Case Report

Post-mortem computed tomography visualised fire related post-mortem changes of the head

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Conflict

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Abstract

As post-mortem computed tomography (PMCT) becomes more routinely utilised in day-to-day autopsy practice around the world it is important that those reporting the images are aware of changes that may not be encountered in clinical radiology that can result in the post-mortem period but resemble antemortem pathology. Two cases are presented to illustrate the PMCT findings of three of the four classical changes that occur to the head after death as a result of the effect of prolonged exposure to heat.

Introduction

Since post-mortem computed tomography (PMCT) was recognised to have a role in autopsy practice a small number of publications have reported the PMCT findings seen to the body as a result of the effect of prolonged exposure to heat [1,2,3].

A number of time-dependent post-mortem changes are recognised by pathologists to occur to the body as a result of the effect of fire [4,5]. In the case of the head, the heat from fire can result in splits to the scalp ("heat lacerations") [6], fractures of the outer table of the skull ("heat fractures") [7], the collection of blood in the extradural space ("heat haematoma") [8] and more rarely reported brain herniation into the extradural space [9,10]. These changes are not

encountered in clinical radiology and thus may cause interpretational difficulties to radiologists reporting PMCT images when encountered for the first time.

We present two cases where post-mortem computed tomography (PMCT) imaging showed post-mortem heat-related changes to the head including the more rarely encountered brain herniation into the extradural space which on PMCT can be misinterpreted as a heat haematoma. We hope this will assist others using PMCT to differentiate between ante-mortem injuries and post-mortem heat-related changes.

Case 1

The body of an adult female was found in a fire damaged garage at her home address. The body was positioned face-up with her arms outstretched. There was extensive heat damage to the body with exposure of the chest and abdominal cavities to air and heat related damage of the limbs. Following investigation of the scene, including the attendance of the duty forensic pathologist, the body was recovered and taken to the Leicester Royal Infirmary for autopsy examination. Prior to autopsy, the body underwent non-enhanced PMCT using our standard forensic protocol. The findings of the PMCT head scan discussed below were all confirmed by the subsequent autopsy.

Case 2

The body of an unknown adult female was found face-down, close to a “burnt-out” vehicle fire in a rural location in the East Midlands, England. The body was still alight. Both hands were close to her face area and were reduced to carbonized finger bones with associated extensive heat damage of the forearms, neck and head areas. The rest of the body also showed severe heat damage. The fire investigator at the scene estimated that the body had remained alight for approximately 2 hours. Following investigation of the scene, including the attendance of the duty forensic pathologist, the body was recovered and taken to the Leicester Royal Infirmary for autopsy examination. Prior to autopsy the body underwent non-enhanced PMCT using our standard forensic protocol. The findings of the PMCT head scan discussed below were all confirmed by the subsequent autopsy.

PMCT

For both cases a whole body PMCT scan was performed using a Toshiba Aquilion CXL 128 slice scanner (120 kVp, 300 mA and 128 x 0.5 mm slice thickness, matrix 512 x 512) reconstructed to 1mm (head and neck) or 2mm (chest, abdomen, pelvis and legs) slices. The head was scanned both perpendicular to the scan table and parallel to the base of skull (as per clinical practice). The purpose of using two angles is to avoid artefact from dental implants obscuring important areas of the posterior fossa and neck.

PMCT findings

Specific “heat fractures” were identified in both Case 1 and Case 2 (Figure 1). PMCT images clearly show splitting and lifting of the outer table of the skull, typical of the effect of heat. There were no fractures to the base of the skull.

Figure 1: PMCT images for Case 2. Axial (a) and coronal (b) views of the head showing heat fractures to the frontal and parietal bones with separation of the outer and inner tables (arrows). (c) Heat fractures in Case 1.

The second change seen in Case 1, and to a lesser extent in Case 2, was blood in the extradural space, a “heat haematoma” (Figure 2). At autopsy this had the typical dark, honeycomb appearance caused by the effect of the heat. It must be distinguished from an ante-mortem extradural haematoma by its appearance and pattern.

Figure 2: PMCT images for Case 1. (a and b) Collection of heat related blood in the extradural space (asterisk). There is no associated ante-mortem fracture. (c) Case 1 heat haematoma

Finally in Case 2 there was extensive brain herniation due to heat (Figure 3). The brain is contracted within the shrunk dura. A defect in the dura can be seen on PMCT to the left temporal region.

Figure 3. : PMCT images for Case 2. Axial (a) and coronal (b) PMCT images showing brain herniation into the extradural space. The dural defect in the left temporal area where the brain has herniated is marked by arrows. (c) Case 2 brain herniation into extradural space.

Discussion

Forensic pathologists are well aware of the effect of heat from fire on the body. However, these findings are never seen clinically and radiologists new to PMCT image interpretation may therefore misinterpret them as indicative of ante-mortem injury. This is especially important if PMCT is used as a replacement rather than adjunct to the invasive autopsy. Only a few papers exist to date within the forensic radiology literature reporting the prolonged effect of heat on the body [1, 2, 3, 8]. This paper focuses on the effect of heat on the head.

In both of our cases there was extensive fire damage to the scalp, so “heat lacerations” were not seen. These should be recognised on external examination of the body, prior to either PMCT or autopsy.

Crematorium observations show that exposure of the skull bones to intense heat over a period of about 20 minutes will result in a typical separation of the external and internal tables, usually on the lateral aspects of the skull. These “heat fractures” are reported to resemble a “spider’s web” [7]. These “heat fractures” have not been reported in the base of the skull, hence if a basal skull fracture is seen an ante-mortem injury should be suspected.

The formation of a “heat haematoma” was first reported 1860 [10]. It is thought to occur due to blood boiling out of the dural sinuses and diploic spaces into the extradural space as the dura contracts. It can exceed 100mls in volume and has a typical dark brown colouration and honeycomb appearance [4,5]. It will often have a different pattern to traumatic extradural haematomas and is not associated with ante-mortem fracture.

A similar boiling mechanism is postulated for the herniation of brain, usually through a lateral heat-related defect in the dura. The accumulation is usually found in the temporal area but, as illustrated in Case 2, a considerable amount of brain may enter the extradural space as the dura contracts due to prolonged intense heat [4,5,10].

Our cases illustrate the typical features of the three of the four heat-related post-mortem changes to the head that occur in bodies exposed to prolonged intense fire. We present these to assist radiologists and pathologists who may not have encountered these PMCT findings yet.

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Highlights

1. Four principal changes can occur in the post-mortem period to the head due to prolonged exposure to heat.
2. The changes of heat fractures, heat haematoma and heat related extradural brain herniation can be diagnosed on post-mortem computed tomography
3. As these changes are not encountered in clinical radiology they may cause diagnostic difficulties to those not encountering them before.

4. These changes should not be confused with true antemortem injuries.