# Lichtenberg figure in a patient with electric burn caused by lightning. A case report

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**Background:** Lichtenberg figures are typical dermatological lesions on people who are struck by lightning, which are infrequent and extremely mortal. We present a case about a 41-year-old male who was struck by lightning while working outdoors, suffering first and third degree burns with the distinctive Lichtenberg pattern, also presenting thoracic trauma as consequence of high impact mechanism which caused fractures in fourth and fifth left ribs with no clinical repercussion. Despite high voltage and the injury mechanism, it was affected only 2% of total body surface area, with no injury at other organs or systems. Therefore, the patient had a favorable recovery. Because of the low evidence and incidence concerning the topic, it was added a small review about lightning injuries as well as the physiopathology and main features of Lichtenberg figure.

**Keywords:** Lichtenberg figure, burns.

Case Report

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Electrical injuries are a common form of trauma and can be caused by high voltage energy (> 1000 Volts), low voltage energy (< 1000 Volts), and lightning strikes. These injuries are associated with high morbidity and mortality rates.[1] According to epidemiological data in North America, there are approximately 1,000 deaths annually as a result of electrical injuries, with 400 of these associated with high voltage injuries and 50 to 300 linked to lightning victims. Electrical injuries account for 5% of admissions to burn intensive care units. In the adult patient population, these injuries represent the fourth leading cause of death in occupational settings.[1] It is estimated that lightning strikes occur 50 to 100 times per second worldwide, with 20% striking the ground freely. As a result, thousands of deaths due to lightning are estimated, and the number of injuries is believed to be ten times higher than reported due to a low percentage of notifications or reports of such events. In India, there are reports of 1,755 deaths each year from lightning contact. Epidemiological findings suggest that for every 40,000 hospitalized patients, one is due to a lightning-related injury. [2] Reports from the United States documented 27 deaths per year between 2009 and 2018. The likelihood of receiving an electrical shock from lightning is infrequent, with an estimated probability of 1 in 1.22 million. Deaths and injuries are more common in males, with peak incidence occurring from May to September.[3] The skin findings associated with these injuries are referred to as Lichtenberg figures, which are unique to this type of injury and typically appear around the burn sites.[3] Due to the rarity of this pathology in burn centers, we have chosen to report the following case received in our trauma intensive care unit and provide a brief review.

## Case report

A 41-year-old male with no significant medical history suffered lightning strike while working on a metal structure outdoors in rainy conditions. After the incident, he experienced a transient loss of alertness and generalized paralysis, recovering quickly. Upon arrival at the emergency department, he was conscious, oriented, with a Glasgow Coma Scale score of 15, hemodynamically stable, and no cardiac abnormalities. Simple, non-displaced fractures of the 4th and 5th ribs on the left side were identified, along with burn injuries; first-degree burn on the 5th toe of the right foot (electric current entry) (Figure 1), erythematous lesions following a linear pattern with branching from the lateral of the right leg, abdomen, and neck (Figures 2 and 3), third-degree burns on the neck (electric current exit) with a circumferential pattern corresponding to a metal chain the patient was wearing. (figure 4).

Laboratory results: mild elevation of CPK (1125 mg/dl) without elevation of cardiac enzymes, normal electrolytes, and no signs of renal injury or coagulopathy. Normal CT scan of the skull.

Supportive care and analgesia were provided, and wound washing and debridement of the burns were performed. The patient showed clinical and biochemical improvement without organ failure and was successfully discharged from the intensive care unit with good clinical progress.

## Discussion

Lightning carries an immense amount of energy, as it can transport voltages exceeding 10 million volts. Additionally, temperatures can be

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**Figure 1.** Tense serous blister on the dorsal of the fifth right toe measuring approximately 2 cm.

extreme, with reports indicating values of up to 30,000 Kelvin (29,727 °C). Lightning can switch its energy from positive to negative and can exhibit both direct current and alternating current. Exposure to this energy typically lasts between 1/1000 and 1/10 of a second. Lightning injuries have been classified into three categories: direct strike, side strike, and contact or ground current injuries. Direct strikes are relatively rare, accounting for only 5% of cases, and occur when lightning makes direct contact with an individual. Contact injuries happen when a person touches an object that has been struck by lightning. Side strike

**Figure 2.** right leg with erythema and crusts in a linear trajectory with ramifications

**Figure 3.** Right abdomen with erythema, hyperpigmentation, and hematoma crusts in a linear distribution, epidermal detachment, with erosions along its path.

injuries constitute approximately one-third of lightning-related injuries and occur when current jumps from a nearby object and travels along a path of least resistance to a person. Lastly, the most common type of injury is ground current or ground contact injury, which accounts for 50% of cases. This occurs when lightning strikes an object or the ground near a victim and travels through the ground to reach the individual, as was the case with our patient, who sustained a discharge while working.[4], [5], [6]

Lightning injures patients through various mechanisms, including the effect of electric current on tissues, burns due to the conversion of electrical energy into thermal energy, mechanical trauma, and falls resulting from impact or muscle contraction. Sudden death following a lightning strike is attributed to simultaneous cardiorespiratory arrest, with this scenario being more common in direct strikes. Patients experience cardiac arrest due to the immediate depolarization of myocardial cells. Ventricular arrhythmias may occur, but they are relatively rare.

