Rare but Real: Tension Pneumopericardium in a Patient with a Left Ventricular Assist Device

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INTRODUCTION

There has been a growing trend in the United States toward increased left ventricular assist device (LVAD) implantation compared with cardiac transplantation.[1] With an ever increasing population of patients with heart failure requiring mechanical support, the wealth of knowledge regarding the nuances of appropriate candidate selection and management of the devices continues to grow. Commonly encountered complications associated with LVAD use include (but are not limited to) bleeding events, thromboembolic events, infections, right ventricular dysfunction, and aortic insufficiency. Other less commonly seen complications can arise, each with associated difficulty in diagnosis and treatment. The role of imaging, in particular echocardiography, has been well documented in the management of these complex patients.[2,3] In this case report, we present a unique case of diagnosis and treatment of tension pneumopericardium related to bowel perforation in an LVAD patient.

CASE PRESENTATION

A 72-year-old man underwent uncomplicated LVAD (HeartMate I; Thoratec, Pleasanton, CA) implantation for destination therapy. His postoperative course advanced in an uneventful fashion until postoperative day 10, when he received neostigmine for ileus and rectosigmoid distention. He subsequently became hypotensive, and during the evaluation, chest radiography demonstrated free air under the diaphragm. The patient was promptly taken to the operating room, where a jejunal perforation was noted and repaired. His abdomen was managed with the typical delayed primary closure following viscus perforation. On postoperative day 17, a routine film demonstrated a large pneumopericardium (Figure 1). A computed tomographic scan was performed to further define the extent and potential etiology of the pneumopericardium (Figure 2). No definitive source of air was identified, and at this point the patient was convalescing from prior surgical procedures and remained hemodynamically stable, so the pneumopericardium was conservatively managed.

The patient subsequently developed a *Clostridium difficile* infection and on postoperative day 21 experienced major gastrointestinal bleeding and underwent urgent sigmoidoscopy, revealing full-thickness necrosis of his colon. He was then taken back to the operating room for exploratory laparotomy. Intraoperative transesophageal echocardiography was performed during the laparotomy because of nearly persistent low-flow alarms from the LVAD and hypotension requiring high-dose epinephrine and norepinephrine.

Intraoperative transesophageal echocardiography demonstrated left atrial collapse with adjacent fluid and air in the pericardial space (Figure 3, Video 1). The left atrium appeared to be under external compression consistent with tamponade, with the free wall of the left atrium touching the aortic root in the midesophageal four-chamber view. The left ventricle was small and underfilled, consistent with the concurrent "low-flow" alarms the LVAD was signaling. Concerns that the findings were consistent with tamponade were balanced with concerns that the patient had sepsis and a distributive picture consistent with low arterial tone. He therefore underwent volume expansion with crystalloid and colloid fluids to improve intravascular volume. Despite additional resuscitation, the patient remained acidotic and hypotensive, requiring escalating doses of inotropic and pressor support despite maximal medical support.

Following a team discussion about the echocardiographic findings and the hemodynamic parameters measured from both the LVAD and invasive monitors, the idea of tension pneumopericardium was seriously entertained, and a decision was made to attempt to drain

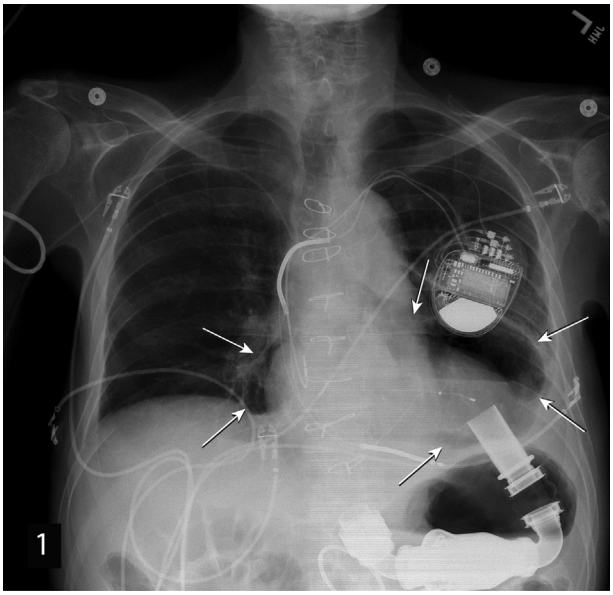

Figure 1 Portable (anteroposterior) chest radiograph demonstrating presence of pneumopericardium (*arrows*).

