ESC European Society of Cardiology
European Heart Journal - Case Reports
doi:10.1093/ehjcr/ytaa485

CASE REPORT
Cardiac imaging

Aortic intervention guided by contrast-enhanced transoesophageal ultrasound whist waiting for cardiac transplantation: a case report

Mireya Castro Verdes[1,†], Xun Yuan [2,3,†], Wei Li [1,3], Roxy Senior[1,3], and Christoph A. Nienaber[2,3]*

[1]Imaging Department, Royal Brompton & Harefield NHS Foundation Trust, London SW3 6NP, UK; [2]Department of Cardiology and Aortic Centre, Royal Brompton and Harefield NHS Foundation Trust, Sydney Street, London SW36NP, UK; and [3]National Heart and Lung Institute, Faculty of Medicine, Imperial College London, Exhibition Road, South Kensington, London SW72BU, UK

Received 30 June 2020; first decision 28 September 2020; accepted 4 November 2020

Background Aortic complications can happen during left ventricular assist devices (LVADs) insertion and its treatment remains challenging. Percutaneous aortic interventions can be an alternative to surgery in such high-risk cases.

Case summary We present a patient with idiopatic dilated cardiomyopathy and advanced heart failure requiring LVAD insertion as a bridge to transplant, who developed an aortic pseudoaneurysm below the anastomosis of the LVAD tube. He was successfully treated with percutaneous coiling under contrast-enhanced transoesophageal echocardiography (TOE) guidance, reaching destination therapy (heart transplantation) a year later.

Discussion Left ventricular assist devices provide haemodynamic support for patients with advanced heart failure waiting for heart transplantation. Although uncommon, aortic complications can happen as a result of LVAD insertion and be life-threatening. Percutaneous aortic interventions can be performed in such cases to promote thrombosis and remodelling of false lumen or aneurysmatic spaces, hence potentially reducing the risk of sudden death. Contrast-enhanced TOE can be easily and safely used to monitor the intervention in order to improve anatomic definition, guide positioning of wires and catheters and assess early results.

Keywords Transoesophageal echocardiography • Contrast-enhanced ultrasound • Aortic percutaneous intervention • Left ventricular assist device • Case report

Learning points

- Life-threatening aortic complications can arise as a consequence of left ventricular assist device insertion.
- Percutaneous aortic interventions are a technically feasible alternative to surgery in high-risk cases.
- Contrast-enhanced transoesophageal echocardiography is helpful and safe in monitoring percutaneous aortic interventions.

* Corresponding author. Tel: +44 02073528121, Email: C.Nienaber@rbht.nhs.uk
† These authors contributed equally to this work.
Handling Editor: Belinda Grey
Peer-reviewers: Hugow Rodríguez-Zanella and Eftychia Galiatsou
Compliance Editor: Rahul Mukherjee
Supplementary Material Editor: Cassilios Parisis Memtsas

Introduction

Heart transplantation for treatment of advanced heart failure is limited by the shortage of donors. Patients are listed to wait for long periods of time, at risk of clinical deterioration and death before transplantation. Implantable left ventricular assist devices (LVADs) provide haemodynamic support for patients waiting for heart transplantation (bridge to transplant) or as destination therapy. They provide better survival than medical therapy alone.[1] However, with increased use of LVADs, potential life-threatening complications have emerged,[2] including traumatic damage to the aorta.[3]

We present a case of a patient with advanced heart failure who developed an ascending aorta pseudoaneurysm at the aortic insertion site of the LVAD tube and was managed successfully with percutaneous embolization of the pseudoaneurysm. The intervention was performed under fluoroscopy and contrast-enhance transoesophageal echocardiography (TOE) guidance.

Timeline

Time	Clinical management
17 February 2017	Implant of cardiac resynchronization therapy defibrillator for severe left ventricular dysfunction despite medical therapy
10 July 2018	Left ventricular assist device implanted for advanced heart failure and listed for heart transplantation
18 January 2019	A localized pseudoaneurysm at ascending aorta was detected by a follow-up computed tomography
1 February 2019	Aortic intervention (coiling pseudoaneurysm) was performed after multidisciplinary meeting (MDT) discussion
28 February 2020	Orthotopic cardiac transplantation

