Case report:

"Thunderstruck" – penetrating thoracic injury from lightning strike

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Introduction

Penetrating injuries secondary to lightning strike are extremely rare especially in paediatric patients. Referral of lightning strike victims to a burn unit is currently usually advised [1,2]. This paper reviews the epidemiology, clinical presentation and management principles of penetrating injury resulting from lightning strike blast.

Case Report

A male twin, 8 years of age was presented to our emergency department (ED), after being injured as a result of lightning strike in an AC (Alternating Current) transformer housing. At the time of the strike, the victims were located in a textile dome tent approximately 15 meters from the housing. On physical examination by dispatched Helicopter Emergency Service Team both patients had a GCS of 15 without respiratory distress or hemodynamic abnormalities. The patients were referred to a regional level 1 trauma centre. Upon arrival in the emergency department they were evaluated utilizing PTLS (Paediatric Trauma Life Support) guidelines. During primary survey the first patient was normotensive (117/70 mmHg) with a normal heart rate of 90 bpm, a free airway and a maximum paediatric Glasgow coma score. During full exposure two protruding copper wires were noted at the level of the scapula as well as a 2nd degree burn mark in the face. Conventional thoracic radiography revealed no fractures or pneumothorax. Routine electrocardiography showed no signs of cardiac injury. The facial burn wound was treated per protocol and the copper wires were removed surgically under local anaesthesia. The patient was admitted to the paediatrics ward for observation and treatment of the burn wound and was discharged the ensuing day.

His twin brother was normotensive (125/65 mmHg) with a normal heart rate of 100 bpm, a free airway, normal chest auscultation bilaterally and a saturation of 97% without supplemental oxygen. Routine electrocardiography showed no signs of cardiac arrhythmia. Despite a large occipital laceration of 5 by 2 cm,

the paediatric Glasgow coma score was 15. Upon inspection of the body a minute puncture wound was identified at the lateral border of the right pectoral muscle (at the level of the 4th rib). Conventional thoracic radiograph in two directions showed a hemato-pneumothorax on the right side. Furthermore, a foreign body was identified in the thoracic cavity (figure 1). Additional Computer Tomographic angiography (CTA) revealed a missile trajectory through the lung, a projectile located in lung parenchyma and an increase of the pneumo- and hematothorax compared to the conventional thoracic radiograph (figure 2).

During urgent exploratory right-sided antero-lateral thoracotomy the lung lacerations were sutured with polypropylene sutures and a fragment of copper wire, approximately 2 centimetres in length, was removed from the dorsal thoracic wall. Two chest drains were inserted. On the second day post-operatively the two chest tubes were removed. The patient was discharged after uneventful recovery on day seven.

Discussion

Most commonly lightning strikes act through one or more of five separate mechanisms recognized in keraunomedicine [3,4].

Direct strikes by lightning result in current flowing through the body. Additionally contact voltage, side splash, ground strike, wire-mediated lightning injury have been described extensively in the literature [3,4,5]. Only recently have Blumenthal et al added a possible sixth mechanism in which a nearby strike causes a blast wave to create barotrauma to the hollow viscus of the patient (see table 1) [6].

In a case report the same author describes an autopsy of a patient suffering from secondary missile injury to the patient's lower extremities after lightning strike to the adjacent pavement. Small pieces of concrete shrapnel were found embedded within the wounds. The patient succumbed from the lightning strike [7]. Penetrating thoracic blast injury caused by a nearby lighting strike has not been reported previously, and is potentially devastating

in nature. The authors hence propose a seventh type of lighting strike injury; penetrating blast injury due to lighting strike induced explosion of nearby structure. (see table 1)

The penetrating injury pattern and mechanism described in this case has great similarities with those seen in victims of improvised explosive devices (IED) [8,9]. Blast injuries are commonly categorized by mechanism into primary, secondary, tertiary and quaternary (e.g. burns or toxic effects) injuries. Primary injury is the result of blast overpressure (BOP) followed by under pressure and affects (air-filled) organs that are stretched beyond their limits. The secondary mechanism results in penetrating injury through shrapnel. In the tertiary mechanism the patients are hurled by the blast, resulting in blunt trauma from impact [10,11]. Blast injuries with penetrating injury in the civilian setting are fortunately rare [12].

The authors are familiar with the treatment of IED type of injuries from deployment in the recent military conflict in Afghanistan, where the victims arrive in hospital "peppered" by shrapnel as several body cavities are violated and the respective organs injured. It is of utmost importance to include full and complete exposure during the primary survey in these patients to identify possible sites of injury. Special attention needs to be given to the body folds (neck, axillae, groin, gluteal) as wounds located there may be easily missed. In the herein described case the missile entered the thoracic cavity through only small puncture wound in the axilla, which could have been easily missed, but revealed gross injury to the lung parenchyma at surgical exploration.
The most common injuries from exposure to lightning are burns, which usually require immediate care in specialised burn units. However, one must be prepared for additional barotrauma and penetrating blast injuries or possible fractures as a result of the pressure wave.

