

Secondary right heart failure due to haemodynamically relevant iatrogenic atrial septal defect: does the sequence of structural interventions sometimes matter? A case report

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Background

Edge-to-edge mitral valve repair is a common procedure for treating severe symptomatic mitral valve regurgitation in patients not eligible for surgery.

Case summary

After necessary transeptal puncture during the MitraClip procedure, an iatrogenic atrial septal defect (iASD) routinely remains and closes spontaneously in most cases. We present a case in which this shunt persisted due to increased left heart pressure, causing repeated rehospitalization, and ultimately requiring interventional closure: after successful transcatheter edge-to-edge repair of severe, symptomatic mitral regurgitation, the iASD persisted presumably due to underestimated paradoxical low-flow, low-gradient aortic valve stenosis. Despite transcatheter aortic valve implantation, the iASD became haemodynamically relevant requiring successful interventional iASD closure in the end after a long period of rehospitalizations. We evaluated the symptoms, haemodynamic, and functional characteristics of the patient using several diagnostic tools, as well as the comorbidities of the patient, in terms of their potential to favour the persistence and haemodynamic relevance of iASDs.

Discussion

The combination of sophisticated diagnostic tools, such as cardiac magnetic resonance imaging and transoesophageal echocardiography (TOE), physical examination, and symptoms can be used to identify patients vulnerable to the development of a haemodynamic-relevant iASD that will need early interventional treatment.

Keywords

iASD • MitraClip • Right heart failure • CMR • Case report

Learning points

- Diseases that result in a pressure or volume overloaded left heart may favour iatrogenic atrial septal defect persistence following percutaneous edge-to-edge mitral valve repair.
- Close follow-up including medical history, physical examinations, and meaningful multimodal imaging can lead to successful diagnosis and treatment.
- The sequence of structural interventions in multivalvular disease should be strictly based on a good understanding of haemodynamic conditions and possible treatment-related consequences.

Introduction

Percutaneous edge-to-edge therapy for mitral regurgitation (MR) was first introduced in 2003 and was successfully being performed 2 years later.¹ Since then, this therapy has become a well-established treatment option for patients suffering from symptomatic, severe MR who are not eligible for surgery. Recent guidelines recommend percutaneous procedures for primary and secondary MR in high surgical risk or inoperable patients.² To date, more than 45 000 procedures are documented to have been performed, with comparable mortality results when compared with surgical treatment.³

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The intraprocedural puncture of the interatrial septum causes an iatrogenic atrial septal defect (iASD), which usually closes spontaneously. However, some iASDs persist and become haemodynamically relevant, ultimately requiring interventional closure.

Timeline

May 2015	Transcatheter edge-to-edge repair of severe, symptomatic mitral regurgitation. Transoesophageal echocardiography (TOE): aortic valve orifice, area 1.5 cm ² .
September 2015	Routine follow-up cardiac magnetic resonance imaging (CMR) after the MitraClip therapy: iatrogenic atrial septal defect (iASD) with left-to-right shunting (pulmonary-to-systemic flow ratio, Qp/Qs = 1.3). TOE: iASD diameter, 5.1 mm; aortic valve orifice area, 1.2 cm ² .
December 2016	Rehospitalization with dyspnoea and peripheral oedema: severe paradoxical low-flow, low-gradient aortic valve stenosis (orifice area: 0.8 cm ²). CMR: increased dilatation of the right atrium and right ventricle with reduced ejection fraction and worsening of the iASD: Qp/Qs = 1.5.
January 2017	Transcatheter aortic valve implantation.
March 2017	Rehospitalization with progressive dyspnoea (New York Heart Association IV) TOE: increased iASD diameter, 13.1 mm. Successful interventional iASD closure.

Case summary

In March 2017, an 83-year-old Caucasian woman presented herself to the emergency department with a 2 week history of progressive orthopnoea and peripheral oedema. The patient's current medications, including heart insufficiency therapeutics, i.e. beta-blockers (metoprolol), sartane (candesartan) and spironolactone, as well as diuretics (torasemide), bronchodilators (salbutamol), and oral anticoagulation (phenprocoumon), had been taken regularly without interruption. The patient had an extensive medical history, including coronary artery disease with several previous coronary treatments, mixed severe pulmonary hypertension due to secondary right heart pressure and chronic obstructive pulmonary disease, and advanced multivalvular disease. The medical history was reprocessed as follows.

