

Percutaneous closure of accidental left atrium puncture: a case report

Gustavo Sá Mendes^{1*}, Pedro De Araújo Gonçalves^{1,2}, Sérgio Madeira¹, and Paulo Oliveira³

¹Cardiology Department, Hospital de Santa Cruz, Centro Hospitalar de Lisboa Ocidental, Av. Prof. Dr Reinaldo dos Santos, Carnaxide 2790-134, Portugal; ²Nova Medical School, Campo Mártires da Pátria 130, 1169-056 Lisboa, Portugal; and ³Cardiothoracic Surgery Department, Hospital de Santa Cruz, Centro Hospitalar de Lisboa Ocidental, Av. Prof. Dr Reinaldo dos Santos, Carnaxide 2790-134, Portugal

Received 12 February 2020; first decision 13 March 2020; accepted 5 June 2020; online publish-ahead-of-print 23 August 2020

Background

Minimally invasive alternatives to surgical closure of cardiac perforations are a recognized need, especially in critically ill patients in whom predicted surgical mortality is prohibitive. To the best of our knowledge, this is the first reported case of an iatrogenic left atrium (LA) puncture closed with a plug-based vascular closure device (VCD).

Case summary

During a palliative right-sided thoracentesis on a 73-year-old woman, with end-stage heart failure due to rheumatic valvular heart disease, an accidental puncture and insertion of a central venous catheter into an aneurysmatic LA occurred. This complication was successfully managed percutaneously, under transthoracic echocardiographic guidance, after cardiac computed tomography planning, using a plug-based VCD.

Discussion

This case demonstrates the possible utility of plug-based devices for iatrogenic LA perforation closure, when surgical risk is deemed prohibitive.

Keywords

Left atrium puncture • Vascular closure device • Thoracentesis • Case report

Learning points

- Less invasive alternatives for the management of cardiac punctures in high-risk patients should be an option.
- Vascular closure devices, when possible, can be a successful and safe alternative for heart chambers perforations.

Introduction

There is a recognized need for less invasive alternatives to overcome the high mortality associated with surgical closure of cardiac perforations in high-risk patients. Several non-surgical approaches, namely percutaneous techniques using Angio-Seal[®],^{1–4} fibrin glue,⁵ Amplatzer[™]⁶ devices, and expectant management⁷ have been

recently reported as compassionate treatments. Moreover, these may be a reasonable option as bridge to surgery in patients who are at risk of sudden haemodynamic collapse.

Here, we report the first case, in literature, of percutaneous closure of an accidental iatrogenic left atrium (LA) perforation with a vascular closure device (VCD).

*Corresponding author. Tel: +351 968815206, Email: gustavo.samendes@gmail.com

Handling Editor: Luigi Biasco

Peer-reviewers: Andras Janosi and Alessia Azzano

Compliance Editor: Christian Fielder Camm

Supplementary Material Editor: Ross Thomson

© The Author(s) 2020. Published by Oxford University Press on behalf of the European Society of Cardiology.

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited. For commercial re-use, please contact journals.permissions@oup.com

Timeline

Time	Events
1984	Rheumatic valvular heart disease diagnosis: severe mitral stenosis and moderate aortic stenosis
1986	Implantation of a mitral and aortic mechanical prosthesis
2012	New York Heart Association (NYHA) Class II symptoms owing to pannus of aortic mechanical prosthesis
2015	NYHA Class III symptoms and transprosthetic aortic mean gradient of 34 mmHg Refused for surgery due to a high surgical risk score (EuroSCORE II 14%)
2015–2019	Two hospitalizations for congestive heart failure (HF) managed with intravenous diuretics
2019 July	Hospitalization for congestive HF, refractory to intravenous diuretics, with severe dyspnoea and large pleural effusion iatrogenic left atrium (LA) perforation during thoracentesis, for symptomatic relief Successful percutaneous closure of LA accidental puncture with a vascular closure device

