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Case Report

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Near Miss Lightning In A Child During Recreational Outdoor Activity

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Abstract

Lightning-related fatalities and hospitalizations are likely underestimated. Lightning injuries occur most commonly in young males who are involved in work or recreational activities outdoors. We report a case of near miss lightning strike in an Italian boy hit during sport activity. A 12-years-old male, during an outdoor soccer training session, was struck directly by lightning, causing electrocution. Just by chance, close circuit video surveillance camera took the images of the striking, which are presented. The child suffered cardiac arrest. Prompt rescue measures by his coach included immediate start of cardio-pulmonary resuscitation maneuvers. On admission to the hospital emergency room, he was in coma (Glasgow Coma Scale score 4). The lightning hit was evident with two second-third degree burns on the medial surface of the distal third of the left leg and the submalleolar region of the left foot. The patient was put on continuous infusion with midazolam (0.2 mg/kg/h) and remifentanil (0.10 mcg/kg/min) (RASS -4, BPS 3). On day 2, gradually awakening and respiratory weaning were carried out until extubation on day 2. The burn was treated conservatively. On day 7, the boy could be discharged. Five months later, the boy is doing fine with no sequelae. In this unusual case of video evidence of a direct lightning hit, the boy was probably rescued by the presence of a professional rescuer, which turned the event into a near miss with favorable outcome.

Introduction

There are more than 6,000 lightning strikes every minute around the globe [1,2]. Up to 40 percent of serious electrical injuries are fatal [3,4]. In Italy, on average around 1,600,000 lightning strikes per year, especially in the months of July and August, but the phenomenon can occur, more rarely, even in winter. Although some more affected areas have been identified (Friuli, Lombardy lake region, Rome, pre-Alpine and Apennine mountains),

there are no areas in Italy free from the risk of lightning. However, there are no studies relating to the number of victims and damage to people caused by lightning [5]. It is likely that lightning-related fatalities and hospitalizations are underestimated [6]. Lightning injuries occur most commonly in young males who are involved in work or recreational activities outdoors, predominately in the spring and summer months. Lightning may strike individuals or injure a group of people simultaneously. Lightning is a widespread danger to the physically active population.
We report a case of near miss lightning strike in an Italian boy hit during sport activity.

Case Presentation

F.D. is a 12-years-old male, born by elective caesarean section at term of a normal pregnancy, with normal psychomotor development and physical growth. His medical history included acute gastroenteritis requiring hospital admission in the newborn age, and chickenpox at the age of two. During an outdoor soccer match, he was struck directly by lightning, causing electrocution, which resulted in cardiac arrest. Prompt rescue measures by his coach included immediate start of cardio-pulmonary resuscitation maneuvers, while the emergency service ("118") was activated. Within 10 minutes he was collected and transferred to the local hospital. On admission to the emergency room, he weighed 51 kg (90^{th} centile), with height 148 cm. ($25\text{-}50^{th}$ centile); he was in coma, with a Glasgow Coma Scale score of 4 (E1, V2, M1), upward gaze, isochoric isocyclic pupils, slightly mydriatic and hyporeactive to light; spontaneous/assisted ventilation by resuscitation bag; non-invasive blood pressure 125/70 mmHg; heart rate 110 bpm. Blood Gas Analysis (BGA) showed: pH 7.06, pO2: not assessable, pCO2 47.7, lactate 5.6 mmol/L in the absence of electrolyte disorders. A 20G peripheral intravenous catheter was positioned into both upper limbs. Following administration of Fentanest, Propofol and Rocuronium in Rapid Sequence Induced, he underwent intubation and mechanical ventilation with the following parameters: Vt: 340 ml, PEEP 5 cmH2O, FiO2: 50%, RR 20 breaths/min. ECG showed sinus tachycardia with HR: 131 bpm and right bundle branch block **(Figure 1)**. No pathological alterations were found at transthoracic echocardiography. Total body CT scan showed almost complete collapse of the left lung with cardio-mediastinal displacement **(Figure 2)**. Thus, endotracheal tube was re-located at 2 cm. from the keel, thus resolving the left lung collapse. Bone lesions included non-displaced fracture of the posterior arch of the left seventh rib; cortical infractions of the posterior arches of the right fourth to seventh ribs. Atelectasis in the posterior segment of the right lower pulmonary lobe; signs of hepatic steatosis; no evidence of traumatic lesions in the abdomen. Skull and brain CT scan was also negative for bleeding, traumatic or ischemic lesions.

