The occasional cardiac tamponade

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This article has been peer reviewed.

INTRODUCTION

A 67-year-old man with generalized weakness and dyspnea is brought to your rural emergency department by paramedics. A neighbour found him lying at the bottom of the stairs in front of his home. The patient is confused and unable to provide details about what occurred. No past medical history is known. On examination, the man's blood pressure is 85/57 mm Hg, heart rate 121 beats/min, respiratory rate 34 breaths/min, oxygen saturation 92% on a nonrebreather mask and temperature 37.2°C. His Glasgow Coma Scale Score is 13 (eyes 4, verbal 4, motor 5). He appears diaphoretic, indraws as he breathes rapidly and exhibits peripheral cyanosis, with cool extremities. Heart sounds are muffled, his chest is clear, and abdominal examination is normal. You are unable to appreciate any jugular venous distension. His electrocardiogram reveals sinus tachycardia with normal-sized QRS complexes and nonspecific T-wave inversion in V5–V6.

CARDIAC TAMPONADE

Undifferentiated shock is a common presentation to the rural emergency department, and cardiac tamponade needs to be considered in the differential diagnosis. Cardiac tamponade is a clinical diagnosis describing a cardiogenic shock state that occurs when accumulation of fluid in the pericardial space (pericardial effusion) results in hypotension and systemic hypoperfusion from decreased cardiac output. It is a life-threatening condition requiring immediate intervention.[1]

Point-of-care ultrasonography

For a patient in undifferentiated shock, point-of-care ultrasonography (PoCUS) during the initial assessment is rapidly becoming the standard of care in emergency departments. As part of the extended focused assessment with sonography for trauma (eFAST), cardiac PoCUS is useful for answering focused questions such as whether pericardial effusion is present.

In fact, cardiac PoCUS is the primary imaging modality for detecting pericardial effusion and definitively diagnosing cardiac tamponade. It is preferred because of its portability, lack of ionizing radiation, noninvasiveness, rapid image acquisition and interpretation, and dynamic evaluation. Furthermore, ultrasonography has been shown to better correlate to the volume of fluid drained at pericardiocentesis than computed tomography.[2] Ultrasonography is able to detect fluid collections as little as 20 mL and can show findings consistent with impending tamponade before the development of clinical signs and hemodynamic compromise.[3] Cardiac PoCUS performed by emergency physicians has a sensitivity of 96%, specificity of 98%, and overall accuracy of 97.5% for detecting pericardial effusion.[4]

Equipment

- Any ultrasonography machine
- Low-frequency (2–5 MHz) curvilinear probe (Fig. 1) or phased-array probe
- Ultrasound gel or water-based lubricant

Procedure

Ideally, 2 or more cardiac views are suggested for assessment of pericardial effusion, as the use of only 1 view may miss a smaller effusion that is dependent or loculated. However, we present the technique for obtaining the subxiphoid view (also known as the subcostal view). This is the view generally regarded to be easier for beginners to gain competence with, and it facilitates the subxiphoid pericardiocentesis approach that was traditionally taught to be done without imaging assistance.

- With the depth of the ultrasound machine set to maximum, begin by placing the probe at the level of the umbilicus and slide it toward the xiphoid process with the probe aiming slightly toward the patient's left shoulder and the probe marker pointing toward the patient's right side (Fig. 2).
- Gradually rotate the probe toward the patient's chin until the heart comes into view on the ultrasound screen. Hold the probe with your hand on top, to facilitate flattening of the probe, often required to obtain a good image of the heart.
- The heart should be visible at the top of the screen (near field) as a beating entity.
- If the heart is not immediately visible, sweep the probe anterior–posterior (tilt the probe slowly until it is almost flat on the patient's abdomen). One can also reposition the probe, with the probe head pointing toward the neck rather than the shoulder, and repeat the anterior–posterior sweep.
- If the heart is still not visible, and the patient is able to cooperate, ask the patient to breathe in slowly. This will drop the diaphragm and the heart so that they are brought closer to the probe.
- When the entire heart is visualized, minimize the depth to enlarge the image.
- From near field to far field (top of screen to bottom of screen), the structures appear in this order: liver, pericardium, right ventricle, left ventricle and pericardium (Fig. 3).
- To complete the scan, slowly sweep the probe completely through the heart, passing from anterior to posterior and back again, ensuring that the heart disappears completely from the screen at each extreme.
- The pericardium generally appears as a bright, thick white line around the heart. This can be more easily seen by increasing the gain on the ultrasound machine.

Pericardial effusion

Pericardial fluid appears as an anechoic (black) space between the 2 pericardial layers. A small effusion (< 100 mL) is defined as less than 10 mm in thickness, moderate (100–500 mL) is 10–15 mm thick, and large (> 500 mL) is greater than 15 mm thick.[5]

- Make several measurements and document their location.

