



EFFECT OF LIGHTNING BOLT ON A GERMAN SHEPHERD: A REAL INCIDENCE

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Received 13/07/2016; Revised 29/07/2016

Accepted 11/08/2016

ABSTRACT

In the present study, findings were recorded from a survivor dog of lightning bolt incidence in a house. Physiological parameters were investigated which included recording of heart rate, respiration rate and rectal temperature; cortisol, gamma glutamyl transferase enzyme (GGT) and glucose in plasma; packed cell volume and erythrocyte sedimentation rate and colour, pH and specific gravity of urine. Dog was not having any sign of astrophobia previously. However, after the incidence, it showed the signs like tachycardia, higher respiration rate, anorexia, pyrexia, dullness, depression, polydipsia, oligouria etc. Pyrexia persisted for about four days after incidence of lightning bolt. Blood cortisol level was higher even on day 4 of incidence than the normal. Packed cell volume was higher on day 2 and 4 of incidence suggesting haemoconcentration. This finding coincided well with the ESR measurement, which was lower on day 2 and 4 in comparison to day 6. Higher levels of plasma GGT also confirmed the stress to the pet in association with cortisol. Raised concentration of glucose on day 2 and 4 after incidence suggested the effect of higher cortisol. After the incidence, the colour of the urine was amber and colour became normal on day 6. Higher urine specific gravity showed the dehydration. On day six of incidence, physiological parameters returned to normal. Observations considered as pre warning signs of

lightning stroke were also recorded from the same young adult female German Shepherd, who was confident, alert with strong behaviour and steady temperament, intelligent with good sense of smell and hearing, loyal and protective. Signs included hyperactivity, intense barking and a serious attempt to drag the house lady out of the house which saved the life of three humans in the house. Epidemiological analyses of the causes of death and vulnerability associated with meteorological disasters can provide the necessary information for establishing future adaptation measures against climate change. Therefore first hand observations recorded in this study by veterinarians may help in more directive studies towards the lightning bolts and may help in educating dog owners to understand pet psychology and warnings which can save them from ensuing disaster.

Keywords: Cortisol, GGT, lightning bolt, PCV, Specific gravity.

INTRODUCTION

World over lightning is considered as one of the most important natural disasters. Lightning is a particularly unsettling product of bad weather. It kills more people than other natural disasters such as floods, hurricanes, and tornadoes, but, because lightning usually



kills people one at a time, it tends to be an under rated hazard. High risk groups are uneducated, unsheltered and rural people [1]. Meteorological disasters are an important component when considering climate change issues that impact morbidity and mortality rates. However, there are few epidemiological studies assessing the causes and characteristics of deaths from meteorological disasters. In a study regarding meteorological disasters, specific causes of death were categorized as drowning, structural collapse, electrocution, lightning, fall, collision, landslide, avalanche, deterioration of disease by disaster and others [2]. Natural disasters can cause major accidents in chemical facilities where they can lead to the release of hazardous materials which in turn can result in fires, explosions or toxic dispersion. Lightning strikes are the most frequent cause of major accidents triggered by natural events [3]. Weather and environmental hazards at mass gathering events have not been fully researched. Prior health resource and environmental planning for heat and cold-related illness, lightning and storms and disease outbreak can advance emergency preparedness and response to potential disasters [4]. Although lightning strike is an important cause of sudden death in livestock on pasture, scientific information on this subject is limited. Lightning strikes occur regularly in grazing animals, which have greater risk of death from step potentials (ground current) in addition to direct strike and contact injury. Such cases may have no lesions, external signs of linear or punctuate burns, keraunographic markings or exit burns on the soles of the hooves or the coronary bands [5]. Documentations of animals walloped and killed by lightning are not virtually as complete. Statistics for lightning strike in pets is practically non-existent. Dogs left out in large, open fenced yards may have little protection from lightning strike. Shelter in a dog house or under a tree may present a greater risk. Dogs chained to metal poles, metal lines or trees are at significant risk in a storm.

