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CASE REPORT

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Left internal mammary artery injury and subsequent hypovolemic shock due to a hemothorax after subxiphoid pericardiocentesis in a postoperative cardiac surgery patient

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Abstract

Multimodality imaging is recommended in patients in shock after seemingly uneventful pericardiocentesis. The aim of this study was to heighten awareness that LIMA injury can lead to a life-threatening hemothorax in postoperative cardiac surgery patients.

KEYWORDS

bleeding, cardiogenic shock, pericardium, valvular surgery, vascular complications

1 | INTRODUCTION

Injury to the left internal mammary artery (LIMA) as a result of ultrasound-guided subxiphoid pericardiocentesis is rare. This case highlights that in postoperative cardiac surgery patients, injury to the LIMA may lead to a potential life-threatening hemothorax instead of recurrent cardiac tamponade and therefore may be unrecognized.

Pericardiocentesis is an invasive procedure that may be required for the diagnosis and management of acute and chronic pericardial effusions. The procedure can be lifesaving in patients with cardiac tamponade or when hemodynamic compromise occurs due to a large pericardial effusion. Echocardiographic-guided pericardiocentesis is currently considered the standard clinical practice as it decreases the rate of major complications to approximately 1%-3%.[1] The mortality rate from injuries directly caused by pericardiocentesis is less than 1%.[1] Other major complications of pericardiocentesis include arrhythmias including ventricular fibrillation, injury to the heart and coronary arteries leading to tamponade, pericardial/epicardial thrombus, cardiac chamber laceration requiring surgery, injury to internal thoracic vessels or intercostal vessels, pneumothorax requiring chest tube placement, injury to lung parenchyma or phrenic nerve, injury to abdominal viscera, hepatic injury, and local/systemic infection.[2] In addition, minor complications include vasovagal response with transient hypotension, pericardial catheter occlusion, and pleuropericardial fistula.[2]

We present a rare case of left internal mammary artery (LIMA) injury and subsequent hypovolemic shock due to hemothorax following echocardiographic and fluoroscopy-guided subxiphoid pericardiocentesis in a postoperative cardiac surgery patient.

2 | CASE HISTORY/ EXAMINATION

A 56-year-old male patient with a history of idiopathic dilated cardiomyopathy, atrial fibrillation, nonsustained ventricular tachycardia, implantation of an intracardiac defibrillator for primary prevention, and known severe tricuspid regurgitation (TR) for the last 3 years had progressive symptoms of right-sided heart failure. Despite medical therapy with lisinopril and bumetanide, he repeatedly gained weight up to 15 kilograms and had peripheral edema.

2.1 | Differential diagnosis, investigations, and treatment

The differential diagnosis for right-sided heart failure included coronary ischemia, valvular heart disease, or underlying atrial or ventricular arrhythmias. Echocardiography showed (a) severe TR based on annular dilatation (51 mm in diameter), dilated right atrium (RA), and ICD lead in situ; (b) dilated right ventricle (RV) (RVIDd 77 mm) and left ventricle (LV) (LVIDd 64 mm) with a mid-range right and left ventricular ejection fraction; and c) moderate mitral regurgitation (MR) based on tenting of the mitral leaflets, annular dilatation, and dilatation of left atrium (LA). After discussion in the multidisciplinary heart team, the patient underwent tricuspid valvuloplasty (Contour 3D™ annuloplasty T-ring 36 mm, Medtronic, Minneapolis, USA), mitral valvuloplasty (Carpentier-Edwards Physio Annuloplasty Ring 32 mm, Edwards Lifesciences), and implantation of a left ventricular lead (CapSure EPI 4968-35 cm, Medtronic). At the end of the surgical procedure, chest tubes were placed in the mediastinal, pericardial, and pleural space and removed the next day. Directly postoperative, the patient was in distributive shock due to a systemic inflammatory response syndrome treated with norepinephrine and dobutamine. On the fourth day postoperative, the vasopressor and inotropic support could be stopped and the patient was transferred to the cardiothoracic surgical ward.

