Int J Legal Med (1997) 110 : 326–328

CASE REPORT

F. Zack · U. Hammer · I. Klett · R. Wegener

Myocardial injury due to lightning

Received: 3 February 1997 / Received in revised form: 7 May 1997

Abstract The report deals with a 27-year-old male who was standing in a tent and was injured by lightning as it struck a tree about 1.5 m away. He immediately lost consciousness and exhibited ventricular fibrillation when the emergency physician arrived. A clinical picture of hypoxaemic brain damage emerged after initially successful resuscitation. Brain death was diagnosed on the fifth day after injury. The discrete external findings (remaining arborescent skin marks) contrasted markedly with the severe thermal damage to the pectoral muscle and cardiac musculature found during the autopsy. The histological cardiac findings indicated severe acute myocardial infarction affecting virtually all parts of the myocardium.

Key words Lightning strike · Lightning burns · Myocardial injury

Introduction

Lightning can strike a victim in one of three ways, by a direct hit, a side splash or a ground strike. A direct hit has an obvious entry site and causes extensive thermal injury and barotrauma. In a side splash, the current of lightning jumps through the air to the victim after striking an object such as a tree. In a ground strike, after directly hitting an object energy is transferred through the ground and enters the body of persons in contact with the ground [13].

Injury by lightning is lethal in about every third case [8, 9, 16], the principal cause of death being conduction disturbances [10]. Myocardial damage in lightning injury victims who have survived or temporarily survived is shown by conduction disturbances, changes in the ECG and/or the release of the cardiac isoenzyme fraction of creatine phosphokinase [1].

F. Zack (✉) · U. Hammer · R. Wegener
Institut für Rechtsmedizin, Universität Rostock,
St.-Georg-Strasse 108, D-18055 Rostock, Germany
FAX: +49 (381) 494 9902

I. Klett
Klinikum Schwerin,
Klinik für Anaesthesiologie und Intensivmedizin,
Wismarsche Strasse 397, D-19049 Schwerin, Germany

Case report

Case history

A 27-year-old male who was standing in a tent was injured by lightning as it struck a poplar tree about 1.5 m away (side splash). Another 64 persons attending the event also received treatment, most of them as outpatients. The majority complained of disturbed motoricity and sensitivity of the lower extremities (ground strike). The thunderstorm occurred on a May afternoon in Mecklenburg (Germany).

The young man was standing facing the damaged poplar tree and immediately lost consciousness. Immediate resuscitation was undertaken by onlookers without formal medical training. When the emergency physician arrived, the man exhibited ventricular fibrillation and pupillary rigidity. After successful defibrillation, intubation and artificial respiration he was admitted, still unconscious, to a nearby hospital. The principle clinical findings were normotensive blood pressure, slight changes in the ECG (transitory right bundle-branch block, T wave insertion, discrete ST seg-

Fig. 1 The remains of the arborescent skin marks found on the left breast 5 days after the lightning accident ▶

Fig. 2 Extensive thermal damage to the pectoral muscle is visible after preparation of the skin

Fig. 3 Necroses with almost no inflammatory-resorptive reactions in the pectoral muscle (HE × 224)

Fig. 4 Necroses with almost no inflammatory-resorptive reactions beside undamaged cells of the pectoral muscle (HE × 112)

Fig. 5 Necroses with an inflammatory-resorptive reaction and predominantly striated haemorrhages in the myocardium (HE × 56)

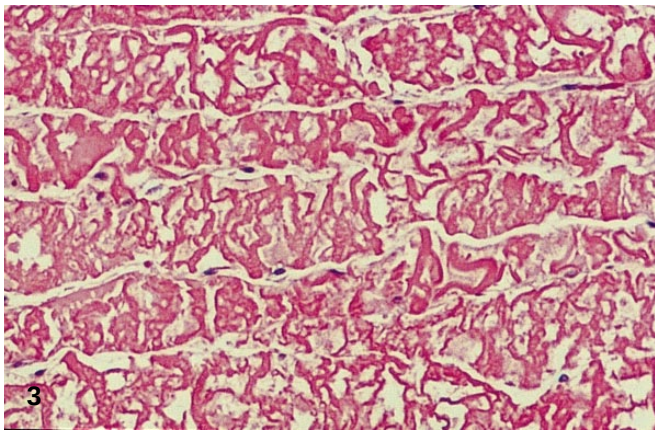
Fig. 6 Contraction bands and necroses with inflammatory-resorptive reactions of the myocytes (HE × 224)

