

CASE REPORT

Diagnostic echocardiography in an unstable intensive care patient

R Gray, F Baldwin and S Bruemmer-Smith

Intensive Care, Royal Sussex County Hospital, Brighton, UK

Correspondence
should be addressed
to R Gray
Email
beckygray@doctors.org.uk

Summary

A previously fit and well 57-year-old gentleman who had recently undergone a colonoscopy and biopsy of a polyp presented with a 4-day history of progressive breathlessness and abdominal discomfort. The day after admission, he became haemodynamically unstable, developed ischaemic legs and suffered a brief cardiac arrest. Blood tests demonstrated a coagulopathy and hypoglycaemia. Continued haemodynamic instability post-arrest and clinical findings of high right-sided heart pressures were investigated by bedside screening echocardiogram. This demonstrated a massive pericardial effusion causing tamponade of the right ventricle. Heavily blood stained pericardial fluid was drained, with marked improvement in haemodynamic stability. Retrospective review of the admission-electrocardiogram (ECG) and chest X-ray demonstrated electrical alternans and cardiac enlargement. The differential diagnosis included bowel malignancy causing a haemorrhagic metastatic pericardial effusion and a type A aortic dissection. Therefore a computerised tomography (CT) scan of chest, abdomen, pelvis and aorta was performed. This was negative for disseminated malignancy and showed a type B aortic dissection, but was inconclusive for a type A aortic dissection. A subsequent transoesophageal echocardiogram confirmed the diagnosis of type B dissection and ruled out a type A dissection. The histology of the colonic polyp was negative for malignancy, but it was subsequently discovered that the patient had metastatic adenocarcinoma from a primary lung cancer diagnosed from pleural fluid cytology. With hindsight the presenting clinical picture was of type B aortic dissection with concurrent but not directly related pericardial tamponade.

Learning points:

- Basic echocardiography skills are increasingly being used acutely by physicians' as part of resuscitative care in intensive care unit (ICU) patients.
- The availability of expert skills in transoesophageal echocardiography are essential in ICU, as demonstrated in this case, where it was needed for discriminating between sub types of aortic dissection.
- Cardiac tamponade is a clinical diagnosis, although the presence of electrical alternans on an ECG with associated tachycardia is highly suggestive of cardiac tamponade.

Background

Echocardiography can help decision-making in critically unwell patients with haemodynamic instability. Basic echo training for intensive care registrars is a valuable screening tool, which can be used quickly and effectively in the management of patients in acute settings (1, 2, 3). This case demonstrates the practical use of echocardiography in

acute cardiovascular care, both in diagnosing and treating a pericardial effusion by drainage.

Echocardiography, in more experienced hands, can add valuable diagnostic information in cases of aortic dissection. In this case, echocardiography was also used to confidently exclude type A aortic dissection when CT was inconclusive and as a result, unnecessary surgery was avoided.

Case presentation

A previously fit and well 57-year-old man presented with 4-day history of increasing breathlessness and abdominal discomfort. He had a 40-pack year smoking history and was on no regular medications. On initial assessment, he was found to be febrile (temperature 39 °C), tachycardic (heart rate 120 beats/min) and had a lactate of 4 mmol/l. Five days before this admission, he had undergone a surveillance colonoscopy with biopsy of a splenic flexure polyp (subsequent histology was benign) also diverticular disease was noted at the time. He was admitted and a diagnosis of possible abdominal perforation and sepsis was made, given the history of recent colonoscopy.

The next day he suddenly deteriorated, developed painful cold legs and became hypotensive (blood pressure 70/50 mmHg). On examination he was agitated and sweaty with peripheral mottling. He was also noted to have massive hepatomegaly. An arterial blood gas demonstrated a lactate of 14 mmol/l and marked hypoglycaemia (glucose 0.8 mmol/l). He was resuscitated with crystalloid and dextrose and then transferred to the intensive care unit (ICU) for further treatment. The patient was reviewed by the general surgeons, who felt that colonic perforation was unlikely in the absence of any clinical finding of peritonism.

