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Can ruptured abdominal aortic aneurysm be accurately diagnosed as the cause of death without postmortem computed tomography when autopsies cannot be performed?

Yohsuke Makino [a,b,*], Seiji Yamamoto [c], Seiji Shiotani [d], Hideyuki Hayakawa [e], Hajime Fujimoto [f], Hajime Yokota [a], Takuro Horikoshi [g], Hirotaro Iwase [b,h], Takashi Uno [a,g]

[a] Department of Radiology, Chiba University Hospital, 1-8-1 Inohana, Chuo-ku, Chiba 260-8677, Japan
[b] Department of Forensic Medicine, Graduate School of Medicine, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan
[c] Autopsy Imaging Information Center, 4-6-10 Ginza, Chuo-ku, Tokyo 104-0061, Japan
[d] Department of Radiology, Tsukuba Medical Center, 1-3-1 Amakubo, Tsukuba 305-8558, Japan
[e] Department of Forensic Medicine, Tsukuba Medical Examiner's Office, 1-3-1 Amakubo, Tsukuba 305-8558, Japan
[f] Department of Radiology, Numazu City Hospital, 550 Harunoki-aza, Higashishiiji, Numazu, Shizuoka 410-0302, Japan
[g] Department of Diagnostic Radiology and Radiation Oncology, Chiba University, 1-8-1 Inohana, Chuo-ku, Chiba 260-8670, Japan
[h] Department of Legal Medicine, Graduate School of Medicine, Chiba University, 1-8-1 Inohana, Chuo-ku, Chiba 260-8670, Japan

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ABSTRACT

Purpose: This study aimed to conduct a multicentre retrospective review of cases to clarify how many ruptured abdominal aortic aneurysms (RAAAs) as the cause of death could be diagnosed without post-mortem computed tomography (PMCT) when autopsies cannot be performed.
Methods: We collected consecutive PMCT data from January 2002 to December 2009 from three institutes where PMCT examinations are performed on a routine basis for deceased patients with unknown causes of death. A total of 19 cases were identified where PMCT revealed RAAAs. Ante-mortem clinical presentations, post-mortem external examinations, and peri-mortem ultrasonography findings were assessed for their diagnostic accuracy.
Results: The correct diagnosis based on the classic triad of shock, acute abdominal pain, and pulsatile abdominal mass was made in only one of 19 (5.3%) patients. Shock, acute abdominal pain, and abdominal swelling were found in five of 19 (26%) patients. Shock and acute abdominal pain or abdominal swelling were found in two of 19 (10%) patients. Ten of 19 (53%) patients only had shock. Peri-mortem ultrasonography was performed in seven of 19 patients; one was diagnosed with RAAA (14%). No patients had pre-mortem CT examinations.
Conclusions: Post-mortem diagnosis of RAAA is difficult to make based on ante-mortem clinical presentation, post-mortem external examinations, or peri-mortem ultrasonography. PMCT is recommended for diagnosing RAAA as the cause of death if pre-mortem CT examinations are not carried out when autopsies cannot be performed.

1. Introduction

The rate of autopsies, especially that of non-forensic examinations, has been declining worldwide for decades [1,2]. However, post-mortem imaging (PMI) has increased in use in many countries worldwide [3–7]. Post-mortem computed tomography (PMCT) examinations for deceased patients with unidentified causes of death, even if they are un-enhanced, are useful for detecting certain types of causes of death, including haemorrhagic aetiologies, such as intracerebral haematoma or hemopericardium [3,5,8–10].

