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Pericardial tear as a consequence of cardiopulmonary resuscitation (CPR) involving chest compression: A report of two postmortem cases of acute type A aortic dissection with hemopericardium ☆

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ABSTRACT

We present two cases of a pericardial tear as a consequence of cardiopulmonary resuscitation involving chest compressions in fatal acute type A aortic dissection (AoD) with hemopericardium. For each case, postmortem computed tomography revealed a hematoma in the false lumen of the ascending aorta with a slight hemopericardium and a large left hemothorax, as well as focal pericardial dimpling and discontinuity around the left ventricle. At autopsy, we confirmed a convex lens-shape gaping pericardial tear at the left posterolateral site of the pericardium and a massive volume of bloody fluid in the left thoracic cavity. It has been hypothesized that the pericardium ruptured due to chest compressions during resuscitation in these cases of acute type A AoD with hemopericardium and that intrapericardial blood leakage through the pericardial tear resulted in a hemothorax.

1. Introduction

Aortic dissection (AoD) is the most common catastrophic event affecting the aorta in forensic/medicolegal fields. Hemopericardium is the most common cause of death in AoD cases [1,2]. Postmortem computed tomography (PMCT) is particularly useful in cases of sudden death from hemorrhagic lesions, such as aortic aneurysmal rupture and AoD [3–5]. The characteristic PMCT findings of lethal AoD are a hyperattenuating crescent of the ascending aorta, which indicates a hematoma in the false lumen, and hemopericardium [6]. A hemothorax also occurs in some AoD cases, and most cases are considered to be the result of a rupture in the descending aorta [7–9]. Other cases have had an unusual presentation of a left pleural effusion complicated by AoD [10,11] or a congenital pericardial defect with ruptured type A AoD [12–15].

Complications of cardiopulmonary resuscitation (CPR) are frequently encountered in the field of forensics [16,17]. Resuscitative injuries related to chest compression are observed in the chest. Rib/sternal fractures and pneumothorax are regarded as frequent complications. Cardiac rupture and injuries to the pericardium, pleura, and diaphragm are rare events [16–18].

In this paper, we present two cases of a pericardial tear as a consequence of CPR involving chest compressions in fatal acute type A AoD with hemopericardium. On the basis of the postmortem examinations, a left hemothorax could be associated with type A AoD in these cases. It has been hypothesized that the pericardium ruptured due to chest compressions during CPR in these cases of type A AoD with hemopericardium and that intrapericardial blood leaked through the pericardial tear resulting in a hemothorax. In this study, we describe the pathophysiology of pericardial rupture, particularly its anatomical features.

2. Case reports

Each subject was transported in asystole to Tsukuba Medical Center by emergency medical technicians (EMTs). Cardiopulmonary resuscitation (CPR) was performed; however, these subjects

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were subsequently pronounced dead in the emergency room (ER). Whole-body PMCT was performed to ascertain the cause of death immediately after the confirmation of death. PMCT was performed with a 64-channel multidetector row CT scanner (Lightspeed VCT; GE Healthcare, Milwaukee, USA) in the radiology department of our institution. The scan parameters for the helical scan mode for the thorax, abdomen, and pelvis were as follows: auto mA (standard deviation value: 20), 120 kV, 1.0 s/rotation, 0.625 mm collimation, pitch 1.375, and contiguous 1.3-mm sections. A board-certified radiologist observed and interpreted all the images at appropriate window settings for each region. An autopsy was recommended to the family of each subject, and consent was obtained. A board-certified forensic pathologist performed the autopsies.

2.1. Case 1

A 57-year-old male with an unknown medical history complained of severe dorsal pain and collapsed. The subject was in a state of cardiopulmonary arrest (CPA) when the EMTs arrived at the scene. CPR was attempted for 40 min by the EMTs during transport to our ER and for an additional 30 min by the emergency medical physicians in the ER. The subject was pronounced dead despite the attempt at CPR.

A portable chest X-ray (CXR) in the ER showed enlargement of the cardiac silhouette (Fig. 1a). In contrast to the CXR, the PMCT scout image showed a left pleural effusion and a rightward shift of the mediastinum (Fig. 1b). The PMCT displayed a hematoma in the false lumen of the ascending aorta, a small amount of hemopericardium, and a large amount of left hemothorax. The PMCT also displayed focal pericardial dimpling and discontinuity around the left ventricle (Fig. 1c).

