

The "Silent" Arrest: Diagnostic Value of the Contrast Agent Pooling (CAP) Sign in CT Pulmonary Angiography

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Abstract

Cardiac arrest during diagnostic imaging is uncommon but clinically critical event. In contrast-enhanced computed tomography (CECT), circulatory collapse may manifest as dependent contrast pooling and layering within the venous system and right-sided heart chambers. These radiographic features are documented indicators of absent or severely impaired cardiac output, and their prompt identification is essential for clinical recognition.

We report the case of a 48-year-old Indian male with a chronic subdural hematoma who underwent right-sided craniotomy and clot evacuation. On the fifth postoperative day, he experienced clinical deterioration, and CT pulmonary angiography (CTPA) was performed to evaluate for suspected pulmonary embolism. Imaging revealed dependent contrast pooling within the inferior vena cava, hepatic veins, and right heart chambers, with poor opacification in the pulmonary arteries, left heart and systemic circulation. These findings suggested that cardiac arrest had already occurred prior to contrast administration. Although immediate resuscitation achieved the return of spontaneous circulation, but the patient died three days later.

This case emphasizes the critical importance of recognizing CT features of cardiac arrest.

Keywords: Cardiac Arrest, Computed Tomography Pulmonary Angiogram, Contrast Pooling, Cardiopulmonary Resuscitation, Cardiac Output.

Introduction

Cardiac arrest is a critical event demanding immediate recognition and intervention. Although it is rarely encountered during radiologic procedures, when it does occur, contrast-enhanced computed tomography (CECT) may inadvertently reveal imaging features suggestive of circulatory failure. Previous literature has highlighted the significance of dependent pooling observed in the inferior vena cava, hepatic veins, and right-sided heart chambers during contrast-enhanced CT [4]. This pattern results from gravitational settling of contrast in the absence of effective forward blood flow, often indicating cardiac arrest. Similarly, documented findings in patients undergoing CT scanning during acute hemodynamic collapse suggest these radiologic signs may serve as early indicators of cardiac arrest or impending cardiogenic shock [3]. Recent retrospective analyses of the "Contrast Agent Pooling (CAP)" sign have demonstrated a strong association with poor prognoses, reinforcing its diagnostic and prognostic utility [2].

This report presents a postoperative neurosurgical patient who experienced cardiac arrest during CT pulmonary angiography (CTPA). The CT images demonstrated classical signs of contrast pooling and layering within the venous system and right heart, characterized by absence of

opacification in the pulmonary arteries and left-sided heart structures which strongly suggest that the arrest preceded contrast injection. This case emphasizes the importance of recognizing these imaging patterns to facilitate rapid diagnosis and resuscitative efforts in critical care settings.

Case Presentation

A 48-year-old male was admitted to our service with altered mental status caused by a chronic right frontoparietal hematoma. After an initial non-contrast CT confirmed a significant midline shift and cerebral edema, he underwent a right-sided craniotomy for clot evacuation. While his immediate recovery was stable, he experienced a sudden clinical decline on postoperative day five. Given the suspicion of pulmonary embolism, the patient who remained intubated and mechanically ventilated was referred for CTPA to assess for thromboembolic disease.

The CTPA was initiated using the test bolus method. A 20 mL bolus of intravenous contrast was administered, followed by a saline flush, with a small region of interest (ROI) placed in the pulmonary trunk is repeatedly imaged at short intervals to obtain time-attenuation curve to track contrast arrival and peak opacification timing within the pulmonary trunk.

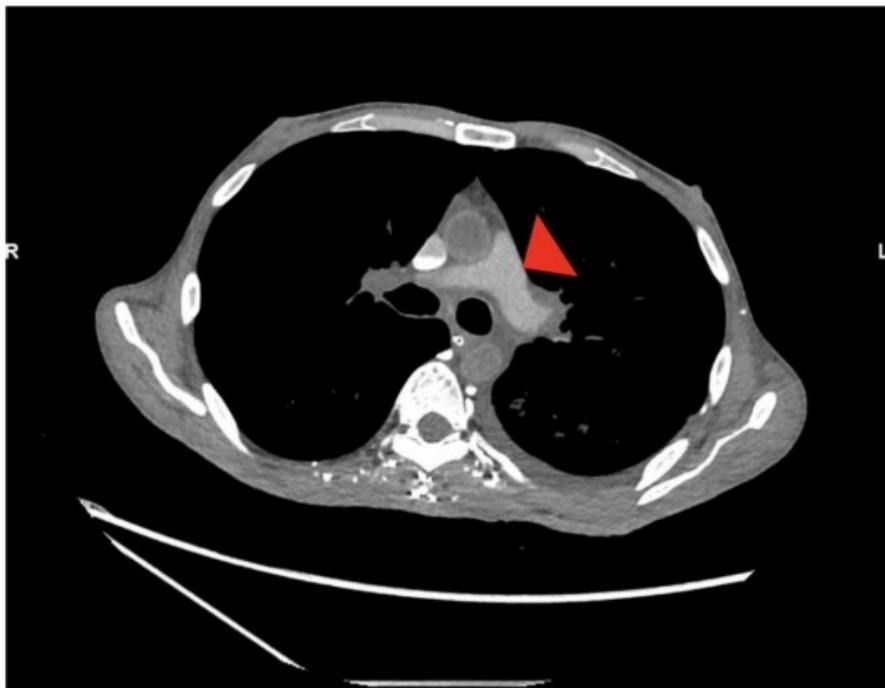


Figure 1: Poor opacification of the pulmonary trunk following the test bolus is annotated by an arrow head.

