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Automated Chest Compression Allows Sufficient Resuscitation During Computed Tomography to Reveal the Cause of In-hospital Cardiac Arrest–A Case Report

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Abstract

Computed tomography (CT) may be used to determine the reversible causes of in-hospital cardiac arrest (IHCA), while the automated chest compression devices (ACCDs) might be helpful to maintain sufficient circulation in x-ray environment during CT. We describe a case, where ACCD was used for continuous cardiopulmonary resuscitation during the CT procedure in an 82-year-old patient with IHCA of unknown cause. Artifact-free CT helped to identify the retroperitoneal hemorrhage as a cause of IHCA, which could not be identified using bedside diagnostics. This observation suggests ACCDs as a helpful adjunct for cardiopulmonary resuscitation in patients undergoing CT diagnostics of IHCA.

Keywords: Cardiopulmonary resuscitation, computed tomography, automated chest compression

Introduction

Computed tomography (CT) may be successfully used to determine the reversible causes of in-hospital cardiac arrest (IHCA).[1] The use of automated chest compression devices (ACCDs) has been suggested as feasible and helpful to maintain circulation in x-ray environment during CT in a phantom investigation with subsequent case series.[2] We describe a case, where the application of ACCDs in a patient with IHCA provided sufficient circulation during the CT procedure and, thus, helped to identify the cause of IHCA. An informed consent could not be obtained since the patient passed away; thus, the local ethics commission waived the need for informed consent and approved this publication (Approval No. BB 141/18).

Case Presentation

An 82-year-old man with the history of arterial hypertension, prostatic cancer and asymptomatic infrarenal aortic aneurysm with the stenosis of the left renal artery underwent elective aortic stenting with percutaneous transluminal angioplasty of the left renal artery.

Five hours later during post-interventional monitoring at an intermediate care unit, he developed sinus tachycardia up to 160 beats min^{-1}, while systolic blood pressure decreased from over 100 to 60 mmHg within 15 minutes. Fluid resuscitation and catecholamine therapy were started immediately; however, the patient developed cardiac arrest due to electromechanical dissociation. Manual chest compression (MCC) with controlled lung ventilation was started in the bed after endotracheal intubation (Figure 1); bedside ultrasound examination of abdomen and thorax during MCC as well as transthoracic echocardiography did not reveal the cause of IHCA. In order to find the suspected source of bleeding, the patient was transferred to CT examination room of the radiology department where the multi-slice spiral contrast-enhanced CT of thorax and abdomen was performed.

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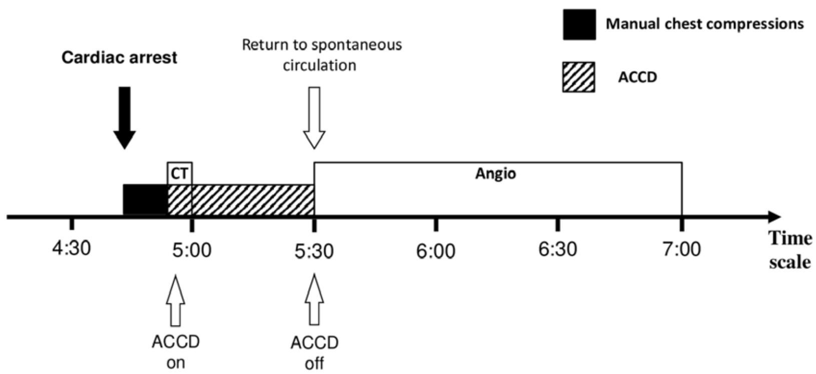

Figure 1. Timeline of the case. ACCD, automated chest compression device; CT, computed tomography; Angio, angiography examination.

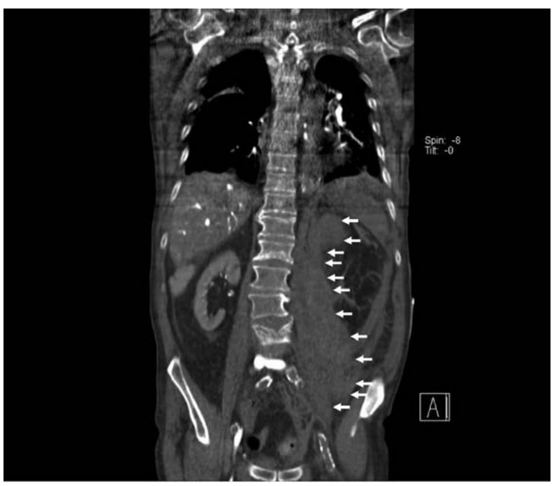

Figure 2. Horizontal slice of contrast-enhanced computed tomography. White arrows show the retroperitoneal haematoma.

