

1 **Case report:**

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3 **“Thunderstruck” – penetrating thoracic injury from lightning strike**

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1 **Introduction**

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

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8 **Case Report**

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

28 His twin brother was normotensive (125/65 mmHg) with a normal heart rate of
29 100 bpm, a free airway, normal chest auscultation bilaterally and a saturation
30 of 97% without supplemental oxygen. Routine electrocardiography showed no
31 signs of cardiac arrhythmia. Despite a large occipital laceration of 5 by 2 cm,

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

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

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18 **Discussion**

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

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

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

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

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

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15 The authors are familiar with the treatment of IED type of injuries from
16 deployment in the recent military conflict in Afghanistan, where the victims
17 arrive in hospital "peppered" by shrapnel as several body cavities are violated
18 and the respective organs injured. It is of utmost importance to include full and
19 complete exposure during the primary survey in these patients to identify
20 possible sites of injury. Special attention needs to be given to the body folds
21 (neck, axillae, groin, gluteal) as wounds located there may be easily missed.
22 In the herein described case the missile entered the thoracic cavity through
23 only small puncture wound in the axilla, which could have been easily missed,
24 but revealed gross injury to the lung parenchyma at surgical exploration.

25 The most common injuries from exposure to lightning are burns, which usually
26 require immediate care in specialised burn units. However, one must be
27 prepared for additional barotrauma and penetrating blast injuries or possible
28 fractures as a result of the pressure wave.

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1 **Conclusion**

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

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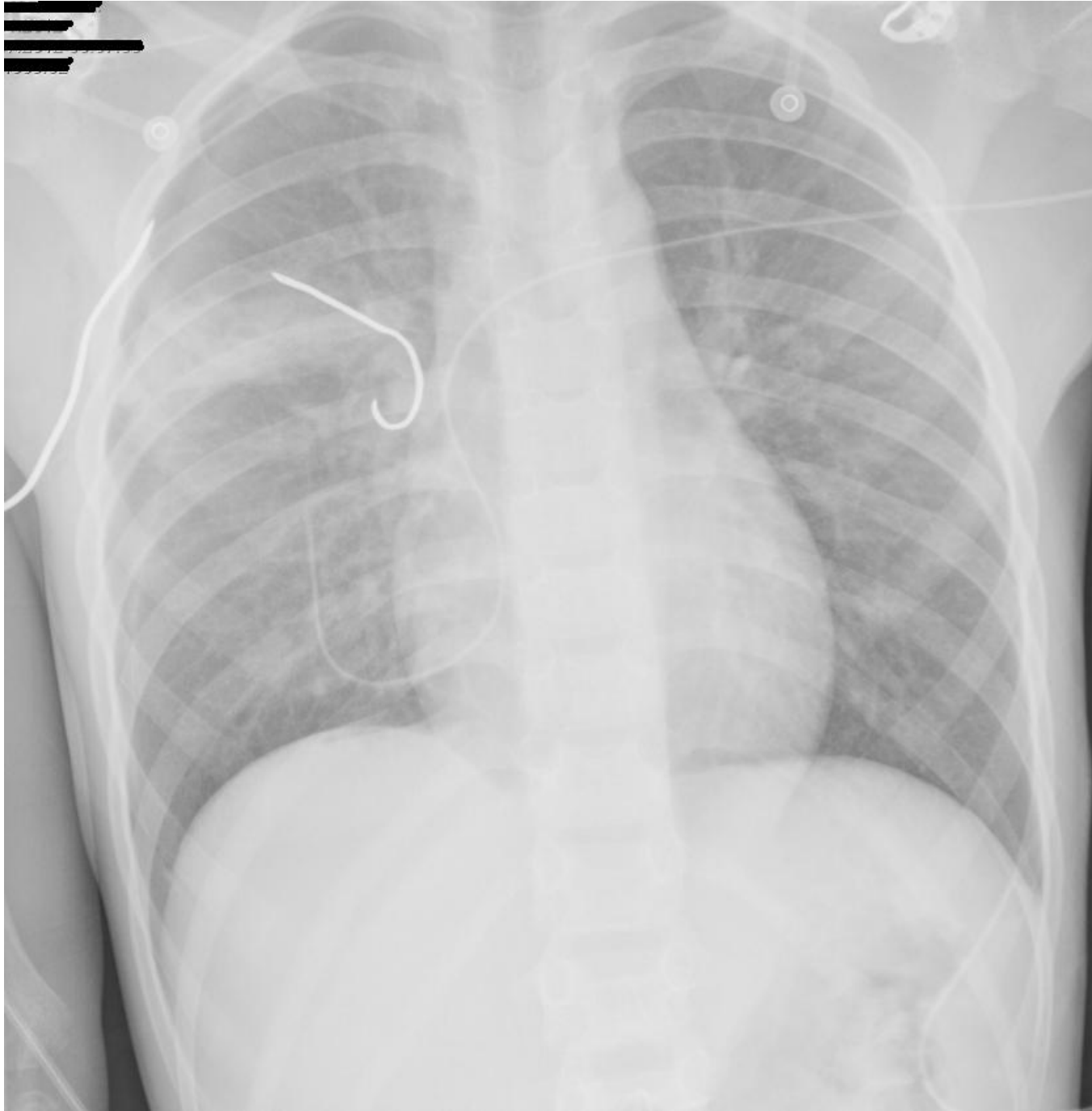
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1 **Figure 1**

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



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1 **Figure 2**

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



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

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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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