

The Dangerous Life of a Storm Chaser: A Lightning Strike Injury Causing Serious Injury

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Abstract

Lightning strikes to people are rare events that cause significant injuries and mortality when they do occur. We describe an uncommon case of a storm chaser in Oklahoma who was struck by lightning who suffered cutaneous burns, bilateral tympanic membrane ruptures, as well as pulmonary edema, which is an atypical finding in survivors. This case report highlights several injury patterns seen in lightning strike cases and provides evidence that these patients should be managed at a center with multidisciplinary services available.

Keywords

lightning strike, pulmonary injury, storm chaser

Introduction

Lightning strikes may cause serious injury or death through the powerful electrical current produced. Although a rare event, a lightning strike does carry a significant mortality of at least 10%, while approximately 75% of survivors suffer permanent sequelae.^{1,2} According to the National Oceanic and Atmospheric Association, there are on average 49 people killed each year from lightning strikes in the United States.¹ Summer months are the peak months for these types of injuries, often occurring during outdoor activities such as fishing, camping, swimming, and boating. This is the only reported case to our knowledge of a lightning strike causing injury to a storm chaser.

Lightning strikes are uncommon but may cause life-threatening injuries such as cardiac dysrhythmias, blunt trauma, neurologic syndromes, muscle damage, and burns. Respiratory injuries associated with lightning strikes include pulmonary edema, pulmonary contusion, acute respiratory distress syndrome, and pulmonary hemorrhage.³ Pulmonary edema is typically seen secondary to accompanying severe cardiac damage.⁴ It is important for physicians caring for these patients to understand the pathophysiology and management of injuries caused by lightning strikes, and to evaluate victims as multisystem trauma patients. We present a case report of a 26-year-old male who sustained a lightning strike while storm chasing, resulting in multiple cutaneous burns, muscle damage, hearing loss, and pulmonary edema. While several published case reports describe common injuries of

individuals struck by lightning, pulmonary injuries in victims who did not sustain cardiac arrest or damage is extremely uncommon and has not been previously reported. We additionally review the pathophysiology of lightning and high-light potential injuries and key features of clinical care.

Case Presentation

A 26-year-old male without any significant past medical history initially presented to an outlying facility for being struck by lightning while storm chasing. According to bystanders, he was standing on a concrete pylon when the lightning struck, and he was thrown an unknown distance from the pylon. He was next seen at the side of a bystander's vehicle partially clothed and confused (Figure 1). He was taken to the nearest emergency department (ED) immediately.

According to the medical record at the outlying ED, he arrived neurologically intact with stable vital signs. After receiving pain medication and 3 L of normal saline, he was

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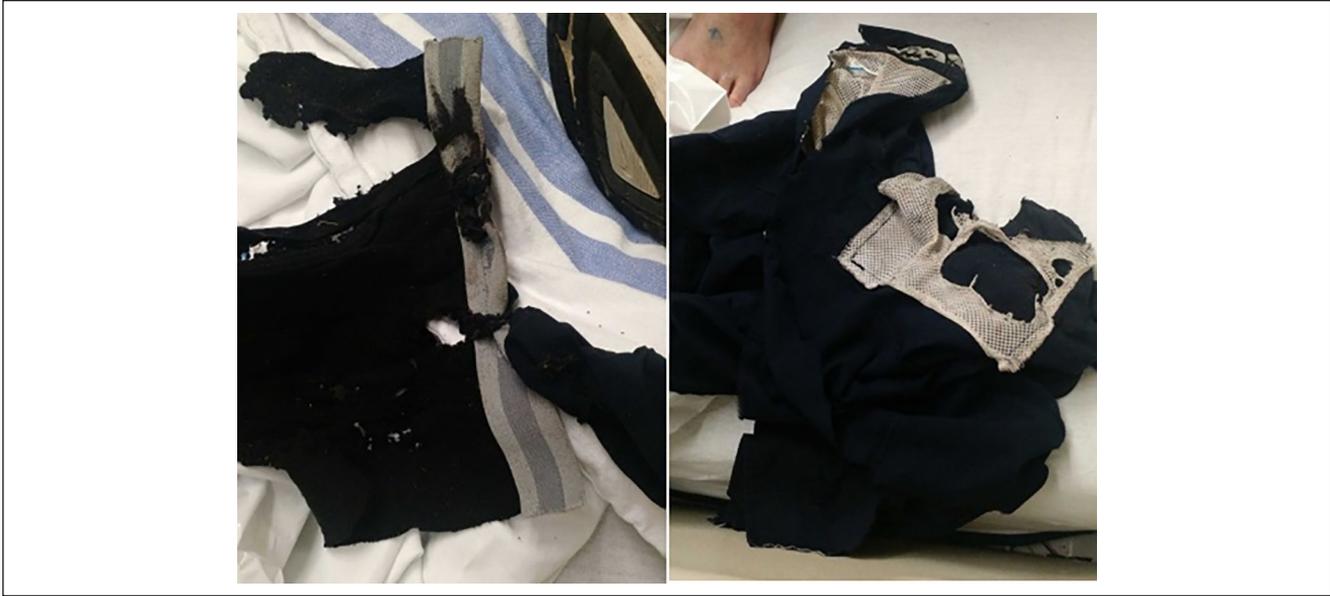


