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CASE REPORT

Demonstration of liver metastases on postmortem whole body CT angiography following inadvertent systemic venous infusion of the contrast medium

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Abstract An 86-year-old woman was hospitalized for breathlessness and a large right-sided pleural effusion. Approximately 1 h after thoracentesis, she developed a hemothorax resulting in hypotension and death. Routine postmortem CT scanning showed a large volume right hemothorax and a markedly enlarged liver. In an attempt to determine the origin of bleeding prior to autopsy, a postmortem CT angiogram was performed. Following inadvertent cannulation of the left long saphenous vein and infusion of ~1,700 mL of a polyethylene glycol 200 and iodine-based radiographic contrast solution into systemic veins using a mechanical pump, CT scanning revealed a dense hepatic "parenchogram" containing multiple large, filling defects indicative of metastases. These were confirmed at autopsy. Microscopic evaluation of the liver using hematoxylin and eosin staining showed marked histological artifact characterized by centrilobular sinusoidal expansion although histology of the adenocarcinoma metastases was typical and apparently unaffected by the contrast solution. Postmortem CT angiography using an aqueous radiographic contrast agent in the so-called venous phase seems to be useful for the identification of hepatic parenchymal metastatic disease although it does cause histological artifact.

Keywords Postmortem · CT scanning · Angiography · Liver metastases · Histology · Artifact

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Introduction

Multidetector computed tomography is a standard investigation in clinical practice and is increasingly being applied to the assessment of cause and mechanism of death in forensic practice [1, 2]. Postmortem CT scanning (PMCT) in our state is a routine component of the so-called preliminary examination as defined by the Coroners Act 2008 (http://www.austlii.edu.au/au/legis/vic/num_act/ca200877o2008166/). Based on the analysis of admission PMCT images, together with a review of available clinical data and circumstances surrounding death, toxicological analysis of blood and external examination of the deceased, duty pathologists form an opinion on the availability of a "reasonable" cause of death and the necessity for autopsy. Assessment of the abdominal viscera including the liver on PMCT is generally poor due to the absence of intrinsic tissue contrast [3]. In clinical practice, radiographic contrast agents are injected intravenously during the course of CT scanning. Techniques of postmortem, minimally invasive whole body CT angiography (PMCTA) have recently been devised using both water- and lipid-soluble contrast agents [4, 5]. These procedures have been advocated for the detection of bleeding sources and vascular occlusions in the deceased. It has been also proposed that PMCTA in collaboration with CT-guided biopsy may be able to replace conventional autopsy [6].

Case report

An 86-year-old woman was hospitalized for breathlessness and a large right-sided pleural effusion. Physical examination revealed a large, firm mass in the upper abdomen. A coagulopathy characterized by an elevated international normalized

ratio of 1.8 was corrected using vitamin K, prior to the insertion of a small cannula into the right posterior chest wall by a resident medical officer. A total of 1.5 L of clear fluid was aspirated. Approximately 1 h following this procedure, the patient became profoundly hypotensive. Urgent supine chest radiography demonstrated more extensive right pleural opacity. A large bore intercostal catheter was inserted and heavily blood-stained fluid was drained. Subsequent maximal resuscitation measures proved unsuccessful.

Routine PMCT was undertaken ~8 h after death on the mortuary CT scanner (Aquilion16® multidetector CT scanner, Toshiba Medical Systems, Minato-ku, Tokyo, Japan). The head and body were scanned using separate acquisitions. Acquisition and reconstruction parameters are listed in Table 1. Images were sent to the Institute's PACS server (IMPAX®, Agfa HealthCare NV, Mortsel, Belgium) and analyzed on a Vitrea® 2 workstation (Vital Images, Inc., Minnetonka, MN, USA). These scans demonstrated a large volume right hemothorax with mediastinal displacement.

In an attempt to determine the origin of hemorrhage prior to autopsy, PMCTA was undertaken approximately 57 h later, i.e., 65 h following death. The left groin of the deceased was dissected in the manner described by Ross et al. [4] and a plastic cannula inserted into a vessel (presumed to be the femoral artery). Infusion of a contrast solution containing Iosovue370 (Bracco s.p.a, Milan, Italy) and polyethylene glycol 200 (PEG200, Merck Schuchardt OHG, Hohenbrunn, Germany) in a 1:10 dilution was undertaken using a mechanical embalming pump (Dodge, MA, USA). A total volume of 1,700 mL was infused. The deceased was CT scanned immediately following this infusion using the same acquisition and reconstruction parameters as conventional PMCT.