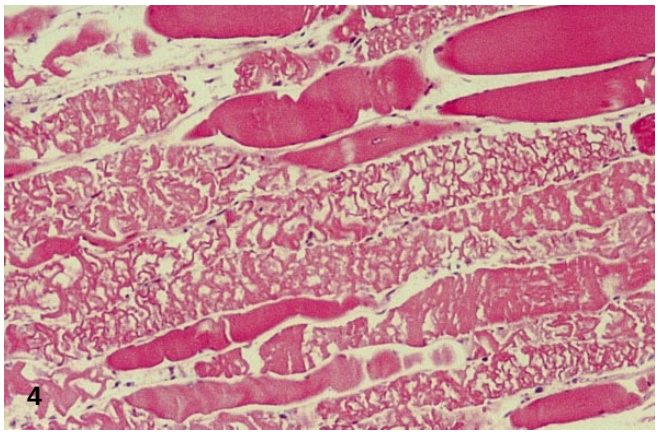
Fig. 7 Necroses of myocytes with degeneration of tissue structures (HE × 224)

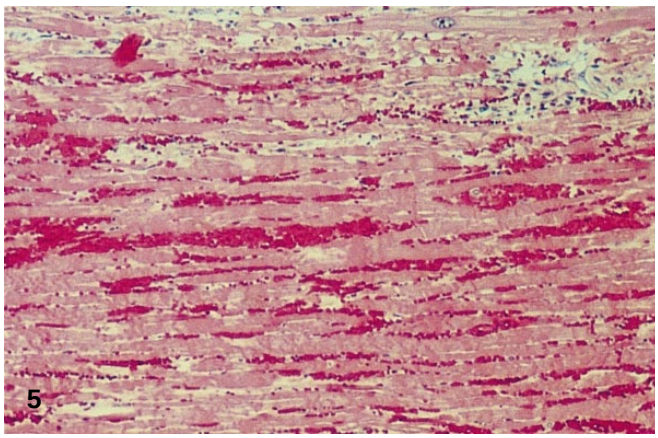
Fig. 8 Numerous contraction bands (cross band type myofibrillar degeneration) of the myocytes (CAB × 168)

