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CASE REPORT
Other

Percutaneous closure of left ventricular pseudoaneurysm using simultaneous transseptal and transapical approach: a case report

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Background Left ventricular (LV) pseudoaneurysm (PSA), also referred to as contained LV wall rupture, is a clinically uncommon but potentially life-threatening condition that can occur after myocardial infarction or cardiac surgery. If the anatomic characteristics of LV PSA are not eligible for the transfemoral approach, percutaneous closure of LV PSA can be technically difficult and appropriate approach selection may contribute to procedural success.

Case summary An enlarging LV PSA was discovered in a 65-year-old man with Marfan syndrome and three prior cardiothoracic surgeries. Arterial access was not possible due to invagination of the previously placed surgical graft in the descending thoracic aorta. This was managed with a novel approach of simultaneous transseptal LV access and direct puncture of PSA through the chest wall followed by a vascular plug placement.

Discussion This case demonstrates that percutaneous LV PSA closure using a hybrid approach of transseptal and direct apical puncture is a feasible and effective alternative for high-risk surgical candidates, although the anatomic characteristics are unsuitable for the transfemoral approach.

Keywords Case report • Left ventricular pseudoaneurysm • Percutaneous closure

Learning points

- To recognize left ventricular (LV) pseudoaneurysm (PSA) as a serious complication of cardiac surgery and of myocardial infarction.
- To understand percutaneous closure of PSA is a feasible treatment option in patients with prohibitive surgical risk.
- If LV PSA is not amendable to standard endovascular treatment via femoral approach, a hybrid approach of transseptal and transapical access can be considered.

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Introduction

Left ventricular (LV) pseudoaneurysm (PSA), also referred to as contained LV wall rupture, is a clinically uncommon (0.29%) condition that can occur after myocardial infarction (55%), surgery (33%), or trauma (7%).[1,2] Although usually asymptomatic, untreated PSA carries a 35% to 40% risk of rupture within the 1st year.[3] Surgical repair remains the conventional treatment but is associated with high surgical mortality (23–30%), so decision-making weighing benefit and detriments of the surgical approach is critical.[3,4] Transcatheter closure of the LV PSA is a feasible alternative for high-risk surgical candidates.

Timeline

11 years prior to admission	Emergent repair for type A dissection witd Marfan syndrome, witd a Bentall procedure using a biological aortic valve conduit (27 mm Magna pericardial valve witd a 32 mm Dacron graft).
8 years prior to admission	Elective repair of a descending thoracic aortic aneurysm and chronic residual type B dissection with a 30 mm Dacron graft
1.5 years prior to admission	Repair of an extent-3 thoracoabdominal aortic aneurysm (extending from the mid-descending aorta to the aortic bifurcation and involving the visceral branch vessels) via re-operative thoracotomy with left heart bypass
1 year prior to admission	13-mm left ventricular (LV) pseudoaneurysm (PSA) is newly detected
2 months prior to admission	Repeat computed tomography (CT) demonstrated enlargement of the PSA to 3.4 × 2 cm
8 May 2020	1st attempt of percutaneous closure using transseptal approach; failed
12 June 2020	2nd attempt; successful percutaneous LV PSA using a hybrid approach of transseptal and direct apical puncture
13 June 2020	Successful discharge to home without any complications
2 February 2021 (6 months after index procedure)	Repeat CT angiography demonstrated resolution of the LV pseudoaneurysm

Case presentation

A 65-year-old man with Marfan syndrome presented with an enlarged LV PSA after a series of three thoracic surgeries in the preceding 11 years. In 2009, a then 54-year-old man with hypertension and Marfan syndrome presented with a complex type A aortic dissection which was emergently repaired with a Bentall procedure using a biological aortic valve conduit (27 mm Magna pericardial valve with a 32 mm Dacron graft). In 2012, he underwent elective repair of a descending thoracic aortic aneurysm and chronic residual type B dissection with a 30 mm Dacron graft.

In 2018, he required repair of an extent-3 thoracoabdominal aortic aneurysm (extending from the mid-descending aorta to the aortic bifurcation and involving the visceral branch vessels) via re-operative thoracotomy. Left heart bypass (LHB) was required for distal aortic perfusion and the LV apex was chosen as the inflow site to avoid instrumentation of the left atrium, which was used during the previous operations. His postoperative course was complicated by lower extremity paraparesis which resolved with supportive measures including cerebrospinal fluid drainage and permission hypertension to optimize spinal cord perfusion.