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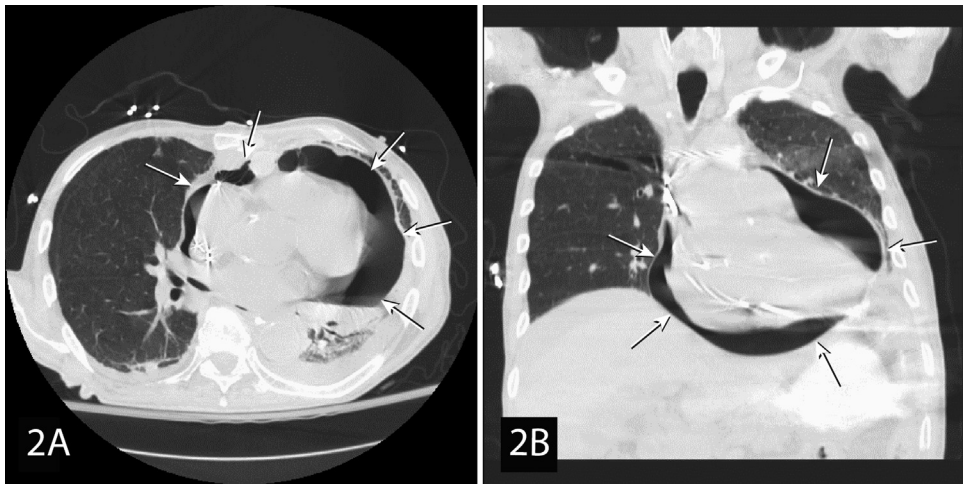

Figure 2 Chest computed tomographic image demonstrating presence of large pneumopericardium (*arrows*). **(A)** Axial plane image; **(B)** coronal plane computed tomographic image.

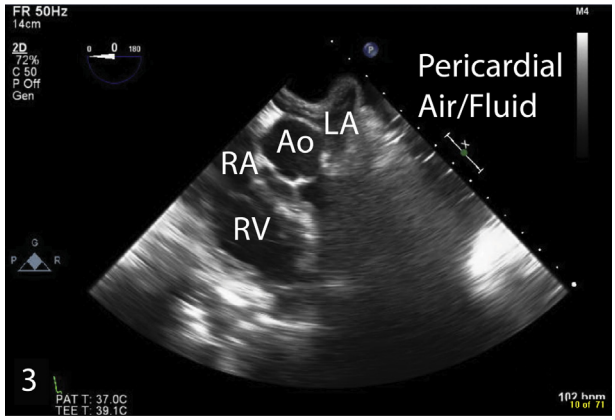

Figure 3 Transesophageal echocardiographic image of the midesophageal four-chamber view prior to decompression. Note the presence of the collection adjacent to the left atrium (LA), the collapse of the LA, and the inability to visualize the left ventricle. *Ao*, Aorta; *RA*, right atrium; *RV*, right ventricle.

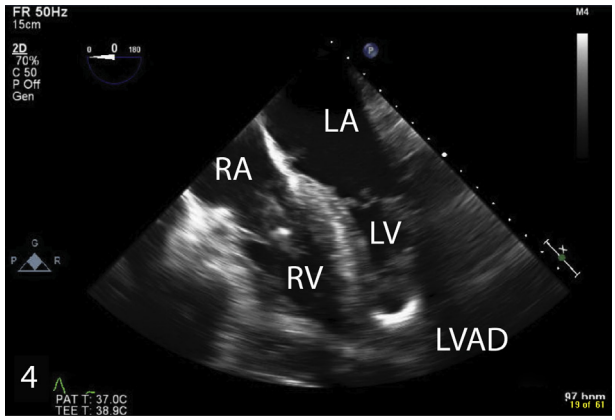

Figure 4 Transesophageal echocardiographic image of the midesophageal four-chamber view following decompression. Note the return of the left atrium (LA) to normal size, the ability to visualize the left ventricle (LV), and the reduction in the size of the pericardial collection. *RA*, Right atrium; *RV*, right ventricle.

