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CASE REPORT
Cardiac Imaging

Case report: Concomitant MitraClip implantation for severe mitral regurgitation and plug closure of endocarditis induced fistula between aortic root and left atrium after transcatheter aortic valve implantation

Ben Ren *, Peter P.T. de Jaegere, and Nicolas N.M. van Mieghem

Department of Cardiology, Thoraxcenter, Erasmus University Medical Center, Rotterdam, the Netherlands

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Background Infective endocarditis (IE) after transcatheter aortic valve implantation (TAVI) occurs in up to 1.5% of patients within the first year. The development of an aorto-atrial fistula (AAF) is a rare but problematic complication of IE, which can be confirmed with transoesophageal echocardiography (TOE). We present an exceptional case of occluding an aorto-left atrial fistula only diagnosed with intraprocedural TOE during a subsequent procedure of MitraClip implantation.

Case summary A 79-year-old symptomatic male patient with multiple comorbidities was referred due to severe mitral regurgitation (MR). He has had prior TAVI which was complicated with streptococcal IE for which he had received prolonged antibacterial therapy. Transthoracic echocardiography (TTE) revealed severe MR. The patient was accepted for a MitraClip procedure by the heart team. Intra-procedural TOE revealed also a significant continuous shunt through an AAF which was likely caused by the endocarditis. The strategy was therefore defined as to occlude the fistula with an Amplatzer Vascular Plug II 12 mm. The plug was released in the fistula leaving an insignificant residual shunt. After the transseptal puncture one MitraClip XTR was implanted, reducing the MR to mild. After the procedure, the patient's general clinical condition improved without signs of haemolysis. The pre-discharge TTE confirmed trace residual shunt, mild residual MR and mild paravalvular leakage.

Discussion Our case illustrates a complex transcatheter structural heart intervention with improvised procedural strategies based on the intra-procedural TOE findings. We conclude that the pre-procedural TOE needs to be comprehensive rather than exclusive, particularly in the context of bioprosthesis-related endocarditis.

Keywords Case report • Transoesophageal echocardiography • Aorto-atrial fistula • Mitral regurgitation • Transcatheter aortic • Endocarditis

* Corresponding author. Tel: 31 10 7035260, Email: b.ren@erasmusmc.nl
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Learning points

- Infective endocarditis after transcatheter aortic valve implantation occurs in ~1.5% of patients within 1st year. Aorto-atrial fistula is a rare life-threatening complication of infective endocarditis which can be detected accurately with transoesophageal echocardiography (TOE).
- Pre-procedural TOE needs to be comprehensive particularly in the context of bioprosthesis-related endocarditis.

Introduction

Infective endocarditis (IE) after transcatheter aortic valve implantation (TAVI) occurs in up to 1.5% of patients within the first year.[1] The development of an aorto-atrial fistula (AAF) is a rare but problematic complication of IE, which can be confirmed with transoesophageal echocardiography (TOE).[2] We present an exceptional case of occluding an AAF diagnosed with intraprocedural TOE during a subsequent procedure of MitraClip implantation.

Timeline

Timeline	Events
August 2018	Patient had undertaken transcatheter aortic valve implantation (TAVI)
February 2019	Streptococcal infective endocarditis (IE) after TAVI; prolonged antibacterial therapy was started immediately after the diagnosis
August 2019	IE-related symptoms relieved, negative blood and imaging tests
April 2020	Patient presented again progressive dyspnoea without IE-related symptoms; transthoracic echocardiography (TTE) and transoesophageal echocardiography (TOE) showed severe functional mitral regurgitation (MR) with no other significant findings; Patients was accepted for MitraClip implantation by the Heart Team
4 May 2020	Intra-procedural TOE showed besides severe MR, an aorto-atrial fistula; the procedure was redirected to first occlude the aorto-atrial fistula (AAF) with an Amplatzer Vascular Plug II, afterwards MitraClip implantation
7 May 2020	Patient was discharged with improved symptoms without haemolysis, mild residual AAF shunt and mild residual MR.
30 October 2020	6-month follow-up: patient presented reasonable state: New York Heart Association Class 2, no fever, stable vital signs without significant heart murmur. Laboratory results yielded an increased creatinine level (known) and C-reactive protein level which was suspected due to the gout. TTE showed sustained results: mild residual MR, mild residual AAF shunt and mild-moderate paravalvular leakage of the aortic prosthesis.