Figure 1. Torn clothing blown off the patient.



Figure 2. Anterior chest with linear thermal burn on chest/torso.

transferred to a Level 1 trauma center via ambulance. On arrival, he was awake and alert with complaints of muscle cramping, bilateral ear pain, and amnesia to the actual event.

His initial vital signs were within normal limits and he was neurologically intact. He was found to have mild bilateral otorrhea with bilateral tympanic membrane ruptures. He also had superficial partial thickness cutaneous linear burns that extended from the sternal notch down the anterior chest and abdomen in the midline (Figure 2), splitting to travel down the medial aspect of each thigh and calf, ending at the medial malleoli bilaterally (Figure 3). It was determined that this burn was approximately 13% of his body surface area. The remainder of his physical examination was normal with no other evidence of traumatic injury.

Initial laboratory values were drawn and were unremarkable with the exception of an elevated creatine kinase (CK). An electrocardiogram was obtained and demonstrated normal

sinus rhythm with a right bundle branch block. A chest X-ray showed no acute cardiopulmonary disease. Computed tomography (CT) scan of the head revealed no acute intracranial process; however, there was a small amount of fluid in the left mastoid air cells and middle ear without clear evidence for temporal bone fracture. CT of the facial bones, cervical spine, thoracic spine, and lumbar spine were negative for acute fracture. CT angiogram of the chest showed ground glass opacities in the bilateral lung apices consistent with pulmonary edema (Figure 4).

The patient received 3 L of normal saline at outlying facility and was continued on maintenance fluids calculated by the Parkland formula on arrival to the ED at the Level 1 trauma center. A Foley catheter was placed for accurate measurement of urine output. Additionally, he was given intravenous pain medication and ciprofloxacin otic drops in his bilateral ear canals. He was admitted to the hospital for observation on the trauma service with an otorhinolaryngology (ORL) consult.

Once admitted, maintenance fluids were continued and his laboratory values were monitored closely. ORL recommended dry ear precautions and suggested follow-up for audiogram in 4 to 6 weeks. Wound care evaluated the patient and dressed his anterior chest and abdominal burns with silver sulfadiazine. His CK was monitored closely and results are listed in Table 1. Urine output stayed above 1 mL/kg/h. During his hospital stay, he did have several episodes of severe muscle cramping. He did receive morphine, phenergan gel, and zofran as needed throughout his stay. He was discharged on hospital day 2 with his pain well-controlled and was given follow-up for burn care and his hearing loss.

The patient did follow-up with ORL and had to undergo tympanoplasty of both ears and sustained permanent hearing loss. He also followed-up with cardiology and his



Figure 3. Right and left feet showing extension of the linear burns down both legs.

bundle branch block had resolved completely. According to the patient, his burns healed fairly quickly; however, the lower portion of his abdomen does still have some significant scarring. At 10 weeks after sustaining the lightning strike, the patient reported some hearing loss and memory disturbances, as well as psychological stress and anxiety associated with the event.