On surveillance computed tomography (CT) scan following this hospitalization, a 13-mm LV PSA was found at the site of LHB cannulation. This was initially managed conservatively, with observation and tighter blood pressure control. One year later at age 65, repeat CT demonstrated enlargement of the PSA to 3.4 × 2 cm (*Figures 1* and *2*). Transthoracic echocardiogram showed preserved LV systolic function and normal function of the bioprosthetic aortic valve. There was a significant concern for rupture due to this growth in the size of the defect, but he was deemed to be at high risk for a fourth thoracic surgery, so the patient was referred for transcatheter therapy.

Percutaneous closure was first attempted via a transfemoral approach, but invagination of the descending thoracic aortic graft prevented wire passage into the aortic arch. And then, we decided to perform a transseptal approach under general anaesthesia and with transoesophageal echocardiogram (TEE) guidance. Transseptal puncture was performed at a mid and slightly posterior position in the interatrial septum. A medium curve Agilis steerable guide catheter with a telescoped 6F pigtail catheter was used to visualize the defect with left ventriculography (*Video 1*). This was done at a fluoroscopic angle perpendicular to the PSA neck as seen on the preoperative CT. The pigtail catheter was then exchanged for a 6F JR4 guide catheter. An 0.014-inch soft tip coronary wire was then passed into the PSA, but limited guide support and the narrow defect neck prevented passage of the guide into the PSA despite telescoped microcatheters and use of extra-support wires (*Figure 3*). To limit contrast and radiation, the first closure attempt was aborted.

After heart team discussion, we decided to proceed with a second attempt via direct puncture of the PSA and with extra-long guide catheters. The patient was readmitted to our institution after 1 month. Transseptal access was obtained and an 8F JR4 catheter was advanced into the LV through an 8.5F Agilis steerable guide catheter. Through the anterolateral chest wall, we then used a micropuncture needle to access the PSA under TEE and fluoroscopic guidance and passed a long balance 0.014″ wire through the neck of PSA into the LV (*Figure 4A*, *Video 2*). An EN Snare (Merit Medical System) was used to snare the wire within the LV and then externalize it via the right femoral venous access site (*Video 3*). Using the externalized wire as a rail, we then advanced a 125-cm 6F MP guide catheter through the 8F JR4 catheter and into the PSA. The position of the MP catheter was confirmed angiographically (*Figure 4B*, Supplementary material online,

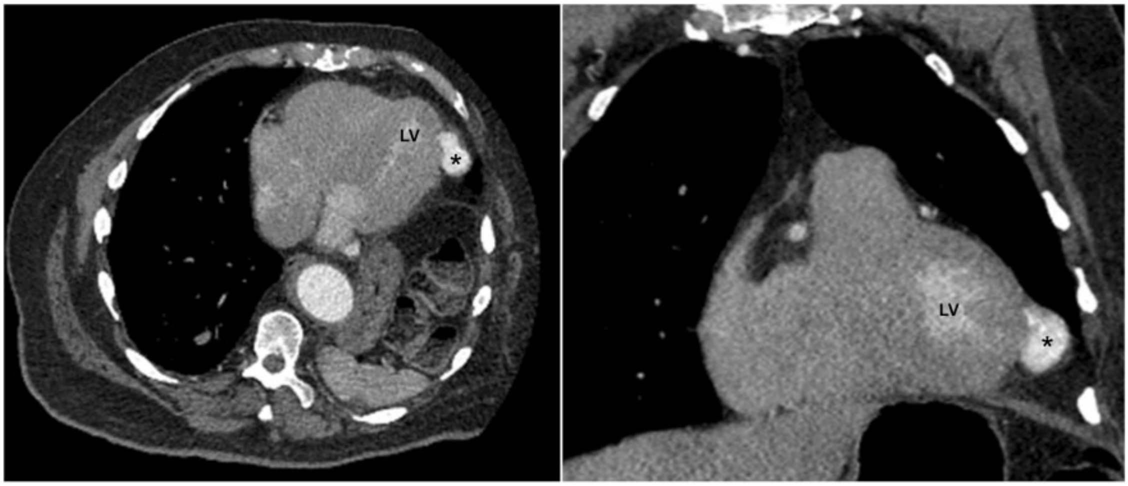


Figure 1 CTA showing left ventricular apical pseudoaneurysm (asterisk).