However, the acquisition revealed persistently poor opacification of the pulmonary trunk throughout the imaging interval (Fig. 1). The axial slices demonstrated pathognomonic features of circulatory collapse including dependent layering of contrast within the right ventricle, con-

trast pooling within inferior vena cava (IVC) and absence of contrast within the left ventricle and aorta, indicating lack of forward flow (Fig. 2). Due to these highly suspicious findings, the examination was extended to the abdomen, which confirmed pooling of contrast within the hepatic veins (Fig. 3).

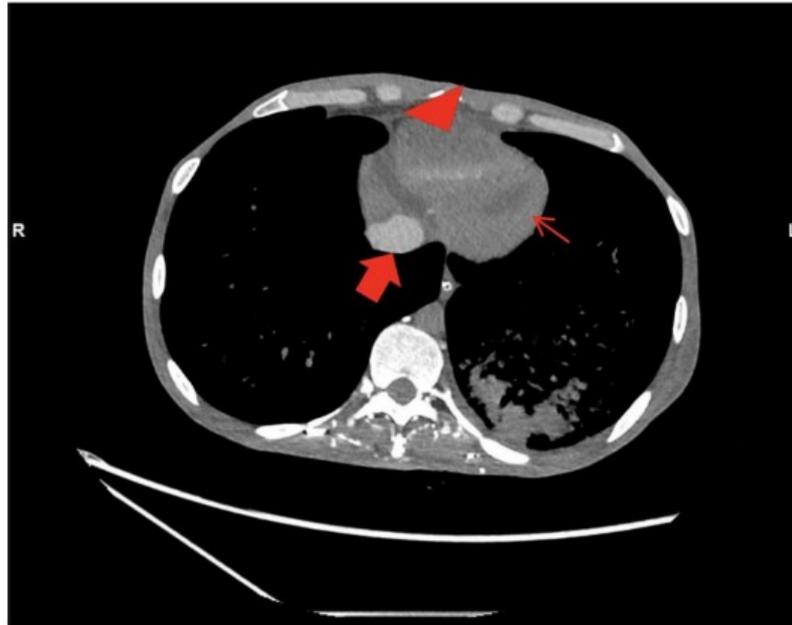


Figure 2: Dependent layering of contrast within the right ventricle is annotated by a red arrow head. Contrast pooling within inferior vena cava is annotated by a thick red arrow. Absent of contrast in the left ventricle and aorta is annotated by thin red arrows.



Figure 3: Pooling of contrast material in the hepatic veins annotated by thin red arrows.

The presence of these radiological markers provided definitive evidence that a "silent" cardiac arrest had occurred prior to the contrast injection. Upon recognizing these features, our team immediately transitioned from diagnostic imaging to active resuscitation. Although we achieved the return of spontaneous circulation (ROSC), the patient succumbed to his illness three days later in the intensive care unit.

Discussion

Cardiac arrest during diagnostic imaging procedures is uncommon but represents a critical clinical challenge. While CTPA is typically indicated for evaluation of pulmonary embolism, it may inadvertently provide definitive evidence of circulatory failure. Recognition of these specific imaging findings is essential, as they may provide the initial clinical indicator of a cardiac arrest occurring within the CT suite.

The hallmark findings in this case were dependent contrast pooling and layering within the inferior vena cava, hepatic veins, and right heart chambers, accompanied by absent opacification of the pulmonary arteries and left heart. These features reflect a total cessation of effective cardiac output. In the absence of forward flow, the high-density contrast medium (which is heavier than blood) leading to gravitational sedimentation of contrast in the most dependent venous structures. This phenomenon is further characterized by the absence of contrast opacification in the pulmonary arteries and left-sided cardiac structures. The additional observation of contrast stasis in the right heart further underscores the severity of circulatory arrest.

The radiographic manifestations observed in this study align with established literature in the context of cardiac arrest or profound cardiogenic shock which include dependent pooling as a contrast-enhanced sign of arrest [4], while other studies confirmed its association with imminent collapse and poor prognosis [2,3]. Other study [5] emphasized these signs as early radiological markers in critically ill patients, particularly when continuous ECG monitoring is

unavailable or fails to trigger an immediate alarm. Likewise, there is a case report described comparable features in trauma patients, stressing the importance of prompt recognition during emergency imaging [1].

What distinguishes this case is the evidence that cardiac arrest likely preceded the contrast injection, rather than developing during or after scanning. This "silent" arrest highlights the importance of correlating CT findings with the immediate clinical context. A misinterpretation of poor arterial opacification could delay life-saving resuscitation. This case therefore reinforces the critical role of the radiologists and clinicians in identifying CAP sign and must be vigilant for dependent venous pooling and absent arterial enhancement on CT. Prompt identification and communication of these features allows for the immediate initiation of resuscitative efforts and improve the chances of patient survival.

Conclusion

Recognizing the pathognomonic patterns of the Contrast Agent Pooling (CAP) sign during a CTPA provides immediate, visual evidence of circulatory failure. By identifying contrast stagnation in the right heart and its total absence in the arterial system, clinicians can bypass technical troubleshooting and initiate life-saving resuscitation without delay. Our experience with this case demonstrates that for postoperative or critically ill patients, maintaining a high index of suspicion for these radiologic markers is essential for detecting unrecognized cardiac arrest and facilitating a rapid transition to emergency care.

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