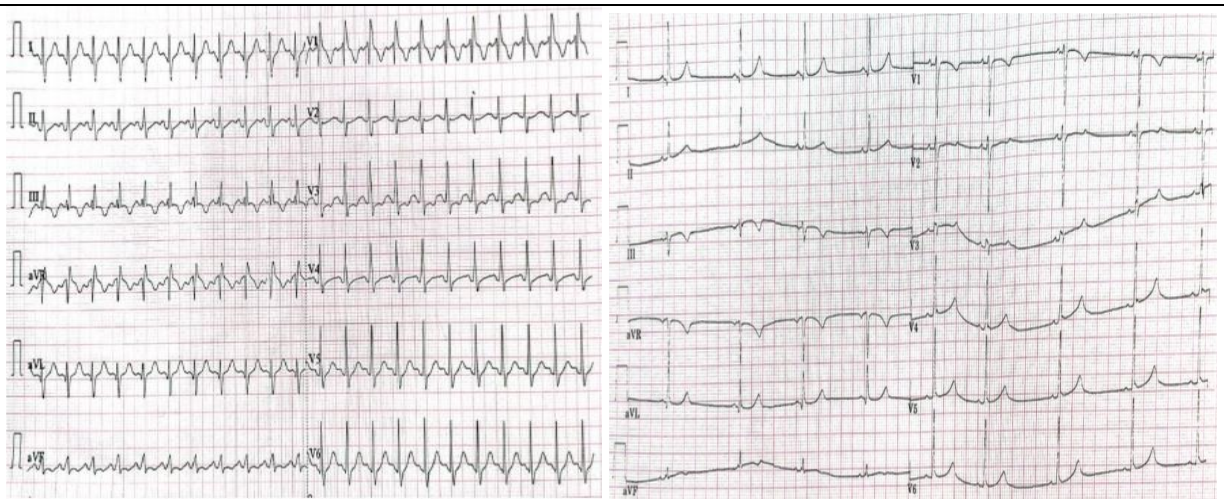

Figure 1: a) Electrocardiogram showing sinus tachycardia (131 bpm) and right bundle branch block. b) Electrocardiogram showing sinus bradycardia (53 bpm).

Figure 2: Lightning strike of the boy during a soccer training session. The trainer wears a green T-shirt.

On the same day, the patient was referred to our Pediatric Intensive Care Unit (PICU). He was connected to mechanical ventilator, BIPAP mode, with FIO2 35% and peripheral pulse oximetry values SPO2 99%. To ensure vascular access, under ultrasound guide, left radial artery was cannulated with a 22G catheter, and a 5 Fr, 12-cm. trilumen central venous catheter was placed in the right brachiocephalic vein by Seldinger technique. Nasogastric tube and bladder catheter were also positioned. Physical examination showed aligned eyeballs with isochoric-isocyclic miotic pupils, still hyporeactive to light; two second-third degree burns on the medial surface of the distal third of the left leg and the submalleolar region of the left foot were evident. His hemodynamics were stable, without