Rupture of an abdominal aortic aneurysm (RAAA) is another common fatal haemorrhagic aetiology that PMCT can detect. Aortic aneurysm rupture is still the most frequent extracardiac cause of sudden cardiovascular death [11]. Deaths caused by aortic aneurysms and aortic dissection in Japan are approximately 13,000 annually, according to national vital statistics [12]. This

* Corresponding author at: Department of Radiology, Chiba University Hospital, 1-8-1 Inohana, Chuo-ku, Chiba 260-8677, Japan. Tel.: +81 43 222 2100; fax: +81 43 222 2101.
E-mail addresses: ymakino-tky@umin.ac.jp (Y. Makino), seikichi@autopsyimaging.com (S. Yamamoto), shiotani@tmch.or.jp (S. Shiotani), hayakawa@tmch.or.jp (H. Hayakawa), hfujimot@lilac.ocn.ne.jp (H. Fujimoto), rd8h-ykt@radio.ne.jp (H. Yokota), taku_steelfish@yahoo.co.jp (T. Horikoshi), iwase@faculty.chiba-u.jp (H. Iwase), unotakas@faculty.chiba-u.jp (T. Uno).

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number represents approximately 1% of all deaths in Japan. In England and Wales, RAAA was reported as the cause of 2% of all deaths [13]. These statistics, however, are only as reliable as the pre- and/or post-mortem diagnostic techniques.

In the clinical setting, computed tomography (CT) is the optimal diagnostic tool for RAAA [14,15]. In the post-mortem setting, the best diagnostic tool for RAAA is autopsy. However, with the decline in non-forensic autopsies, if there is no pre-mortem imaging, RAAA is diagnosed or ruled out based on only ante-mortem clinical presentations, and post-mortem external examinations. PMCT may be more definitive in cases when autopsies cannot be performed. To clarify how many RAAA cases can be diagnosed by ante-mortem clinical presentations and post-mortem external examinations without PMCT, we performed a multicentre retrospective review.

2. Materials and methods

PMCT data from January 2002 to December 2009 from three institutes that perform PMCT were collected. These institutes perform PMCT on a routine basis for all deceased patients with unknown causes of death when the next of kin consent to the scan. The PMCT protocol was different in each hospital as follows. Institute A used a 64-row multi-detector CT (Aquilion 64; Toshiba Medical Systems, Tokyo, Japan). Spiral scanning from the top of the head to the foot was performed with 120 kVp, 360 mAs, 0.75 s/rotation, pitch factor of 0.828, and 0.5-mm collimation. Reconstruction slice thickness was 5 mm using soft tissue and lung kernels. In this institute, the PMCT protocol was unchanged throughout the study period. From December 2002 to April 2004, Institute B used a single-detector CT scanner (Accel Proceed; GE-Yokogawa Medical Systems, Tokyo, Japan). Scanning for the thorax, abdomen, and pelvis was performed with 120 kVp, 250 mAs, 1.0 s/rotation, and 10-mm collimation. Reconstruction slice thickness was 15 mm using a standard soft tissue and lung kernels. From April 2004, this institute used 16-row multi-detector CT (Aquilion 16; Toshiba Medical Systems). Spiral scans of the thorax, abdomen, and pelvis were performed with 120 kVp, 200 mAs, 0.7 s/rotation, pitch factor of 0.938, and 1-mm collimation. Reconstruction slice thickness was 10 mm using soft tissue and lung kernels. Institute C used a 64-row multi-detector CT (Aquilion 64, Toshiba Medical Systems). Spiral scanning from the top of the head to the lower leg was performed with 120 kVp, 0.5 s/rotation, and a pitch factor of 0.841. Volume exposure control was applied for tube current. Reconstruction slice thickness was 5 mm using soft tissue and bone kernels. In this institute, the PMCT protocol was unchanged throughout the study period. All of these scans in the three institutes were performed in the supine position with the cadavers' arms at their sides. No contrast media were used.