The patient then had a cardiac arrest in the ICU, with pulseless electrical activity. He was intubated and required 2 min of cardiopulmonary resuscitation (CPR) before

return of spontaneous circulation. A central venous catheter was inserted under ultrasound guidance. The right internal jugular vein was noted to be large and non-compressible on ultrasound examination and the first central venous pressure recorded was 31 mmHg. Blood tests that had been taken pre cardiac arrest demonstrated a marked consumptive coagulopathy (INR 5.9, fibrinogen 0.2 g/l, platelets $38 \times 10^9/l$).

Investigation

An intensive care registrar with limited experience in the technique performed a transthoracic echo and the patient was found to have a massive pericardial effusion causing right ventricular collapse. Figure 3 shows a subcostal view of the pericardial tamponade. This image was performed by an inexperienced operator and is inverted; however, the diagnosis can still be made.

An electrocardiogram (ECG) and chest X-ray taken during admission to the Emergency Department (ED) were reviewed retrospectively. The ECG was found to demonstrate the classical appearance of electrical alternans (Fig. 1). The chest X-ray showed an enlarged heart shadow compared with a chest X-ray taken 4 years before (Fig. 2).

Treatment and outcome

The large pericardial effusion was immediately drained and 700 ml of fluid was aspirated, stabilising the patient

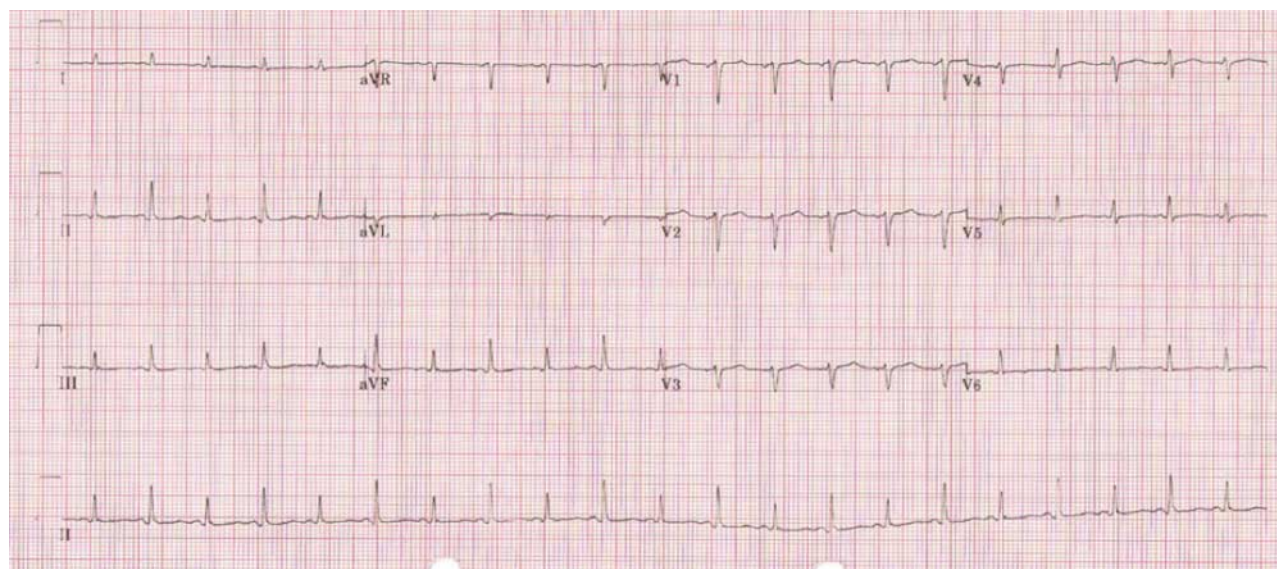
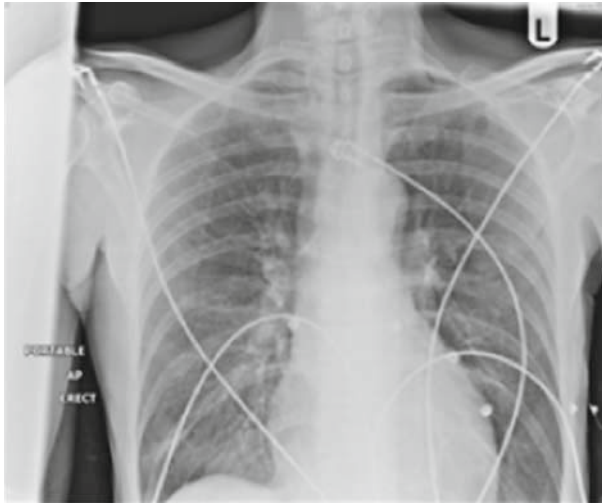