Arrival of summer ushers in health hazards ranging from bee stings to lightning strikes [6]. Lightning constitutes a significant stochastic source of mortality in humans and animals. Research on the clinical and pathological effects and features of lightning-related injury remains neglected [7]. Researchers have reported lightning-induced cardiac arrest and neurological sequelae in human subjects [8]. Incidence of lightning is higher in tropics resulting in death of considerable number of livestock every year. Importance of this incidence can be judged on the basis of a case report in which an incomplete human skeleton found in a forest was examined and on the basis of assessment of posttraumatic lesions in the skull bones, the cause of death of a man who had died 14 years prior to the examination was determined with high probability to be due to a lightning strike [9]. In another case of death due to lightning was discussed in reference to autopsy

findings that revealed damage to the tongue, pharynx, larynx, sclera and oesophagus [10]. Scientists are also trying to find out the ill effects which are secondary to distant lightning strike [11]. Lightning bolt is the electrical discharge between the clouds or between the clouds and ground. Most available reports of lightning are for human beings. A report suggest that lightning injuries are responsible for an average of 300 injuries and 100 deaths per year in the US [12]. In Germany, approximately 50 people per year are injured by a lightning strike. Typically, people involved in outdoor activities are endangered and affected. A lightning strike usually produces significantly higher energy doses as compared to those in common electrical injuries. Therefore, injury patterns vary significantly. Especially in high voltage injuries and lightning injuries, internal injuries are of special importance [13]. Scientists are trying to address a concurrent multidisciplinary problem regarding animal safety against lightning hazards. In regions where lightning is prevalent, either seasonally or throughout the year, a considerable number of wild, captive and tame animals are injured due to lightning generated effects [14]. Dogs with a close relationship to humans sometimes seems to know some thing is going to happen before it does happen. They are known to give forewarning about many natural disasters. Epidemiological analyses of the causes of death and vulnerability associated with meteorological disasters can provide the necessary information for establishing future adaptation measures against climate change. The purpose of this study is to raise awareness and propose that a concerted and coordinated attempt be made to report and collate data regarding lightning stricken animals.

MATERIALS AND METHODS

The present investigation included the recording of physiological parameters from an adult young female German Shepherd dog after an incidence of lightning bolt. The incidence occurred on the house of authors (both veterinarians) and pet belonged to authors so that recordings were made immediately after the incidence. Physiological parameters were investigated which included recording of heart rate, respiration rate and rectal temperature; cortisol, gamma glutamyl transferase enzyme (GGT) and glucose in plasma; packed cell volume and erythrocyte sedimentation rate and colour, pH and specific gravity of urine. Small sample of blood was collected on the day 2, 4 and 6 to monitor the health condition of pet and for investigating physiological parameters. Blood was collected through saphenous vein with anticoagulant (EDTA dipotassium) and processed on the same day by using standard methods [15] for determination of packed cell volume and erythrocyte sedimentation rate (ESR). Then plasma was separated to determine cortisol, glucose and gamma glutamyl transferase enzyme. Cortisol was determined by



radioimmunoassay (RIA) using kit as per the manufacturer's protocol. Plasma glucose was determined by Folin-Wu method [16]. Gamma glutamyl transferase (GGT) was determined by spectrophotometric method [17]. Observations were also made on urine which included pH, colour and odour and specific gravity (Urinalysis strips). Heart rate, respiratory rate and rectal temperature were also recorded along with behaviour observations.