Case presentation

A 79-year-old male patient who presented progressive dyspnoea and cardiac decompensation was presented in the heart team meeting. The patient had been known with an extensive medical history including diabetes, atrial fibrillation (AF), non-Hodgkin lymphoma, and hostile chest. He had undergone a percutaneous coronary intervention to the left anterior descending artery for non-ST-elevation myocardial infarction 3 years ago and a TAVI due to severe aortic valve stenosis 1.5 years ago.

Seven months after the TAVI, the patient was hospitalized in a peripheral hospital due to persistent high fever including night sweating and chills. The blood bacterial test showed instant Gram-positive and subsequent blood culture-confirmed positive *Streptococcus mitis* infection. Blood culture of other suspicious Gram+ bacteria and urine culture yielded negative results. The TOE revealed a suspicious mobile structure in the left ventricular outflow tract and 6 days later the TOE was repeated and demonstrated tissue thickening and abscess formation around the aortic bioprosthesis with a large vegetation extending towards the anterior mitral valve leaflet. The multidisciplinary endocarditis team acknowledged the indication for surgery because of the explicit TOE findings; however, the patient was deemed inoperable due to the hostile chest (sternum destruction from non-Hodgkin lymphoma). Therefore, the patient received prolonged antimicrobial therapy (~6 months). At 1-year follow-up visit of TAVI, the patient seemed fully recovered and the transthoracic echocardiography (TTE) showed no more signs of vegetation or other destructive findings.

At the subsequent follow-up visit 8 months later, the patient presented again with progressive dyspnoea and New York Heart Association (NYHA) Class 4, without fever, pain, or other complaints. Besides a Grade 2 diastolic cardiac murmur, the physical examination yielded no other significant findings. The blood culture yielded negative results and C-reactive protein (CRP) level was not elevated. The TTE revealed significant MR with an eccentric jet due to posterior mitral leaflet tethering (*Figure 1A–C*) and enlarged mitral annulus (diameter 41 mm in the apical four-chamber view). The MR flow convergence radius was 7 mm with an effective regurgitant orifice area (EROA) of 22 mm^2. The mitral inflow E-velocity was 1.3 m/s. The MR was deemed as severe functional MR. The left ventricular ejection fraction was 55% and the diastolic function could not be ascertained due to AF. The aortic bioprosthesis appeared unremarkable with mild paravalvular leakage (PVL) (*Figure 1D*). There was also moderate tricuspid regurgitation with a systolic pulmonary artery pressure of 49 mmHg. The subsequent TOE confirmed the MR aetiology and severity (with obvious pulmonary vein systolic flow reversal). To assess the eligibility of MitraClip implantation, the following parameters were measured: posterior leaflet length (P2) 17 mm, coaptation length 3 mm, and coaptation depth 4 mm. There was no significant calcification on the annulus, leaflets, or subvalvular chordae.

Based on the symptoms, laboratory and echocardiographic results, the possibility of endocarditis relapse was ruled out. According to the