Table 1 Acquisition and reconstruction parameters

Acquisition parameters	
Body position	Supine, feet first
Detector configuration	16×1.0 mm
kVp	120
mA	~180 modulated throughout the scan
Rotation time	0.5 s
Scan acquisition type	Helical
Table movement per rotation	11 mm
Beam width	32 mm
Pitch	2.9
Field of view (FOV)	500 mm
Reconstruction parameters	
Slice thickness	2 mm
Interval	1.6 mm
Reconstruction algorithm	FC 10 (soft tissue)
Artifact suppression	3D BOOST

After the CT scans were obtained, images were reviewed by the radiologist who confirmed that contrast had been inadvertently injected into the left long saphenous vein close to the sapheno-femoral junction with resultant filling of major abdominal veins including the IVC and hepatic veins, right side of the heart, and pulmonary arteries. There was no contrast in the major arteries. Marked enhancement of normal hepatic parenchyma was also detected interspersed by large rounded mass lesions showing no apparent contrast enhancement (Fig. 1a, b). No cause for hemothorax was detected. There was no evidence of contrast leak into the right thoracic cavity to indicate a systemic venous or pulmonary arterial origin of bleeding.

At autopsy, the pathologist confirmed an enlarged liver containing multiple hepatic metastases (Fig. 2). A significant (1.2 L) right hemothorax was confirmed together with a small defect in the right posterior chest wall, consistent with a needle puncture wound, passing through the eighth and ninth rib interspace transecting the intercostal artery. A circumferential tumor measuring 7 cm in length was also identified in the sigmoid colon. Histological examination of this mass revealed a moderately differentiated adenocarcinoma. Similar histological appearances were seen in the liver metastases. The intervening liver parenchyma showed artifactual "centrilobular dilatation of the hepatic sinusoids" and mild steatosis (Fig. 3).

Discussion

PMCTA constitutes a substantial development in postmortem imaging as it can provide sufficient evidence for definitive diagnosis of vascular pathology using a minimally invasive, whole body approach. Historically, angiographic imaging after death has only been possible by direct vessel injection at autopsy, thus confined to the investigation of individual organs or vessels. As such, it is rarely employed in modern forensic investigation [7].

Arterial phase, whole body PMCTA involves the infusion of radiographic contrast into the entire systemic circulation via the femoral artery. Venous cannulation may be undertaken at the time of PMCTA in order to "vent" the venous side of the circulation during arterial infusion, so as to prevent overdistension of the vascular tree with resultant rupture and artifactual contrast leak. The femoral venous cannula can also be used to infuse contrast into systemic veins with reflux into the right side of the heart and pulmonary arteries for the detection of pulmonary embolism and venous hemorrhage.

The technique of cannula insertion requires meticulous dissection of the femoral triangle and identification of the

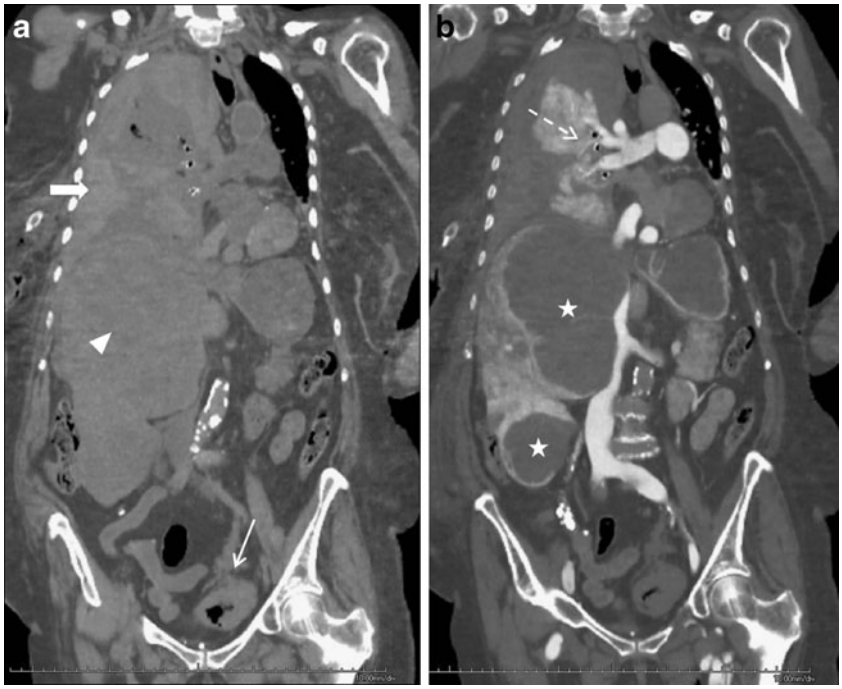

Fig. 1 Coronal reconstruction of the preliminary postmortem non-contrast CT scan (**a**) showing right hemothorax (*broad arrow*), enlarged liver (*arrow head*), and circumferential mass lesion in the sigmoid colon (*thin arrow*). The comparable venous phase PMCTA (**b**) demonstrates right pulmonary artery and branches (*hash arrow*) filled with contrast as well as multiple non-enhancing filling defects in the enhancing normal liver (*stars*)

femoral artery and vein prior to incision and cannulation [4]. If these vessels are not adequately exposed, then there is a risk on inadvertent cannulation of other vessels such as the long saphenous vein at the sapheno-femoral junction, as has occurred in this case.

