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CASE REPORT
Coronary heart disease

Percutaneous closure of an iatrogenic right ventricular perforation with an angio-seal vascular closure device: a case report

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Background Iatrogenic perforation of the right ventricle (RV) is a rare but recognized complication of pericardiocentesis. Treatment strategies for RV perforation include surgical repair and percutaneous closure. In this case report, we describe the use of an angio-seal vascular closure device (Terumo Interventional Systems) to seal an iatrogenic RV perforation secondary to incorrect placement of a pericardial drain.

Case summary A 55-year-old female presented with an anterior ST-elevation myocardial infarction. Coronary angiography demonstrated occlusion of the left anterior descending artery. The patient went on to have primary percutaneous coronary intervention and both the left anterior descending and D1 were wired. During kissing balloon inflation, the Sion Blue wire migrated distally in the D1 causing an Ellis type 3 wire tip perforation in the distal D1. Emergency pericardiocentesis was performed however the 8 French (8 Fr) pericardial drain was inadvertently inserted into the RV. It was decided to attempt percutaneous closure with an 8 Fr angio-seal in the catheter lab under echocardiographic and fluoroscopic guidance. Our patient did not demonstrate any recurrence of pericardial effusion on repeat echocardiography over 60 days post-procedure.

Discussion Our patient did not demonstrate any recurrence of pericardial effusion on repeat echocardiography over 60 days post-procedure. We feel that the angio-seal vascular closure device represents an effective, minimally invasive treatment for this rare but potentially catastrophic complication of pericardiocentesis. In this case, the technique spared our patient a sternotomy with its associated morbidity.

Keywords Case report • Pericardial effusion • Angio-seal • Coronary perforation • Right ventricular • Perforation

Learning points

- Iatrogenic perforation of the right ventricle (RV) is a dreaded complication of pericardiocentesis. Angio-seal vascular closure device represents a potential treatment option for patients suffering from iatrogenic RV perforation secondary to incorrect placement of a pericardial drain into the RV.
- The angio-seal vascular closure device represents an effective, minimally invasive treatment for this rare but potentially catastrophic complication of pericardiocentesis. In addition, it confers the advantage of being fully absorbed. In this case, the technique spared our patient a sternotomy with its associated morbidity.

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Introduction

Iatrogenic perforation of the right ventricle (RV) is a rare but recognized complication of pericardiocentesis.[1,2] Treatment strategies for RV perforation include surgical repair and percutaneous closure. In this case report, we describe the use of an Angio-Seal™ vascular closure device (Terumo Interventional Systems) to seal an iatrogenic RV perforation secondary to incorrect placement of a pericardial drain. This minimally invasive approach resulted in an excellent outcome for our patient, obviating the need for surgical closure.

Timeline

Day	Event
0	ST-elevation myocardial infarction
	Primary percutaneous coronary intervention to left anterior descending with pericardial tamponade caused by distal wire perforation
	Inadvertent placement of pericardial drain into the right ventricle (RV)
1	Removal of pericardial drain in RV
	Closure of RV perforation with 8 Fr angio-seal device
2	Removal of pericardial drain in the pericardium
3	Cardiac magnetic resonance imaging demonstrates no recurrence of pericardial effusion
56	Echocardiography demonstrates no recurrence of pericardial effusion