RESULTS AND DISCUSSION

Incidence of lightning bolt occurred on a house where the pet in the study was living with three humans including authors. Observations were recorded immediately after the lightning strike included increased respiratory rate, tachycardia, hypersensitivity, dumbness, scariness and dry muzzle. There was no barking. Later on the dog developed high fever which persisted for next four days even after the start of the treatment. Levels of plasma cortisol, gamma glutamyl transferase and glucose; packed cell volume (PCV) and erythrocyte sedimentation rate (ESR); colour, pH and specific gravity of urine on day 2, 4 and 6 after incidence are presented in table 1. Plasma cortisol level was 3.6 times higher on day 2 and 3.36 times higher on day 4 of incidence than the normal value observed on day 6 after incidence. The value of plasma cortisol on day 6 corroborated the earlier findings in dog [18]. This showed stress to the animal. After four days of incidence 2.5 kg weight loss was observed. Anorexia was evident after the incidence and persisted for one day only. Though the pet was drinking water very frequently after the incidence but dehydration was evident as the urine was scanty and amber coloured. Packed cell volume was higher on day 2 and 4 of incidence suggesting haemoconcentration. This finding coincided well with the ESR measurement, which was lower on day 2 and 4 in comparison to day 6. Higher levels of plasma GGT also confirmed the stress to the pet in association with cortisol. Higher levels of glucose on day 2 and 4 after incidence suggested the effect of higher cortisol. After the incidence, the colour of the urine was amber and colour became normal on day 6. Higher urine specific gravity showed the dehydration. On day six of incidence, physiological parameters observed were in normal range. However, sensitiveness of the dog persisted for about six months past incidence.

Stress for an extended period is harmful for the body. Stress reactions stimulate various glands to secrete higher concentration of hormones which mobilizes fuel molecules in the way so that body can handle the situation. Hypothalamic-pituitary-adrenal or HPA axis plays an important role in helping the coping strategies. Stress interceded higher secretion of endogenous opiates is an important aspect of pain alleviation and a feeling of well-being. Adrenal steroids like cortisol and aldosterone

play a major role during stress situations. Cortisol release is part of HPA axis. It increases glucose level in the blood and ready the animal to face the extreme situation. It also brings about a feeling of well-being in animal. Aldosterone is also released during stress although not mediated via ACTH system. Its secretion is associated to water conservation and help in building up of blood volume resulting in an increase of blood pressure. In stress mechanisms locus coeruleus-noradrenergic system is considered very important because former is the chief site of epinephrine synthesis in brain. This nucleus has connections with the limbic system, hypothalamus, spinal cord and higher centres. The limbic system is the control area for emotion and the processing area for memory. The limbic system also help in analyzing the situation based on the memory. The locus coeruleus also receives impulses from hypothalamus. Stressors affect hypothalamus and stress mediated release of norepinephrine. The mechanism of action of stressors involves the sensory aspect and information from sight, hearing, smell, taste and touch go to brain for further action in terms of modification of physiological mechanisms. These modifications can be perceived in the form of alertness of the dog. Senses of the dog like smell and hearing in particular help to perceive the happenings and can be taken as forewarning. Physiologically they are considered as arousal and adjustment of the action of the autonomic nervous system. Involvement of ANS can be seen in the form of various parameters like blood flow, heart rate, blood pressure and respiration. Physiological adjustments are observed in the form of temporary shifting of blood to important organs in order to make animal more attentive. Increased heart rate, respiratory rates and anxiety are due to stimulation of sympathetic nervous system. Depression in the dog can be explained on the basis that prolonged exposure to stress may lead to non-responsiveness of the body and physiological exhaustion. Lightning represents a trigger for headache in migraineurs that cannot be completely explained by other meteorological factors. It is unknown if lightning directly triggers headaches through electromagnetic waves or indirectly through production of bioaerosols (ozone), induction of fungal spores or other mechanisms [19]. Temperature, ultraviolet light, lightning, and altitude are some of the most common elements that cause illness [20]. Dogs are known to provide prewarning signs of disasters. They are assumed to be triggered by various pattern of wind, thunder, lightning, barometric pressure changes, static electricity and low-frequency roars previous to a storm that humans are not able to pick up. Researchers [21] have observed that presence of children at lightning strike was an event among the several stressful life events which increased the risk for development of type 1 *diabetes mellitus* in children. Pet in the investigation became dumb after



incidence. Researchers have observed that lightning stroke can result in subtle cognitive impairments [22]. In the condition of natural lightning, scientists have observed that alteration of the duration of daylight regardless of the male rats season of birth modified rate of sexual maturation, growth, weight, food and water consumption, daily urine output and blood glucose compared with the analogous parameters in the condition of standard light and dark interchange [23]. In present study plasma glucose concentration was found higher after incidence.