Case presentation

A 50-year-old patient with advanced heart failure due to congestive, idiopathic dilated cardiomyopathy with severe biventricular dysfunction, previously on cardiac resynchronization and defibrillator therapy (CRT-D), underwent implantation of an LVAD as a bridge to transplant. Routine computed tomography (CT) performed 6 months post-LVAD insertion revealed aortic haematoma and a false aneurysm located 24 mm inferior to the anastomosis with the LVAD tube. Thus, the aortic lesion was considered iatrogenic, appearing as localized aortic dissection with a single entry tear. Since the patient was haemodynamically stable with the LVAD and under warfarin therapy (INR target range 2.5–3.5), the time until cardiac transplantation was difficult to predict as was the risk of rupture of the iatrogenic false aortic aneurysm under anticoagulation. In addition, surgical risk was deemed prohibitive. Therefore, catheter-based management of the false aneurysm was recommended to stabilize the expanding pseudoaneurysm and buy time until transplantation. The patient was then transferred to our centre and underwent successful percutaneous coiling of the false aneurysm, avoiding exposure of the sac to the constant non-fluctuating blood pressure.

Under general anaesthesia for patient comfort and with percutaneous access via the left femoral artery, a 6F right coronary diagnostic catheter (JR 4.0 Cordis®) was used to navigate the entry to the false lumen. Based on the angiographic appearance of the false lumen, six coils (three spiralling 15 × 15 mm and three spiralling 5 × 5 mm, MReye® Cook® Medical) were carefully advanced through the catheter and placed in the aneurysmal space and induced thrombosis.[4] The procedure was guided not only by fluoroscopy, but primarily by TOE. In particular, TOE was instrumental to visualize the space to be coiled and to verify the successful completion of the coiling procedure. The additional use of contrast-enhanced ultrasound (SonoVue®, Bracco, Milan, Italy) injected via a 5F pigtail catheter placed in the aortic root via radial access could demonstrate complete obliteration of the aneurysmal space. No leak was present immediately post-intervention on TOE (*Figure 1*) or fluoroscopy (*Figure 2*).

The patient was continued on heparin to avoid LVAD thrombosis, which may have facilitated the re-appearance of a small reperfusion leak that was noted in a pre-discharge CT done 6 days after the procedure. Conservative management of this leak was accepted, given the fact that it was small and coils were placed to the capacity of the aneurysmatic volume to avoid further progression of it. Surveillance CT angiography 6 months of post-intervention confirmed further regression of the pseudoaneurysm (*Figure 3*). The patient finally underwent cardiac transplantation 12 months after coiling and was discharged home.

Discussion

Percutaneous interventions to the thoracic aorta offer an attractive alternative to surgery in selected cases and in presence of suitable anatomy. For instance, thoracic endovascular aortic repair in complicated type B aortic dissection or descending thoracic aorta aneurysm, and stenting of co-arctation, are currently consolidated procedures even preferable to surgery in many circumstances.[5]

Most recently, new transcatheter interventions have been developed to target patency of the false lumen in aortic dissections, given the relationship between its expansion and the risk of rupture.[6] In this context, our group has previously described our experience with the FLIRT concept (false lumen intervention to promote remodelling and thrombosis),[4] which has been developed as an alternative to open surgical repair in cases of either prohibitive surgical risk (as this case) or palliative care as the only other option. Coils, occluders, and sometimes glue can be instrumental to induce false lumen thrombosis and close the communication between true and false lumen, which in turn favours aortic remodelling and potentially decreases the risk of fatal complications.

During such interventions, TOE provides real-time, high-resolution imaging of native anatomy, guides positioning of wires and catheters, and may rule out early complications. Its added value as intraoperative monitoring tool has also been described in percutaneous aortic interventions in the descending thoracic aorta,[7] although the incremental information may be even more relevant in the