After 13 minutes of MCC, the chest compressions were continued using a load-distributing band ACCD AutoPulse® (Zoll Medical Corporation, Chelmsford, MA, USA) in order to provide sufficient circulation during transport and CT procedure (Figure 1). CT examination, which was performed under chest compressions using an AutoPulse device, could exclude the suspected pulmonary artery embolism and revealed a large retroperitoneal haematoma around the left kidney (Figure 2 and video of CT examination in Supplemental Digital Content).

However, CT diagnostics was unable to identify the exact source of bleeding due to insufficient enrichment of the contrast medium. Spontaneous circulation returned after rapid infusion of 2000 mL of balanced electrolyte solution and 500 mL of hydroxyethyl starch 130/0.4 (Figure 1) with subsequent transfusion of six packed red cells and six fresh frozen plasma concentrates, so that the ACCD could be finished. The total time of mechanical chest compression using the ACCD, which was started at the intermediate care unit and finished at the CT room, was 75 minutes. After regaining spontaneous circulation, the patient could be transferred to the interventional room of the radiology department, where he underwent an angiography with the contrast medium. During angiography, the source of his active bleeding from two segmental kidney arteries could be identified and stopped by vascular embolisation using six endovascular coils. In further course of treatment, the patient regained the Glasgow Coma Scale of 14 and the highest value of neuron specific enolase was 23.4 mcg mL^{-1} on the third day following IHCA. The patient could be weaned from mechanical ventilation on the third day following IHCA. However, he developed respiratory insufficiency followed by multiple organ failure and passed away 10 days after following the IHCA.

Main Points

- Computed tomography (CT) may be used to determine the reversible causes of in-hospital cardiac arrest (IHCA).
- The presented case demonstrates successful resuscitation during the CT procedure using an automated chest compression device (ACCD).
- Artifact-free CT under resuscitation using the ACCD helped to identify the retroperitoneal haemorrhage as a cause of IHCA.

Discussion

We describe the case of successful treatment of IHCA due to rapid diagnostics using CT, where sufficient circulation during the CT procedure was maintained using the load-distributing band ACCD.

Although the use of ACCDs does not improve the initially expected survival in patients after cardiac arrest in comparison with MCC,[3] these devices are able to maintain constant circulation with sufficient coronary and cerebral perfusion.[4] Therefore, the ACCD can replace the caregiver during exhausting MCCs, thus giving an opportunity to solve other emergency tasks during cardiopulmonary resuscitation (CPR). Clear benefits of ACCDs were demonstrated in patients who required prolonged CPR under special circumstances, such as cardiac arrest due to hypothermia, intoxication and pulmonary embolism[4,5] as well as for patients requiring transport or coronary intervention when cardiac arrest persists.[6,7]

In our case, bedside ultrasound could neither reveal nor gave the diagnostic hints for the cause of IHCA; thus, CT examination was of utmost importance for rapid clinical decision. Under these circumstances, ACCD enabled sufficient circulation during the transport of the patient to radiology department and during CT examination itself. The multi-phase whole-body CT is associated with high-dose x-ray exposure (around 30 mSv), which doubles the risk of cancer in vulnerable population.[8]

Although the spread of contrast medium due to insufficient blood supply in peripheral vessels under ACCDs precluded the precise identification of bleeding source during the initial CT diagnostic procedure, the quality of the image (Figure 2 and video of CT examination in Supplemental Digital Content) was sufficient for the clinical diagnosis, which facilitated the therapeutic decision for aggressive fluid resuscitation. Due to the rapid correction of intravascular volume losses, spontaneous circulation was achieved so that the patient was able to undergo further CT diagnostics, which led to causal therapy of his pathology.

Our observation in this clinical case supports the findings of Wirth et al.[2] who demonstrated the feasibility of CT during CPR in a phantom study and case series in three patients using various types of ACCDs. However, in this investigation, the action of ACCDs was interrupted in all three cases because of various reasons. In our observation, we could show that using ECG-triggered multi-slice spiral contrast-enhanced CT scan, the ACCD should not be interrupted to get a good image quality and can be maintained active on the patient.

Although current guidelines do not recommend the routine use of ACCDs for IHCA,[5] these devices may be useful to enable sufficient CPR when caregivers are at risk, compressions are ineffective, or long pauses are unavoidable.

In conclusion, the application of ACCDs enabled successful diagnostics of massive internal haemorrhage as a reversible cause of IHCA in this case. This observation suggests ACCDs as a helpful adjunct in cardiopulmonary resuscitation in patients undergoing CT diagnostics of IHCA.

Ethics Committee Approval: Ethical committee approval was received from the University Medicine of Greifswald (Greifswald, Germany) (Approval No. BB 141/18 on October 19, 2018).

Informed Consent: This was a case of emergency resuscitation. Since the patient passed away and the patient's relatives were not available, the authors asked the Ethics Commission at the University Medicine of Greifswald (Greifswald, Germany) to approve the consent for publication of this retrospective case report (Approval No. BB 141/18 on October 19, 2018).

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Conflict of Interest: The authors have no conflicts of interest to declare.

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