Dogs with a close relationship to humans sometimes seems to sense something is going to happen before it does happen. They are known to give forewarning about many natural disasters. Observations considered as pre warning signs of lightning stroke were also recorded from the same young adult female German Shepherd. It was confident, alert with strong behaviour and steady temperament, intelligent with good sense of smell and hearing, loyal and protective. Pre warning signs included hyperactivity, intense barking and a serious attempt to drag the house lady out of the house and therefore saved the life of three humans in the house. It is due to their well-developed senses like sight, smell,

touch, hearing etc. They can smell changes in the air produced when lightning strikes. Lightning produces electromagnetic field. They can perceive changes in the electromagnetic field occurring due to lightning. Lightning events can cause fast polarization rotations and phase changes in optical transmission fibers due to strong electrical currents and magnetic fields [24]. Epidemiological analyses of the causes of death and vulnerability associated with meteorological disasters can provide the necessary information for establishing future adaptation measures against climate change. Therefore first hand observations recorded in this study by veterinarians (authors) may help in more directive studies towards the lightning bolts and may help in educating dog owners to understand pet psychology and warnings which can save them from ensuing disaster. The behaviour of the pet can contribute to the discussions in the field of pre warning of many disasters by the dogs. It is advised that such types of the warnings must be heeded by the owners and never be ignored. The upshot of the study may help in providing information for more directive studies towards the lightning bolts and may help in educating dog owners to understand pet psychology and warnings which can save them from ensuing disaster.

Table 1. Values of physiological parameters in German Shepherd dog after lightning bolt incidence

S.No.	Physiological parameters	Days after incidence		
		Day 2	Day 4	Day 6
1.	Plasma cortisol nmolL ⁻¹	108.00	101.00	30.00
2.	Plasma glucose mmolL ⁻¹	5.82	5.42	5.00
3.	Plasma Gamma glutamyl transferase UL ⁻¹	200.00	180.00	32.00
4.	PCV LL ⁻¹	0.44	0.42	0.38
5.	ESR mmhr ⁻¹	4.20	4.00	6.00
6.	Urine pH	7.20	7.00	6.00
7.	Urine colour	Amber	Amber	Pale yellow
8.	Urine specific gravity	1.080	1.070	1.050

CONCLUSION

It can be concluded that lightning produced electromagnetic field in the area which resulted in changes in the physiological mechanisms to cope up with the disaster. Change in the environment was able to produce behaviour modifications to handle the dreaded situation. It can be suggested that pet behaviour must always be

monitored with sincerity and such types of the warnings must be heeded by the owners and never be ignored. The upshot of the study may help in furnishing knowledge for further investigations in the direction of the lightning bolts and possibly will facilitate in edifying pet owners to comprehend the psychology and warnings signs as protection measurement.

REFERENCES

1. Meel BL. (2007). Lightning fatalities in the Transkei sub-region of South Africa. *Medicine, Science and the Law*, 47:161-164.
2. Myung HN, Jang JY. (2011). Causes of death and demographic characteristics of victims of meteorological disasters in Korea from 1990 to 2008. *Environment Health*, 27, 10, 82.
3. Renni E, Krausmann E, Cozzani V. (2010). Industrial accidents triggered by lightning. *Journal of Hazardous Materials*, 15,184(1-3), 42-48.
4. Soomaroo L, Murray V. (2012). Weather and environmental hazards at mass gatherings. *PLoS Currents*, 4:e4fca9ee30afc4.