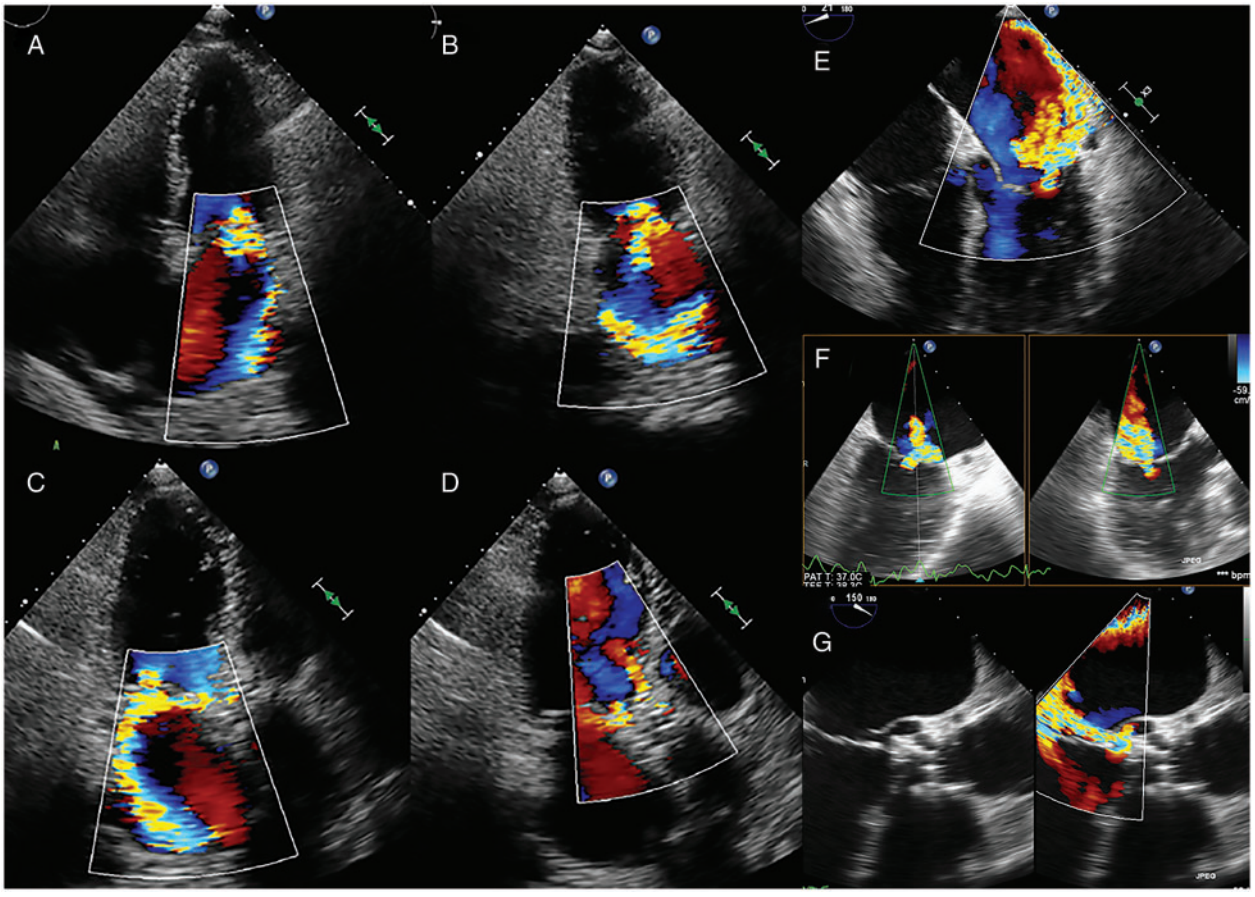


Figure 1 Pre-procedural transthoracic echocardiography showing severe eccentric mitral regurgitation (*A–C*) with mild paravalvular leakage of the transcatheter aortic valve (*D*). Intra-procedural transoesophageal echocardiography showing severe eccentric mitral regurgitation (*E, F*) and a significant continuous shunt via a fistula between the aortic root and left atrium (*G*).

latest recommendation of the decision pathway on management of MR,[3] this patient was deemed inoperable due to multiple comorbidities and eligible for a MitraClip procedure by the multi-disciplinary heart team based on:

- TTE findings:
  - Severe MR based on TTE and TOE using the multi-parametric approach including EROA, dominant mitral inflow E wave, and pulmonary vein flow systolic reversal
  - MR aetiology secondary to annular dilatation (presumably caused by permanent AF) and posterior leaflet tethering (presumably caused by the prior myocardial infarction)
  - Normal mitral valve area and transmitral pressure gradient
- TOE findings:
  - MR aetiology and jet location (A2-P2)
  - Adequate posterior leaflet length, coaptation length and small coaptation depth
  - no significant calcification on leaflets grasping zone