Contrast agents used for PMCTA can be classified into either water- or lipid-soluble contrast agents (oils). Oils have been advocated as individual oil globules that block small capillaries allowing for a prolonged postmortem scanning time period [8]. Conversely, traditional radiographic water-soluble contrast agents readily leak from capillaries into the interstitium of organs especially if there has been a substantial postmortem interval. Commonly, a viscous diluent such as PEG200 is added to the water-soluble contrast agent in order to retard this process [9, 10]. Nonetheless, there is a reduction in the available postmortem scanning time period with water-soluble contrast compared with oils and a potential detrimental effect on vascular distension as the water-soluble agent is only retained within the vascular tree for a limited period [4].

One of the unanticipated benefits of the water-soluble PMCTA technique is the leak of contrast into the

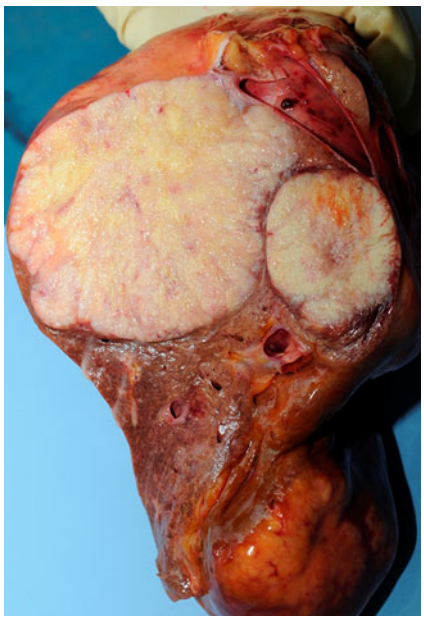

Fig. 2 Sagittal section of the liver at autopsy showing multiple large mass lesions consistent with metastases

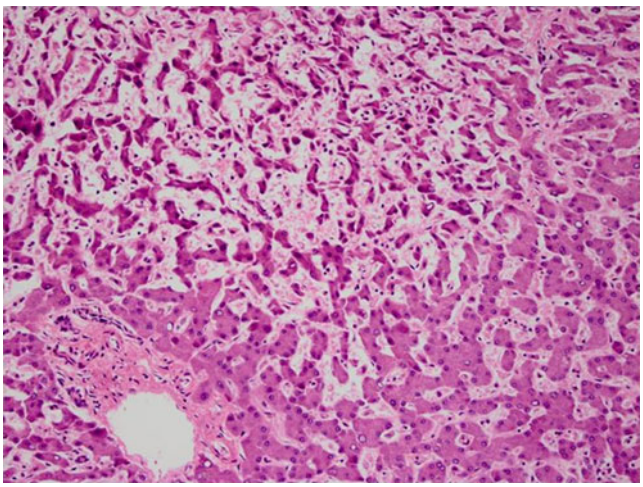

Fig. 3 H&E stain of normal liver parenchyma at ×200 magnification showing zonal sinusoidal expansion

interstitium producing so-called visceral parenchymograms with a similar albeit denser appearance to that seen on clinical contrast-enhanced CT. This effect is routinely identified on the arterial phase of the PMCTA in many organs including the pancreas, thyroid, kidneys, and salivary glands. In general, it is not particularly prominent in the liver following systemic arterial infusion. In this unique case, isolated venous contrast infusion or venography resulted in marked retrograde filling of hepatic veins and considerable opacification or enhancement of hepatic parenchyma.

On routine non-contrast PMCT imaging, the differential X-ray attenuation of normal liver parenchyma and neoplastic masses is minimal thus mass lesions are difficult to detect. In order to improve conspicuity in the clinical scenario, water-soluble radiographic contrast is injected intravenously, with rapid scanning through the liver at various time intervals after injection producing variable arterial and portal venous enhancement of liver tissue, reflecting the relative blood supply to the organ [11]. Hepatic mass lesions are thus identified based on the differential enhancement of normal liver parenchyma and tumor during these various scan phases. In this case, there was dramatically improved detection of metastases following venous infusion of the contrast solution. This is also thought to reflect a difference in normal hepatic parenchymal venous drainage compared with the neoplastic circulation.

Histological analysis in this case has demonstrated marked distention of hepatic sinusoids and swelling of the surrounding interstitium in a centrilobular distribution. This is consistent with retrograde contrast filling of the sinusoids emanating from the veins or venules located centrally in the hepatic lobules, leaking into the adjacent interstitium. It should be contrasted with routine PMCTA where enhancement of liver parenchyma is minimal despite filling of both hepatic arterial and portal venous branches.

Conclusion

Whole body, minimally invasive, postmortem CT angiography is a new procedure that has already been shown to assist pathologists in determining sites of hemorrhage and vascular occlusion. Water-soluble contrast agents leak rapidly into the interstitium of organs with a time-dependent detrimental effect on arterial distension. This contrast leak is retarded by the addition of PEG200 causing the solution to be more viscous. Paradoxically, our case has shown that following systemic venous infusion of the contrast/PEG200 solution there is substantial filling of hepatic sinusoids and contrast leak into the interstitium with differential CT enhancement of normal liver tissue and neoplasm that can be used to improve postmortem detection of hepatic mass lesions such as metastases.

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