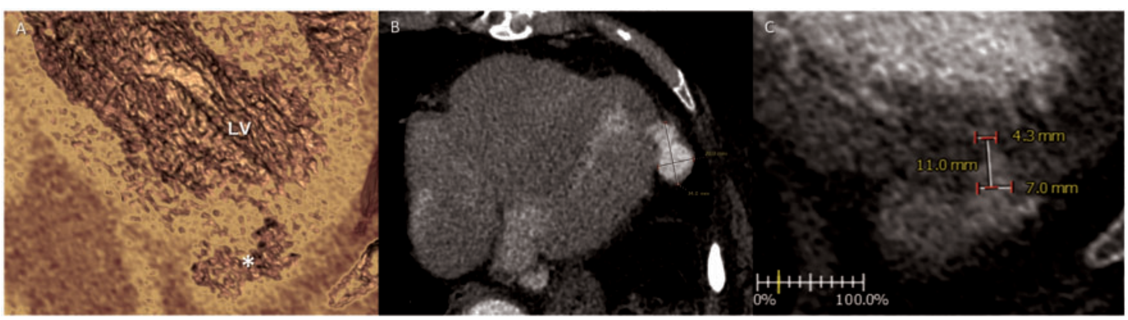
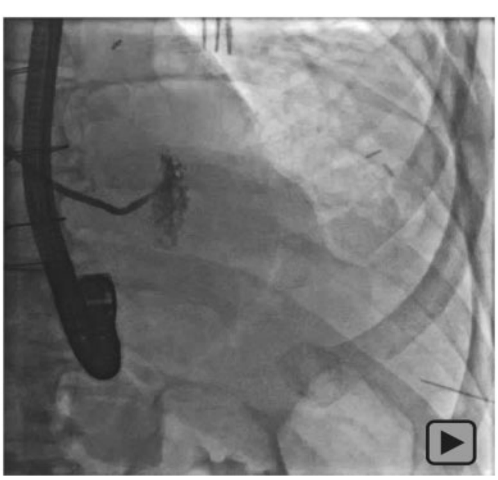


Figure 2 Evaluation of pseudoaneurysm with CTA image. (*A*) Three-dimensional reconstruction of left ventricular apical pseudoaneurysm (asterisk). (*B*) A transverse slice of CTA demonstrating a pseudoaneurysm measuring 3.4 × 2.0 cm of posterolateral wall of left ventricule. (*C*) The neck size of left ventricular pseudoaneurysm.



Video 1 Identification of pseudoaneurysm with angiography.

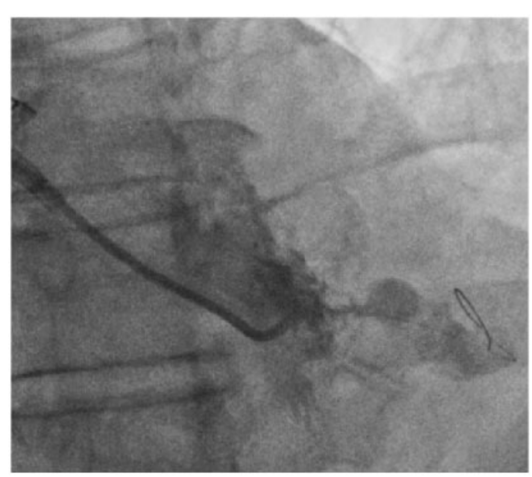


Figure 3 Identification of pseudoaneurysm and wiring.

