolian Region of Turkey. Forensic Sci Med Pathol. 2022 Aug 5. doi: 10.1007/s12024-022-00512-2. [Epub ahead of print].
11. Ritenour AE, Morton MJ, McManus JG, et al. Lightning injury: a review. Burns. 2008;34:585-94.
12. Ströhle M, Wallner B, Lanthaler M, et al. Lightning accidents in the Austrian alps-a 10-year retrospective nationwide analysis. Scand J Trauma Resusc Emerg Med. 2018;26:74.
13. Yılmaz R, Bulut E, Özer E, et al. Evaluation of lightning-related deaths. Adli Tıp Bülteni. 2007;12:112-7.
14. Zafren K, Durrer B, Herry JP, et al. Lightning injuries: prevention and on-site treatment in mountains and remote areas: official guidelines of the International Commission for Mountain Emergency Medicine and the Medical Commission of the International Mountaineering and Climbing Federation (ICAR and UIAA MEDCOM). Resuscitation. 2005;65:369-72.
15. Hösükler E, Hösükler B, Melez İE, Koç S. Lightning related deaths in Istanbul, between 2007-2012. J Contemp Med. 2021;11:846-52.
16. Hinson S, Herndon R. 2005 Annual summaries: flood/flash flood, lightning, tornado, hurricane. Asheville, NC: Storm Data Publication, NOAA; 2007.
17. Pincus JL, Lathrop SL, Briones AJ, et al. Lightning deaths: a retrospective review of New Mexico's cases, 1977–2009. J Forensic Sci. 2015;60:66-70.