



# Electrothermic damage to the nail due to arcing in high-voltage discharge



Lena Bielefeld<sup>a,\*</sup>, Katrin Mierdel<sup>b</sup>, Stefan Pollak<sup>a</sup>, Markus Große Perdekamp<sup>a</sup>

<sup>a</sup> Institute of Legal Medicine, University Hospital of Freiburg, Albertstraße 9, 79104 Freiburg, Germany

<sup>b</sup> Landeskriminalamt Baden-Württemberg, Kriminaltechnisches Institut, Taubenheimerstraße 85, 70372 Stuttgart, Germany

## ARTICLE INFO

### Article history:

Received 5 July 2013

Received in revised form 2 September 2013

Accepted 6 September 2013

Available online 13 September 2013

### Keywords:

Electrocution

Flash burn

Nail plate

Micro-blisters

Metallization

X-ray fluorescence

## ABSTRACT

The burn effects in high-voltage electrocutions are manifold ranging from inconspicuous marks to deep charring. Apart from lesions caused by direct contact with a live conductor, the victim's body may suffer flash burns from arcing resulting in extensive scattered or confluent heat damage of the skin. In such cases, the nail plates of fingers and toes may undergo thermal changes which up to now have not been mentioned in the pertinent literature. Macroscopically, the nail shows a yellowish discoloration with tiny and closely arranged verruciform elevations. Histologically, the uppermost layer of the nail plate is interspersed with small vacuoles resembling micro-blisters as seen in the corneal layer of common electric marks. The surface of the nail is coated with a thin film of carbonaceous material. Based on an accidental high-voltage electrocution recently observed by the authors, attention is also drawn to the possible occurrence of contact burns from metal objects heated by the current as this finding is usually described only in victims of lightning strikes and not in the context of high-voltage discharges of technical electricity.

© 2013 Elsevier Ireland Ltd. All rights reserved.

## 1. Introduction

The postmortem diagnosis of electrocution may be challenging due to the great variety of external findings. Apart from cases without any visible skin burns (mainly in low-voltage accidents), there is a broad spectrum of local damage from Joule heating: electric marks on friction and meshed skin, crater-like lesions, charring, tissue severance, flash burn effects from arcing with concomitant singeing of hair (the latter ones in high-voltage and lightning accidents) [1–13].

Finger and toe nails are a special kind of dermal appendages that may be exposed to electric current. Nevertheless, to the best of our knowledge the electrothermic changes of nails have never been dealt with in the medicolegal literature. A fatal high-voltage accident recently investigated at our institute induced us to examine current-related findings on the nail. In addition, the article also describes the occurrence of patterned contact burn marks due to a flashover effect in high-voltage electrocution, since this phenomenon is usually mentioned only in the context of lightning strikes and not with deaths from technical electricity.

## 2. Materials and methods

### 2.1. Case history

A 19-year-old alcoholized man and his friend climbed on a diesel locomotive. While standing on the locomotive, the young man was struck by an electric arc generated by an overhead contact line (15 kV). He fell down and died at the site of the accident. According to the statement of his companion, the victim had not had any heat-induced injury prior to the incident.

### 2.2. Histological examinations

Apart from small pieces of the internal organs, an altered fingernail and burnt skin from the nape were fixed in formalin and embedded in paraffin. Sections (3 µm) were cut using a microtome (Microm HM 355, Walldorf, Germany) and stained with hematoxylin/eosin and Prussian blue (with acid solution of ferrocyanide).

### 2.3. X-ray fluorescence

X-ray fluorescence is a method to analyze the elemental composition of metals, glass, ceramics and other materials but is also suitable for the examination of elements covering biological surfaces like the skin.

When materials are exposed to short-wavelength X-rays, the component atoms may be ionized. If electrons of inner orbitals are expelled, electrons of higher orbitals fill the gap while energy in the form of radiation characteristic of the atoms present is released.

Samples of the burnt nape skin and the affected fingernail were dried, positioned in the energy dispersive X-ray (EDX) spectroscopy device (M4 Tornado, Bruker AXS, Germany) and mapped automatically.

\* Corresponding author. Tel.: +49 761 203 6420.

E-mail address: [lena.bielefeld@uniklinik-freiburg.de](mailto:lena.bielefeld@uniklinik-freiburg.de) (L. Bielefeld).

### 3. Results

#### 3.1. Clothing and autopsy findings

Autopsy showed the corpse of a young man (body length 192 cm, body weight 86 kg) with manifold alterations due to high voltage power.

The right sleeve of the sweater worn by the victim adhered tightly to the polo shirt owing to melted synthetic fibers. Sweater, shirt and jeans showed grayish-black discoloration and textile damage. The body surface, mainly on the right side, was extensively burnt. Head and body hair, eyebrows and eyelashes were singed (Fig. 1).

The leather upper of the right shoe exhibited two perforations each measuring 2 mm in diameter. The holes were located in the area of the foot's arch (Fig. 2a and b). Corresponding to that, the right cotton sock was damaged and singed (Fig. 2c). The medial surface of the right foot revealed extensive burns (Fig. 2d).

Around the neck there was a necklace made of silver-colored metal links (Fig. 3a). An about 2.5 cm long piece of the necklace had been torn off and its links were partially melted (Fig. 3b). Along the nape of the victim's neck, a linear patterned burn mark congruent with the structure of the necklace was discernible (Fig. 3c). The adjacent skin was not affected.

Macroscopically, the right thumbnail showed a yellowish-ochre discoloration with tiny, closely arranged, verruciform elevations (Fig. 4). The skin of the right hand was affected by 3rd degree burns.

Further findings were a 10 cm long laceration on the right forehead, a linear fracture of the right frontal and parietal bone, moderate lung contusions and skin abrasions (accompanying mechanical injuries due to the secondary fall from the locomotive). The thoracic and abdominal organs did not show any pathological findings.

The concentrations of ethanol were 1.74 mg/g in the peripheral blood and 2.88 mg/g in the urine.

#### 3.2. Histological examinations

Histological examination of the internal organs did not provide any pathological findings except for minor lung contusions.



Fig. 1. Singeing of head hair.

Along the patterned burn of the nape skin, the basal epidermal cells had a palisade-like appearance with elongated nuclei resembling a “typical” electric mark (Fig. 5).

The uppermost layer of the altered nail plate revealed the formation of micro-blisters (diameter: 7–30  $\mu\text{m}$ ) arranged in a row (Fig. 6a). Deposits of dark particles were seen on the surface of



Fig. 2. (a) Right shoe. (b) Detail of (a) showing perforations in the leather upper. (c) Right sock with burn holes. (d) Right foot with electric burns and partial detachment of the epidermis.

Download English Version:

<https://daneshyari.com/en/article/6552731>

Download Persian Version:

<https://daneshyari.com/article/6552731>

[Daneshyari.com](https://daneshyari.com)