The inclusion criteria for the study were an RAAA on PMCT images that was compatible with the cause of death. The diagnosis of RAAA on PMCT images was made by consensus of at least two board-certified radiologists with at least 4 years of experience, each interpreting PMCT images. In diagnosing RAAA, the radiologists checked three criteria as follows: the presence of abdominal aortic aneurysm (AAA), the presence of massive retroperitoneal haematoma and/or peritoneal haematoma, and the absence of a fat plane between the aneurysm and haematoma. All three findings were required for diagnosis of RAAA. These are the most pathognomonic findings of RAAA in the clinical setting [16]. AAA was defined by dilatation of the abdominal aorta >3 cm in the maximum transverse diameter, derived from the common clinical definition of AAA [17]. Because some post-mortem AAAs were collapsed, with loss of sphericity and a short anteroposterior diameter (Fig. 1), we did not use the anteroposterior diameter for measurement. Institutional ethics committee approval for this retrospective study was obtained with waiver of informed consent according to the national guidelines of epidemiological research [18].

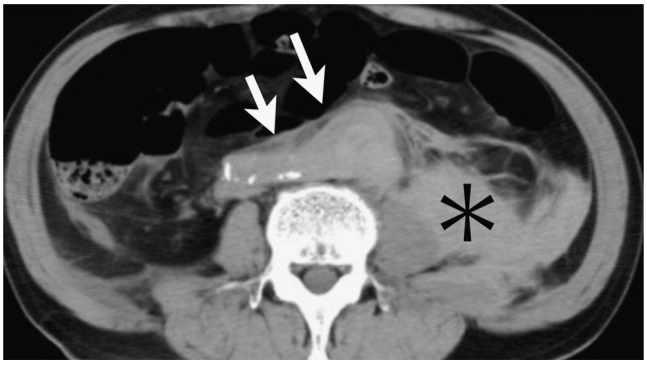

Fig. 1. Representative PMCT image of a collapsed abdominal aortic aneurysm (AAA). CT shows an extremely deformed AAA with a shortened anteroposterior diameter (arrows). Dilatation of the aorta can only be detected by the transverse diameter. Massive retroperitoneal haemorrhage is also shown in this image (asterisk).

A total of 19 subjects met the criteria after evaluation of 1250 subjects from the three facilities. We concluded that all of the 19 subjects did not have RAAA caused by external force, including traffic accidents or assaults, and there was no apparent evidence of other causes of death than RAAA. These 19 subjects consisted of 16 men and three women with an age range of 61–97 years (mean, 78 years). Of these subjects, 18 of 19 (95%) were in cardiopulmonary arrest on arrival. Autopsy had been performed in three (16%) subjects. When three cases were excluded, all PMCT scans were performed no more than 2 h after death. In the three autopsy cases, PMCT was performed just prior to autopsy (27, 45, and 96 h after death). These cadavers were preserved in the refrigerator before autopsy. There were no cases where PMCT missed RAAA that was revealed by autopsy.

We assessed the patients' ante-mortem clinical records for the presence of the classic triad of shock, acute abdominal pain, and pulsatile abdominal mass prior to death [19]. With regard to abdominal pain, we checked the time that had elapsed between the beginning of symptomatology and death. Subjects in the state of cardiopulmonary arrest on arrival were considered to meet the shock criterion in our assessment.

Abdominal swelling was included in the check list to be considered as an external examination finding suggesting RAAA. This was evaluated by physicians who determined the cause of death of the subjects, and if the examiners thought the abdomen was abnormally swollen for his/her physical size, they considered it as abdominal swelling.

We also reviewed clinical or peri-mortem ultrasound (US) findings. US was performed in seven of 19 subjects. US was performed just before or after death and prior to PMCT examinations. When both dilatation of the abdominal aorta and retroperitoneal and/or peritoneal haematoma were detected by US, this was considered diagnostic of RAAA.

Records of ante-mortem CT were also checked in the subjects. However, CT examinations were never performed after admission to the hospital and prior to death in any of the 19 subjects. In only one subject, there was a past history with an abdominal CT scan, which showed an unruptured abdominal aortic aneurysm.

3. Results

3.1. Ante-mortem clinical presentations and post-mortem external examinations

The proportion of findings of the classic triad and abdominal swelling are shown in Table 1. The complete classic triad was only