Figure 1
Admission-ECG showing the classical appearance of electrical alternans.

(a) Admission chest X-ray



(b) Chest X-ray 4 years preceding admission



Figure 2

Enlarged heart shadow visible on admission-chest X-ray (A) compared with chest X-ray 4 years preceding admission (B).

haemodynamically. Figure 4 shows the subcostal view post aspiration.

The pericardial fluid was heavily blood stained and consequently cytological examination was not possible. The presence of both a pericardial effusion and limb ischaemia was strongly suggestive of a type A dissection; however, the possible diagnosis of metastatic bowel cancer causing a malignant haemorrhagic pericardial tamponade was also considered. At this time, the histology from the

splenic flexure polyp was still pending. Therefore a CT of the chest, abdomen and pelvis was performed, with a CT aortogram in attempt to distinguish between the two differential diagnoses.

The CT showed a haematoma in the distal arch of the aorta and the descending aorta, but due to the poor quality of the images of the CT angiography, it was not possible to confidently exclude type A dissection. The CT angiogram was repeated in an attempt to gain better images and two transoesophageal echocardiograms were performed 12 h apart to distinguish between a type A and B dissections and the differing treatment options for each type of tear. Type A aortic dissection was excluded following the transoesophageal echocardiogram by an experienced cardiologist. Following a case management discussion with the intensivists, cardiologists, cardiothoracic surgeons and the vascular team, the dissection was felt to be manageable medically.

Figures 5, 6, 7 and 8 show transoesophageal echocardiogram images. Figure 5 shows a normal mid-oesophageal short axis of the aortic valve and Fig. 6 shows a normal long-axis view of the aortic valve, therefore excluding a type A dissection. Figures 7 and 8 show the dissection flap in the descending aorta and a left-sided pleural effusion. Figure 8 shows colour flow Doppler added to demonstrate the true lumen.

The patient remained in the ICU for several weeks requiring ongoing cardiovascular, respiratory and renal support. Serial echocardiograms were performed, which showed a moderate recurrence of the pericardial effusion but no associated significant haemodynamic compromise. The patient developed paraplegia as a consequence of type A dissection. A pleural effusion evolved during the

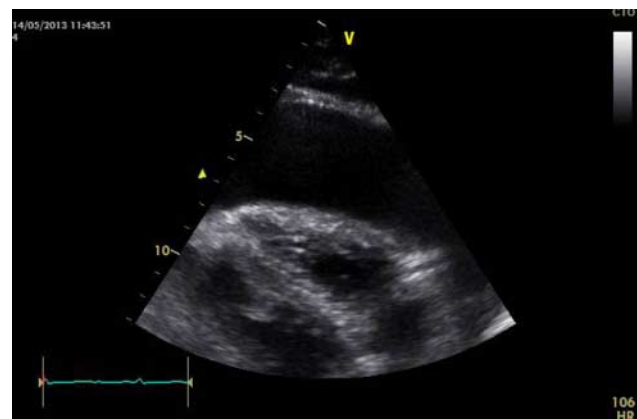


Figure 3

Subcostal view of the pericardial tamponade.



Figure 4
Subcostal view post aspiration.