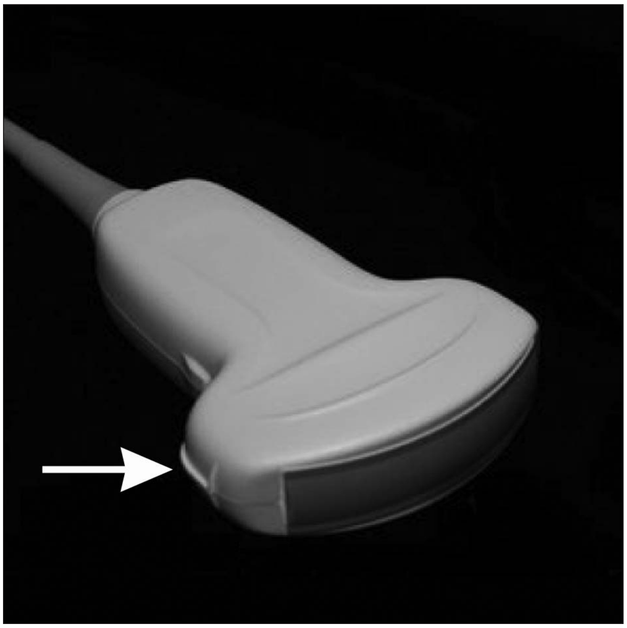

Fig. 1. Low-frequency (2–5 MHz) curvilinear probe. The probe marker (arrow) should always be pointed toward the patient's right side.

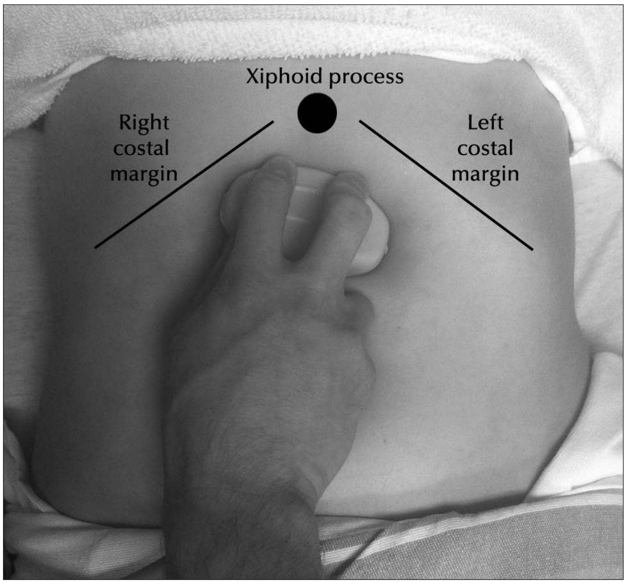

Fig. 2. Correct probe placement to obtain a subxiphoid view of the heart. Starting from the umbilicus, the probe is slid up toward the xiphoid process, which allows for the liver to be used as an acoustic window.

- In the presence of suspected cardiac tamponade, the most important thing to look for is the pericardial effusion (Fig. 4). However, cardiac PoCUS generally also shows right ventricular collapse during early diastole, right atrial collapse during late diastole and the inferior vena cava to be dilated. Patients with pulmonary hypertension and right ventricular hypertrophy may not have right heart collapse until later in the course of tamponade.[6]
- With a large circumferential effusion, the classic pattern of "swinging heart" will be seen, reflecting the heart floating in the pericardium.

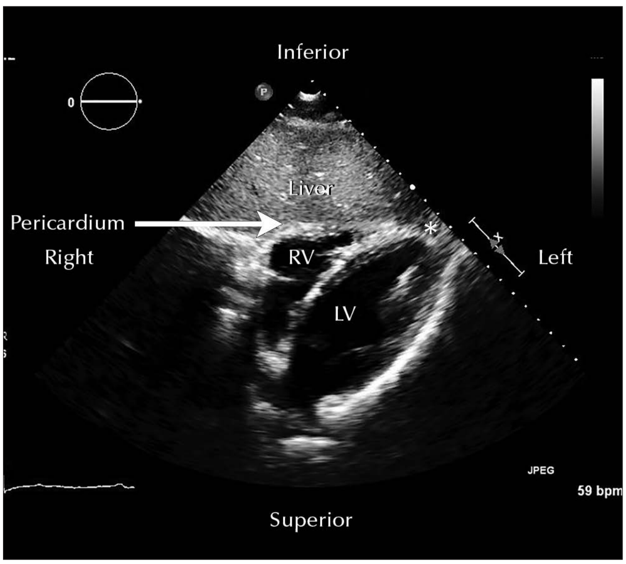

Fig. 3. Normal subxiphoid view of the heart. The right ventricle (RV) is the most inferior part of the heart and is separated from the left ventricle (LV) by the septum. For an optimal image, the operator must be able to visualize the right side of the inferior pericardium (arrow) all the way until it meets with the septum at the apex (*). The liver provides the acoustic window. P = probe marker.