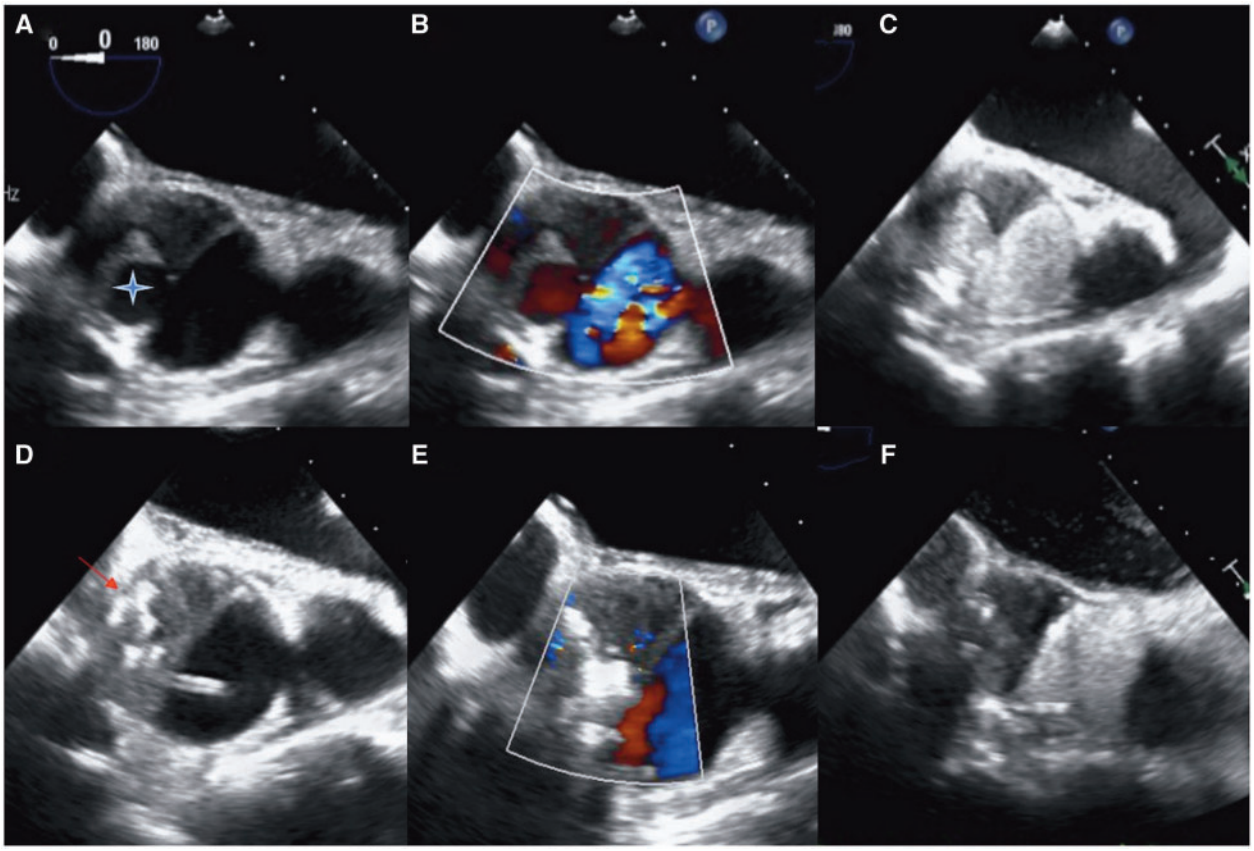

Figure 1 Intraoperative transoesophageal echocardiography: modified mid-oesophageal five-chamber view demonstrating entry point (star) in two dimensions (*A*), colour Doppler flow (*B*), and contrast opacification (*C*). A wire is entering the false lumen from the true lumen in contrast images (*C*). Coils (red arrow) and induced thrombosis in false lumen with wire seen inside the true lumen (*D*). No residual flow communicating with the false lumen seen by colour Doppler flow (*E*) or contrast opacification (*F*) post-procedure.

