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An unusual case of homicidal near drowning followed by electrocution

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Abstract A young woman was found dead in a bath-tub with her facial orifices under water and current burn marks at the right big toe and at the neck near the hairline. Initial police investigations assumed an accidental electric shock due to a radio falling into the water. The forensic autopsy was followed by extensive histology and immunohistochemistry of the internal organs and skin marks. Intensive vital reactions of a near-drowning were detected that suggested a survival period of at least 20 min. Furthermore, an energy dispersive x-ray spectroscopy analysis on the current burn marks and on possible current applicators was performed, as well as reconstruction experiments with a cadaver of a pig that had been slaughtered shortly before. The results of all investigations revealed a two-step procedure with a primary near-drowning and a final current application with consecutive cardiac arrest.

Keywords Near drowning · Electrocution · Homicide

Introduction

Homicidal electrocution is rare, and only a few cases have been published (Höpler 1931, Svensson and Wendel 1955, Schwerd and Lautenbach 1960, Schneider 1973, Al-Alousi 1990, Pfeiffer and Karger 1998). In the case presented here, the electrocution was found to be preceded by a homicidal near-drowning in a bath-tub. The circumstances of death became clear only after extensive histology, immunohistochemistry and energy dispersive x-ray spectroscopy (EDX) analysis of the electrical marks and other pieces of evidence. In addition, we have used the cadaver of a pig

that had been slaughtered shortly before. This was to reconstruct certain elements of electrophysiology. In agreement with the literature (e.g. Janssen 1984, Karger et al. 2004, Pfeiffer et al. 2004, Fineschi et al. 2004), this case demonstrates again the importance of histological and immunohistochemical investigations in forensic casework.

Case history

On a July Saturday morning at 5 a.m., the husband of a 21-year-old woman rang at the neighbour's door and asked him for help because his wife had been locking herself in the bathroom. When the door was kicked down, the woman was found dead in the bath-tub. Her facial orifices were under water. A radio connected to a socket had obviously fallen into the water and was lying close to her legs. The key of the bathroom was lying inside on the floor behind the door. There was a 0.5-cm slit beneath the door. Primary police investigations assumed an accidental electric shock due to the radio falling into the water.

Autopsy findings

A circular current mark existed at the right big toe, and partially dark red partially greyish-white "abrasions" were found at the neck near the hairline (Fig. 1a,b). Further findings were:

1. Acute emphysema of the lungs with diffuse large (Paltauf haemorrhages) and clearly defined petechial (Tardieu haemorrhages) subpleural haemorrhages (Fig. 2)
2. Faint subcutaneous bruising at the right lower leg
3. Few petechiae in the eye lids, the scalp and sub-epicardial
4. No bleedings in the neck muscles, no bleedings in the posterior soft tissues (completely dissected), no bleedings in the soft tissues of both arms (completely peeled out)

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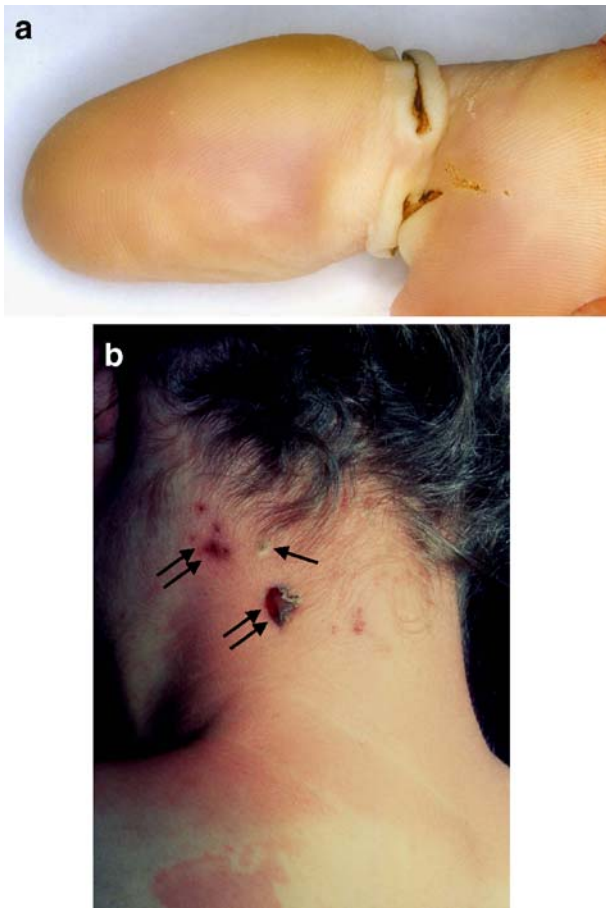


Fig. 1 a Circular current mark at the right big toe. b Greyish-white (↑) and dark red (↑↑) “abrasions” at the neck

Preliminary diagnosis: suspicion of drowning in combination with electrocution

After autopsy, the circumstances of death remained unclear. The blood alcohol concentration was 1.36‰. Results of further toxicological investigations were negative and gave no indication of an influence of illicit drugs.

