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CASE REPORT

A fire death with a rare finding: anthracosis or soot embolism?

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Abstract

Charred human remains were found in the smoking ambers of a dying fire in an oil palm plantation in Selangor, Malaysia in the midnight of January 28, 2013. Investigations showed that palm fronds and rubber tires were used to light and sustain the blaze. At least four to five tires were estimated to be used based on the residual burnt metal wires at the site. The remains were brought to the Department of Forensic Medicine, Hospital Sungai Buloh, Selangor for post-mortem examination. Pre-autopsy imaging showed a fractured skull with presence of a bullet in the head. The body belonged to a male with unrecognizable facial features, pugilistic attitude, and reduced body size caused by fire damage with sparing of the posterior surface. A large fracture was present at the skull vault. An entry gunshot wound was observed on the left side of the body of mandible, which was associated with base of skull fracture. Heat-related fractures were also noted on the right side of the frontal bone. A projectile was retrieved from the right side of the occipital lobe. Further examination showed presence of soot and hyperaemic larynx, trachea, main bronchi, and oesophagus. Black spots measuring 1 to 2 mm were present on the surface and parenchyma of the heart, liver, pancreas and kidneys. Histopathology examination showed black particles within the vessels in the affected organs. We report this rare finding in a charred body and present a discussion based on published literature on this issue.

Keywords: charred body; life existence; anthracosis; macrophages; autopsy

INTRODUCTION

Charred bodies can be very challenging for forensic pathologists. Autopsy examination of severely burnt victims aims to establish the identity of the deceased, presence or absence of ante-mortem trauma, as well as the cause and manner of death. Given that the effects of heat on the body frequently continues beyond death leading to continuing destruction and consumption of the body, medico-legal examination of a severely burnt victim demands that post-mortem heat-related changes be differentiated from ante-mortem trauma.[1, 2]

When a human body is exposed to fire, the post-mortem changes include: flexion of the upper limbs (pugilistic attitude), skin splitting, loss of soft tissues, exposure of body cavities, shrinking of organs, heat fractures, and thermal hematoma in the extradural space.[1,3] The presence of soot on the tongue, in the larynx, trachea and bronchi is an indication that the deceased was breathing and therefore alive during the fire[3]. Oedema of the larynx may also be observed as the deceased inhaled hot air (whether dry or moist), which can rapidly cause airway obstruction.[2,4,5] Despite charring of the soft tissue wall, the thoracic and abdominal organs are relatively intact and can be assessed well.[6]

Immediate deaths in a fire can be caused by thermal injury or smoke inhalation;[2,4] thus, lung injury may be the main cause of mortality. Histological examinations are important in establishing the cause of death and in excluding other modes of death (such as asphyxia) in the case with no gross findings.[2] Histopathology study of respiratory tissues with fire injury may

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show bronchiolar dilatation, ductal and alveolar over-insufflation or collapse, passive congestion, alveolar oedema, and interstitial and alveolar haemorrhage.[2]

Anthracosis is black spots seen in the tissue adjacent to the bronchioles of the lungs.[5] It is carbon deposition often seen in smokers and city dwellers.[5] Pathogenetically, carbon particles entering the alveoli would be engulfed by macrophages which then exit the airway and become deposited in the tissue. In burn victims, as mentioned above, carbon particles would enter the airway as soot and precipitate in the upper airways by percolation and the lower by inhalation if the victim was alive. It should be noted that both anthracosis and soot would be seen in the airways of the stroma but not within blood vessels.

This article reports a case of a charred body with typical changes previously mentioned. We observed a rare finding of tiny black spots on the surface and parenchyma of the internal organs. On histology, these particles are black in colour and they are found within the blood vessels. A literature search has failed to yield such a finding in burn victims. A discussion of published literature on this subject is presented.

CASE REPORT

A severely burnt body was found in the smoking ambers of a dying fire in an oil palm plantation in Rawang, Selangor, Malaysia. Police investigation showed that palm fronds and rubber tires were used to light and sustain the blaze; these materials were found piled on the body. Approximately four to five tires were used based on the remaining metal wires of the tires. The remains were brought to the Department of Forensic Medicine, Hospital Sungai Buloh, Selangor, Malaysia for post-mortem examination.

Pre-autopsy investigation

The body was subjected to a full body X-ray prior to autopsy. The imaging showed a fractured skull vault with the presence of a radio-opaque foreign object, possibly a deformed bullet, within the head.

Autopsy findings

The severely charred body belonged to a man with a residual body length of 143 cm and mass of 58 kg. The facial features were unrecognizable. Both the upper extremities were flexed; the soft tissues of the right arm and forearm were completely consumed by fire, exposing the radius and ulna. The left upper limb was less damaged. The chest and abdomen skin as well as large parts of the subcutis were missing; however, the back and buttocks were relatively spared. The lower extremities sustained heat-related fractures bilaterally and were shortened, with fall-away muscles observed on the left thigh (Fig. 1).