Intra-procedural TOE (2 weeks after the pre-procedural TOE) confirmed mixed aetiology of degenerative and functional MR including posterior mitral leaflet tethering and leaflet malcoaption (*Figure 1E, F, Video 1*) and anterior leaflet billowing (*Videos 2* and *3*). Additionally, a significant continuous shunt through a fistula between the aortic left coronary cusp region and left atrium was noticed (*Figure 1G*, Supplementary material online, *Video S1*), which was deemed a sequela of the prior endocarditis episode. The treatment strategy was therefore modified to first occlude the fistula with an Amplatzer Vascular Plug II (AVP II, St. Jude Medical, Abbott). A 6-Fr Amplatz left the diagnostic catheter in combination with a 0.035″ Kimal straight wire was easily navigated through the fistula from the sinus of Valsalva (*Figure 2A*). This assembly was exchanged for a 7.5-Fr sheathLess JR4 Guiding Catheter (Asahi Intecc Co Ltd) (*Figure 2C*) over a 0.035″ Safari small Guidewire (Boston Scientific) (*Figure 2B*). A 12 mm AVP II was released in the fistula (*Figure 2D*, Supplementary material online, *Video S2*) leaving an insignificant residual shunt (*Figure 3A*). The severe mixed (leaflet tethering, annular dilation, and A2 billowing) MR persisted after the plug deployment. After the transseptal puncture one MitraClip XTR (Abbott Vascular) was implanted on the central-lateral position (Figure 4, Supplementary material online, *Video S3*) reducing the MR from severe to mild (*Figure 3B*) with a transmitral pressure gradient of 2 mmHg. After the

