Case Report

Diagnosis of bone cement implantation syndrome using point of care ultrasound examination

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ABSTRACT

Once regarded as a rare complication, the potentially fatal bone cement implantation syndrome (BCIS) has been increasingly reported. BCIS can present as transient desaturation, hypotension, cardiac dysrhythmias, and cardiovascular collapse. Diagnosis of BCIS is often clinical and confirmed with computed tomography (CT) imaging postoperatively. However, point of care ultrasound (POCUS) examination could be a helpful and timely tool to clinch the diagnosis in a sudden cardiovascular collapse. We present a case of Grade 3 BCIS where POCUS examination revealed a massive clot in the right atrium, which supports the diagnosis.

Keywords: Clot, pulmonary artery, right atrium, saddle pulmonary embolism, transthoracic echocardiography

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Once regarded as a rare complication, the potentially fatal bone cement implantation syndrome (BCIS) has been increasingly reported.[1] A study from Sweden quoted the incidence of BCIS for cemented hemiarthroplasty to be as high as 28%.[1] BCIS can present as transient desaturation, hypotension, cardiac dysrhythmias, and cardiovascular collapse.[2] Donaldson *et al.* developed a classification system for severity of BCIS based on clinical presentation. They proposed Grade 1 as moderate hypoxia (Pulse oximetry oxygen saturation, SpO_2 <94%) or hypotension [decrease in systolic blood pressure (SBP) >20%]; Grade 2 as severe hypoxia (SpO_2 <88%) or hypotension (decrease in SBP >40%) or unexpected loss of consciousness; Grade 3 as cardiovascular collapse necessitating cardiopulmonary resuscitation (CPR).[2] The incidence of Grade 3 BCIS has been suggested to be between 0.14% and 0.68% for cemented total hip arthroplasty, and between 0.4% and 4.3% for cemented hemiarthroplasty.[3] Intraoperative mortality from BCIS has been estimated to be 0.1%.[3]

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Transthoracic echocardiography (TTE) is routinely used by some centers to evaluate cardiac function perioperatively.[4] As a noninvasive imaging tool, the intraoperative use of TTE has helped with the diagnosis and management of BCIS-related hypotension.[4-6] The combination of echocardiographic findings that may support the diagnosis of BCIS include acute right ventricular (RV) dilation, regional RV dysfunction consisting of akinesia of mid free wall segment with normal motion at apex (McConnell's sign), septal wall motion abnormality, compressed left ventricle, and inferior vena cava dilatation.[7,5]

CASE REPORT

An octogenarian female suffered a right neck of femur fracture 5 months earlier and had undergone proximal femoral nail antirotation (PFNA) fixation with cement

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augmentation. Following which, she was transferred to a community hospital for inpatient rehabilitation. Two months later, she developed right hip and groin pain after physiotherapy. Orthopedic consultation revealed a shift of the PFNA implant, and she was scheduled for elective implant removal and cemented total hip replacement procedure.

Her medical history includes hypertension, osteoporosis, anemia of chronic disease, and essential thrombocytosis, for which she was prescribed hydroxyurea and clopidogrel. She was prescribed clopidogrel as she was allergic to aspirin. Clopidogrel was stopped 1 week prior to surgery.

She did not have any preoperative echocardiogram. Her ECG was normal sinus rhythm QTc 411 ms.

For the surgery, spinal anaesthesia was administered at the L3-4 space. Bupivacaine 12.5 mg (2.5 ml) was deposited into the subarachnoid space via a Quincke 23G needle inserted through a midline approach. She received intravenous midazolam for sedation and intravenous tranexamic acid 500 mg to reduce blood loss. Intravenous bolus doses of phenylephrine were administered to maintain her blood pressure following administration of spinal anesthesia. Blood pressure readings were stable prior to the injection of cement.

During the injection of cement for implant, patient became bradycardic; heart rate decreased to 40 beats per minute (bpm). Her blood pressure decreased from 120/85 mmHg to 40/25 mmHg. She became unconscious. Electrocardiogram showed sinus bradycardia. CPR was commenced for severe hypotension. The patient was intubated and mechanically ventilated. A total of 4180 μg of adrenaline were administered during the resuscitation. Approximately 14 min later, there was return of spontaneous circulation. An intra-arterial cannula, central venous catheter, and a pulmonary artery catheter sheath were inserted for further monitoring and resuscitation. Point of care analysis of arterial blood gas performed with inspired oxygen concentration of 1.0 revealed: pH 7.234, PaO_2 341 mmHg, $PaCO_2$ 36.4 mmHg, base excess-12 mmol/L, HCO_3^- concentration of 15.4 mmol/L, SaO_2 100%, hemoglobin concentration of 7.5 g/dL, Na^+ concentration of 135 mmol/L, K^+ concentration of 4.3 mmol/L, ionized Ca^{++} concentration of 1.24 mmol/L, and glucose concentration of 5.4 mmol/L.

An intraoperative TTE was performed by a Cardiac anaesthesiologist from Department of Anaesthesiology. With the demonstration of a mass in the right atrium [Figure 1], the clinical impression was that the patient most likely had BCIS and the acute cardiovascular event was likely due to right ventricular outflow tract obstruction from pulmonary embolism.

As the patient was hemodynamically unstable, a joint decision was made to terminate the surgery. Her right lateral thigh wound was covered with Gamgee dressing. Plans were made to transfer her to the surgical intensive care unit for ventilatory and hemodynamic stabilization, before undergoing CT imaging of her thorax to evaluate for embolism. Just before proceeding for her CT scan, her heart rate and blood pressure were 126 bpm and 129/80 mmHg, respectively, on adrenaline 0.2 μg/kg/min.