The scalp was partially burnt; a large skull fracture was present involving the middle part of frontal and parietal bones, most probably caused by blunt force trauma. The right side of the fronto-temporal area showed heat-related fractures, as evident by completely burnt scalp, discoloured bone, and fine lines of 'spider-web' fracture pattern. The base of skull showed presence of depressed fracture at the right occipital bone and a circular fracture with bone loss at the clivus. In addition, a 1-cm entry gunshot wound was observed on the left side of the body of mandible. The brain had a

FIG. 1. Charred body with flexed upper limbs and shortened lower limbs. The face was beyond recognition.

cooked appearance and increased consistency. A projectile was retrieved from the right side of the occipital lobe.

Examination of the upper airways showed a grossly hyperaemic mucosa. Soot was clearly visible in the larynx, trachea, and the main bronchi. Heat damage, such as oedematous swelling or vesicular detachment of the trachea, was not observed. Soot was also present in the oesophagus. Both lungs were congested and oedematous. The heart was morphologically normal, and several black spots, measuring approximately 1 mm to 2 mm in diameter, were present on the epicardial surface (Fig. 2). The liver, stomach, spleen, kidneys, and intestines were cooked, and the same black spots were clearly observed on the surface of the pancreas, liver, and kidneys (Fig. 2). Organ sections showed that these black spots were also present in the parenchyma.

Histopathology findings

Sections from the lungs showed alveolar dilatation with the presence of oedema in the alveolar spaces. The blood vessels were congested. Some other areas exhibited intra-alveolar haemorrhage. Numerous macrophages with engulfed carbon particles were observed (Fig. 3). The tiny black spots on the surface of the liver and kidneys were sampled and showed the presence of large black particles within medium-sized and small blood vessels of the subcapsular areas as well as the parenchyma (Fig. 3). Perls stain done on the sections containing the black particles yielded a negative result.

DISCUSSION

Burnt bodies are commonly seen at autopsy. Fire is the usual method used to conceal a crime or to make it unrecognizable because of radical morphostructural alterations caused by heat.[5] Fire affecting the head may cause advanced destruction. The heat will destroy the scalp first. Over a prolonged period, the skull cap bursts and disintegrates into fragments with accompanying epidural heat hematoma as well as shrinking and destruction of the brain.[6] The increased brittleness of the charred bone combined with steam pressure within the skull causes calvaria fractures. However, heat-related fracture involving the base of the skull has not been described in the literature.[6]

Histopathology findings on burn victims can be broadly categorized into two. The first category is described as 'fire lungs,' characterized by bronchiolar dilatation, ductal over-insufflation, and alveolar haemorrhage, which totally fills the alveolar spaces. Smoke inhalation causes dilatation of the small airways (mainly terminal

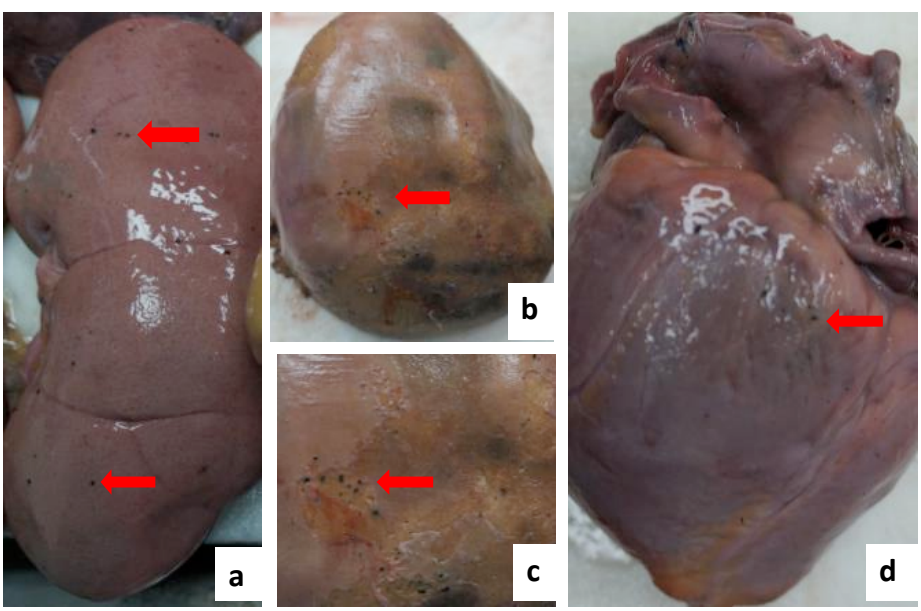

FIG. 2. Gross examination of the (a) kidney, (b) liver and (d) heart showed multiple back spots on the surface of the organ (arrows). These spots are shown at closer view in (c) (arrow). Serial slices showed that these dots were also present within the parenchyma of the organs.