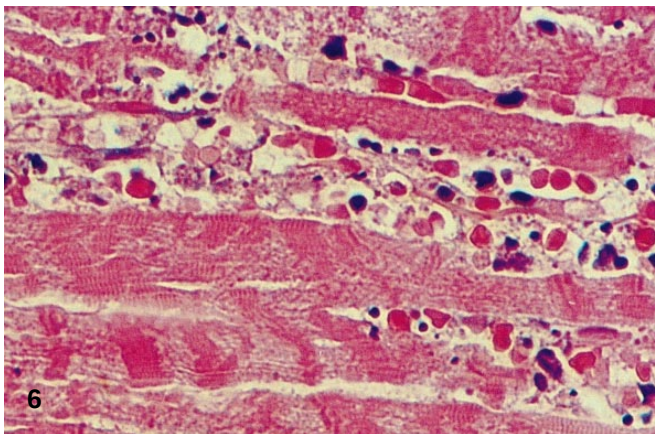

1

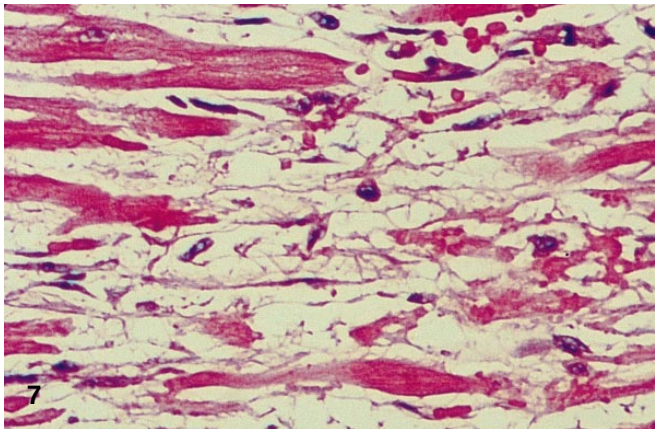

2

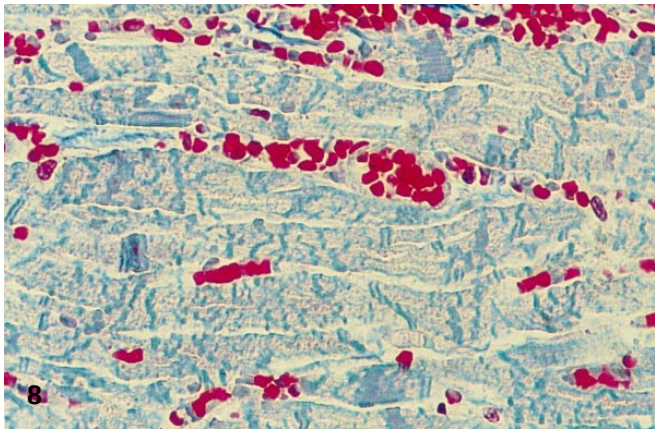

3


4


5


6


7


8

ment elevation), considerable elevation of serum levels of total creatine phosphokinase (CK) to 275 μmol s^{-1} l^{-1} (normal value: 0.0–3.25 μmol s^{-1} l^{-1}), the cardiac fraction of creatine phosphokinase (CK-MB) to 11.48 μmol s^{-1} l^{-1} (normal value: 0.0–0.42 μmol s^{-1} l^{-1}) and myoglobin to up to 13 200 μg/l (normal value: 16–76 μg/l) and fever from the second day onwards. Cerebral symptoms (deep coma due to ventricular fibrillation) predominated during intensive care, and brain death was diagnosed on the fifth day after injury by lightning. The kidneys of the man, which had continued to function properly up to the date of death, were transplanted.

Autopsy findings

At the autopsy, the discrete external findings contrasted sharply with the severe internal findings. The skin of the breast region exhibited discrete remains of arborescent skin marks (Fig. 1). Dissection of the skin revealed extensive lightning burns of the pectoral muscle which histologically were found to consist of pronounced necroses with virtually no inflammatory-resorptive reaction (Figs. 2–4). Macroscopical examination of the heart showed disseminated focal thermally damaged regions besides haemorrhagic areas in the myocardium of both atria and both ventricles, neither side being more severely damaged than the other. Both the appearance and intensity of the lesions were equally apparent in all areas examined. The coronary arteries appeared normal and exhibited no signs of thrombosis. Histological examination revealed a mixture of necroses, mainly striated haemorrhages, inflammatory reactions, eosinophilia of some myocytes and contraction bands (Figs. 5–8). Further findings included signs of brain death, purulent tracheobronchitis and acute bronchopneumonia.

The clothing of the young man, which might also have borne traces of the effects of the lightning, was unfortunately not available.