the pericardial space. Using both transesophageal and transthoracic echocardiography to guide the location of access, an 18-gauge needle was passed into the pericardial space, with an immediate rush of air. Although some of the air persisted, there was immediate evidence of resolution of the tension physiology, with better filling of the left atrium and improvement of the hemodynamics (Figure 4, Video 1). The LVAD stopped alarming for low-flow conditions, and the inotropic requirements were decreased as the LVAD output increased, resulting in temporary hypertension. A sample of the fluid was sent for culture, which grew *Escherichia coli*, *Pseudomonas*, and *Enterococcus faecalis* consistent with enteric content contamination.

Although the patient did eventually succumb to complications associated with his underlying infection, the removal of the tension pneumopericardium and placement of a pericardial drain resulted in persistent relief from the hypotension and low-flow state he had been in before drainage.

DISCUSSION

Tension pneumopericardium is a rare but real phenomenon. It has been described in the literature in the setting of trauma or bronchopleural fistula, with a high mortality rate (50%), likely related to the severity of the underlying condition.[4,5] It is imperative to consider tension physiology early in any patient with pneumopericardium. Chest computed tomographic imaging is essential to demonstrate the extent of the pneumopericardium, while transesophageal echocardiography aids in establishing the degree of hemodynamic compromise. In our case, echocardiographic guidance was vital for aspiration of the air and to confirm resolution of tension physiology.

The proposed theory was that air was siphoned from the abdominal cavity up into the pericardium through the negative inspiratory pressure of the chest, similar to the propagation of a traumatic diaphragmatic hernia. Retrospective review of imaging demonstrated air within the left upper quadrant device pocket on the computed tomographic scan performed after initial chest radiography. The peritoneal space was entered during device pocket creation, and the enteric gas became loculated in that region (because of several prior abdominal explorations and perforations), until it was pressurized and driven up into the pericardium through the driveline tract.

Because the filling pressure within the left atrium is relatively low compared with various other intrathoracic pressures, and left atrial pressure is often reduced in the setting of LVAD mechanical support, it is theorized that this phenomenon would be much more difficult to occur outside of the setting of LVAD support. This technology has the opportunity to provide individuals with debilitating cardiac dysfunction another chance to live fulfilling lives, but as the number of LVAD implantations continues to soar, understanding and recognizing potential complications in this unique patient population is key to improving outcomes.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.case.2017.08.001.

REFERENCES

1. Lampropulos J, Kim N, Wang Y, Desai MM, Barreto-Filho JAS, Dodson JA, et al. Trends in left ventricular assist device use and outcomes among Medicare beneficiaries, 2004–2011. Open Heart 2014; 1:e000109.
2. Scalia GM, McCarthy PM, Savage RM, Smedira NG, Thomas JD. Clinical utility of echocardiography in the management of implantable ventricular assist devices. J Am Soc Echocardiogr 2000; 13:754-63.
3. Platts D, Sedgwick F, Burstow D, Mullany D. The role of echocardiography in the management of patients supported by extracorporeal membrane oxygenation. J Am Soc Echocardiogr 2012;25:131-41.
4. Lin WT, Hung CC, Tu CL, Chao CM. Blunt chest trauma associated with tension pneumopericardium. J Emerg Med 2016;50:672-3.
5. Levin AI, Visser F, Mattheyse F, Coetzee A. Tension pneumopericardium during positive pressure ventilation leading to cardiac arrest. J Cardiothorac Vasc Anesth 2008;22:879-82.