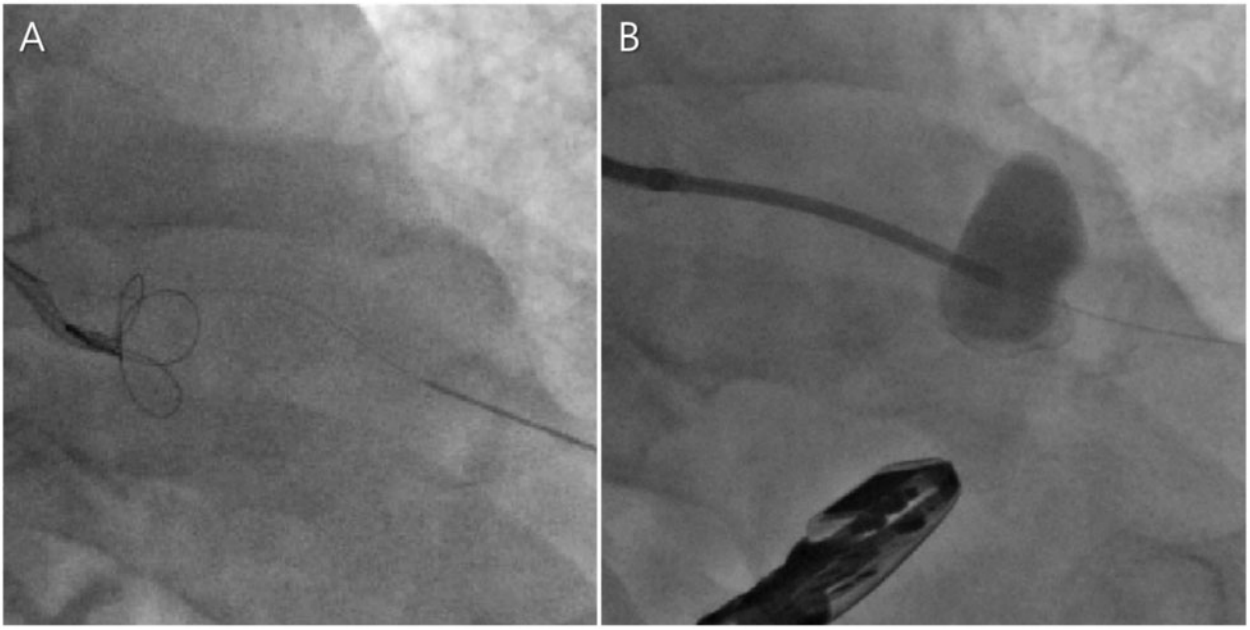
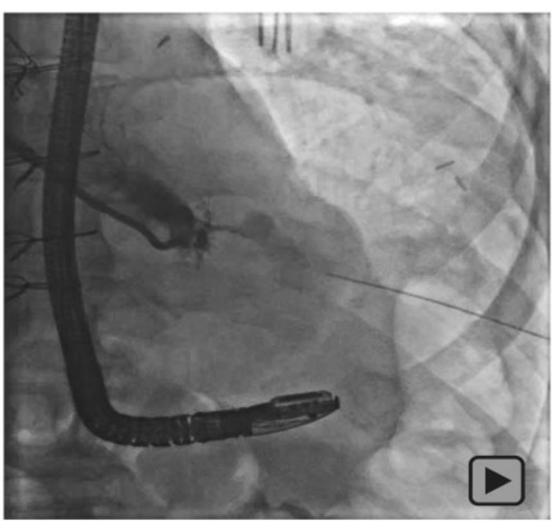
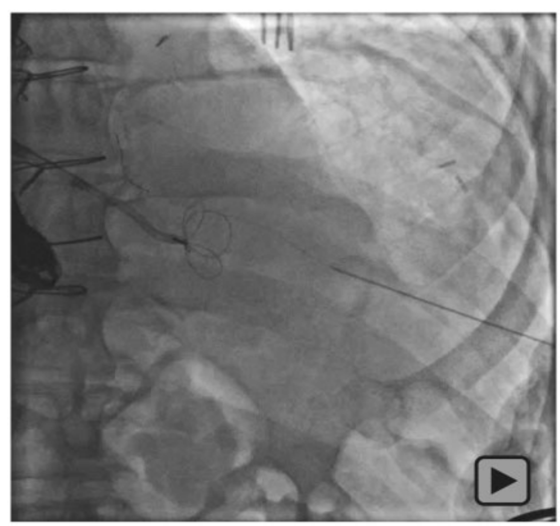


Figure 4 (*A*) Direct puncture of pseudoaneurysm through the chest wall and a wire in the snare catheter. (*B*) MP catheter into pseudoaneurysm and confirmation of its position with angiography.



Video 2 Direct puncture of pseudoaneurysm through the chest wall and wiring into left ventricle.



Video 3 Snaring a retrograde wire for externalization.

Video S1) and the rail wire was withdrawn. A 12-mm Amplatzer vascular plug type II (St. Jude Medical, St. Paul, MN, USA) was then placed through the MP guide. The distal disc was deployed in the PSA and the proximal disc was deployed in the LV (*Figure 5A*, Supplementary material online, *Video S2*). Left ventriculography verified plug position and complete exclusion of the defect (*Figure 5B*, Supplementary material online, *Video S3*). The patient was discharged home the next day post-procedure with no neurological or cardiovascular complications.