Discussion

The case described here is of forensic interest for various reasons: This case of a young athlete is a typical example of lightning injury by "side splash" in which the victim is standing near a tree when the lightning strikes it. In such events, part of the energy of the lightning is transmitted to the victim [13]. The discrepancy between the severe morphological changes in the myocardium and the clinical observation that, after ventricular fibrillation, the heart exhibited normotensive blood pressure and a regular sinus rhythm with only slight, partly transitory repolarization disturbances is surprising. The histological findings on the heart were the same as those for severe acute myocardial infarction. Owing to the 5-day interval between the accident and death, the myocardial damage was so severe that special histopathological procedures could be dispensed with. However, immunohistochemical markers should always be used when examining early myocardial lesions [2, 6]. Determination of the myosin concentration in the serum and/or pericardial fluid can also be helpful during the post mortal diagnosis of early myocardial damage [15]. Even though the 27-year-old man had received cardiac massage for a considerable time and cardiac defibrillation had been performed, the severe damage to the myocardium was very probably a consequence of the lightning effect. In the present case there were no morphological signs of arterial involvement. Acute myocardial infarction and ECG changes indicative of myocardial infarction have been reported relatively often in lightning victims [3–5, 7, 12, 14]. The discrepancy between the discrete external findings and the extensive internal thermal damage, which resembled that frequently reported in victims of injury by lightning, must also be noted. Kirchmair and Dienstl [11] emphasized that in such cases the burns and other thermal damage in the muscles are caused by ohmic heat due to the passage of the current, and the extent of the lesions is often not externally evident. In the present case, the renal functions of the victim remained intact until the fifth day (day of death) despite the severe damage to the pectoral muscles and myocardium and the increased serum levels of the creatine phosphokinase and myoglobin. The young man's kidneys were transplanted. Whether or not a crush syndrome developed in the kidneys after the transplantation is unknown to the authors.

References

1. Amy BW, McManus WF, Goodwin CW, Pruitt BA (1985) Lightning injury with survival in five patients. JAMA 253: 243–245
2. Brinkmann B, Sepulchre MA, Fechner G (1993) The application of selected histochemical and immunohistochemical markers and procedures to the diagnosis of early myocardial damage. Int J Legal Med 106:135–141
3. Burda CD (1966) Electrocardiographic changes in lightning stroke. Am Heart J 72:521–524
4. Chia BL (1981) Electrocardiographic abnormalities and congestive cardiac failure due to lightning stroke. Cardiology 68:49–53
5. Eber B, Himmel G, Schubert B, Zeuschner J, Dusleag J, Seerainer C, Antoni H, Gasser R, Lind P, Eber O, Klein W (1989) Myokardiale Schädigung nach Blitzschlag. Z Kardiol 78:402–404
6. Edston E, Kawa K (1995) Immunohistochemical detection of early myocardial infarction. An evaluation of antibodies against the terminal complement complex (C5b-9). Int J Legal Med 108:27–30
7. Ekoe JM, Cunningham M, Jaques O, Balague F, Baumann RP, Humair L, de Torrente A (1985) Disseminated intravascular coagulation and acute myocardial necrosis caused by lightning. Intensive Care Med 11:160–162
8. Iranyi K, Orovecz B, Somogyi E (1962) Das Blitztrauma in neuer Sicht. Münch Med Wochenschr 104:1496
9. Karobath H, Undt W, Hofschneider H (1971) Zur Wirkung des Blitzschlages auf den Organismus mit besonderer Berücksichtigung der Auswirkungen auf das Herz. Verh Dtsch Ges Inn Med 77:455–457
10. Karobath H, Redtenbacher M, Hofecker G, Walde I, Syre G (1977) Zur Frage der Todesursache beim Blitzunfall. Münch Med Wochenschr 119:29–32
11. Kirchmair W, Dienstl F (1982) Nach Elektrounfall: kardiale Überwachung? Dtsch Med Wochenschr 107:857–859
12. Kravitz H, Wasserman MJ, Valaitis J, Anzinger RE, Naidu SH (1977) Lightning injury: management of a case with ten-day survival. Am J Dis Child 131:413–415
13. Lichtenberg R, Dries D, Ward K, Marshall W, Scanlon P (1993) Cardiovascular effects of lightning strikes. J Am Coll Cardiol 21:531–536
14. Lossnitzer K, Faulhaber JD, Stauch M (1972) Elektrokardiographische Frühbeobachtungen in kurzzeitiger Folge nach Blitzschlag. Z Kardiol 62:520–525
15. Perez-Carceles MD, Osuna E, Vieira DN, Luna A (1995) Usefulness of myosin in the postmortem diagnosis of myocardial damage. Int J Legal Med 108:14–18
16. Taussig BH (1968) "Death" from lightning - and the possibility of living again. Ann Intern Med 68:1345–1353