Echocardiography on the sixth day postoperative showed dilatation of both ventricles with a normal LV function and a moderate RV function, absence of TR and MR, and circumferential pericardial effusion of 1 cm without signs of a cardiac tamponade (normal deployment of RV and RA, and exaggerated respiratory variability of 11% mitral inflow velocity). The pericardial effusion was accepted as the patient had a normal blood pressure and no pulsus paradoxus. On the eleventh day postoperative, however, the patient's clinical signs deteriorated as he became short of breath, hypoxic, hypotensive (blood pressure 100/54 mm Hg), and anuric. Echocardiography showed circumferential substantial (2.5 cm) pericardial effusion (Figure 1). The patient underwent a pericardiocentesis via the subxiphoid approach under fluoroscopy and echocardiographic guidance. A total of 950 cc serosanguineous fluid was aspirated from the pericardial space. Immediately, the patient's clinical signs improved and the blood pressure normalized. A drain was left in place, and an additional 460 cc serosanguineous fluid was collected in the hours thereafter. About 4 hours after the pericardiocentesis, the patient again became short of breath and hypotensive (blood pressure 100/49 mm Hg). Immediate echocardiography showed the absence of pericardial effusion. Chest X-ray revealed the presence of a substantial amount of left-sided pleural effusion (Figure 2). Laboratory findings, however, showed a decrease in hemoglobin from 5.5 to 4.5 mmol/L. A computed tomography (CT) thorax was performed directly hereafter, which showed substantial left-sided

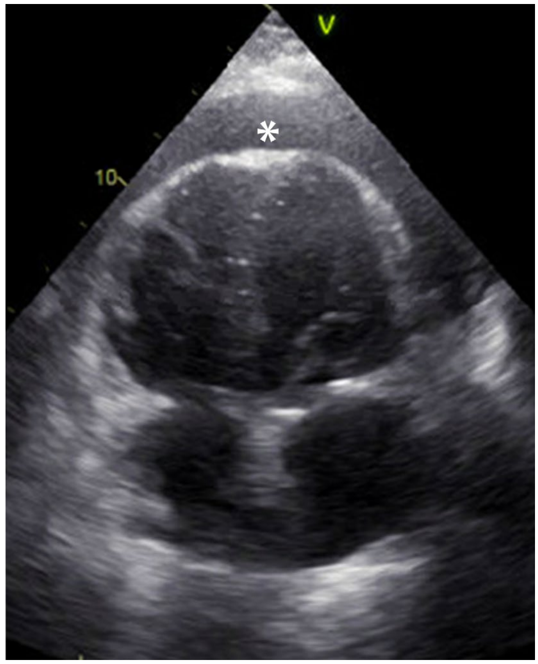

FIGURE 1 Parasternal long-axis echocardiographic view with substantial pericardial effusion (*)

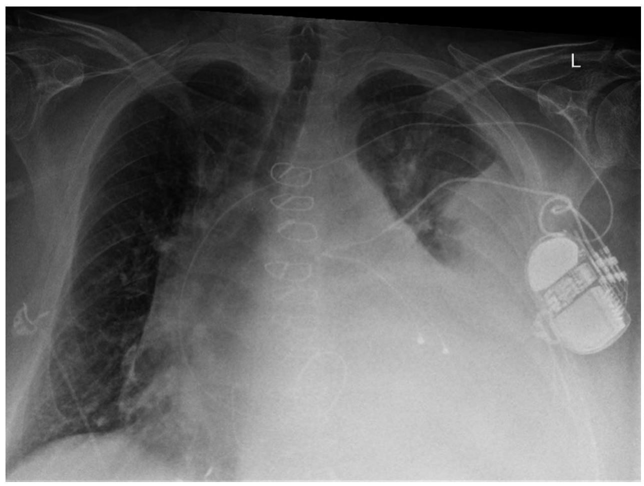

FIGURE 2 Chest X-ray showing large pleural fluid on the left side

pleural effusion with a high Hounsfield unit level (HU 72) suspicious for blood. Furthermore, it was noted that the pericardial drain ran through the distal part of the LIMA but well away from the pleural space. A chest tube was placed in the left pleural space, and 1300 cc blood was drained. This rapidly improved the condition of the patient. The interventional radiologist was consulted, and by angiography, it was confirmed that the distal LIMA crossed the pericardial drain; however, a clear blush was not visible (Figure 3A and Video S1). The finding was discussed with the thoracic surgeon, and it was decided to coil the distal LIMA to prevent a rebleed (Figure 3B and Video S2). Hereafter, the patient remained clinically stable. The next day, a CT thorax was repeated showing that the pericardial drain runs through the coils in the LIMA (Figure 4A-D) and the pleural effusion was largely resolved. The pericardial drain was removed, and on the sixteenth day postoperative, the chest tube in the pleural space could be removed.

2.2 | Outcome and follow-up

The patient had an uneventful rest of the hospital stay and was discharged to a home on the thirtieth day postoperative. At 2-month follow-up, the patient was doing well and echocardiography showed a good result of the valvuloplasty with no TR or MR.