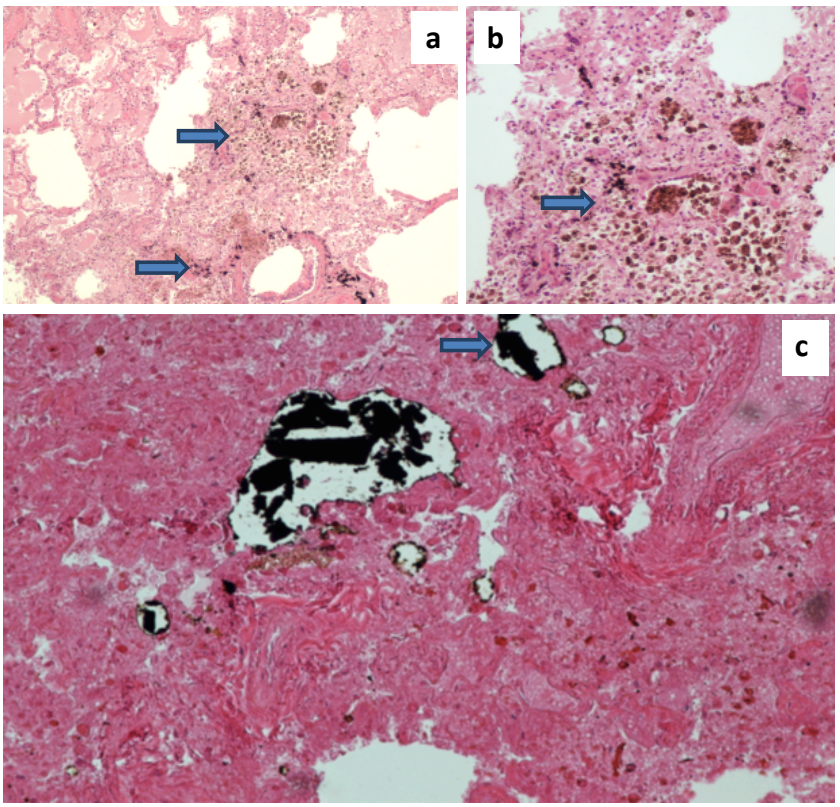

FIG. 3 (a) Sections from the lungs showing numerous macrophages engulfing black pigments; 100X (arrows), (b) higher power view showing the cells with the particles (arrow) at higher power; 400X. (c) Sections from the liver showed coagulative necrosis of the liver cells with numerous black material within dilated vascular spaces (arrows).

and respiratory bronchioles). The morphological disarrangement of the bronchiolar and alveolar architecture affects changes in the ventilation/perfusion relationship, leading to alveolar haemorrhage.[2, 7]

The other category of damage is described as 'suffocation lungs,' characterized by alveolar collapse and oedema associated with passive congestion. The morphological disarrangement of alveolar architecture causes changes in blood circulation, which leads to a particular pattern—vascular congestion.[2, 7] In both categories, the presence of macrophages engulfing soot in the lung parenchyma is not a reported feature.

In our case, the findings were a mixture of both categories; some were ante-mortem injuries, while others were induced by heat. The findings of soot in the lower airway with tissue reaction on histology proved that the victim was still alive when the fire started. Heat injuries observed were alveolar dilatation, congested blood vessels, oedema in the alveolar spaces and intra-alveolar haemorrhage.

Numerous macrophages engulfing black particles were present in the alveolar spaces as well as the tissue adjacent to the bronchiole, indicating anthracosis. This showed that the victim was possibly a cigarette smoker, a city dweller or possibly had an occupation which exposed him to these pollutants. However, as the victim's identity could not be ascertained to this day, this could not be verified.

The presence of multiple black dots in and on the organs was a surprising finding. Histology of these organs showed blocks of black particles within vascular spaces of the parenchyma and subcapsular area. The complete blackness of the particles indicates that they are carbon particles rather than hemosiderin. A negative Perl's stain reaction confirms this. However, there was no available stain for carbon in our institution as well as other laboratories in the vicinity. The only support that the particles were carbon was that they were absolutely black in colour on histology.

How did the carbon particles ended up in

the parenchyma and the surface of the internal organs? There is no definite answer for that. Since the particles were inside blood vessels, we hypothesized that they may be emboli. Certainly in the case of fat embolism, fat embolises through ruptured blood vessels in fractured long bones and travels to distant organ such as the lungs. In this case, the burning tyres produces tremendous amount of soot, and possibly a small amount could enter the small vessels at the ruptured skull and could be carried by the still beating heart to the distal organs. This assumes that the victim could be alive for a few minutes in the fire. A whole cardiac cycle lasts for 0.8 seconds; therefore there would be time for the soot particles to travel from the vein to the lungs and to the systemic circulation. Nevertheless, these are only speculations; we have never encountered such a finding, and nothing like it has been described in published work. It could be a rare artefact.

Another possible origin of this intravascular black substance is decomposed blood, which may also appear black. However decomposed blood would show positivity on Perl's stain. Moreover the internal organs appeared rather fresh and were not decomposed.

In conclusion, the autopsy and histological findings in this case supported the impression that the patient was alive when his body was set on fire. Presence of black carbon particles within organs was a rare finding.

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