Two years prior to this presentation, transcatheter edge-to-edge mitral valve repair was performed due to severe symptomatic secondary MR and high surgical risk according to the heart team's

assessment. Four months after successful transcatheter mitral valve repair, routine cardiac magnetic resonance imaging (CMR) was performed after the MitraClip therapy already presented dilatation of the right atrium (diameter, 48 mm; area, 3.44 cm²) with severe tricuspid valve insufficiency, as measured by indirect quantification. The right ventricle showed normal volumes [end-diastolic volume/body surface area (EDV/BSA), 80 mL/m²; end-systolic volume (ESV)/BSA, 40 mL/m²] with mildly reduced systolic function [ejection fraction (EF), 45%] (Figure 1).⁴ Cardiac magnetic resonance imaging also displayed mild residual MR and normal left ventricular systolic function. An iASD following percutaneous edge-to-edge therapy with predominantly left-to-right shunting was still present with a Qp/Qs ratio of 1.3. Transoesophageal echocardiography confirmed a median iASD diameter of 5.1 mm (Figure 2). Taken together, while these findings presented no indications for closure regarding the current recommendations, a close follow-up was performed.⁵

Nearly 1 year later, in 2016, the patient presented to the emergency department again with dyspnoea and peripheral oedema. Transoesophageal echocardiography detected severe paradoxical low-flow, low-gradient aortic stenosis (pLFLG-AS) due to reduced stroke volume with heart failure and EF preservation. The orifice area was 0.8 cm² with functional bicuspid anatomy. Cardiac magnetic resonance imaging showed increased dilatation of the right atrium (diameter, 64.1 mm; area, 3.7 cm²) and increased right ventricular volumes according to the patient's body surface area (EDV/BSA, 133.3 mL/m²; ESV/BSA, 83.3 mL/m²) with a reduced right ventricular EF of 37.5% (Figure 3).⁴ The Qp/Qs ratio was calculated as 1.5 at this time. We discussed this case thoroughly during the heart team's meeting and observed the cardiac decompensation in the context of a long-underestimated aortic valve disease. The heart team speculated that the shunt would remain at this severity after transfemoral transcatheter valve implantation, which took place 2 months before the third rehospitalization with dyspnoea and peripheral oedema in March 2017.

In March 2017, physical examination revealed a normotensive brachial blood pressure (116/58 mmHg), irregular mild tachycardia, and

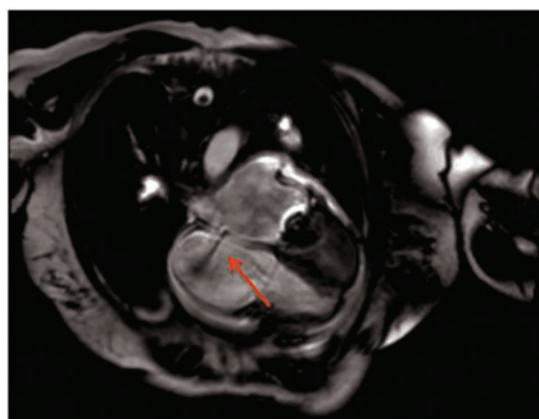


Figure 1 Cardiac magnetic resonance imaging presenting the iatrogenic atrial septal defect (red arrow) with a Qp/Qs ratio of 1.3 and no indications for closure.

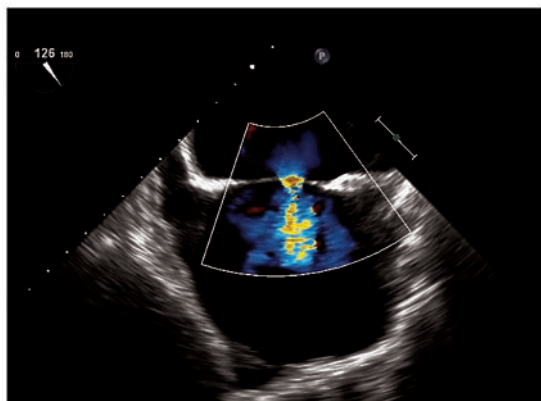


Figure 2 Transoesophageal echocardiography in bicaval view showing the iatrogenic atrial septal defect at 4 months after edge-to-edge mitral valve repair with left-to-right shunting.

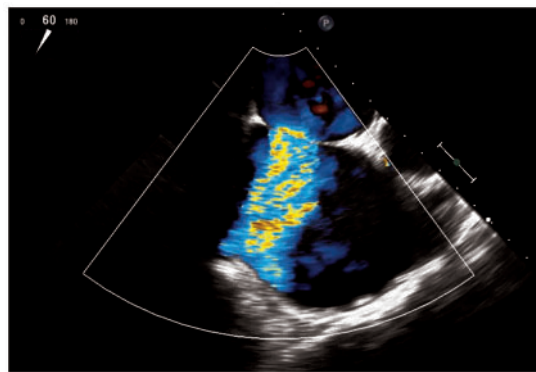


Figure 4 Transoesophageal echocardiography in short-axis view/45° (1 year later): iatrogenic atrial septal defect with significantly increased left-to-right shunting.