3 | DISCUSSION

This report illustrates a case of pericardiocentesis via the subxiphoid approach complicated by an injury to the LIMA resulting in a hypovolemic shock due to a hemothorax in a postoperative cardiac surgery patient. Pericardial effusion is a common complication after adult cardiac surgery occurring in 50%-64% of cases and compromises cardiac function in 0.8%-6% requiring an intervention.[3] Delayed cardiac tamponade is uncommon and occurs more often after isolated valve operation, as opposed to coronary artery bypass grafting. Delayed tamponade tends to occur in younger patients and typically in the second to third postoperative week in patients who are aggressively anticoagulated. Our patient was treated with coumarins, and maximum INR was 1.60 in the days prior to the development of cardiac tamponade. The preferred treatment of delayed cardiac tamponade is percutaneous pericardiocentesis.

Pericardiocentesis via the subxiphoid approach is the most commonly used technique with the advantage of a decreased likelihood of laceration of the coronary and internal thoracic arteries.[4] It involves introducing the needle between the xiphoid process of the sternum and the left costal margin at an angle of 30-45 degrees, typically directed toward the left shoulder. In an emergency without access to ultrasound, a subxiphoid puncture is the safest approach. In contrast, it has the highest risk of liver injury, diaphragm and phrenic nerve irritation, and colonic and gastric injury. The apical approach involves introducing the needle in the intercostal space 1 cm lateral to the apical impulse angled toward the right shoulder. The pericardium is superficial at the cardiac apex bare area, where the pleura is usually absent, thus facilitating easier targeting. Because of the high risk of ventricular puncture and ventricular fibrillation, this approach should be avoided in emergency situations. The parasternal approach involves introducing the needle close to the sternum, usually in the left fifth intercostal space superior to the rib to avoid damage to

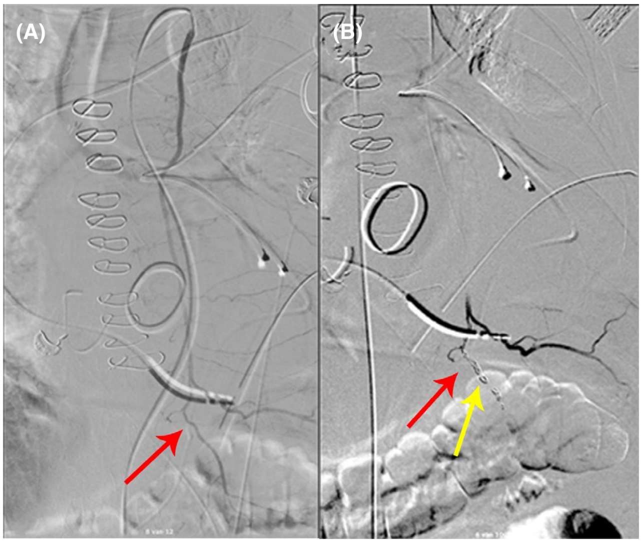

FIGURE 3 Angiography before (A) and after coiling (B) (yellow arrow) showing the distal LIMA crossing the pericardial drain (red arrow), a clear blush is not visible

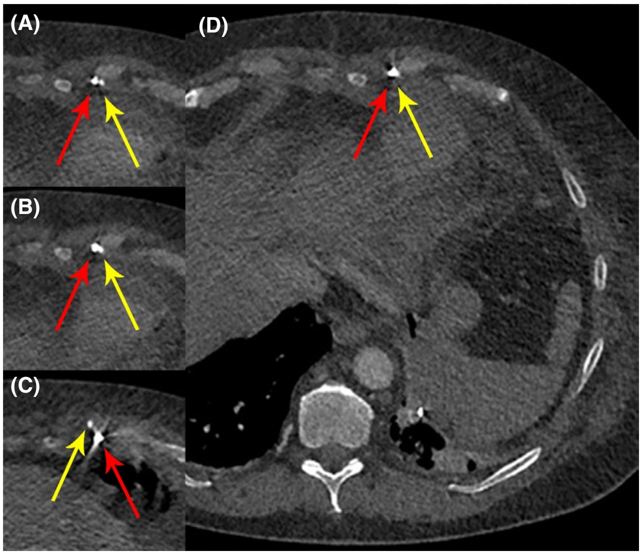

FIGURE 4 A-D: Chest CT showing pericardial drain (red arrow) ran through the distal part of the LIMA (yellow arrow) but well away from the pleural space