Discussion

Lightning injuries are rare but potentially serious and life-threatening. Direct lightning strikes are uncommon but often fatal, involving approximately 5% of strike events.^{5,6} Indirect injuries include side flash injury, where the victim is in contact with the struck object, ground current, when lightning traverses from the striking point through the ground and into the victim, and blast injury from sonic waves produced by lightning striking the ground.^{7,8} Lightning strikes are a complex event that can result in a broad spectrum of injuries from blunt trauma to cardiopulmonary arrest. Special care and attention should be taken when evaluating the lightning strike victim.

Lightning strikes are unique compared with other electricity-related injuries in that the duration of current is much shorter, but the intensity and voltage are much higher. There

are marked differences between injuries caused by high-voltage electrical accidents and lightning.⁴ Lightning strikes are instantaneous, typically causing superficial burns, while high-voltage electrical injuries normally last seconds longer and cause deeper burns and massive internal thermal injury. Burn injuries sustained from high-voltage electrical accidents may require amputation or extensive fasciotomies. Pronounced myoglobin release may lead to acute renal failure. Conversely, the vast majority of lightning injuries are indirect, making serious burns and deep injury uncommon. However, lightning strikes do frequently cause life-threatening injuries to cardiac and neurologic systems.⁴

Although not as serious as cutaneous manifestations associated with other electricity-related injuries, lightning strikes do typically cause burns. Lichtenberg figures are pathognomonic for lightning strike. These are superficial feathering or ferning on the skin and are thought to be due to capillary rupture or electron showering over the skin.² These are not true thermal burns and are transient. Contact burns, flash burns, punctate burns, blistering burns, and linear burns can also be seen. Linear burns, which occurred in this case, are superficial or partial thickness burns that may be apparent immediately, or take hours to develop. They progress in a linear pattern beginning at the head, extending to the torso, and typically splitting to both legs. Linear burns are caused