ICU admission and was subsequently drained. The pleural fluid showed cells with positive epithelial and mesothelial immunostains (positive CK7, negative for CK20). This was consistent with metastatic adenocarcinoma from a primary lung tumour. On review of the CT scans, there was a suspicious spiculate lesion in the left upper lobe. Sadly, the patient died 2 months after his initial presentation. He did not undergo a post mortem.

The absence of a type A dissection would suggest that, in fact, the patient had two diagnoses: a symptomatic pericardial effusion (presenting with breathlessness) which was related to his undiagnosed lung cancer and an acute type B aortic dissection.

Discussion

This case demonstrates both the usefulness of basic echocardiography skills in the ICU and also the need for comprehensive echocardiography assessment by fully trained expert operators within, or available to, the intensive care team. Echocardiography facilitated a collaborative approach between clinical teams in this complex patient management.

Our first learning point was that basic echocardiography skills are useful as part of resuscitative care in ICU patients. In our case study, basic echocardiography aided rapid diagnosis of pericardial tamponade in the ICU setting. In the UK, several basic-level echocardiography courses have been developed. The Intensive Care Society (4) recommends Focused Intensive Care Echocardiography (FICE) certification as a basic competency for intensivists. Operators are taught to be able to assess left and right ventricular function, the presence of pericardial effusion, the inferior vena cava size and any valve

thickening or unusual morphological appearance. Focused Echo Evaluation in Life (FEEL) support (5) and focused cardiac ultrasound (FOCUS) (6) are other protocols that are aimed at teaching basic echocardiogram skills for the acute setting. These have been developed following the work of Jensen & Sloth (7), which demonstrated that a focused protocol was beneficial in the assessment and optimisation of the patient's haemodynamic status.

The recommendation of each of these basic competency courses is that abnormal studies should be referred for specialist comprehensive echocardiography to ensure high standard of patient care.

The two studies from UK general ICUs, one district general hospital (1) and one teaching hospital (2), showed that basic echocardiography changed management in 50% of patients. These management changes included fluid administration, inotrope or vasopressor initiation, or aiding further diagnosis such as severe valvular disease or pulmonary hypertension.

The second learning point was that the availability of expert skills in transoesophageal echocardiography are essential in the ICU, as demonstrated in this case where transoesophageal echocardiography was necessary for the diagnosis. Transoesophageal echocardiography is sensitive for discriminating between sub types of aortic dissection. The diagnostic distinction between type A (dissection involving the ascending aorta with or without involvement of the descending aorta) and type B (dissection involving the descending aorta) aortic dissection was important because treatment options would have differed markedly. On first presentation, the patient



Figure 5
Normal aortic valve via mid-oesophageal short-axis view.



Figure 6
Normal aortic valve via mid-oesophageal long-axis view.

had cardiac tamponade and ischaemic legs; therefore the most likely unifying diagnosis was a type A aortic dissection. Type A aortic dissection was not excluded on two CT scans, however, leaving a degree of uncertainty over management. An ICU physician and a cardiologist, both fully trained in transoesophageal echocardiography performed two sequential transoesophageal echocardiograms and were able to confidently exclude the diagnosis of the type A dissection in evolution, avoiding a need for surgical intervention.

Transoesophageal echocardiogram has been quoted to have sensitivity, specificity and negative predictive values of nearly 100% (8). This compares to CT scanning



Figure 8
Colour Doppler view of the dissection flap in the descending aorta with left-sided pleural effusion.

which has been shown to have a sensitivity of 90–100% and a specificity from 87 to 100% (8). In type A aortic dissection, transoesophageal echocardiogram is also better than CT in localisation of the entry tear and identification of the mechanism of aortic regurgitation and dynamic false lumen flow (9).