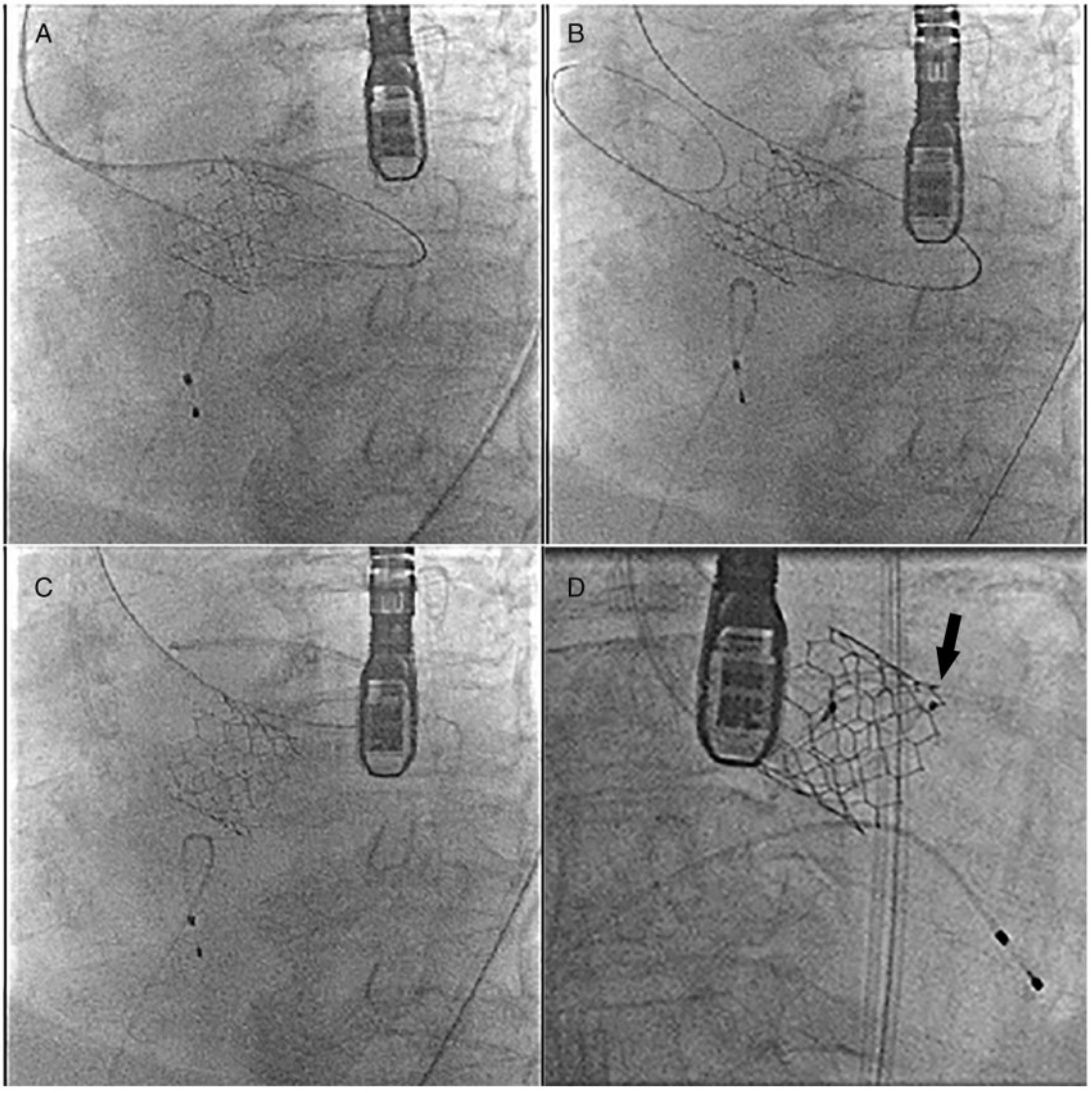


Figure 2 Deployment of the Amplatzer Vascular Plug II shown with fluoroscopy. (*A*) An assembly of 6-Fr Amplatz left diagnostic catheter with a 0.035″ Kimal straight wire through the fistula from the sinus of Valsalva; (*B*) Safari small Guidewire through the fistula; (*C*) the 7.5-Fr sheathLess JR4 Guiding Catheter through the fistula; (*D*) the Amplatzer Vascular Plug II was released in the fistula (arrow).

procedure, the patient's general clinical condition improved without signs of haemolysis. The pre-discharge TTE confirmed all devices *in situ* with trace residual shunt, mild residual MR and mild PVL (*Figure 5*). The patient was discharged 3 days after the procedure. During the most recent follow-up (6 months after the procedure) the patient presented a reasonable state: NYHA Class 2, no fever or syncope, stable vital signs without significant heart murmur. There was no limb oedema but the signs of gout. Laboratory results yielded increased creatinine and CRP levels. The deterioration of the renal function had been identified before the procedure and elevated CRP level was suspected due to the gout. The TTE showed sustained results: mild residual MR, mild residual AAF shunt and mild-moderate PVL of the aortic prosthesis.

Discussion

Endocarditis after TAVI occurs in up to 1.5% of patients within the first year and is strongly associated with younger age, male sex, history of diabetes, moderate to severe PVL,[1] and compromised renal function.[4] Approximately 50% of the patients show transcatheter aortic bioprosthesis involvement on the TOE of prosthesis with mitral valve involvement in 20% of cases.[1,4] In the present case, the diagnosis of prosthetic valve endocarditis was established based on the combination of clinical manifestations, positive blood cultures and the presence of vegetation and abscess around the aortic root by TOE examination. Per decision of the multidisciplinary Endocarditis and Valve Teams, open heart surgery was ruled out (inoperable due to hostile chest)