Discussion

Percutaneous closure using Amplatzer vascular plugs can be an attractive alternative in patients at high surgical risk and those requiring

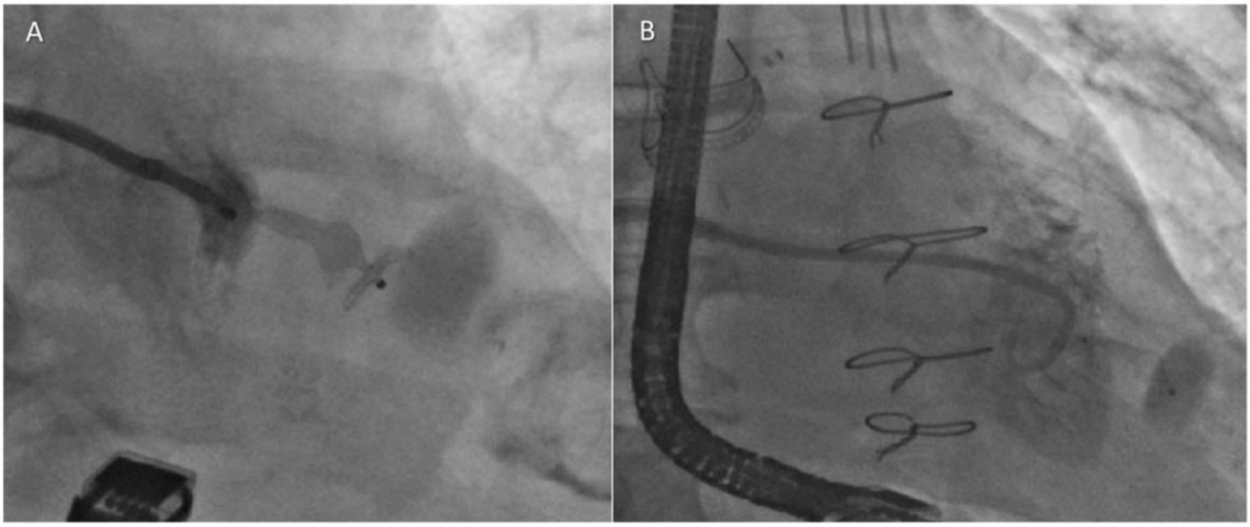


Figure 5 (*A*) Deployment of vascular plug. (*B*) Left ventriculography demonstrating secure plug position and sealing of pseudoaneurysm.

a redo cardiovascular surgery. Advances in transcatheter structural heart interventions have enabled percutaneous LV PSA closure as an increasingly practical option. A transfemoral arterial approach is most often used compared with transseptal or transapical access. Transapical access carries a risk of haemothorax and haemopericardium but has become more accepted for structural heart interventions as it has been employed for transcatheter mitral valve repair/replacement and left-sided paravalvular leak repair.[5] In this case, transfemoral arterial access was not possible and transseptal access did not provide adequate support for closure, so we used a hybrid approach with both transseptal and transapical access. Careful selection of the proper puncture site and trajectory is essential to procedural success. Additionally, direct puncture with a micropuncture needle facilitated rapid haemostasis when the rail wire was subsequently removed. Lastly, an extra-long telescoped guide catheter was used in this case due to the patient's height (2.032 m/6 feet-8 inches) but may not be needed for most patients.

At present, there is no standardized access or approach for the percutaneous treatment of LV PSA. Anatomic characteristics including the unique size, shape, and location of the PSA should be considered to individualize an approach.[6] In addition, the CTangiography images and intra-procedural TEE imaging are also vital to best appreciate the anatomy of the PSA and adjacent structures and selecting an approach for closure.

Conclusion

This is the first report of percutaneous closure of LV PSA using a novel hybrid of transseptal and transapical access. This approach facilitated closure in this patient's complex anatomy when arterial access was not feasible and transseptal access provided inadequate support. Transcatheter closure of LV PSA should be considered as a promising alternative for high-risk surgical candidates and individualized approach selection is required for higher procedural success.

Lead author biography

Isic Kim graduated from Jeonbuk National University Medical School, Korea. He completed a residency in internal medicine and a fellowship in interventional cardiology at Jeonbuk National University Hospital, Korea. He is currently working as a research fellow in the Smidt Heart Institute of Cedars-Sinai Medical Center, Los Angeles, CA, USA.

Supplementary material

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

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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 written consent for submission and publication of this case report including images and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: R.R.M. has received grant support from Edwards Lifesciences Corporation; is a consultant for Abbott Vascular, Cordis, and Medtronic, and holds equity in Entourage Medical. The remaining authors have nothing to disclose.

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