**Figure 4.** Ulcerations with a clean base and defined edges, peripheral hyperpigmentation, erythema and hemorrhagic crusts in a linear distribution.


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Return of spontaneous circulation is typically achieved with sinus bradycardia and is accompanied by a recovery of the respiratory center; however, arrest may recur if management is not timely and prompt. The peripheral and central nervous systems can also be affected, as intracerebral hemorrhages have been documented, predominantly in the basal ganglia and brainstem. Temporary paralysis has also been described due to vascular spasms and instability of the sympathetic nervous system, most commonly observed in the lower extremities. This condition is typically temporary and resolves with the appropiate management. Skin injuries are common, with superficial injuries being the most prevalent. Linear injuries are typically partial thickness and occur when sweat vaporizes as energy travels across the victim skin. Punctiform injuries are grouped circular burns resulting from the current passing from deep tissue as it exits the body. Deep injuries or third-degree burns are uncommon, as the exposure time is short, occurring in less than 5% of patients. These injuries arise when individuals have metal objects that heat to a high degree, melting or burning the skin directly. In the case of our patient, wearing a metal object around the neck (a chain) resulted in energy accumulation and a third-degree injury. Contusion injuries associated with this type of discharge are frequent, causing trauma of various types, including to the thorax, skull, spine, and extremities. Our patient presented with thoracic trauma accompanied by rib fractures. Eardrums may sustain injuries in up to 80% of cases and are associated with intracranial injuries. The eyes can also be affected, with injuries such as bilateral cataracts being the most common; however, other conditions may present. [4], [7]

Lichtenberg figures were first described in the late 18th century during experiments with static electricity. They appear one hour after contact with lightning energy and may persist or disappear in surviving patients. These figures are not classified as burns; they do not follow the pattern of nerve or vascular pathways and are not associated with damage to the epidermis. They can occur in 17% to 33% of lightning victims. Their etiology is not definitively known, but they have been explained as injuries that follow the moisture of the skin. There is ongoing debate among various researchers, with some suggesting that this sign is generated by interstitial hemorrhage, although this theory lacks a clear explanation. Byard explored the lesions through histological studies without finding evidence of hemorrhage, only observing dilation of dermal vessels, thereby explaining their clinical behavior.[8]

In terms of treatment when dealing with lightning strike victims an inverted triage should be performed, as those who survive the initial impact rarely die during the event. Therefore, efforts should be focused on victims who appear to be in cardiac arrest.[4] The hospital management of this condition, once assisted by pre-hospital services, involves a rapid assessment of neurological, cardiovascular, respiratory functions, and soft tissues, as these are the areas most frequently affected by injuries, as previously explained. All patients with confirmed lightning injuries should undergo a 12-lead electrocardiogram to identify bradycardia, arrhythmias, QT interval abnormalities, or ischemia. A cranial CT scan should be requested in cases of suspected brain injury, either due to neurological symptoms or hearing loss. Additionally, biochemical analyses should be performed as with any patient who has sustained high-voltage electrical injuries. Management should be guided by the recommendations for patients with major trauma and extensive burns (ATLS), evaluating the need for intravenous fluids and addressing care for other injuries. There is a special population, such as pregnant women, where the incidence is fortunately low; however, if this occurs, a complete fetal assessment should be conducted by a specialist for any patient over 20 weeks of gestation. All patients should be monitored for a minimum of 24 hours in a facility with vital signs monitoring in an intensive care unit. [3], [4], [9], [10]

## Conclusions

Lichtenberg figures are lesions observed in patients with burns that appear in the early stages of injury and tend to disappear in the days following electrical exposure. The origin of these lesions, as well as their histological characteristics, remains unclear; their occurrence is infrequent, as victims of electrical injuries caused by lightning are rare in intensive care settings.

This case illustrates the complexity of electrical injuries, particularly those caused by lightning. Burns and rib fractures are common complications, and appropriate management is crucial for recovery. Identifying the specific characteristics of electrical burns, such as entry and exit patterns, is essential for diagnosis and treatment. The patient's good clinical outcome highlights the importance of prompt medical attention.

## Conflicts of interests

The authors declare no conflicts of interest.

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