POCUS in cardiac arrest and its therapeutic implications – a case report

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Abstract

Point of Care Ultrasound is an increasingly popular modality in the emergency department as well as in the critical care unit. Its applications are varied, centered on its role in diagnosis, thereby minimizing the time taken for the appropriate diagnosis to be made and hence incorporate definitive treatment. There are currently no international guidelines published with regards for point of care ultrasound in the context of cardiac arrest. We propose to delineate the impact of the role of point of care ultrasound in a patient with cardiac arrest, in the evaluation of the cause, its prognostic role, as well as possible implications for therapies based on a case report.

Introduction

Point of Care Ultrasound (POCUS) is increasingly used in the acute care setting. We highlight a case of cardiac arrest in which POCUS had a direct impact in diagnostic and therapeutic interventions.

Case description

An 80-year-old man with ischaemic heart disease and paroxysmal atrial fibrillation (on long-term aspirin, digoxin and carvedilol therapy) presented to the emergency department with large volume diarrhoea lasting three days. This was complicated by acute renal failure and severe metabolic acidosis: pH 7.08, sodium 127 mmol/L, potassium 5.3 mmol/L, chloride 113 mmol/L, bicarbonate 5.1 mmol/L, lactate 2.4 mmol/L, creatinine 1043 μmol/L. His initial vital signs were as follows: temperature 37 oC, respiratory rate 16 breaths/min, heart rate 72 beats/min, blood pressure 65/32 mmHg, pulse oximetry 100% in room air. He was given 500 mL of balanced crystalloids with improvement of blood pressure to 91/33 mmHg in the Emergency Department. A 12-lead electrocardiogram showed normal sinus rhythm of 69/min and T wave inversions in the lateral leads. the patient was referred to and was accepted for admission into the Intensive Care Unit (ICU) from the Emergency Department.

Upon ICU admission, although the patient's blood pressure and heart rate remained stable (92/41 mmHg, 80/min), he became increasingly breathless. Another 500 mL of balanced crystalloids was infused while preparations for intubation were made. He was intubated, placed on mechanical ventilation and started on continuous renal replacement therapy (CRRT) with regional anti-coagulation using citrate without any fluid removal in context of clinical and laboratory symptoms of dehydration. One hour into CRRT, he sustained an unexpected cardiac arrest with pulseless electrical activity. There was return of spontaneous circulation following two minutes of cardiopulmonary resuscitation. A bedside transthoracic echocardiogram was performed (Fig. 1, Video 1).

The subcostal view showed a thrombus in transit from the right atrium to the right ventricle. In addition, the interventricular septum appeared flattened (D-shape ventricle) and the ratio of the right ventricle to the left ventricle was >0.9. These signs are strongly suggestive of pulmonary embolism as the cause of the patient's cardiac arrest. McConnell's sign was not observed. The patient was treated on 100 mg of IV alteplase administered over 2 hours, followed by infusion of IV unfractionated heparin. Computed tomography
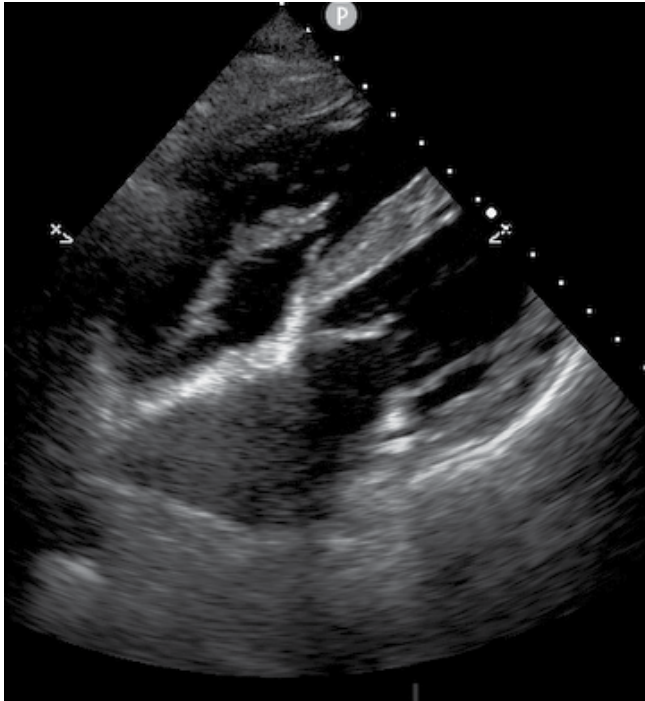
Fig. 1. *Still image of echocardiogram showing thrombus in transit on echocardiography*

pulmonary angiography (CTPA) was then performed, which showed filling defects within the left lower lobe, left upper lobe and right lower lobe pulmonary arteries. The ratio of the right ventricle to the left ventricle was >0.9, and was also documented by the CTPA.