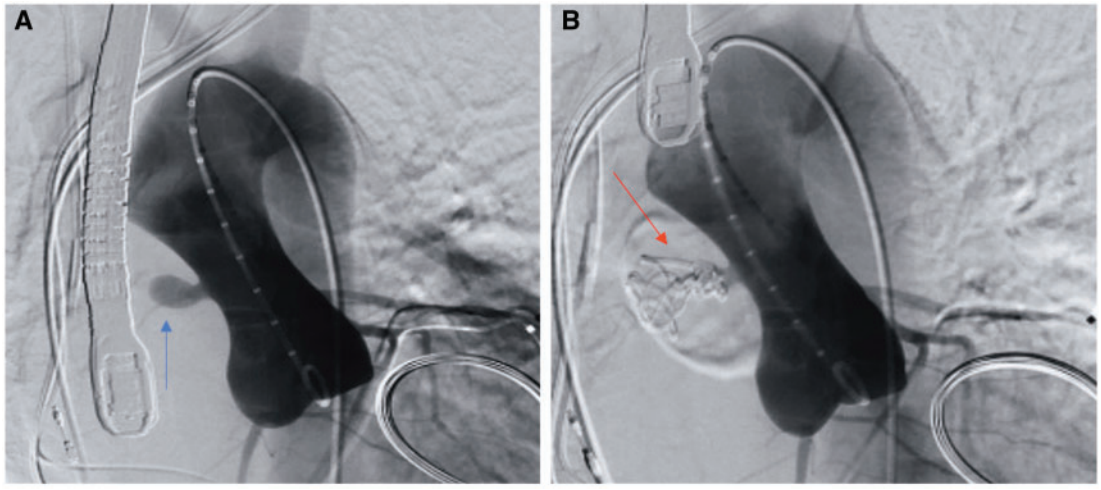

Figure 2 Aortic angiography. Note extravasation of contrast to false aneurysm (blue arrow) pre-intervention (*A*). Post-intervention (*B*), the false aneurysm has been filled in with coils (red arrow) and there is no residual leak.

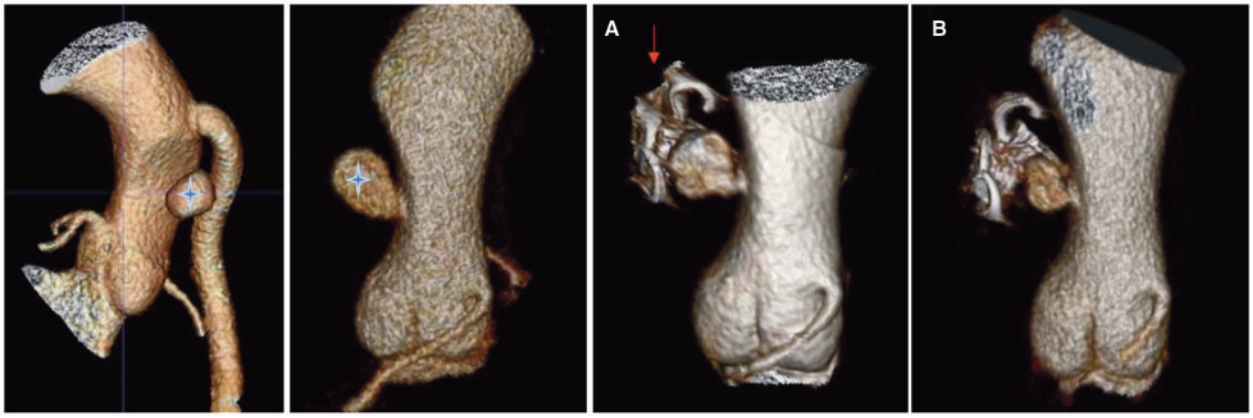

Figure 3 Computed tomography 3D reconstructions. Pre-intervention study showing pseudoaneurysm (star) on the right-hand side of the proximal ascending aorta wall, below the left ventricular assist device tube anastomosis, measuring 18 × 15 mm (*A* and *B*). Follow-up computed tomography performed 3 months later showing coils *in situ* (arrow) and small residual leak, with overall size of residual cavity reduced to 14 × 6 mm (*C*). Follow-up computed tomography at 6 months demonstrating further reduction of the pseudoaneurysm to 10 × 9 mm (*D*). 3D, three dimensions; CT, computed tomography; LVAD, left ventricular assist device.

proximal ascending aorta, as in this case. The unique role of TOE even in detecting aortic complications in patients undergoing LVAD insertion has also been described[3,8] and its use is currently recommended in the perioperative period and whenever complications are suspected.[9]

In concert with TOE, ultrasonic contrast agents further enhance visualization of cardiac structures and improve diagnostic accuracy, with an excellent safety profile. This is particularly relevant with a suboptimal acoustic window and when detailed definition of anatomy is needed[10] for optimal management.[11,12] For our case, contrast-enhanced ultrasound was extremely helpful to identify the communication between the true and false lumen and instrumental to confirm thrombosis of the aneurysmal space once the coils had been deployed. Colour Doppler alone is limited by the appearance of artefacts when a low Nyquist scale is used to assess slow residual flow, as likely present in the described case.

This challenging case demonstrates complications on the waiting list for transplantation with possible solutions for such an iatrogenic aortic problem. Moreover, the incremental information gained from contrast-enhanced TOE to guide such percutaneous aortic interventions is evident, as real-time imaging has shown potential to document successful coiling of a false aneurysm that constitutes a significant threat for deadly bleeding under warfarin and on LVAD. Interventional coiling of the false aneurysm seems to be safer under contrast-enhanced TOE guidance and led to obliteration of the false aneurysmal space with no further progression. Ultrasound contrast agent (SonoVue®) was very useful to confirm the result and minimize the need for nephrotoxic contrast media (particularly in this case with compromised renal function).