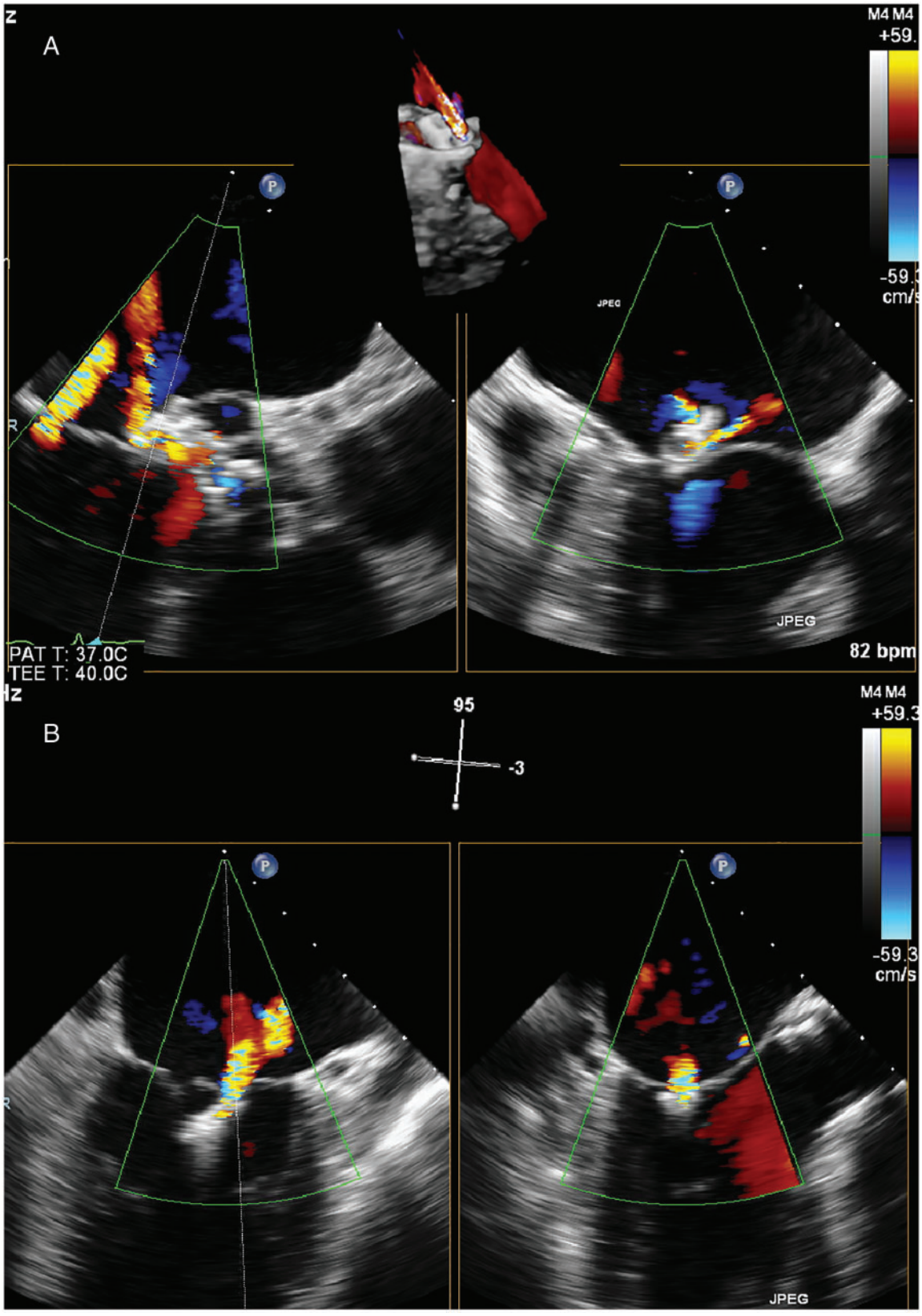


Figure 3 (*A*) Mild residual shunt after the Amplatzer Vascular Plug II deployment; (*B*) mild residual mitral regurgitation after MitraClip implantation.