Case presentation

A 55-year-old female presented with chest pain and anterior ST elevation on electrocardiogram. She had no medical history and was taking no regular medications. Coronary angiography demonstrated occlusion of the left anterior descending (LAD) artery at the level of the first diagonal (D1) bifurcation. The patient went on to have primary percutaneous coronary intervention and both the LAD and D1 were wired with a Sion (Asahi Intecc) and Sion Blue (Asahi Intecc) wire, respectively. The procedure was performed with therapeutic unfractionated heparin (6000 units) and monitoring of the activated clotting time. A stent was deployed to the LAD. Proximal optimization technique was performed and the D1 was re-wired with the Sion Blue wire. During kissing balloon inflation, the Sion Blue wire migrated distally in the D1 causing an Ellis type 3 wire tip perforation in the distal D1 (*Figure 1A*). The D1 was initially occluded with a semi-compliant balloon to stop the bleeding into the pericardium. Despite this, the patient became increasingly unstable with pulsus paradoxus initially seen on the arterial line tracing and subsequent haemodynamic collapse. Transthoracic echocardiography demonstrated a large pericardial effusion with evidence of cardiac tamponade. Emergency pericardiocentesis was performed however the 8 French (8 Fr) pericardial drain was inadvertently inserted into the RV. This drain was left *in situ* and the 3-way tap placed off to drainage. A second

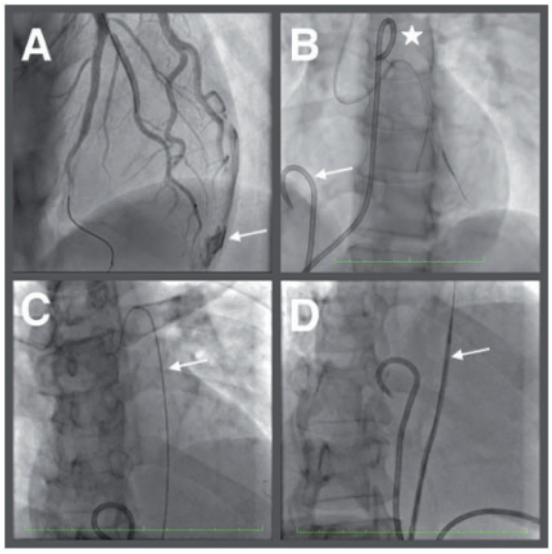

Figure 1 (*A*) Ellis type III perforation with frank extravasation of contrast into the pericardium (arrow). (*B*) Pericardial drains in both the right ventricle (star) and pericardium (arrow). (*C*) Removal of right ventricular drain over 0.038 guidewire (arrow). (*A*) Insertion of angio-seal vascular closure device into right ventricle (arrow).

pericardial drain was successfully inserted into the pericardium with complete drainage of the pericardium and subsequent stabilization of the patients' haemodynamics. A hilal straight coil was deployed to the D1 to seal the coronary perforation. Both pericardial drains were left in place (*Figure 1B*), and the patient was transferred to coronary care unit (CCU).

Echocardiography post-procedure demonstrated no re-accumulation of blood in the pericardium; however, the patient had severe impairment of left ventricular (LV) function and peak troponin was >10 000 ng/L (normal 0–14 ng/L). Clinically, the patient was persistently hypotensive with evidence of congestive cardiac failure on examination. Following discussion with the cardiothoracic team if was felt that the 8 Fr hole in the RV would not self-seal and surgical management was a high risk given the patient's precarious clinical status. The patient had a normal body mass index (BMI) (height: 155 cm, weight: 53 kg, BMI: 22), and it was decided to attempt percutaneous closure with an 8 Fr angio-seal in the catheter lab under echocardiographic and fluoroscopic guidance. The pericardial drain correctly placed into the pericardium was left *in situ* for this procedure to provide backup in case of bleeding into the pericardium post removal of the RV drain. Additionally, the cardiothoracic team kept the theatre on standby in case of any serious complications.

