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Postmortem computed tomography with the use of air for blood vessel enhancement—Early experience

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ABSTRACT

Postmortem computed tomography (PMCT) is gaining popularity in forensic medicine. Computed tomography routinely performed in clinical medicine involves intravenous contrast administration. Unfortunately, postmortem examinations are typically limited to uncontrasted CT scans, where blood vessels and their potential injury sites are invisible. One serious problem is the fact that due to the process of decomposition, contrast agents used for vessel visualization in the living cannot be used in cadavers. Therefore, a special contrast agent designed for cadavers has been developed. This contrast agent has a high density and is lipophilic. Its use ensures very good visualization of blood vessels it is, however, associated with high costs and may alter findings of a later histopathological examination. This study presents early experience with the air as negative contrast agent to enhance all blood vessels in the body. The carbon dioxide (CO_2) gas has been used as a contrast agent in live individuals with contraindications against the use of iodinated contrast. In corpses with advanced postmortem changes, putrefaction gases also considerably enhance the visibility of blood vessels and organs they fill. There have also been some positive effects with the use of gas in postmortem angiography of coronary vessels. These findings encouraged us to attempt air administration via catheters introduced into the femoral artery or a central venous access site in the superior vena cava. The gas distributed easily throughout the body and surprisingly well contrasted both arteries and veins of various caliber. The presence of the air administered into vessels did not cause any apparent, significant alterations in autopsy findings. Although optimization of the gas administration technique requires further studies, we can already say that this is a promising direction in postmortem angiography.

1. Introduction

Postmortem computed tomography (PMCT) is becoming more and more common in the practice of forensic medicine [1]. Apart from its many advantages, unenhanced computed tomography (CT) has a major flaw: it fails to visualize blood vessels. Yet, it is the detection of possible blood vessel injuries that is often of key importance to forensic pathologists. Earlier attempts involving administration of the hydrophilic contrast agents routinely used in clinical practice to visualize blood vessels proved ineffective in cadavers, mainly due to contrast seeping out of vascular lumina and passing through mucous membranes of the gastrointestinal system. This resulted in difficulties with filling the vascular bed fully and the resulting oedema of neighboring tissues [2,3].

This led to the development of the lipophilic contrast agent Angiofil® (Fumedica®) designed especially for use in cadavers. A number of reports demonstrated benefits of this contrast agent and emphasized that, unlike hydrophilic contrast agents, Angiofil® fills blood vessels completely and does not pass through their walls [4–7]. However, it does have certain disadvantages, which makes it difficult to use it in some cases. Firstly, the fat in its composition becomes deposited within blood vessels and confounds histopathological diagnostics of potential pre-mortal fat embolism [4,8]. Conducting this type of a diagnostic assessment requires collecting any desired tissue samples prior to Angiofil® administration. Secondly, and much more importantly, the use of this contrast agent increases the cost of the examination. The contrast agent itself is quite expensive. Moreover, many authors recommend the use of a

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Table 1
Case characteristics.

Case number	Cause of death	Age (years old)	Sex	Time from death to CT scan	Other
#1	Ethyl alcohol poisoning	52	M	5 days	
#2	Hanging	18	M	1 day	
#3	Sudden death due to multiple organ pathology	47	M	3 days	
#4	Pedestrian–multiple trauma, multiple organ failure	31	M	2 days	Died 17 days after admission

special pump – a modified heart-lung machine – for Angiofil® administration, most likely due to the fact that it allows a consistent pressure and the injection of high volumes of the contrast agent which is necessary to completely fill the vessels. There are only few publications indicating that Angiofil® can be injected in different ways [9,10]. However, these papers did not concern the whole body of an adult, hence there was no need to administer a large volume of the contrast agent. Some authors acknowledge that Angiofil®-related expenses are the reason why this contrast agent will not be used in some centers, despite the good effects achieved with its use [1,11].

Thus, there is a need to search for other, alternative contrast agents, which would be inexpensive and easy to administer, and would – at least in part – replace Angiofil® in certain circumstances when the use of Angiofil® would be impossible. Therefore, in May 2015, the Department of Forensic Medicine at Medical University of Warsaw, began collaboration with the Chair and Department of General, Vascular and Transplant Surgery Medical University of Warsaw in order to develop other techniques of blood vessel enhancement. First, we have chosen air as a negative contrast medium.

2. Materials and methods

2.1. Subjects

This manuscript presents the results of CT scans performed in four cadavers, where an attempt was made to visualize blood vessels with air. These cadavers had been selected to illustrate various techniques of air administration. Table 1 presents the basic characteristics of the cadavers used.

2.2. Cannulation and injection method

The technique of air administration was slightly different in each case. In the first three cadavers (#1, #2, and #3), air was administered via the femoral artery dissected following a small inguinal skin incision. In the first two cases (#1 and #2), a vascular surgeon with experience in endovascular procedures introduced a 7-F valve into the femoral artery via arterial puncture and inserted a hydrophilic guidewire and an angiographic "pigtail" catheter into the ascending aorta (Fig. 1).

In order to confirm catheter tip placement, a CT scan was done. The preparation and cannulation of the body was done on a CT table. Inguinal region dissection conducted by an experienced surgeon took approximately 2–5 min, with arterial puncture and vascular catheterization taking additional 3 min. Approximately 5–10 min were needed for a tomographic review and any necessary adjustments in catheter placement. In case #3, air was administered via a Foley catheter introduced via the common femoral artery into the external iliac artery, with the balloon inflated. Arterial cutdown and catheter insertion took approximately 1 min. In case #1, air was administered under a pressure of 2 bar with the use of a Stanley air compressor; and in the remaining cases (#2, #3, and #4), it was administered by hand via a 60-mL syringe connected via a three-way valve with a catheter introduced into the vascular lumen. Air introduction via the compressor lasted only several seconds. However, air introduction via a syringe took several minutes due to the relatively small volume of the syringe and the need to refill it repeatedly. In case #4, air was administered with the use of a triple-lumen catheter that had been introduced via a jugular vein into the superior vena

Fig. 1. (A) Access to the right common femoral artery through longitudinal incision in groin; (B)puncture of the common femoral artery; (C) introducer sheath insertion; (D) pigtail endovascular catheter; (E) transcatheter intraluminal air inflation. Catheter tip is introduced to aorta; and (F and G) end-position of the catheter in the aorta.