amines support; afebrile, blood pressure 125/65 mmHg, HR: 108 bpm, spontaneous diuresis > 1.5 ml/kg/h. BGA: lactate: 3.5 mmol/l, P/F 365 mmHg, in the absence of electrolyte disorders. Blood chemistry tests showed increased inflammation indices, with WBC 14.300/uL, PCT 6,14 ng/ml PCR 39 mg/L; troponin (hs-TnI) 70.8 pg/ml; LDH 996 U/L, creatine kinase 417 U/L; AST 836 U/L ; ALT 1106 U/L; G-GT 108 U/L. On EEG, no evidence of epileptiform graphic elements. The patient was put on continuous infusion with midazolam (0.2 mg/kg/h) and remifentanil (0.10 mcg/kg/min) (RASS -4, BPS 3). Empirical antibiotic therapy with amoxicillin-clavulanate (1 gr q 8 hrs.) and PPI (pantoprazole 40 mg/day) were given. Plastic surgeon advised topic application of a collagenase/chloramphenicol based ointment and fatty gauze every 48 hours. On day 2, gradually awakening and respiratory weaning were carried out until extubation which was followed by an episode of laryngospasm and bronchospasm, treated promptly with i.v. hydrocortisone and nebulized salbutamol sulphate / beclometasone dipropionate. The patient was supported with HFNC (High Flow Nasal Cannula) and dexmedetomidine hydrochloride (0.6 mcg/kg/h) to ensure sedation. On day 3, his vital parameters were stable, with progressive normalization of AST, ALT, and troponin. Dexmedetomidine was withdrawn. Thus, he could be transferred to our pediatric semi-intensive unit. During his stay, he progressively improved, becoming fully alert and reactive, with stable hemodynamics and spontaneous eupneic breathing on room air. Vesical catheter and nasogastric tube could be removed, and he returned to oral feeding. Due to nausea and chest pain, he received ondansetron 2 mg i.v.; ECG showed sinusal bradycardia 53 bpm; his cardiomyonecrosis enzymes were hs-TnI 1.7 pg/mL (n.v., 2.3-19.8). Surveillance nasal, rectal, skin and broncho-aspirate swabs, as well as SARS-CoV-2 swab, were negative. During the following days, biomarkers of inflammation progressively reduced, with no sign of infection. Ondansetron 3 mg/day i.v., pantoprazole 40 mg/day i.v. and oral amoxicillin/clavulanate were given until discharge. The burn was treated conservatively with showers and dressing changes with application of paraffin gauze dressing and topical collagenase/chloramphenicol based ointment. On day 7, the boy could be discharged with follow-up evaluation by the plastic surgeon every other day. Given the persistent sign of infection, and isolation of staphylococcus from the wound swab, i.v. dalbavancin was administered on week 5, and repeated one week later, with complete healing and no residual scars on the burned skin. At the 5.5 months follow-up, the patient is doing well, with no evidence of any physical or neuro-psychological sequelae.

Discussion

Patients receiving a lightning strike should be considered high-energy trauma patients, potentially exposed to any possible injury, with possible manifestations involving the skin, and in whom neurological, cardiological, musculoskeletal and the renal system may occur. Initial therapeutic approach is of paramount importance **[7,8]**. Lightning injury or death can occur via different mechanisms: a direct strike occurs when a lightning bolt hits the victim without striking anything else before contact. It is the least common mechanism, accounting for up to 5% of all reported lightning injuries **[9]** and is often inaccurately perceived as the most important aspect to consider in safety recommendations. In the present case, the boy was directly stroke by the lightning on his leg **(Figure 2)**. Lightning has several direct effects on human systems: cardiovascular, neurologic, and sensory organs. Although the only acute cause of death is cardiac arrest **[10]**, the anoxic brain damage that may occur during delayed or prolonged

resuscitation can be devastating. This boy had the chance to be assisted by his trainer/referee during a soccer game, who observed the lighting strike from a few meters and immediately realized what was happening. Being qualified for cardio-pulmonary rescue, while calling for immediate medical help, he realized the boy was in cardiopulmonary arrest and started cardiopulmonary resuscitation. Remarkably, he was fully aware that the use of an automated external defibrillator in a wet environment is unsafe **[11]**. Thus, since the boy was laying on the watery soccer field, he decided not to apply electric cardioversion by defibrillator, and rather carried on manual cardiac massage and ventilation, until arrival of the professional rescue team. Education regarding lightning danger and precautions to lessen the likelihood of being struck by lightning are critical to reducing casualties. All individuals, particularly leaders in athletics and recreational activities, should appreciate the lightning hazard and learn the published lightning-safety guidelines **[12]**. Long-term injuries may appear soon after the lightning strike or take months to develop. Some patients develop chronic absence-type seizures, or pain syndromes, or psychological and cognitive dysfunction **[13,14]**. In the present case, luckily enough prompt application of resuscitation maneuvers already on the ground allowed to shorten the time of cardiac arrest, thus allowing an adequate brain and tissue perfusion. At the time of writing, 5.5 months later, the boy returned to his life-style, with no evidence of physical or neuro-psychological sequelae.

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