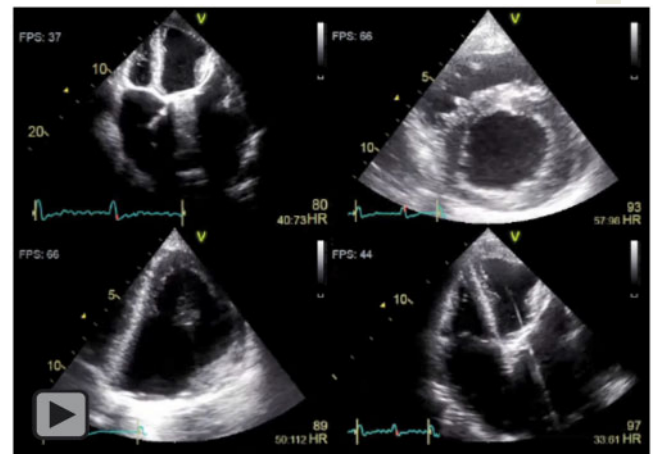
Case presentation

A 73-year-old woman patient with long-standing combined mitral and aortic mechanical prosthesis due to rheumatic valvular heart disease was admitted to our centre for heart failure (HF). Her past medical history was remarkable for type 2 diabetes mellitus, hypertension, permanent atrial fibrillation, type II pulmonary hypertension, cardiac cirrhosis, and haematologic disorder [anaemia (baseline haemoglobin 10 g/dL) and leukopenia]. Since 2012, HF progressively ensued related to aortic prosthetic valve dysfunction, secondary to pannus. In 2015, she was refused for surgery for prohibitively high expected surgical risk (EuroSCORE II 14%), anatomic complexity, comorbidities, and frailty.

On July 2019, she was admitted for acute HF, with dyspnoea at rest, orthopnoea, signs of pulmonary congestion at physical examination and had a systolic blood pressure of ~100 mmHg and irregular tachycardia (~110 b.p.m.). Chest X-ray, also, revealing an extensive bilateral pleural effusion (Figure 1). Previously to admission, she was medicated with furosemide 40 mg bid, spironolactone 50 mg id, metolazone 5 mg three times per week, valsartan 80 mg id, warfarin, digoxin 0.125 mg id, and oral antidiabetic drugs. Transthoracic echocardiography (TTE) showed a left ventricle ejection fraction of 52% (calculated by modified Simpson's rule) (Video 1), a mean aortic prosthesis' gradient of 40 mmHg, an aortic valve velocity ratio of 0.18, and an aneurysmatic LA (indexed LA volume of 688 mL/m²) (Figure 2). Despite increasing doses of intravenous diuretics (maximum furosemide infusion: furosemide 24 mg/h), there was no clinical



Figure 1 Chest X-ray with cardiomegaly and extensive bilateral pleural effusion.



Video 1 Baseline transthoracic echocardiography at admission: four-chamber view; axial view at papillary muscle level; left ventricle focused view; right ventricle focused view.

improvement, impending respiratory failure ensued and the patient was started on non-invasive ventilation, within 48 h. Accordingly, a right-sided therapeutic thoracentesis, for symptomatic relief, was planned and performed by a cardiothoracic surgeon, after the patient had consented.

A 6 Fr single lumen venous central catheter was inserted in the mid-axillary line into the sixth right intercostal space, under ultrasound guidance using Seldinger technique. After an initial 900 mL of haematic fluid drainage, the patient became diaphoretic, with gradual hypotension and tachycardia. Transthoracic echocardiography with

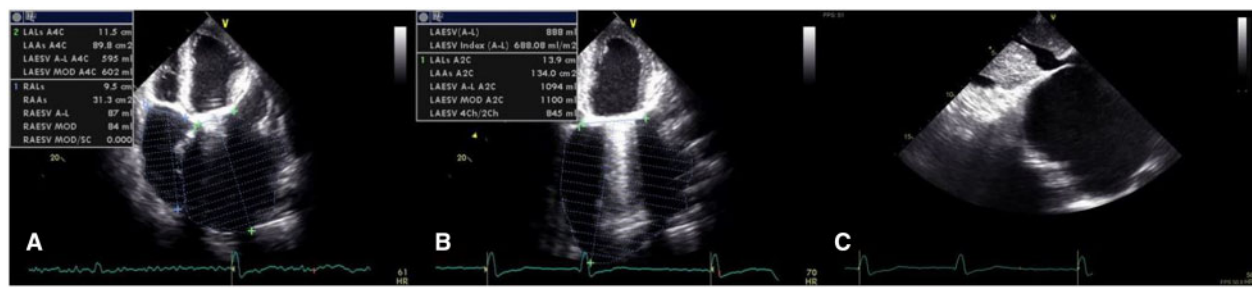


Figure 2 Measurement of left atrium volume from biplane method of discs (modified Simpson's rule) using apical four-chamber (A) and apical two-chamber (B) views at maximum volume; subcostal view of aneurysmatic left atrium, right atrium, and inferior vena cava (C).