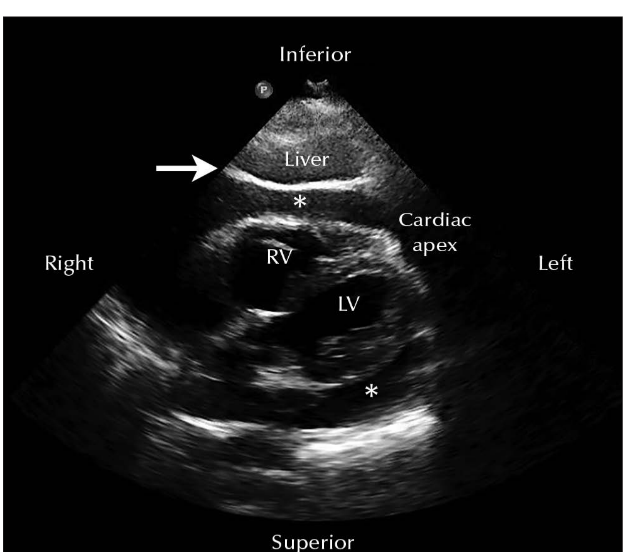

Fig. 4. Subxiphoid view of the heart with pericardial effusion (*). The effusion is identified by the black anechoic fluid surrounding the heart that separates the parietal pericardium (arrow) from the visceral pericardium. LV = left ventricle, P = probe marker, RV = right ventricle.

Additional tips

If abdominal free fluid is present, it may be found around the liver, but it will not conform to the heart border as pericardial effusion will. Pericardial effusions are always within the pericardium!

Commonly, an inexperienced sonographer may encounter a source of false-positive results — the epicardial fat pad. The fat pad is generally less black than fluid and will almost always appear only anteriorly. Note that gravity will make nonloculated effusions appear posteriorly first. This underscores the importance of scanning through the entire heart. If a hypoechoic area is seen only anteriorly while the patient is supine, it is most likely an epicardial fat pad, not pericardial effusion.[7]

In obese patients, a better view may be obtained by asking the patient to flex his or her legs, which relaxes the abdominal muscles to better facilitate image generation.

Management

Pericardiocentesis is the definitive treatment for cardiac tamponade. In rural areas without access to cardiac surgery, cardiac tamponade secondary to free wall rupture or aortic dissection is essentially a fatal condition. Extended drainage with a catheter leads to lower recurrence rates and need for surgery, as reaccumulation of fluid often occurs within 48 hours. This is safe even for children younger than 2 years of age.[6]

Cardiac PoCUS can guide pericardiocentesis more safely than the traditional blind technique. In fact, it can guide the choice of an entry point, with the shortest path to the pericardial fluid without interposed lung (usually anterior chest wall).

- In the traditional subxiphoid approach, the needle needs to traverse the liver and diaphragm. Insert the needle subxiphoid at an angle of 45° to the skin and directed at the left scapula.
- Using sterile precautions, use ultrasonography to dynamically guide needle advancement to avoid ventricular puncture.[8]
- Advance the needle until fluid is aspirated.
- A pigtail catheter should be inserted for

drainage. If that is unavailable, a 7 French central venous catheter can be used.

- In case of perforation of a cardiac chamber during pericardiocentesis, secure the perforating catheter in place and try another percutaneous puncture for drainage.[9]

Pericardiocentesis success rates are greater than 95%. In cases of purulent pericarditis, pericardiocentesis alone may be inadequate. Potential major complications include chamber puncture, vessel injury, pneumothorax, infection, arrhythmia, vasovagal response and pneumopericardium.[6]

Volume resuscitation and catecholamines can be temporizing treatments while awaiting pericardiocentesis. Both are controversial.[10]

In normovolemia or hypervolemia, fluid administration may cause further fluid overload and worsening of the tamponade. In dehydration/hypovolemia, intravascular fluid infusion of 250–500 mL of normal saline can maximize hemodynamic effects, but volumes higher than this have been shown to be deleterious.[10]

If using catecholamines, isoproterenol has been used as a sympathomimetic to increase heart rate and cardiac output while decreasing right atrial pressure and systemic vascular resistance. However, adrenergic stimulation may worsen tachycardia, ventricular relaxation impairment and ventricular filling.[10]

If using vasopressors, dobutamine has theoretical compensatory mechanisms to cardiac tamponade, but endogenous inotropic stimulation of the heart is often already maximized in tamponade, and further pressors may not be helpful.[11]

CASE CONTINUED

After the initial resuscitation of the patient, cardiac PoCUS is applied. The subxiphoid view of the heart identifies a large pericardial effusion, with a rapidly beating heart. A pigtail catheter is inserted under sterile precautions with ultrasound guidance into the pericardium, and 300 mL of serous fluid is drained. The patient's vital signs subsequently return to normal, with immediate resolution of his symptoms. Now, a more thorough history is taken, and further investigations are obtained for diagnosis and treatment of the underlying cause of the pericardial effusion.

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Acknowledgements: The authors thank registered echocardiographers Terri-Lynn O'Reilly and Judy Samways, from the Central Newfoundland Regional Health Centre, for their invaluable assistance with image generation as well as Katie Slaney for acting as our model and being a wonderful person.

Competing interests: None declared.