5. Schulze C, Peters M, Baumgärtner W, Wohlsein P. (2016). Electrical Injuries in Animals: Causes, pathogenesis and morphological findings. *Veterinary Pathology*, pii: 0300985816643371.
6. Laskowski-Jones L.(2000). Responding to summer emergencies. *Dimensions of Critical Care Nursing*, 19(4), 2-8.
7. Blumenthal R, Trengrove E, Jandrell IR, Saayman G.(2012). Lightning medicine in South Africa. *South African Medical Journal*, 6,102(7), 625-626.
8. Scantling D, Frank B, Pontell ME, Medinilla S. (2016). Inducing therapeutic hypothermia in cardiac arrest caused by lightning strike. *Wilderness & Environmental Medicine*, pii:S1080-6032(16)30083-7.doi: 10.1016/j.wem.2016.05.003. [Epub ahead of print].
9. Hauser R, Kaliszan M, Basir A, Basir ID. (2013). Lightning strike as probable cause of death and determining identity based on the examination of skeletal remains. *Journal of Forensic Sciences*, doi: 10.1111/1556-4029.12087.
10. Wankhede AG, Sariya DR.(2013).Damage due to lightning when it strikes the face. *Forensic Science International*, 10;224:1-3.
11. Shukla D, Sharan A, Venkatesh R. (2012). Optical coherence tomography and autofluorescence findings in photic maculopathy secondary to distant lightning strike. *Archives of Ophthalmology*, 1,130(5), 656-658.
12. Desai BK, Fairclough R. (2011). A case of a speech impediment following a near lightning strike. *International Journal of Emergency Medicine*, 19, 4, 60.
13. Hinkelbein J, Spelten O, Wetsch WA.(2013). Lightning strikes and lightning injuries in prehospital emergency medicine. Relevance, results, and practical implications. *Unfallchirurg*, 116(1), 74-79.
14. Gomes C. (2012). Lightning safety of animals. *Int J Biometeorol*, 56(6), 1011-23.
15. Jain NC.(1986).In : Schalm's Veterinary Haematology, 4th edn, Lea & Febiger, Philadelphia, 1986, 20-85.
16. Oser BL. (1976). In:Hawk's physiological chemistry. 14th edn.Tata McGraw Hill Publishing Co Ltd, New Delhi, 900-1125.
17. Wolf PL, Williams D.(1973).In: Practical clinical enzymology, Wiley-Interscience publication, John Wiley & Sons, New York, 22-156.
18. Bovens C, Tennant K, Reeve J, Murphy KF (2014). Basal serum cortisol concentration as a screening test for hypoadrenocorticism in dogs. *Journal of Veterinary Internal Medicine*, 28(5), 1541-1545.
19. Martin GV, Houle T, Nicholson R, Peterlin A, Martin VT. (2013). Lightning and its association with the frequency of headache in migraineurs: An observational cohort study. *Cephalalgia*, PMID: 23349357.
20. DeFranco MJ, Baker CL 3rd, DaSilva JJ, Piasecki DP, Bach BR Jr.(2008). Environmental issues for team physicians. *American Journal of Sports Medicine*, 36(11), 2226-2237.
21. Sipetic S, Vlajinac H, Marinkovi J, Kocev N, Milan B, Ratkov I, Sajic S.(2007). Stressful life events and psychological dysfunctions before the onset of type 1 diabetes mellitus. *Journal of Pediatric Endocrinology and Metabolism*, 20(4), 527-534.
22. van Zomeren AH, ten Duis HJ, Minderhoud JM, Sipma M.(1998). Lightning stroke and neuropsychological impairment: cases and questions. *Journal of Neurology, Neurosurgery & Psychiatry*, 64(6), 763-769.
23. Matveeva IuP, Lotosh TA, Iunash VD, Vinogradova IA. (2013). Influence of the season of birth of male rats on some parameters of biological age. *Rossiiskii fiziologicheskii zhurnal imeni I.M. Sechenova*, 99(11), 1322-1332.
24. Krummrich PM, Ronnenberg D, Schairer W, Wienold D, Jenau F, Herrmann M. (2016). Demanding response time requirements on coherent receivers due to fast polarization rotations caused by lightning events. *Optics Express*, 24(11), 12442-12457.