intercostal vessels and nerve. Echocardiography usually provides good visualization of the target. The risk of damaging the LIMA is high in this procedure as the artery runs 1 cm parallel to the sternum, but the parasternal approach avoids damage to the diaphragm and phrenic nerve. In addition, the risk of pneumothorax is generally higher when compared to the subxiphoid approach. In our case, pericardiocentesis via the subxiphoid approach was performed under fluoroscopy and ultrasound guidance by an experienced operator. Despite the patient being in cardiogenic shock, puncture of the pericardial space was easy. Hours after the pericardiocentesis, the patient was again in shock without signs of recurrence of cardiac tamponade at echocardiography. Unexpectedly, chest CTA revealed a clear relation between the drain and distal LIMA and the presence of pleural effusion suspicious for hemothorax as the cause for a hypovolemic shock. Although angiography of the LIMA did not show a clear blush, the relation between the drain and distal LIMA was confirmed, in particular during digital subtraction angiography and coiling procedure.

Blind pericardiocentesis is typically performed via a subxiphoid approach, and in order to reduce complications, ECG monitoring can be performed to protect against cardiac perforation to identify myocardial contact. An ECG-machine V-lead alligator clip can be attached to the base of the pericardiocentesis needle.[5] The development of PR-segment depression or ST-segment elevation suggests contact with the atrial or ventricular wall. Fluoroscopic-guided pericardiocentesis is also typically performed via a subxiphoid approach and by injection of iodinated contrast through the needle, pooling of contrast inferiorly can be observed when the pericardial space is reached. In contrast, rapid passage of contrast into adjacent cardiac structures is consistent with cardiac perforation. After advancement of a guidewire, fluoroscopic imaging should be performed in 2 orthogonal projections to verify that the wire is following an extracardiac course within the pericardium, rather than an intra-arterial course.

Echocardiography guidance improves procedural safety as appropriate site selection can increase procedural success.[1] Echocardiographic assessment of all potential pericardial access sites, including those distinct from the traditional subcostal window, allows identification and avoidance of adjacent structures. In order to minimize the risk of trauma to adjacent structures and cardiac perforation, pericardiocentesis should be performed at the site with the shortest distance from skin to pericardium and where the pericardial fluid is largest.[5] Moreover, when using the parasternal or apical approach, clear echocardiographic visualization of the pericardial space excludes intervening lung tissue as ultrasound beams are strongly reflected by air, thereby minimizing the risk of pneumothorax. Importantly, in an apical or parasternal approach it is important to puncture at the superior border of the rib, in order to avoid injury to the intercostal nerves running inferior to each rib. Echocardiographic confirmation of an intrapericardial position can be performed by injection of 10 mL agitated 0.9% saline through the needle.[1,5] Alternatively, injection of iodinated contrast through the needle can be performed under fluoroscopy as described above.

The LIMA branches off of the left subclavian artery and descends along the inner surface of the anterior chest wall. The LIMA is located around 1-2 cm lateral to the sternum on the left side giving off anterior intercostal arteries at each intercostal space and perforating cutaneous branches along the thorax. In general, the LIMA ends approximately at the sixth to seventh intercostal space as a bifurcation into the musculophrenic and superior epigastric arteries. The musculophrenic artery runs lateral and descends along the costal margin to supply the diaphragm and pericardium. The superior epigastric artery descends along the abdominal wall to connect with the inferior epigastric artery at the umbilicus. Anatomic variants of the terminal internal thoracic artery are reported. In a study evaluating 62 cadavers, a third terminal branch arising from the LIMA, a xiphoid branch, could be identified.[6] This branch was noted in 61.3% of the cadavers (30.7% on the right, 21% on the left, 9.7% on the bilateral presence). The xiphoid branch contributes to the supply to the lower sternal region. In our case, angiography did not show an evident xiphoid branch, and only after the distal LIMA was coiled, it was considered safe to remove the drain. Alternatively, surgical exploration could have been performed.

4 | CONCLUSION

This case highlights a rare complication of injury to the LIMA and subsequent hypovolemic shock due to a hemothorax following fluoroscopy and ultrasound-guided subxiphoid pericardiocentesis. In a postoperative cardiac surgery patients, awareness of the possibility of this potentially life-threatening complication is important.

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CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

AUTHOR CONTRIBUTION

Maurice AP Oudeman, R. Nils Planken, and Marcel AM Beijk: were involved in the preparation of the manuscript and have read the manuscript.

ETHICAL APPROVAL

For this clinical case report, no ethical approval was needed.

DATA AVAILABILITY STATEMENT

Data sharing not applicable – no new data generated.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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