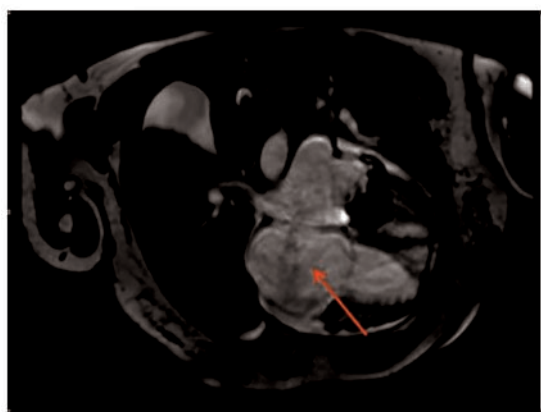


Figure 3 Cardiac magnetic resonance imaging (1 year later) with a Qp/Qs ratio of 1.5 and decreased right ventricular function. The red arrow in the right atrium shows the significant left-to-right shunt.

moderate peripheral oedema, as well as signs of pulmonary congestion. Peripheral oxygen saturation was measured as 89%, in line with the symptoms of orthopnoea. No history of chest pain was indicated by the patient, and there was no evidence of advanced abnormal heart sounds.

Blood examination revealed acute-on-chronic renal failure with an increased creatinine level of 1.5 mg/dL (range <0.9 mg/dL) and an increased international normalized ratio of 4.1 (range 0.9–1.1; target 2.5–3.0) under therapy with phenprocoumon. Electrocardiography showed tachycardia with known atrial fibrillation (108 b.p.m.), which was already under frequency-normalized treatment. Transthoracic echocardiography showed reduced right heart function with dilatation of the right ventricle (mid-cavitary diameter, 42 mm; tricuspid annular plane systolic excursion, 14 mm), severe tricuspid valve

Table 1 Development of aortic valve orifice area, iatrogenic atrial septal defect diameter, and Qp/Qs

Month/year	Aortic valve orifice area (cm ²)	iASD diameter (mm)	Qp/Qs
May 2015	1.5	No iASD	—
September 2015	1.2	5	1.3
January 2016	1.1	10	—
November 2016	0.8	13	1.5
March 2017	TAVR	13	—

insufficiency, and inferior vena cava enlargement. Chest X-ray confirmed pleural effusions on both sides, which were treated conservatively by advanced diuretic therapy (conversion to temporary higher doses of i.v. furosemide) and improved heart insufficiency therapy (intensification of metoprolol and sartane therapy). Mixed (pre- and post-capillary) pulmonary hypertension was confirmed during right heart catheterization [PA_{sys} 68 mmHg; PAWP (wedge pressure) 21 mmHg, PVR >3 WE ‘Wood-Units’]. Taking these medical findings together, the leading diagnosis was symptomatic right heart failure with associated impairments. The subsequent investigations after rehospitalization showed good results concerning the particular valvular treatments but also revealed a haemodynamically relevant iASD. As detected by transoesophageal echocardiography (TOE), the iASD now had a progressive left-to-right shunt, and duplex echocardiography revealed that it had nearly doubled in size, with a median diameter of 13.1 mm (Figure 4). Due to the increased size and advanced secondary right heart failure, interventional closure of the iASD was indicated. Interventional closure with a 22-mm ASD occluder was successful. The patient recovered quickly, and no rehospitalization has occurred thus far. According to her outpatient cardiologist, the patient was in good clinical condition in October 2017.

Discussion

Transcatheter edge-to-edge mitral valve repair has become an elegant therapeutic option for severe, symptomatic MR in patients not eligible for surgical therapy. As the number of treated patients increases, the side effects and their influence on outcome need to receive more attention to help anticipate which patients may be at risk and should thus be followed more closely.

In a meta-analysis, Alkhouli et al.⁶ presented the incidence of persistent iASDs after transseptal puncture as 15%. A recent analysis showed an even higher incidence of iASDs of 23% after edge-to-edge mitral valve repair, as well as higher rehospitalization rates.⁷ Estimation of the haemodynamic relevance of iASDs has been performed with transthoracic echocardiography or TOE in most published studies.^{8,9} Considering right ventricular function, volume and dimension, as well as recent guidelines, CMR is the method of choice and provides additional information for shunt quantification.⁵

In our case report, the combination of TOE and CMR, as leading cardiac imaging techniques, allowed precise monitoring of right ventricular function and dimension. Although increased left heart pressure due to pLFLG-AS was successfully treated with transcatheter aortic valve implantation after edge-to-edge mitral valve repair, the iASD and right heart function worsened. However, interventional iASD closure was finally performed, and no further hospitalization has been documented.

This case clearly demonstrates the possible development of a haemodynamically relevant iASD after transseptal puncture caused by remaining left heart-sided diseases, such as aortic valve stenosis. Our report not only highlights the importance of combining imaging techniques to detect haemodynamically relevant iASDs after edge-to-edge mitral valve repair but also emphasises focusing on patients who might be at a higher risk for worse outcomes. Furthermore, this case presentation shows the importance of correctly assessing valvular disease severity, especially under altered stroke volume conditions, in the context of a meaningful structural intervention sequence.

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.

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