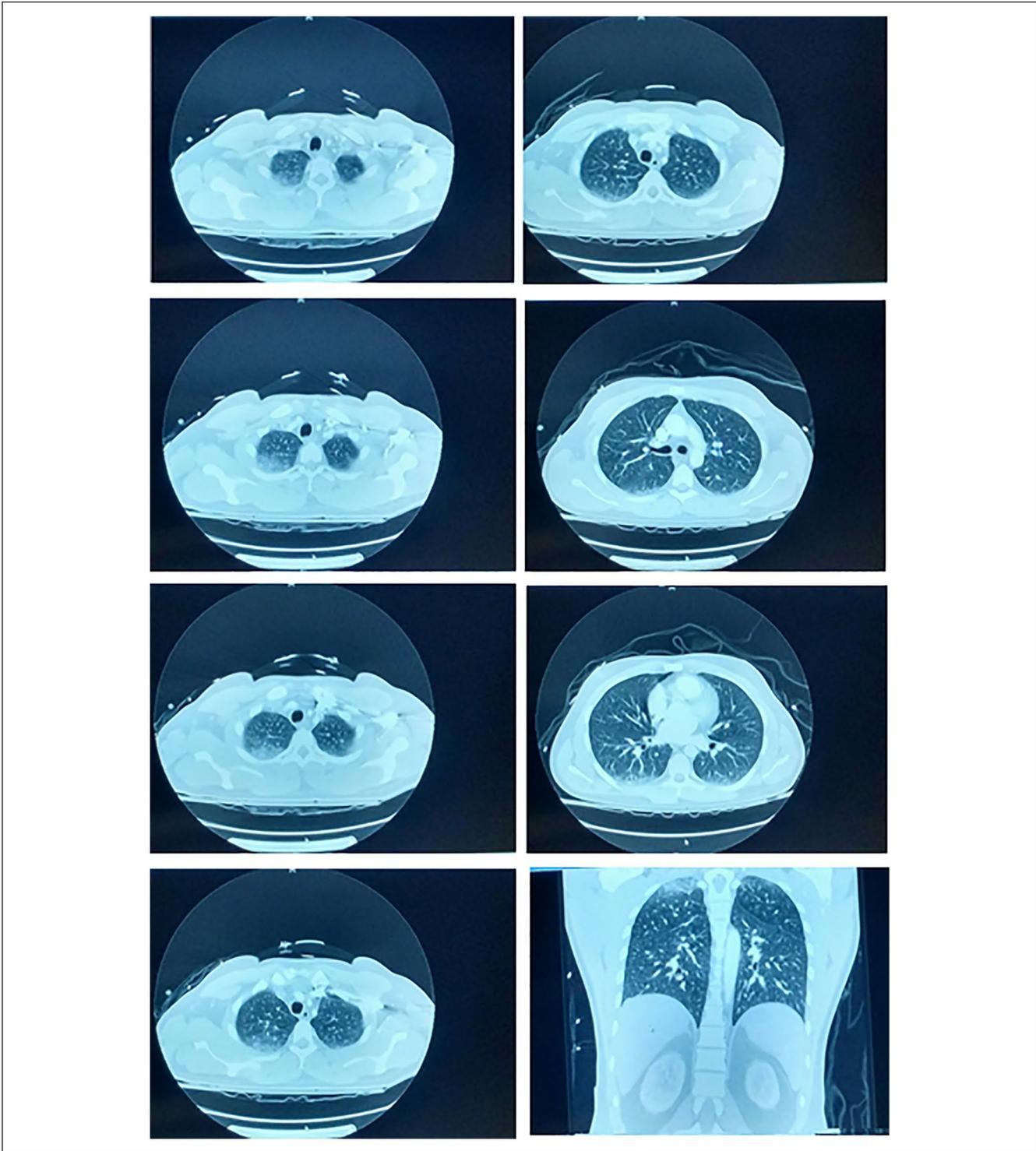


Figure 4. Computed tomography angiogram of the chest showing ground glass opacities/pulmonary edema bilaterally.

by the vaporization of sweat or rainwater into steam from current flow and flashover around the body.⁴

Cardiac damage is a serious and deadly sequela of lightning injury. Cardiopulmonary arrest is the most common cause of death in a lightning strike victim.⁵ In the event of a

cardiac arrest from a lightning strike, prolonged cardiopulmonary resuscitation can be beneficial and reverse triage (care administered to the seemingly unsalvageable first) should be utilized.⁶ Duration of apnea, not duration of cardiac arrest, is a critical prognostic factor.² The most common

Table 1. Trending of Creatine Kinase (CK).

Time	Hospital day 1, 0220	Hospital day 1, 0315	Hospital day 1, 1920	Hospital day 2, 0310
CK	1814	1491	2360	1963

cardiac findings are hypertension and tachycardia.² This is likely due to sympathetic activation. Atrial and ventricular arrhythmias may also occur. Other cardiac manifestations include coronary artery spasm, pericardial effusion, ST segment elevations, QT-prolongation, T-wave inversions, cardiogenic pulmonary edema, and stunned myocardium.^{2,9}

Pulmonary edema in lightning injury survivors is uncommon, though on postmortem examination it is found in up to 70% of cases.⁴ Pulmonary edema typically accompanies severe cardiac damage,⁴ which may explain why it is not often found in survivors of lightning injury. Other than a right bundle branch block on his electrocardiogram, our patient displayed no obvious cardiac injuries. This makes his abnormal pulmonary CT findings exceedingly rare. Noncardiogenic pulmonary edema in lightning injury survivors is remarkably uncommon, with no previously reported cases. One recent case report from Turkey did report pulmonary edema detected on chest CT in a lightning strike victim. However, the patient additionally had global cardiac hypokinesia with a 20% to 25% ejection fraction detected on echocardiography.¹⁰ Overall, pulmonary injuries in lightning survivors are very rare, especially in the absence of obvious cardiac injury.