Conclusion

Lightning strikes victims are rare to be presented at an emergency department. The range of injuries is broad and often burns are the primary focus. Lightning strike resulting in IED like blast injuries has now been added to its possible trauma mechanisms. These “shrapnel” injuries should be excluded in all patients struck by lightning.

Figure 1

Chest radiograph with “shrapnel” in the right side of the right hemithorax.

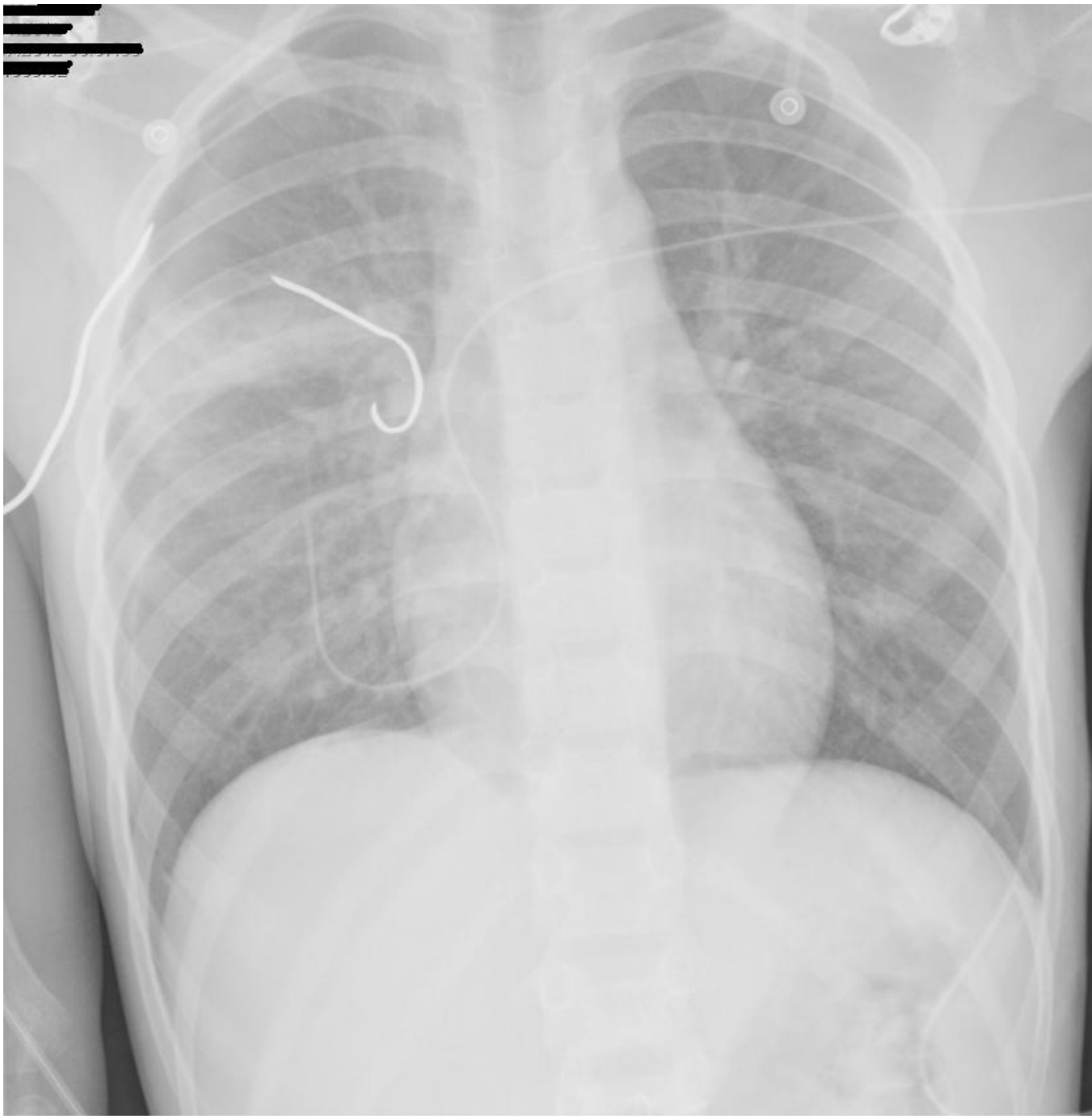

Figure 2

CT with an improvised explosive device-like trajectory through the lung parachyma.

Table 1 Type of lightning strike and ways the human body is affected

Type	Description	Effect on the human body
1	Direct strike	Current flows through the body, high mortality
2	Contact voltage	Lightning strikes an object the victim is touching
3	Side splash	Splashing of current from a nearby direct strike
4	Ground strike	Ground current passes to the victim from the ground strike point
5	Upward streamer	Current flows through the body from the ground upwards
6	Blast Barotrauma	Explosion of the air around the lightning channel causing injury to hollow viscus or fractures by a blast wave
7	Blast penetrating injury	Lighting strike induced explosion of nearby structure in which shrapnel causes penetrating injuries to patient.

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