

Isolated Liver Injury Due to Ground Current Effect of Lightning Strike: The First Case of The Literature

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Abstract

A 26-year-old shepherd man was admitted to the emergency department in June 2020 after ground current effect of lightning strike. With the severity of the trauma, the patient fell to the ground and then fainted. Since the severity of the trauma was not known exactly, there was an open wound in the head, and the patient had dyspnea and elevated liver function tests. Cranial, thorax and abdominal computed tomography (CT) were performed. On CT scan, approximately 7-cm-in length grade 3 liver laceration, extending between segment V and segment VIII was seen without intra-abdominal pathology. The patient was admitted to the intensive care unit (ICU). During the follow-up, liver function tests returned to normal. Liver laceration was managed conservatively. The patient was discharged. On the 6th day of his hospitalization, the patient was discharged without any complications or signs of massive bleeding (the patient's hemoglobin level was 12.4 g/dL before discharge), his vital signs were stable, and his symptoms improved.

Key Words: ground current, isolated, laceration, liver injury, lightning strike

Introduction

Electrical injuries constitute up to 2%–5% of admissions to the burn centers. In such traumas, the excess of electrical voltage directly affects both the severity of trauma and mortality. Among all electrical injuries, the highest mortality group is the lightning strike cases, with 17.6%¹.

Lightning strike is defined as sudden, transient, high-voltage atmospheric electrical discharge. The incidence of lightning fatalities varies depending on region and season; nearly 24,000 lightning related fatalities are reported annually. Lightning can affect people by direct strike, contact injury, side flash, the ground current by pressure or shock wave paths. Also, victims may get injured or die indirectly by reasons such as falling, hit by an object, smoke inhalation, and fire². Penetrating injuries related to a lightning strike caused by shrapnel from the explosion of a nearby structure have also been reported³. Lightning strike injuries also have increased morbidity rate because of critical alterations of the circulatory system, respiratory system, and central nervous system. Most lightning-related deaths occur soon after injury due to arrhythmia or respiratory failure⁴.

In this study, a case of isolated liver laceration treated conservatively due to ground current effect of lightning strike was presented. Also, this is the first case in the literature in which isolated liver injury occurred after a lightning strike.

Case Report

A 26-year-old shepherd man was admitted to the emergency department of Erzurum Regional Education and Research Hospital, Erzurum, Turkey in June 2020 after lightning strike trauma. The lightning strike occurred about 1 meter away from the patient at the Agri mountain. At the time of the incident, there were no objects near the patient. With the severity of the trauma, the patient fell to the ground and then fainted. The patient did not remember the event after fainting.

Vital signs on admission were the following: blood pressure 115/65 mmHg, heart rate 130 beats per minute, respiratory rate 22 per minutes, and O₂ saturation on room air 88%, body temperature 37.8° Celsius. There was no wound on the body except partial opening near the right temple with headache. Breath sounds were diminished. There was only sinus tachycardia in electrocardiography (ECG). On echocardiography, cardiac functions were normal without tachycardia. There was tenderness and pain on deep palpation in the right upper quadrant.

Pathological laboratory parameters of the patient were as follows: white blood cell count (WBC) 14,100/mm³, alanine transaminase (ALT) 163 IU/L, aspartate transaminase (AST) 135 IU/L, creatine kinase (CK) 509 U/L and C-reactive protein (CRP) 28 mg/L. In addition, hemoglobin (Hb) level of the patient was 13.6 g/dL. The remaining laboratory parameters were unremarkable.

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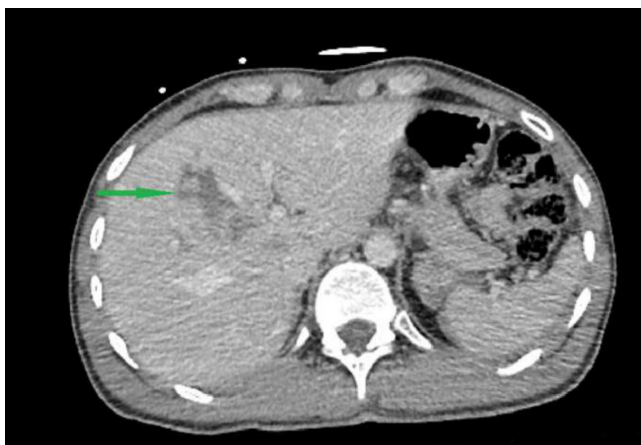


Figure 1. A 26-year-old man who admitted to hospital after lightning injury. Axial image of the CT scan shows approximately 7-cm-in length grade 3 liver laceration, extending between segment V and segment VIII.

Since the severity of the trauma was not known exactly, there was an open wound in the head, and the patient had dyspnea and elevated liver function tests. Cranial, thorax and abdominal computed tomography (CT) were performed. There was no obvious pathology found on brain and thorax CT. On abdominal CT scan, approximately 7-cm-in length grade 3 liver laceration, extending between segment V and segment VIII was seen without intra-abdominal pathology (Figure 1). The patient was admitted to the intensive care unit (ICU) for closely follow-up due to high pressure trauma, cardiac instability, dyspnea, and liver laceration. Supportive oxygen of 2 liters per minute and intravenous 0.9% NaCl hydration were started. The possibility of infection could not be ruled out due to leukocytosis and unreliable history on the initial evaluation, therefore antibiotic treatment of intravenous amoxicillin clavulanic acid (1.2 grams vial twice a day) was started.