A 0.038 guidewire was inserted into the RV pericardial drain under fluoroscopic guidance, and the pigtail drain was retracted over the guidewire (*Figure 1C*). Echocardiography demonstrated flow of blood into the pericardium, and blood was also aspirated from the pericardial drain in the pericardium. The 8 Fr angio-seal was then deployed over the 0.038 guidewire to seal the RV perforation (*Figure 1D*). No further pericardial effusion was seen on echocardiography. The pericardial drain in the pericardium was removed 24 h later when it was

confirmed that there was no re-accumulation of pericardial fluid. Cardiac magnetic resonance imaging performed 4 days later did not demonstrate any residual pericardial effusion. However, the LV function was severely reduced (25%) with eight segments of full-thickness infarction and apical thrombus. This case highlights that the angio-seal vascular closure device can be used to successfully treat an iatrogenic RV perforation. During her inpatient stay, the patient's medication regimen was optimized with an angiotensin-converting enzyme inhibitor (ramipril), beta-blocker (bisoprolol), mineralocorticoid receptor antagonist (eplerenone) in addition to dual antiplatelet therapy (aspirin and ticagrelor). The patient was discharged home on Day 10 post-infarct and repeat echocardiogram 8 weeks post-event again demonstrated absence of any recurrent pericardial effusion.

Discussion

Iatrogenic perforation of the RV is a dreaded complication of pericardiocentesis. It is fortunately rare, complicating less than 2% of procedures in published series.[1,2] Risks of RV perforation include bleeding into the pericardium and development of cardiac tamponade. Many techniques and strategies have been described to prevent this complication. These include fluoroscopic and echocardiographic imaging guidance, contrast agent injection into the pericardial space, and assessment of J wire position in at least two angiographic projections prior to insertion of a pigtail catheter.[3] We would recommend these techniques be performed routinely in order to prevent this complication occurring. Surgical closure of RV perforation with a purse-string suture or patch closure has traditionally been performed and is generally effective.[4] In recent years, percutaneous closure of RV perforation with a variety of closure devices has also been described in the medical literature.[5–8]

Iatrogenic puncture of the LV usually self-seals as the myocardium is thick walled and actively contracts. This has enabled direct LV puncture to be utilized as an access point for a variety of structural heart procedures.[9] Unfortunately, the RV is a thinner walled structure which usually does not seal with ventricular systole. As such, our concern in this patients case was that the RV would not seal with the removal of the 8 Fr pigtail catheter and that our patient would have ongoing bleeding into the pericardium. This was confirmed in our case post-removal of the pigtail catheter with evidence of flow from the RV to the pericardium on echocardiography and aspiration of blood from the pericardium.

We elected to use an angio-seal device to close the residual RV defect, an off-label use of this device. The angio-seal vascular closure device is composed of a bioabsorbable co-polymer anchor, collagen sponge, and suture. The device achieves haemostasis by compressing the collagen plug between the anchor and the suture and has been utilized in a variety of locations.[10–13] The collagen plug also has coagulation inducing properties which assists with this process. The intra-arterial anchor, suture, and collagen seal are all fully absorbed in 60–90 days. Our patient did not demonstrate any recurrence of pericardial effusion on repeat echocardiography over 60 days post-procedure. It is important with this approach that there is a small distance between the skin and the heart in order to allow tightening of the suture knot with the compaction tube. As such, it may not be suitable for with a larger distance from the skin to the pericardium due to obesity or angulation.

Other minimally invasive approaches have been suggested for the closure of RV defects, including the Perclose® suture mediated closure system (Abbott) which has been demonstrated in a cadaveric model.[14] Atrial septal defect (ASD)/ventricular septal defect (VSD) occluder devices have also been utilized although these devices are undoubtedly more invasive.[6,7] We feel that the angio-seal vascular closure device may represent an effective, minimally invasive treatment for this rare but potentially catastrophic complication of pericardiocentesis. In addition, it confers the advantage of being fully absorbed. In this case, the technique spared our patient a sternotomy with its associated morbidity.

Conclusion

Angio-seal vascular closure device may represent a potential treatment option for patients suffering from iatrogenic RV perforation secondary to incorrect placement of a pericardial drain into the RV.

This minimally invasive approach should be considered as an alternative to surgical closure.

Lead author biography

J.J. Coughlan is a specialist registrar in Cardiology.

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 guidelines.

Conflict of interest: none declared.

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