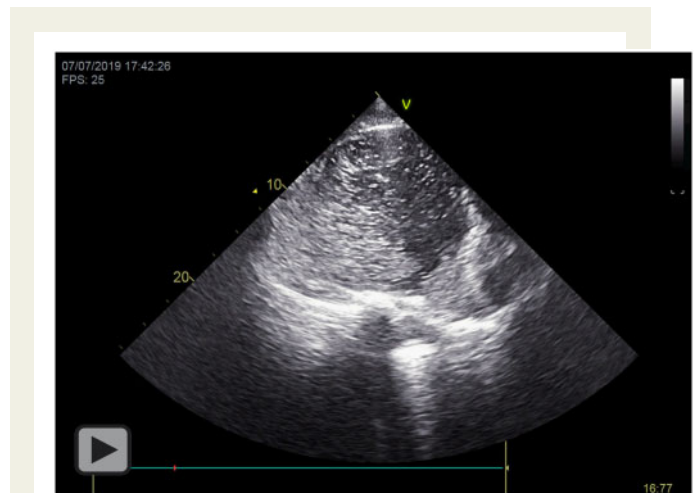
agitated saline contrast injection through the catheter unveiled LA perforation (Video 2). Invasive ventilation was required for haemodynamic and respiratory stabilization and intravenous fluid replacement was initiated. Auto-transfusion of the aspirated blood was performed and on-going oral anticoagulation was neutralized with prothrombin complex [International Normalized Ratio (INR) value before thoracentesis was 2.2].

Cardiac computed tomography (CT) confirmed the aneurysmatic LA (maximum LA volume: 1107 mL) and revealed the close proximity of the LA wall with the right thoracic chest wall (21 mm) (Figure 3). Multidisciplinary team discussion, with interventional cardiologists and clinical cardiologists, cardiac surgeons, and anaesthetists deemed the patient at high surgical risk, and it was decided to perform a percutaneous LA closure with off-label use of the Angio-Seal[®] VCD, with on-site surgical backup.

A short 0.035 guide-wire was advanced through the thoracentesis drain into the LA and the sheath was removed. An 8 Fr Angio-Seal[®] closure device was inserted over the guide-wire and anchored in the LA with the standard technique, under TTE guidance. Thereafter, the collagen plug was successfully deployed, allowing complete perforation closure. Other than guiding the procedure, TTE was paramount to avoid any interaction with mechanical mitral prosthesis, to confirm adequate device positioning and the lack of residual flow by colour Doppler analysis, at the site of LA puncture. Serial TTEs (Video 3) over the following hours and cardiac CT after 7 days (Figure 4) confirmed the sustained correct positioning of the device with minimal residual pericardial effusion, despite of anticoagulation with adjusted unfractionated heparin to prevent mitral thrombosis. Patient's haemodynamic improvement pursued and inotropes were weaned off. However, weaning from mechanical ventilation was not possible given the previous advanced health condition, clinical status progressively deteriorate and the patient died due to sepsis, 11 days after the Angio-Seal[®] closure.

Discussion

Congestive HF is currently the main cause of pleural effusion.⁸ Persistent moderate or severe pleural effusion has been shown to be associated with increased morbidity and mortality. Thoracentesis is performed for either diagnostic and/or therapeutic purposes.



Video 2 Agitated saline transthoracic echocardiography testing confirming the left atrium perforation.

Palliative thoracentesis is advocated for extensive pleural effusions in terminal HF, mainly for quality-of-life improvement and effective symptomatic relief in end-of-life care.

Complications of thoracentesis are seldom observed. Bleeding (including haemothorax) has been reported in approximately ~0–2% of patients undergoing thoracentesis with uncorrected coagulation.⁹ Cardiac injury during chest drain placement is even rarer, but catastrophic complication, with only 10 cases being reported to date.^{10,11} Most of these were related to anatomic distortion, as in post-pneumectomy, extreme kyphoscoliosis, and cardiomegaly. Similarly, to these previous reports, our patient had marked cardiomegaly due to an aneurysmatic LA and passive lung atelectasis. In complex cases such as this, CT-guided thoracentesis, in addition to TTE control during the procedure, should probably be proposed beforehand as a means to avoid iatrogenic punctures.