Lead author biography

Dr Mireya Castro Verdes graduated with honours from the University of Santiago de Compostela, Spain, in 2010. She successfully completed the Spanish National Training in Cardiology in 2016 from the University Hospital Alvaro Cunqueiro of Vigo, Spain. She is currently a fellow in paediatric cardiology at the Royal Brompton Hospital in London, where she is developing her career in imaging and congenital heart disease. She previously trained in peri-interventional echocardiography, including TOE, and echocardiography in critical care.

Supplementary material

Supplementary material is available at *European Heart Journal – Case Reports* online.

Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: The authors confirm that consent for submission and publication of this case report including image(s) and associated text has been obtained from thepatients in line with COPE guidance.

Conflict of interest: None of the author has conflict of interest to declare.

Funding: none declared.

References

1. Li X, Kondray V, Tavri S, Ruhparwar A, Azeze S, Dey A et al. Role of imaging in diagnosis and management of left ventricular assist device complications. *Int J Cardiovasc Imaging* 2019;**35**:1365–1377.
2. Birks EJ, Tansley PD, Yacoub MH, Bowles CT, Hipkin M, Hardy J et al. Incidence and clinical management of life-threatening left ventricular assist device failure. *J Heart Lung Transplant* 2004;**23**:964–969.
3. Lacroix V, d'Udekem Y, Jacquet L, Noirhomme P. Resection of the ascending aorta and aortic valve patch closure for type A aortic dissection after Novacor LVAD insertion. *Eur J Cardiothorac Surg* 2003;**24**:309–311.
4. Yuan X, Mitsis A, Semple T, Castro Verdes M, Cambronero-Cortinas E, Tang Y et al. False lumen intervention to promote remodelling and thrombosis—the FLIRT concept in aortic dissection. *Catheter Cardiovasc Interv* 2018;**92**: 732–740.
5. Erbel R, Aboyans V, Boileau C, Bossone E, Bartolomeo RD, Eggebrecht H et al. ESC Committee for Practice Guidelines. 2014 ESC Guidelines on the diagnosis and treatment of aortic diseases: document covering acute and chronic aortic diseases of the thoracic and abdominal aorta of the adult. The Task Force for the Diagnosis and Treatment of Aortic Diseases of the European Society of Cardiology (ESC). *Eur Heart J* 2014;**35**:2873–2926.
6. Evangelista A, Salas A, Ribera A, Ferreira-González I, Cuellar H, Pineda V et al. Long-term outcome of aortic dissection with patent false lumen: predictive role of entry tear size and location. *Circulation* 2012;**125**: 3133–3141.
7. Koschyk DH, Nienaber CA, Knap M, Hofmann T, Kodolitsch YV, Skriabina V et al. How to guide stent-graft implantation in type B aortic dissection? Comparison of angiography, transesophageal echocardiography, and intravascular ultrasound. *Circulation* 2005;**112**(9 Suppl):I260–I264.
8. Nicolson DG, Porto I, Westaby S, Boardman P, Banning AP. Spontaneous echocardiographic contrast in the ascending aorta mimicking the appearance of aortic dissection in a patient with a left ventricular assist device. *Echocardiography* 2004; **21**:193–195.
9. Chumnanvej S, Wood MJ, MacGillivray TE, Melo MF. Perioperative echocardiographic examination for ventricular assist device implantation. *Anesth Analg* 2007; **105**:583–601.
10. Senior R, Becher H, Monaghan M, Agati L, Zamorano J, Vanoverschelde JL, EACVI Scientific Documents Committee for 2014–16 and 2016–18; EACVI Scientific Documents Committee for 2014–16 and 2016–18 et al. Clinical practice of contrast echocardiography: recommendation by the European Association of Cardiovascular Imaging (EACVI) 2017. *Eur Heart J Cardiovasc Imaging* 2017;**18**:1205–1205af.
11. Evangelista A, Avegliano G, Aguilar R, Cuellar H, Igual A, Gonzalez-Alujas T et al. Impact of contrast-enhanced echocardiography on the diagnostic algorithm of acute aortic dissection. *Eur Heart J* 2010;**31**:472–479.
12. Agricola E, Slavich M, Rinaldi E, Bertoglio L, Civilini E, Melissano G et al. Usefulness of contrast-enhanced transoesophageal echocardiography to guide thoracic endovascular aortic repair procedure. *Eur Heart J Cardiovasc Imaging* 2016;**17**:67–75.