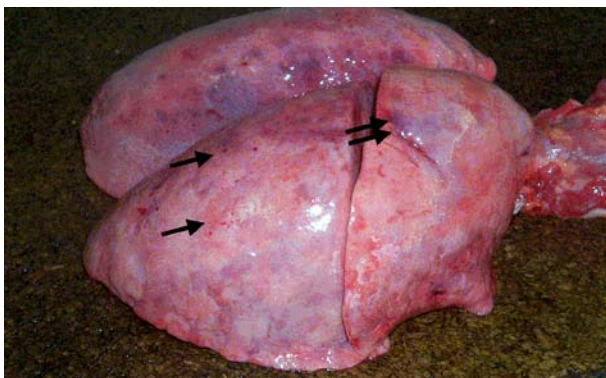


Fig. 2 Acute emphysema with disseminated small petechial (↑) and large diffuse (↑↑) subpleural haemorrhages

When the husband of the victim was confronted with the autopsy findings, he explained the current mark at the toe to have been generated by an intensive embrace with the chain of the bath-tub plug. Additional investigations (see below) were performed refuting this possibility.

Histology/Immunohistochemistry

The marks at the toe and the “abrasions” at the neck showed the classical morphology of an electrical burn with combs and detachment of the epidermis and elongation of the cells and cell nuclei in the malpighian cell layer (Fig. 3).

Lungs Acute emphysema with formation of microcavities, tissue rupturing. Subpleural interstitial emphysema. Microhaemorrhages with diffuse haemoglobin-rich margins. Large areas of total alveolar anaemia alternating with much smaller areas with either normal blood content or even moderate congestion. Areolar demarcations between anaemic and “normal” zones. Patchy haemorrhagic oedema. Activation of macrophages with massive phagocytosis of red cells and haemoglobin, formation of multinuclear giant cells (Fig. 4a–e).

Diagnosis Emphysema aquosum with pronounced reactive changes.

Kidneys Obstruction of the glomerular capsules and the (proximal) tubules with erythrocytes and haemoglobin (Fig. 5).

Diagnosis Acute haemolytic nephrosis.

Heart Swollen fibres. Fresh fibre necroses (Fig. 6).

Diagnosis Acute osmotic and/or ischaemic fibre necroses.

Physico-chemical investigations were performed on the following:

1. Electrical burn marks from the toe and the neck

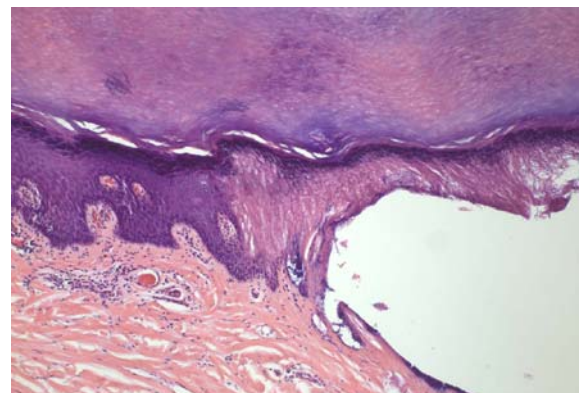


Fig. 3 Electric lesion of the right big toe with a detachment of the epidermis with comb formation and elongation of basal cells (H & E, ×100)