To the best of our knowledge, this is the second case in the literature of LA iatrogenic perforation during chest drainage¹² and the first case of successful percutaneous closure with a VCD of LA.

Iatrogenic cardiac perforation is potentially fatal complication. Cardiac perforation may complicate with cardiac tamponade, requiring emergent pericardial drainage or surgery with repair of the defect

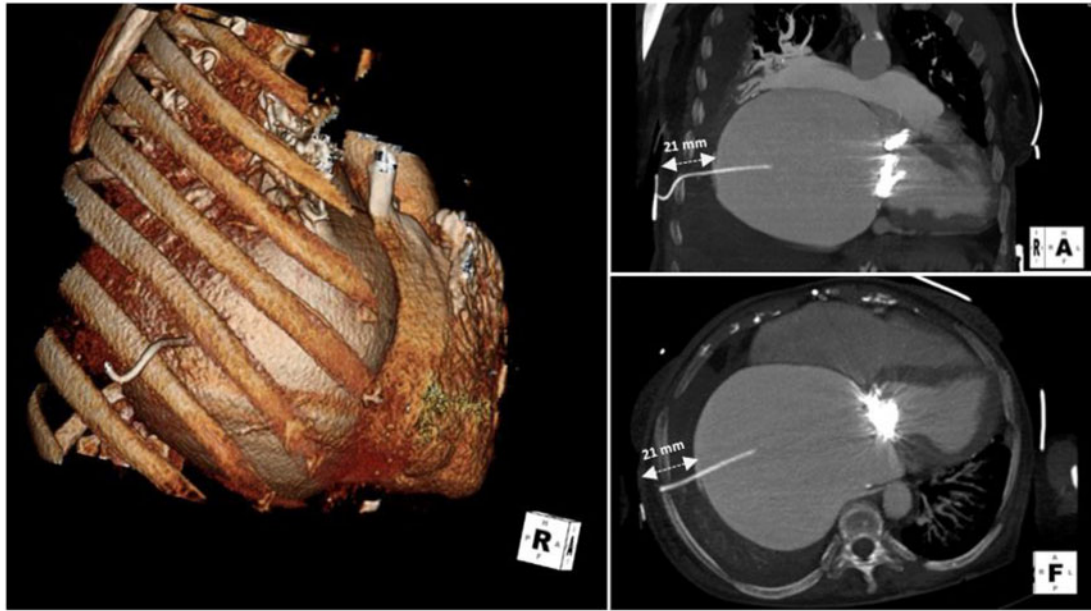


Figure 3 Cardiac computed tomography was essential for the precise planning of the percutaneous procedure confirming the volume size of the left atrium and the distance between thoracic chest wall and left atrium wall (21 mm).



Video 3 Transthoracic echocardiography showing the correct position of the plug device into the left atrium wall, with no pericardial effusion increase after 2 h of the procedure.



Figure 4 Cardiac computed tomography 7 days after the deployment of the Angio-Seal[®].

as standard-of-care. However, pericardiocentesis is not a definitive solution when heart perforation occurs by venous catheters, with a mortality rate approaching 62%.² Similarly, the surgery may not be an acceptable option for high-risk surgical patients, in whom mortality rate has been reported to be as high as 85%.² Minimally invasive procedures could mitigate such high mortality.

Vascular closure device is a proven alternative to mechanical femoral compression after endovascular procedures. Their off-label use

is rather uncommon and usually restricted for atypical vascular sites.^{13–15} Recently, successful use of these devices in right heart punctures (atrium and ventricle) were reported.^{1–4} However, to the best of our knowledge, left chamber closure has not been performed. Indeed, approach to the left chambers are predictively more challenging, given the higher filling and downstream pressures.⁴

Angio-seal[®] VCD consists of a resorbable anchor (tethered by a polymer filament) which is placed in the intravascular compartment,

over which a collagen plug is applied, resting in the extravascular space. When closing the cardiac perforation, the resorbable anchor is released inside the cardiac chamber and the collagen plug remains on the heart's surface.¹⁶ In this case, the measurements and the anatomical relationships revealed by cardiac CT were crucial for multidisciplinary decision and allow the precise planning of the successful percutaneous closure.

