A Blood-contrast Level: A Sign of Cardiac Arrest

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ABSTRACT

Pooling and layering of the contrast material in major venous systems on computed tomography indicates cardiac arrest or impending cardiac arrest. The image almost always presents as a blood-contrast level. We should halt the examination immediately and perform prompt evaluation once the characteristic imaging findings occur, even if there is visible electrical activity on the ECG monitor.

Contrast-enhanced computed tomography (CECT) is not a modality for diagnosis of cardiac cessation, but the imaging features of cardiac cessation are characteristic and are decisive for the timing of early resuscitation [1]. Patients with cardiac arrest or impending cardiac arrest lose normal pumping function [2]. As a result, contrast medium sink to the dependent portions of the major veins due to gravity. A “blood-contrast” level is often observed on an axial view image [2-4].

The causes of cardiac arrest are various. Although there was no single universal definition for pulseless electrical activity (PEA), it is classified as a form of cardiac arrests [5]. Because the electrical activity of PEA can still be detected by the electrocardiography (ECG) monitor, critical timing of immediate resuscitation may be delayed by monitoring the ECG alone. Discrepancy between ECG monitor and oximeter may also be observed [6]. Here we present a case with PEA with his clinical and abdominal CT imaging findings. When there are imaging findings indicating cardiac arrest during CT scanning, the exam should be withheld and prompt evaluations of the patients should be carried out straight away.

CASE REPORT

A 58-year-old man with type 2 diabetes mellitus and hypertension was hospitalized in our intensive care unit (ICU) and had mechanical ventilation support due to septic shock caused by right-sided renal abscess. The patient was sent to our CT room for abdominal condition survey with continuous administration of norepinephrine to maintain his blood pressure. An intermittent noninvasive blood pressure metersphygmometer and an ECG monitor were equipped. Blood pressure of 100/60 mmHg before the exam was detected.

CT scan from the lung base to the pelvis was carried out after contrast material injection (Xenetix®, 350mg/100ml, 80ml). The contrast material was injected through central venous catheter in his right internal jugular vein by injector (missouriTM, Ulrich medical®) at the rate of 2.0 ml/sec. Contrast-enhanced CT showed absent contrast in right ventricle and left heart chambers with contrast reflux into inferior vena cava (IVC). Bedsides, pooling and layering of dense contrast material in the dependent parts of the IVC, pulmonary veins, right hepatic veins and renal veins (Fig. 1, 2) were also noted. There was no visible motion artifact of the heart. We halted the scan immediately and re-evaluated the patient who had lost palpable pulse at that time. PEA was diagnosed, yet we did not call in a "Code Blue" or advanced cardiac life support (ACLS) with respect to the patient’s do-not-resuscitate (DNR) request.
DISCUSSION

Cardiac arrest is a medical emergency. The causes of cardiac cessation are of a great variety. Several kinds of arrhythmias can also cause this catastrophe, and needs resuscitation right away, including PEA. Although there was no single universal definition for PEA, according to the American Heart Association, PEA is classified as one form of cardiac arrests [5]. When PEA occurs, electrical activity can still be visible on the ECG monitor but lacking palpable pulsation. Therefore, PEA may be overlooked during CT scanning when the patient is mainly monitored by ECG alone. The well-known established causes of PEA include hypovolemia, hypoxia, hyperkalemia, acidosis, hypothermia, cardiac or pulmonary thrombosis, cardiac tamponade, tension pneumothorax and ingestion of toxins [7]. Therefore, patients with any relevant history, such as active bleeding, electrolyte imbalance, trauma or low blood pressure, should be examined carefully for palpable pulsation before and after the CT exam. Older age is another established risk factor, and it is more associated with PEA than with ventricular fibrillation (VF) or ventricular tachycardia (VT) [8, 9]. Although CT scan is not a diagnostic tool for cardiac arrest or impending cardiac arrest, our report of the case brings notice of signs leading to timely resuscitation.

Pooling and layering of the contrast material in the dependent parts of major venous systems is a critical sign of cardiac arrest or impending cardiac arrest [3]. The causes are due to the cessation or extreme weakness of cardiac pumping [2]. Failure of cardiac pumping further brings no flow to the circulation. Iodized contrast medium then refluxes into venous system powered by the injection machine, and pools in the dependent portions of the vessels due to gravity, and therefore creates layering. A “blood-contrast level” with blood at the top and relatively

Figure 1

Figure 1. a. b. The contrast was pooled in the right atrium (arrow) and refluxed into left pulmonary veins (arrowhead) and IVC (empty arrow) as a “blood-contrast appearance” Refluxed contrast was also noted in the dependent right hepatic vein (asterisk). The opacification of the left pulmonary vein was due to a small atrial septal defect (ASD), bypassing the right and left circulation.

Figure 2

Figure 2. Reconstructive sagittal view. Dependent pooling of the contrast medium was clearly identified within the right atrium and the IVC and faded in distal portion due to lack of cardiac pumping.
heavier contrast medium (in this case, Iobitridol, Xenetix®, 350mg/100ml, 80ml) at the bottom is clearly identified [3]. With the inability of pumping blood out of the heart into the aorta and arteries, the contrast medium can only be seen in the dependent portion of major venous systems, such as IVC and right side hepatic veins [10]. Bedside, a lack of sufficient blood pressure during shock status also inhibits penetration of contrast medium into organ parenchyma and contributes to the pooling of contrast medium in major vessels [4, 11]. Hong SH et al. [10] reported the unique imaging characteristics as landmarks of impending cardiac arrest, including dense pulmonary artery, dependent pulmonary contrast pooling and pulmonary vein contrast stasis. Slow transit of the contrast medium to the pulmonary vascular structures is probably the most distinct difference between cardiac arrest and impending cardiac arrest [10]. Yet, if collaterals between pulmonary and systemic venous systems or atrial septal defect exists, contrast medium may reflux into pulmonary vein without any heart pumping. In our case, the pulmonary vein was opacified due to ASD.

Contrast-enhanced CT is currently used in wide spectrums of conditions. Because the rapidness of a CT scan, it is also the imaging modality of choice for critical patients, whose condition may change within minutes. It is crucial to monitor the simultaneous images on work station during examination in these critical patients [12]. If findings of impending cardiac arrest are depicted during a CT scan, cessation of the exam and prompt evaluations and resuscitation should be conducted [1].

In conclusion, pooling and layering of the contrast material in major venous systems on CT indicates cardiac arrest or impending cardiac arrest. The images almost always present as a “blood-contrast appearance” with gradual tapering opacification in smaller veins due to lack of active heart pumping. Static dense contrast pooling in right atrium may also present in cardiac arrest patients. We should withhold the examination immediately and perform prompt evaluation once the characteristic imaging findings occur, even if there is visible electrical activity on the ECG monitor.

REFERENCES