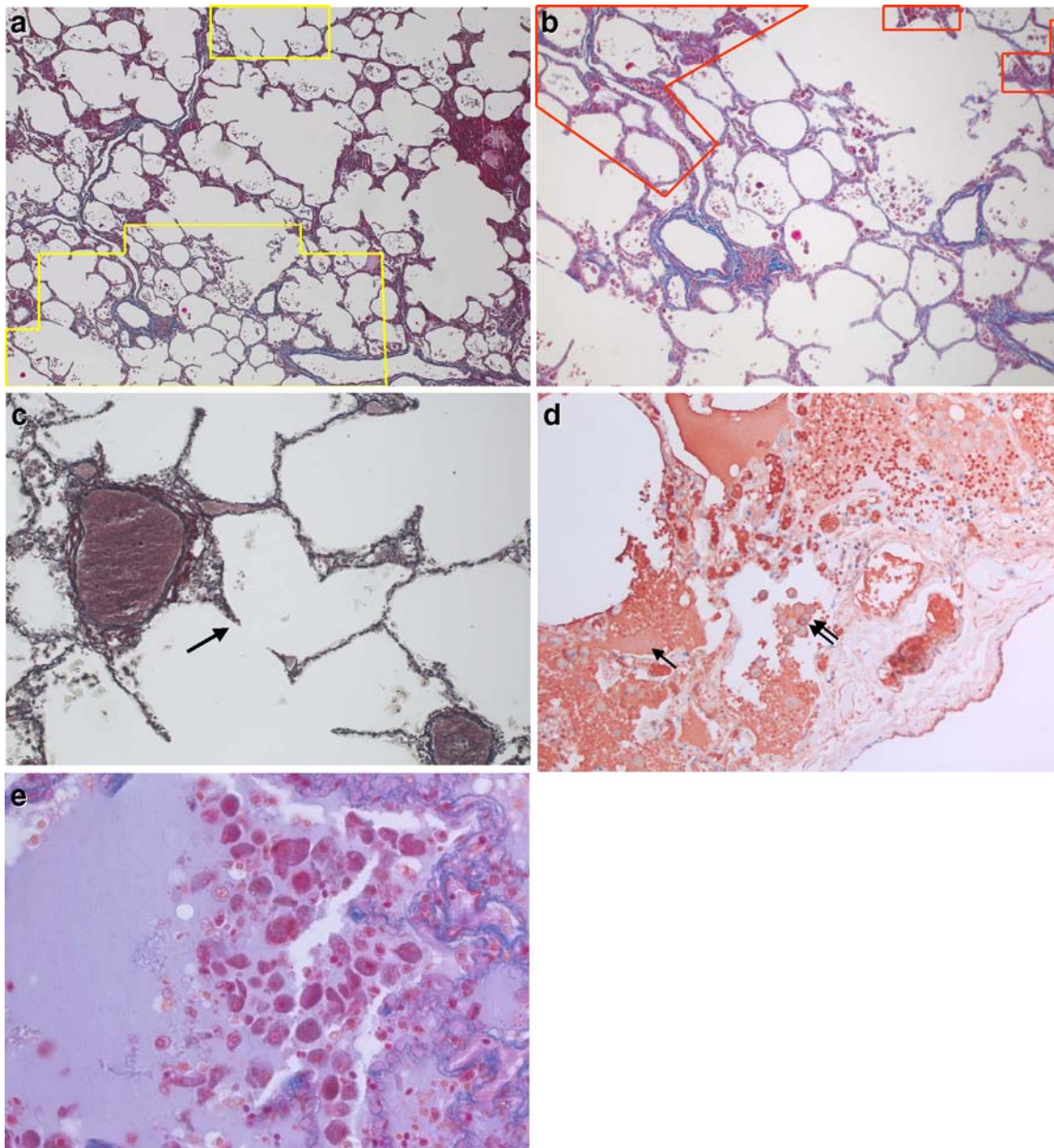


Fig. 4 **a,b** Acute emphysema. Zones of total anaemia (**a** within yellow areas; **b** outside red areas) alternating with hyperaemic zones (**a**, Azan $\times 50$; **b**, Azan $\times 100$). **c** Alveolar wall stretching, ruptures ($\uparrow$) and microruptures (Gomori, $\times 400$). **d** Microhaemorrhages with haemoglobin-rich puddles adjoining the erythrocytes

($\uparrow$). Subpleural emphysema. Macrophages with erythrophagocytosis ($\uparrow\uparrow$) (Immunohistochemistry: rabbit anti-human haemoglobin, DAKO, $\times 100$). **e** Activated macrophages and multinucleated giant cells, phagocytosis of haemoglobin and erythrocytes (Azan, $\times 200$)

2. A metal wire found during further police investigations in the trash
3. The chain of the bath-tub plug
4. The heating (as an earthed object) in the bathroom

Analysis was performed using EDX.
Results:

1. Toe mark: copper as a leading metal ion (Fig. 7)
2. Neck marks: zinc and iron (Fig. 7)
3. Chain of the plug: nickel and chrome (Fig. 7)

4. Metal wire: copper
5. Heating: titanium and iron

Conclusions

The metal wire could well have produced the toe mark. The chain of the plug was definitely excluded. All other possible donors of the neck marks could also be excluded.