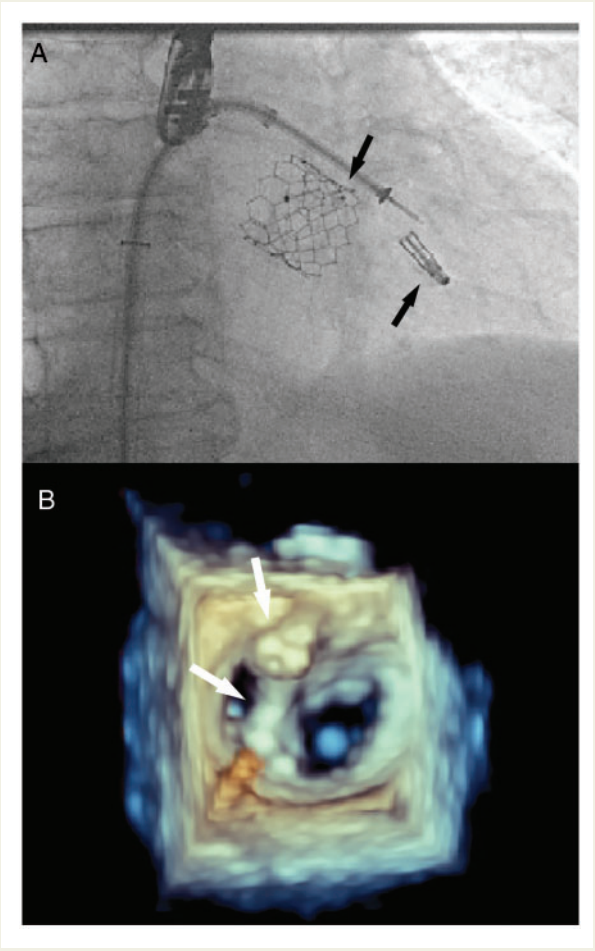


Figure 4 The Amplatzer Vascular Plug II (arrow) and MitraClip (arrow) shown with fluoroscopy (*A*) and 3D transoesophageal echocardiography (*B*).

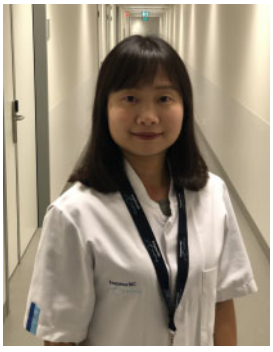
and the patient received prolonged antibacterial therapy and was followed up periodically by the Heart Valve Clinic where blood tests and TTE were repeated following the European guideline and recommendation of IE.[5,6] The risk of recurrence of IE is 2–6%[7,8] and prosthetic valve endocarditis and abscess are associated with an increased rate of relapse,[6] which was ruled out in this case.

Our case illustrates a complex transcatheter structural heart intervention with ad hoc procedural strategy modifications based on the intra-procedural TOE findings of an AAF that was not noticed during the pre-procedural TTE and TOE. Aorto-atrial fistula is a rare (1–2%[9]) but life-threatening complication of IE with high rates of congestive heart failure, haemodynamic instability, conduction abnormalities, and mortality (>40%).[10,11] In our case, the AAF was considered a sequela of the previous IE instead of active/relapsed IE due to negative physical, laboratory and imaging findings (even though it is highly likely that the AAF was actually overlooked during the pre-procedural TOE). Surgery remains the preferred choice for the management of aortocavitary fistulae, yet is associated with significant morbidity and mortality.[10,12] Several cases reported successful transcatheter closure of AAF using Amplatz plugs with promising short-term outcomes.[13–15] Naeim *et al.* reported transcatheter closure of AAF using two AVP II devices in a patient with active IE as a bridge to surgery;[14] For post-operative AAF after surgical aortic valve replacement, Alkhouli *et al.* reported an immediate complete seal of AAF with an ADO-II device[15] and Estévez-Loureiro *et al.* with two AVP III occluders.[13] Potential complications associated with this approach include impingement of the valve, device embolization, stroke, and coronary artery obstruction. Nevertheless, none of these complications has happened in our case, nor has been reported. AAF size and location may determine the complexity of catheter navigation and closure success. Prior computed tomography scans may help define optimal gantry settings to identify the affected cusps. The transcatheter aortic valve frame can serve as an important landmark on fluoroscopy. In this case, catheter manipulations appeared relatively straightforward under fluoroscopy and TOE guidance.