Neurologic injuries after lightning strikes are common, and can range from mild to severe. Minor neurologic injury can include memory loss, as seen with our patient, as well as persistent headaches, diminished cognitive function, and paresthesias. Psychological dysfunction is also common, as many patients will experience anxiety and depression surrounding the event, as seen in our case. Some victims may suffer post-traumatic stress disorder or other more serious psychological sequelae.⁴ Autonomic conditions can include complex regional pain syndrome, pupillary dilation, and anisocoria.^{2,6} Moderately neurologic injured lightning victims may be disoriented, combative, or comatose, and may exhibit *keranoparalysis*, which is transient motor paralysis of the lower extremities.⁴ Severe neurologic injuries can involve heat-induced coagulation of the cerebral cortex, as well as subdural and epidural hematomas and intracerebral hemorrhage from the blunt trauma associated with the lightning strike.

Musculoskeletal injuries are often a result of being thrown during the lightning strike against another object or the ground. Myotonic contractions can occur and lead to shoulder dislocations or spinal fractures. Rhabdomyolysis is rare, but can occur. Our patient did have transient elevation in his CK that did not affect his renal function.

As demonstrated in our case, auditory injuries are common, especially tympanic membrane rupture, leading to long-term deafness and vertigo.² Ocular injuries are also frequently seen and include cataracts, hyphema, vitreous hemorrhage, corneal abrasions, uveitis, and retinal detachments.

Lightning events are a rare but serious event. Emergent resuscitation in the ED is critical. A thorough physical examination and imaging should be performed to rule out traumatic injuries. Thermal burns can occur and should be treated promptly with fluids and/or wound care. This case report highlights rarely seen pulmonary injury as well as several common injury patterns seen in lightning strike cases and provides evidence that these patients should be managed at a center with multidisciplinary services available.

Declaration of Conflicting Interests

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Ethics Approval

Our institution does not require ethical approval for reporting individual cases or case series.

Informed Consent

Written consent was obtained from the patient(s) or their legally authorized representative(s) for anonymized patient information to be published in this article.

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References

1. National Oceanic and Atmospheric Administration. Lightning safety tips and resources. National Weather Service. Accessed April 29, 2020. <https://search.usa.gov/search?v%3Aproject=fir&stgov&query=Lightning+Safety+Tips+and+Resources&affiliate=nws.noaa.gov>
2. Bailey C. Electrical and lightning injuries. In: Tintinalli JE, Stapczynski JS, Yealy DM, Meckler GD, Cline DM, eds. *Tintinalli's Emergency Medicine: A Comprehensive Study Guide*. 8th ed. McGraw-Hill Education; 2016.
3. Sener MU, Demir A, Sener A. Lightning strike induced acute lung injury: a case report. *Ulus Travma Acil Cerrahi Derg*. 2019;25:198-201.
4. Cooper MA, Andrews CJ, Holle RL, Blumenthal R, Navarrete-Aldana N. Lightning-related injuries and safety. In: Auerbach PS, ed. *Auerbach's Wilderness Medicine*. 7th ed. Elsevier; 2017:71-117.
5. Jost WH, Schonrock LM, Cherington M. Autonomic nervous system dysfunction in lightning and electrical injuries. *Neurorehabilitation*. 2005;20:19-23.

6. Cooray V, Cooray C, Andrews CJ. Lightning caused injuries in humans. *J Electrostat.* 2007;65:386-394.
7. Edlich RF, Farinholt HM, Winters KL, Britt LD, Long WB 3rd. Modern concepts of treatment and prevention of lightning injuries. *J Long Term Eff Med Implants.* 2005;15:185-96.
8. O'Keefe Gatewood M, Zane RD. Lightning injuries. *Emerg Med Clin North Am.* 2004;22:369-403.
9. McIntyre WF, Simpson CS, Redfearn DP, Abdollah H, Baranchuk A. The lightning heart: a case report and brief review of the cardiovascular complications of lightning injury. *Indian Pacing Electrophysiol J.* 2010;10:429-434.
10. Portmueller CA, Yikun Y, Haberkern M, Wuest E, Zimmermann H, Exadaktylos AK. Injuries, sequelae, and treatment of lightning induced injuries: 10 years of experience at a Swiss trauma center. *Emerg Med Int.* 2012;12:769-78.