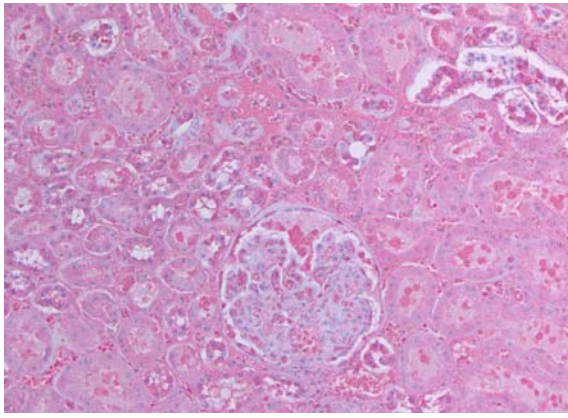


Fig. 5 Obstruction of the glomerular capsule and of the proximal tubules with erythrocytes and haemoglobin (Immunohistochemistry: rabbit anti-human haemoglobin, DAKO, $\times 200$)

Even after extensive search in the whole flat, no instrument or wire or other object that could have been applied as an electric current transfer showing the same element composition compared to the current burn marks was found.

Modification of the confession

After being confronted with the new results of the preceding investigations, the widow reported another variant. He stated that he had found his wife dead on the bathroom floor after an obvious suicide by electrocution. To cover up the suicide, he had placed her body together with the radio into the bath-tub filled with water. After locking the door, he had pushed the key under the door into the bathroom and then contacted the neighbour. However, this variant did not explain for the expressed vital reactions on water aspiration.

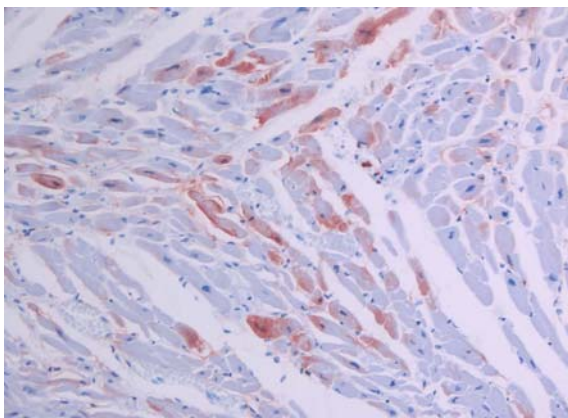


Fig. 6 Fresh myocardial fibre necrosis demonstrated by intrasarcolemmal accumulation of fibronectin (Immunohistochemistry: fibronectin, DAKO, $\times 200$)

Experimental investigations

According to the latter description, a reconstruction was performed. A pig cadaver obtained shortly after killing was placed on the floor of the bathroom without any contact to earthed objects. No current flow through the body could be established when the electric contact was connected to one of the hint paws. This was unexpectedly due to an extremely high electrical resistance of the ceramic floor tiles. After contact of the trunk to an earthed object (heating), the fuse switched off with no burn mark at the contact site. Only when current was applied through the cadaver for a long period did the circuit breaker not switch off, and a current burn mark was generated at the contact site with the heating. However, its metallic composition was grossly different from the burn marks in the actual case. Whilst the pig was in the tub filled with water and a circuit was generated with varying time periods of exposure, no current marks could be produced. With these experiments, the latter alternative of the suspect could be excluded.

Discussion

The following facts of the case could be verified:

The results of the forensic investigations were not compatible with either story reported by the suspect. From the findings, the following sequence of events was reconstructed:

1. Non-fatal drowning: In freshwater drowning, the lung shows a highly specific reaction pattern that is mainly due to the aspiration of water and its absorption into the circulation on the alveolar level (Reh 1970; Mueller 1975; Brinkmann et al. 1983a,b; Janssen W 1984; Polson et al. 1985; Brinkmann 2004). This process leads to the formation of an intensive foam in the airways, to the generation of an acute emphysema and, because of swollen endothelial cells, to an obstructive microangiopathy resulting in severe pulmonary anaemia on the alveolar level. It is the latter process, and not the (mechanical) compression by the over-inflated lungs, that causes the anaemia. Of course, this factor can contribute but not act as the major mechanism: two areas that are in contact can often have the same emphysema, but they have a clearly different blood content (see Fig. 4a and b).