Contributing factors for the development of pulmonary embolism in this patient's case included dehydration, which could have been compounded with the loss of volume from the priming volume required by CRRT. A relative reduction in his mobility during his acute illness could also have contributed to the development of pulmonary embolism. He was not on any anticoagulation for his known atrial fibrillation, due to concerns from the patient over bleeding risk. This also may have been a contributory factor for the development of pulmonary embolism.

In view of concerns over right heart failure due to the presence of pulmonary embolism with evidence of right heart strain, a decision was made for administration of IV alteplase while holding off the infusion of additional IV fluids. This was done to avoid further worsening of right heart failure. Following treatment of the patient's pulmonary embolism and metabolic acidosis, he recovered and was extubated to room air. IV unfractionated heparin was transited to oral rixaroxaban following recovery of his renal function.

Discussion

This patient had a cardiac arrest while on CRRT for severe metabolic acidosis and AKI. Possible causes of cardiac arrest included metabolic acidosis, hyperkalaemia, acute myocardial infarct, cardiac tamponade and pulmonary embolus[1]. As CRRT was in progress, metabolic acidosis and hyperkalaemia were less likely. A bedside transthoracic echocardiogram was performed following return of spontaneous circulation to look for possible causes of cardiac arrest (Video 1).

The signs which supported the diagnosis included the presence of a thrombus "in transit" at the right ventricle, with supporting evidence of right heart strain. Blanco and colleagues[2] have previously shown the utility of POCUS in the diagnosis of pulmonary embolism. POCUS was used in the form of transthoracic echocardiogram as well as bilateral two region leg vein compression ultrasound.

Right ventricular thrombi have been associated with increased mortality up to 45% despite treatment, which is significantly higher compared to the mortality of acute pulmonary embolism with reported mortality at 2.5%[3]. This makes the early detection of right ventricular thrombi imperative in order for early initiation of appropriate therapy.

Besides diagnosis, POCUS also plays a role in the prognostication of patients with cardiac arrest. Kedan and colleagues[4] have previously demonstrated a positive correlation between the presence of cardiac motion on ultrasonography during cardiac arrest and positive outcomes of cardiac resuscitation. Other authors[5,6] have proposed algorithms incorporating POCUS during cardiac arrest resuscitation. While we recognise that there may be differences between each institution's protocol for cardiac arrest resuscitation, the key principle is to ensure that cardiac compressions are not delayed due to POCUS[7].

This recommendation is made considering the foremost need to ensure adequate cardiac output through cardiac compressions during cardiac arrest for the patient, which would override the importance of obtaining the diagnosis. In the context of the aforementioned statement, we recommend the use of the subcostal window as the view of choice to be obtained in the cardiac arrest setting. This has the advantage of its position at the subcostal area, which allows the echocardiographer to quickly perform POCUS without having to require the personnel performing chest compressions to remove his hands. The ability of a subcostal window to visualise all 4 chambers of the heart also enables an informative assessment with just one exposure.

Furthermore, we would also recommend that POCUS should be performed ideally during times when chest compression are held off during the cardiac arrest resuscitation. This would be during the time when pulse check is performed and/or during intubation when CPR may be paused.

We believe that these recommendations would be helpful for other centres with POCUS capabilities in enhancing their response to patients with cardiac arrest in the emergent setting.

Conclusions

In summary, this case report describes a patient with cardiac arrest secondary to pulmonary embolism that was diagnosed with POCUS. It offers another example of the utility of POCUS in diagnosis, prognosis as well as therapeutic implications during cardiac arrest. We have put forth our recommendations centered over the minimization of disruption of cardiopulmonary resuscitation during POCUS in cardiac arrest, so as to ensure that patient safety is maintained while reaping the potential benefits of POCUS in cardiac arrest.

Conflict of interest

Authors do not report any financial or personal connections with other persons or organizations, which might negatively affect the contents of this publication and/or claim authorship rights to this publication.

Written consent

Consent for publication of this case report was obtained from patient.

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