Conclusions

TTE can detect fistulous tracts in 50% of cases, while with TOE, the detection rates increase to 97%.[2] In our case, TOE was not only the key in diagnosing the AAF (besides ascertaining the MR aetiology) providing classic imaging findings but also mandatory in deciding the size of the closure device and guiding the transcatheter closure. When reviewed retrospectively, the fistula could have been identified on the pre-procedural TOE. Therefore the pre-procedural TOE interrogation needs to be comprehensive and exhaustive with multiple views and acquisitions, rather than exclusive, particularly in the context of bioprosthesis-related endocarditis.

Lead author biography



Dr Ben Ren is an interventional echocardiographer and scientific researcher of the structural heart program in interventional cardiology, Thoraxcentre, Erasmus MC, Rotterdam, the Netherlands. She completed her PhD thesis 'Advanced 3D Echocardiography' in the same institution in 2014. She graduated from the West China School of Medicine with a research Master in echocardiography in 2010. Dr Ren works also in an academic research organization as the Echo Core Lab Supervisor.

Supplementary material

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

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

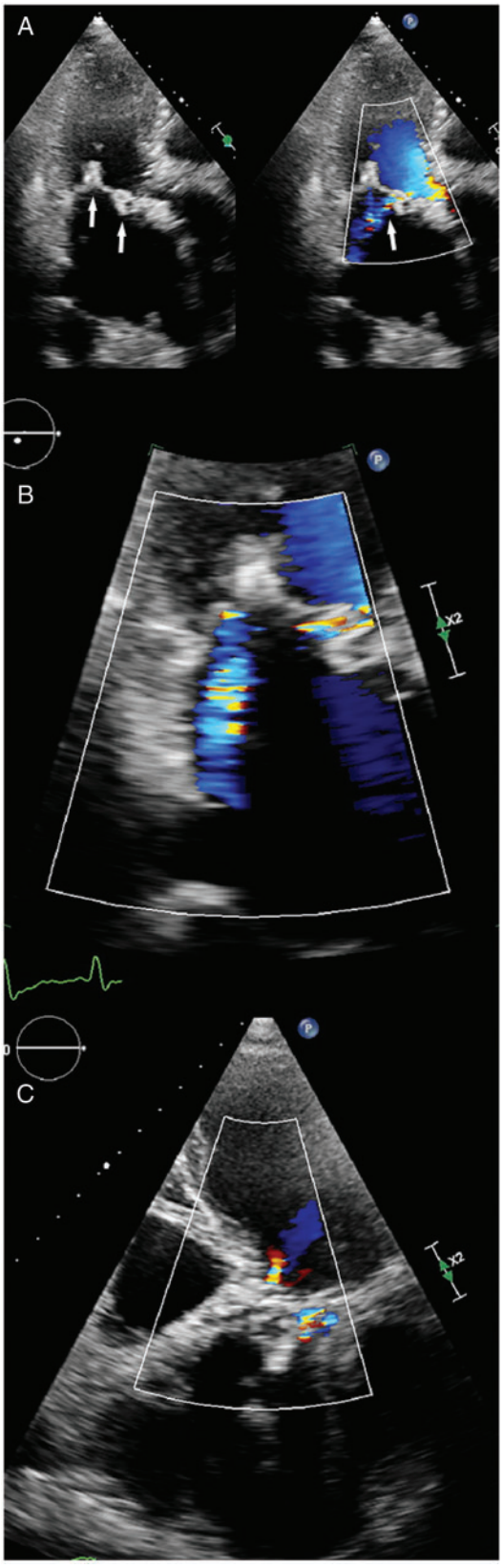


Figure 5 Pre-discharge transthoracic echocardiography showing that all devices were *in situ* (*A*, arrows) with mild residual shunt (*A* arrow), mild residual mitral regurgitation (*B*) and mild paravalvular leakage (*C*).

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: B.R. has nothing to disclose. N.M.v.M. reports grants and personal fees from Abbott, grants from Edwards Lifesciences, grants and personal fees from Medtronic, grants and personal fees from Boston Scientific, outside the submitted work. P.P.T.d.J. reports personal fees from Boston Scientific, outside the submitted work.

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