Finally, the third learning point was that cardiac tamponade is a clinical diagnosis; however, the presence of electrical alternans on an ECG with associated tachycardia is highly suggestive of cardiac tamponade. A point of interest of this case study, in retrospect, is that cardiac tamponade could have been diagnosed on admission to the ED. The admission-ECG showed electrical alternans and a heart rate >100 b.p.m., this sign is highly suggestive of cardiac tamponade (10). The cardiac silhouette appeared unremarkable on the admission-chest X-ray in isolation. However, in comparison with old chest X-rays, the cardiac silhouette was significantly increased. Although the late diagnosis probably did not affect the overall outcome for the patient, this does give further argument about the potential role of basic transthoracic echocardiography as a routine screening tool in all acute care settings.

In summary, we present a case of cardiac arrest due to pericardial tamponade, which was managed acutely with screening echocardiogram-guided diagnosis and treatment. The limitations of screening echocardiography were recognised and subsequently a transoesophageal echocardiogram was able to differentiate between type A and B aortic dissections and guide further important management decisions. Our case clearly demonstrates the



Figure 7
Dissection flap in the descending aorta with left-sided pleural effusion.

role of both transthoracic and transoesophageal echocardiography in the ICU and the usefulness of echocardiography to physicians of all grades and levels of expertise.

Declaration of interest

S Bruemmer-Smith is on the editorial board of Echo Research and Practice.

Funding

This research did not receive any specific grant from any funding agency in the public, commercial or not-for-profit sector.

Author contribution statement

All authors contributed equally to this work.

References

- Orme RL, Oram M & McKinstry C 2009 Impact of echocardiography on patient management in the intensive care unit: an audit of district general hospital practice. *British Journal of Anaesthesia* **102** 340–344. (doi:10.1093/bja/aen378)
- Glen J, Bruemmer-Smith S & Greenway T 2013 Introduction of an echocardiography service to a general intensive care unit. *Journal of the Intensive Care Society* **14** 288–293. (doi:10.1177/175114371301400404)
- Ferrada P, Anand RJ, Whelan J, Aboutanos MA, Duane T, Malhotra A & Ivatury R 2011 Limited transthoracic echocardiogram: so easy any trauma attending can do it. *Journal of Trauma* **71** 1327–1331. (doi:10.1097/TA.0b013e3182318574)
- Intensive Care Society. Focused Intensive Care Echo. (Online) Available at: <http://www.ics.ac.uk/ics-homepage/events/fice-bse/focused-intensive-care-echo-fice>, accessed 03/05/2014, 2012.
- UK Resuscitation Council. Focused Echocardiography in Emergency Life support (FEEL) Course. (Online) Available at: www.resus.org.uk/pages/feelgen.htm, accessed 6/05/2014, 2012.
- Labovitz AJ, Noble VE, Bierig M, Goldstein SA, Jones R, Kort S, Porter TR, Spencer KT, Tayal VS & Wei K 2010 Focused cardiac ultrasound in the emergency setting: a consensus statement of the American Society of Echocardiography and American College of Emergency Physicians. *Journal of the American Society of Echocardiography* **23** 1225–1230. (doi:10.1016/j.echo.2010.10.005)
- Jensen M & Sloth E 2004 Transthoracic echocardiography for cardiopulmonary monitoring in intensive care. *European Journal of Anaesthesiology* **21** 700–707. (doi:10.1097/00003643-200409000-00006)
- National Guideline Clearinghouse. ACR appropriateness criteria – acute chest pain – suspected aortic dissection. (Online) Available at: <http://www.guideline.gov/content.aspx?id=35134>, accessed 20/05/2014, 2012.
- Evangelista A, Avegliano G, Aguilar R, Cuellar H, Igual A, González-Alujas T, Rodríguez-Palomares J, Mahía P & García-Dorado D 2010 Impact of contrast-enhanced echocardiography on the diagnostic algorithm of acute aortic dissection. *European Heart Journal* **31** 472–479. (doi:10.1093/eurheartj/ehp505)
- Bayés de Luna A & Goldwasser D. In *Clinical Arrhythmology*, Ch 10, P 351. Chichester: John Wiley and Sons Ltd, 2011.

Received in final form 16 December 2014

Accepted 7 January 2015