In summary, this case suggests that LA perforation closure using a percutaneous device is a feasible and safe procedure, which may constitute a reasonable approach in critical patients.

Lead author biography



Dr Sá Mendes Gustavo is a resident of Cardiology in Hospital Santa Cruz, Portugal. He graduated from the Nova Medical School in 2015. He has a keen interest in Cardiac Intervention.

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 author/s confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: none declared.

References

1. Chadha DS, Kumar JR, Mishra SC, Jhamb D. Percutaneous closure of accidental iatrogenic right atrial perforation. *IHJ Cardiovasc Case Rep* 2018;**2**:184–186.
2. Petrov I, Dimitrov C. Closing of a right ventricle perforation with a vascular closure device. *Catheter Cardiovasc Interv* 2009;**74**:247–250.
3. Pourdjabbar A, Hibbert B, Hendry P, Labinaz M. Angio-Seal closure of an iatrogenic right ventricular perforation. *Clin Res Cardiol* 2014;**103**:577–579.
4. Bakos Z, Harnek J, Jenkins N, Johnson T, Strange J, Asimakopoulos G et al. How should I treat an accidentally misplaced 8 Fr drainage catheter in the right ventricle? *EuroIntervention* 2014;**10**:768–770.
5. Arai H, Miyamoto T, Hara N, Obayashi T. Haemostasis with fibrin glue injection into the pericardial space for right ventricular perforation caused by an iatrogenic procedural complication. *BMJ Case Rep* 2016;**2016**:1–4.
6. Stolt V, Cook S, Räber L, Wani S, Garachamani A, Vogel R et al. Amplatzer Septal Occluder to treat iatrogenic cardiac perforations. *Catheter Cardiovasc Interv* 2012;**79**:263–270.
7. Ari H, Karakuş A, Ari S, Çamcı S, Melek M. An alternative treatment for iatrogenic right ventricular puncture in primary percutaneous intervention. *Turk Kardiyol Dern Ars* 2017;**45**:638–640.
8. Ault MJ, Rosen BT, Scher J, Feinglass J, Barsuk JH. Thoracentesis outcomes: a 12-year experience. *Thorax* 2015;**70**:127–132.
9. Cantey EP, Walter JM, Corbridge T, Barsuk JH. Complications of thoracentesis: incidence, risk factors, and strategies for prevention. *Curr Opin Pulm Med* 2016;**22**:378–385.
10. Chaim F, Medical S, Aviv T. Another complication of thoracostomy-perforation of the right atrium. *Chest* 1990;**98**:772–773.
11. Goltz JP, Gorski A, Böhler J, Kickuth R, Hahn D, Ritter CO. Iatrogenic perforation of the left heart during placement of a chest drain. *Diagn Interv Radiol* 2011;**17**:229–231.
12. Kerger H, Blaettner T, Froehlich C, Ernst J, Frietsch T, Isselhorst C. Perforation of the left atrium by a chest tube in a patient with cardiomegaly; management of a rare, but life-threatening complication. *Resuscitation* 2007;**74**:178–182.
13. Abbas M, Hamilton M, Yayha M, Angel D, Mwipatayi BP, Sieunarine K. A simple method of closing an iatrogenic subclavian arterial puncture. *Indian J Surg* 2004;**66**:356–358.
14. Hatfield MK, Zaleski GX, Kozlov D, Woo T, Gentile E, Sinnen J. Angio-Seal device used for hemostasis in the descending aorta. *AJR Am J Roentgenol* 2004;**183**:612–614.
15. Lupattelli T, Clerissi J, Clerici G, Minnella DP, Casini A, Losa S. The efficacy and safety of closure of brachial access using the AngioSeal closure device: experience with 161 interventions in diabetic patients with critical limb ischemia. *J Vasc Surg* 2008;**47**:782–788.
16. Krishnasamy VP, Hagar MJ, Scher DJ, Sanogo ML, Gabriel GE, Sarin SN. Vascular closure devices: technical tips, complications, and management. *Tech Vasc Interv Radiol* 2015;**18**:100–112.