CT scan of the thorax revealed the following: (i) a circumscribed 26.3 mm hypodense mass within the distended right atrial cavity [Figure 2a and c]; (ii) acute saddle pulmonary embolism extending from the pulmonary trunk (main pulmonary artery) into both left and right pulmonary arteries [Figure 2b]; (iii) presence of clot in the right atrium and clots in main pulmonary artery [Figure 2c], and right heart strain as evidenced by dilatation of the right ventricle (right ventricular chamber size: left ventricular chamber size >1) with straightening of the interventricular septum [Figure 2d]; and (iv) clots in the distal lobar-segmental branches, predominantly in the lower lobes.

The patient was expediently reviewed by a multidisciplinary team involving cardiologist, cardiothoracic surgeon, interventional radiologist, and intensivist. Surgical thrombolysis and thrombectomy were considered. However, the procedures were deemed not ideal due to the size and location of mass. Furthermore, patient had developed coagulopathy, likely disseminated intravascular

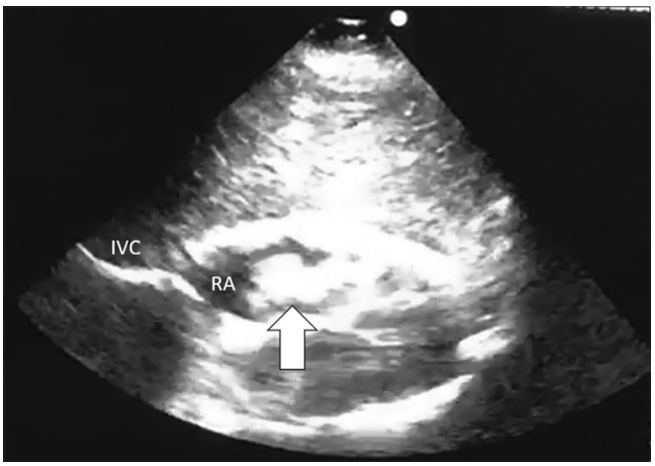

Figure 1: Transthoracic echocardiography subxiphoid view. White arrow points to mass in right atrium

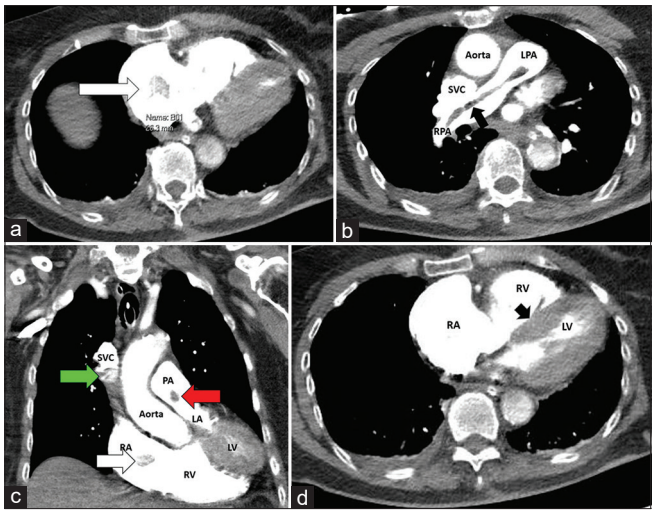

Figure 2: (a) Axial view of computed tomography scan-pulmonary artery (CT-PA) demonstrating right atrium mass. (b) Axial view of CT-PA demonstrating acute saddle pulmonary embolism (indicated by black arrow) extending from the pulmonary trunk (main pulmonary artery) into left pulmonary artery (LPA) and right pulmonary artery (RPA). (c) Coronal view of CT-PA. White arrow points to clot in the right atrium (RA). Green arrow on patient's right points to flow aberration in superior vena cava (SVC). Red arrow on patient's left points to clot in main pulmonary artery. The bright contrast caused the boundaries between main pulmonary artery (PA) and left atrium (LA) to be obscured giving the impression of confluence of two structures. This projection makes the right ventricle (RV) to appear larger than the left ventricle (LV). One consideration is that in this projection, the LV may not be imaged at its true largest diameter. (d) Axial view of CT-PA. Black arrow demonstrating straightening of interventricular septum. Right atrium (RA) is dilated. The ratio of internal diameters of right ventricle (RV) to left ventricle (LV) is >1

coagulopathy (DIC). Thrombolysis is also associated with further massive thromboembolism to the pulmonary arteries.[8] Anticoagulation was not recommended due to high bleeding risk from DIC and the presence of an open surgical wound. Best supportive treatment was instituted instead and patient subsequently demised.

Post-mortem revealed a 6.0 × 3.5 × 1.5 cm dull red, rubbery blood clot in the inferior vena cava. On cut section, lines of Zahn, which are alternating pink bands of platelet and fibrin deposits, and red bands of red blood cells, are seen. This indicates clot formation in an area of rapid flow before death.

DISCUSSION

In time-critical situations such as cardiac arrest, early diagnosis of underlying cause would be of paramount importance for appropriate management of the patient. Point of care ultrasound examination is a timely and valuable tool to assist with diagnosis and evaluation of cardiac function in cardiac arrest.[9] In our case, the use of POCUS had expedited the arrangement for CT scan and multidisciplinary team management. In addition to diagnosis, it could be used to evaluate cardiac function and hemodynamics. We can then use the information to guide fluid and inotrope management.

On the other hand, having an early diagnosis could also lead to earlier prognostication. Should the potential treatment options be limited or futile, the information may have been used to guide the extent of resuscitation and care.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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