A forensic autopsy was performed 38 h postmortem. There were no injuries to the ribs or sternum. A dark red pleural effusion (2800 ml) had accumulated in the left thoracic cavity. A convex-pericardial tear (8.0 cm) was present in the left posterolateral pericardium (Fig. 1d), and a slight hemopericardium (9 ml) was identified within the pericardium. The heart (470 g) did not show any ventricular wall rupture or cardiac herniation. The coronary arteries exhibited moderate calcified atherosclerotic stenosis (left ascending coronary artery, 80%; left circumflex artery, 50%; and right coronary artery, 50%). The aorta showed moderate atherosclerosis. Direct communication between the dissected aorta and the thoracic cavity was not observed. A transverse intimal tear (2.2 cm) was detected 7.6 cm above the left posterior aortic valve. A false lumen was created along an aortic arch and extended to

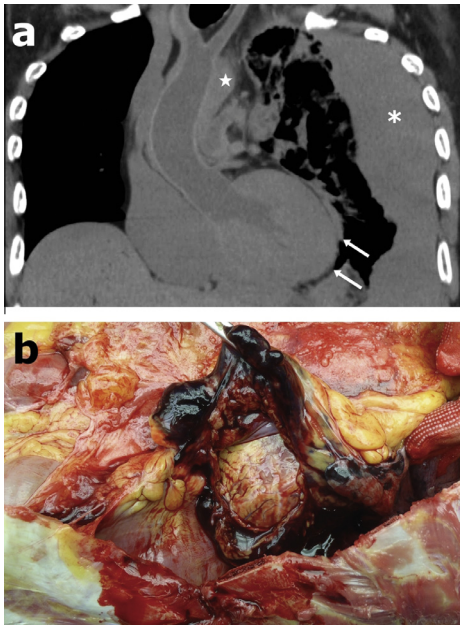

Fig. 2. Coronal view of the PMCT of the thorax and macroscopic appearance of the pericardium for Case 2. (a) The PMCT of the thorax at the mediastinal window setting showed a hematoma in the false lumen of the ascending aorta (*star*), a left hemothorax (*asterisk*), and partial defects of the pericardium around the left ventricle (*arrows*). (b) A pericardial tear (8 cm) was observed at the left posterolateral pericardium.

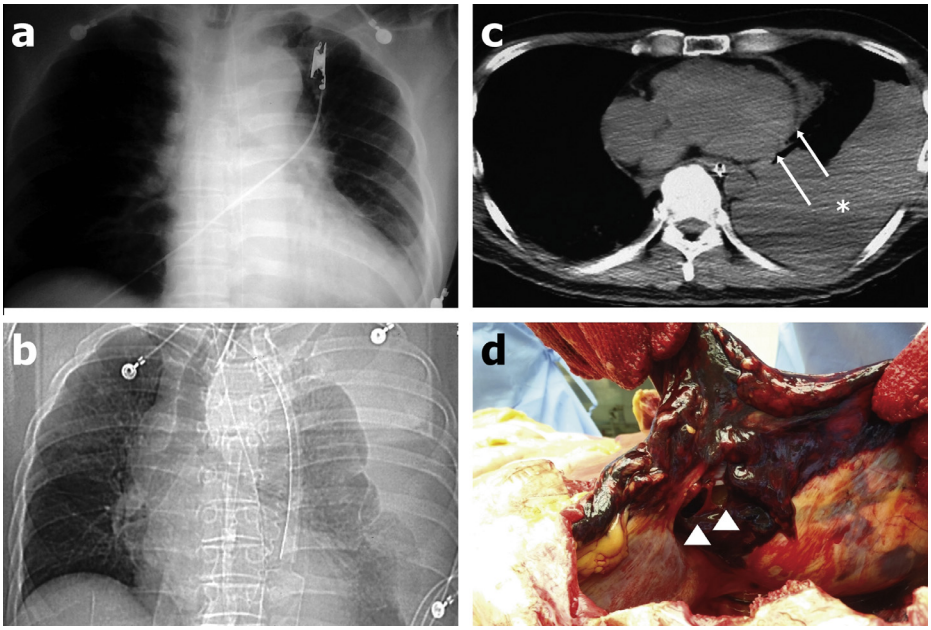

Fig. 1. CXR, PMCT scout image, axial view of the PMCT of the thorax, and macroscopic appearance of the pericardium for Case 1. (a) The CXR showed enlargement of the cardiac silhouette. (b) The PMCT scout image showed a left pleural effusion and a rightward shift of the mediastinum. (c) The PMCT showed a left hemothorax (*asterisk*) and partial defects of the pericardium around the left ventricle (*arrows*). (d) Pericardial tear (8 cm) was observed at the left posterolateral pericardium (*arrowheads*).