The picture of a drowning lung (freshwater) was microscopically and macroscopically fully evolved, but this was associated with an exceptional pattern of reactive changes. Protracted reactions were:

- Lungs: pronounced activation of macrophages with phagocytosis, formation of multinuclear giant cells
- Massive signs of filtration of erythrocytes and haemoglobin in the kidneys resembling a massive haemolytic shock syndrome

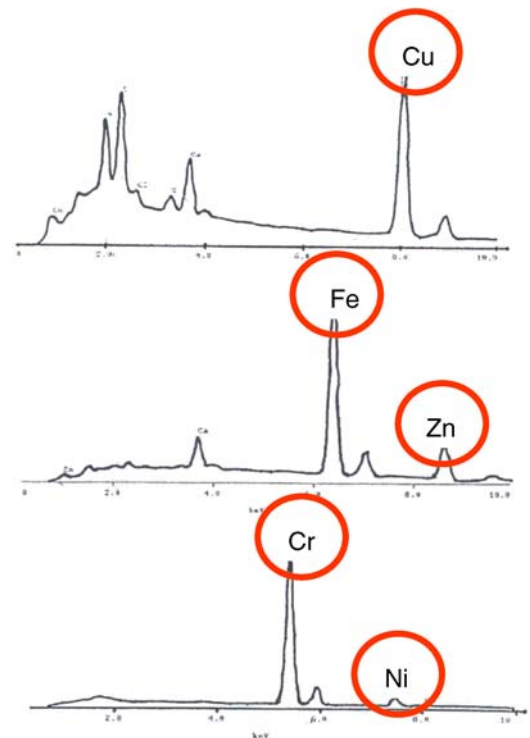
Fig. 7 Dispersive x-ray spectroscopy (EDX) of the current marks from the toe and the neck as well as from the chain of the bath-tub plug

EDX-spectrums

current mark
big toe

current mark
neck

chain
of the plug



- Signs of disseminated fibre necroses with intra-sarcolemmal accumulation of fibronectin in the myocardium

All of the preceding reactive changes can result from different pathologies than freshwater drowning only. For instance, inhalation of toxic gases can be associated with haemorrhagic oedema and thus with an activation of macrophages. However, this case involved a drowning lung (freshwater drowning), which is naturally associated with intraalveolar bleeding. Under such circumstances, it makes no sense to look after toxic gases.

Furthermore, the acute osmotic–haemolytic nephrosis coincided with the drowning process, which is regularly associated with haemolysis (De Bernardi et al. 1965; Caroff et al. 1968). There was no other explanation for the haemolytic syndrome neither from the pathology nor from the toxicology. Same was true for the disseminated type of cardio-fibroncrosis. The accumulation of fibronectin in the myocardium can have many sources, also artificial ones. However, if this occurs intrasarcolemmally, a severe damage of the sarcolemmal membrane must be present to let the rather big molecules pass this barrier and accumulate in the cell (Fechner et al. 1993). In addition, from preceding studies, we have no doubt that this type of reaction proves vital origin (Ortmann et al. 2001). From all findings, we have estimated that the survival period after the near-drowning phase must have been longer than 20 min to produce these and other changes (which are never observed in acute drowning).

- Current application: This had occurred in a dry or semi-dry state of the victim. Otherwise, the generation of the current marks as shown in our case was impossible. One contact instrument was obviously the copper wire that had been twisted around the toe. The other instrument of current application remained unclear. None of the objects installed in the bathroom could have caused this second injury. The time of exposure to the electric current was in the range of more than 1 min. Histologically, there occurred no vital cellular reaction in the current marks and their surrounding. It can therefore be assumed that the electric shock was lethal (the electric route was at least partially through the heart).
- Reconstructions:

(a) *Non-fatal drowning* In the beginning, there had occurred a non-fatal phase of near-drowning. Because of the lack of injuries resulting from defense, fixation and a fight, a so-called Smith mechanism (Polson et al. 1985) would seem to be plausible. After a near-drowning, the victim had partially recovered over a period of 20 min or more. The reasons of this recovery are unknown: it was either accidental, i.e. because the plug had been pulled out during the agony period and the perpetrator had meanwhile left the bathroom, or on purpose, because a two-stage procedure was intended.

(b) *Current application* During this phase, due to unconsciousness, the victim was obviously unable to defend herself. Therefore, the wire could be twisted around the toe and the other contact tool pressed (?) against the posterior neck without any signs of fight. The current application finally was responsible for the death of the victim.

The accused husband was convicted to 12 years of imprisonment. He never admitted, but he also did not dispute.

Conclusion

This uncommon case report underlines the importance of histological and immunohistochemical investigations in forensic medicine.

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