During the follow-up, the WBC count, CRP level, creatine kinase level and liver function tests returned to normal (WBC count, 8,100/mm³; CRP, 3.8 mg/L; AST, 22 U/L; ALT, 28 U/L; creatine kinase, 108 U/L). On the electrocardiography, cardiac rhythms had returned to normal (heart-beat 78 beats per minute). The blood pressure of the patient was 132/72 mmHg. O₂ saturation of the patient on room air increased to 98%. In this case, liver laceration after lightning strike was managed conservatively. The patient was discharged. On the 6th day of his hospitalization, the patient was discharged without any complications or signs of massive bleeding (the patient's hemoglobin level was 12.4 g/dL before discharge), his vital signs were stable, and his symptoms improved. Hemoglobin value of the patient was 12.6 g/dL on the 7th day after discharge. In the control ultrasonography performed on the same day, there was no peri-hepatic and intra-abdominal fluid. There was only intra-parenchymal hematoma of the liver of approximately 5 cm in size.

Discussion

Lightning strike is a frequent occurrence with an estimated 50 occurrences per second and 20% of those resulting in ground strikes. It is important that the clinician has a sound understanding of the injuries that can occur and the proper treatment of lightning-related injuries⁵.

Lightning strike carries an enormous amount of energy, the intensity of which exceeds 10 million volts. Lightning strike injuries can be classified into four categories: a direct strike, contact injury, side splash or ground current. Direct strikes occur after directly struck of lightning. Contact injuries occur by touching an object that is struck. Side splash injury happens when the current jumps or “splashes” from a nearby object then following the path of least resistance to an individual. Ground current is the most common mechanism of injury, accounting for one-half, and occurs when lightning strikes an object/ground near an individual and then travels through the ground to an individual⁶. In this patient, trauma mechanism was ground current, and the patient with isolated liver injury was discharged after conservative treatment.

Lightning can be occurred in multiform pattern. Geographic and climate factors play a major role on etiology. Mountainous areas will often experience more lightning strikes than surrounding lower elevation areas. Lightning strikes are more common in rainy seasons such as June, July and August⁷. In addition, approximately 80% of victims are males. Most deaths occur in people between 20 and 45 years old age. Occupation is also an important factor in etiology. Shepherds, woodsmen and military personnel have a tendency to be exposed⁸. Consistent with the literature, the victim of this case report was a young man shepherd who was injured in the mountain in June.

Lightning strike is a rare and serious trauma. Lightning-related injuries can range widely, depending on the injury type and the affected organ⁹. Mortality is reported up to 30% of cases, most frequently causes of mortality are cardiovascular pathologies. Cardiovascular pathologies vary from benign changes to sudden cardiac death. The ST elevation, cardiomyopathy, atrial fibrillation, and QT prolongation may occur¹⁰. In patients who are unconscious, have head burn, or have abnormal neurologic examination, head CT should be performed because of the increased risk of intracranial hemorrhage. In this case, initial assessment revealed sinus tachycardia. However, the rhythm converted back to normal sinus rhythm without any additional cardiac medication or intervention. Also, the patient had a laceration of head. Therefore, a CT of the head was performed, and no pathology was found on CT.

Injuries may not be visible at first exploration. Possible indirect injuries due to lightning should always be considered. Renal, pulmonary, orthopedic, neurological, dermatological, otologic and ophthalmologic pathologies can also

be seen due to lightning injuries after detailed evaluation of the patient. These pathologies may occur at the time of the event or develop within days or weeks following the event¹¹. Multi-disciplinary follow-up and treatment may be required in lightning injuries. However, there was only isolated laceration of liver in this case and multidisciplinary approach was not required.

There are no required laboratory tests or imaging for all patients struck by lightning strike, but certain tests and studies are recommended for selected patients. Patients with a direct strike, chest pain, dyspnea, status post-arrest, should have an ECG and echocardiogram and be monitored on telemetry for 24 hours with other imaging and labs guided by history and physical exam⁷. In this patient, due to cranial trauma, dyspnea, and right upper quadrant pain with increased liver function tests, computed tomography was taken.

Conclusion

In this case report, it is aimed to present the first case of the literature about isolated liver laceration due to ground current effect of lightning strike. In the case of lightning strike, which is a serious and rare trauma, first aid should be given depending on the resuscitation rules. All systems of patients should be evaluated as a whole at hospital. Necessary tests should be performed according to the patient's symptoms and findings at the time of admission. After evaluation with multidisciplinary approach, the necessary treatment should be started quickly. Although a case of isolated liver laceration treated conservatively is presented in our case, it should be kept in mind that surgical treatment will be required in patients who are hemodynamically unstable and have massive decrease in hemoglobin value.

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