Percutaneous closure of iatrogenic anterior mitral leaflet perforation: a case report

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Background
Severe mitral regurgitation (MR) through the body of the anterior mitral leaflet (AML) is rare. The cause either iatrogenic during open-heart surgery or due to infective endocarditis. We present a case where a successful percutaneous closure of the AML perforation was an alternative to surgery.

Case summary
A 60-year-old male presented with shortness of breath (SOB) class III of 12 months duration. He underwent coronary artery bypass surgery with four grafts plus mitral valve (MV) repair 20 months ago. Transthoracic echocardiogram (TTE) and transoesophageal echocardiogram (TOE) revealed severe MR through the body of AML at A3. The percutaneous closure plan was to cross the AML perforation from the left ventricular side. The venacontracta of the perforation was 6 mm, an amplatzer septal occluder device 6 mm considered appropriate for closure of this hole. A snare catheter snared the wire and exteriorized creating arteriovenous loop. Amplatzer septal occluder 6 mm loaded to the delivery system till larger disc (left-sided) opened safely and freely below the MV apparatus. Once the left ventricular side disc opposed the ventricular surface of AML, the waist and left atrial disc gently released. The patient discharged in the next day. After 6 months, the patient had no more SOB, he returned to his daily activity. Follow-up TTE showed no MR, the closure device was stable in place.

Discussion
We added a successful case of transcatheter AML perforation to the literature. The role of TOE is crucial in diagnosis and procedure guidance.

Keywords
Mitral valve • Anterior mitral leaflet • Perforation • Percutaneous • Case report

Introduction
Anterior mitral leaflet (AML) perforation leading to severe mitral regurgitation (MR) post-open-heart surgery may be iatrogenic.1 Anterior mitral leaflet perforation may be the result of infective endocarditis at the aortic valve.2 The usual treatment of severe MR due to AML perforation is surgical repair of the mitral valve (MV).3 Very few cases have been reported for percutaneous repair of perforated AML.1,4,5 Percutaneous closure of AML perforation is not guideline based and there is insufficient evidence of success, it should

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be reserved for high-risk surgical patients. However, patient preference and local experience in structural heart disease intervention are factors that may contribute in selecting this procedure. We add to the literature a case of successful percutaneous closure of an AML perforation in a patient who underwent coronary bypass surgery plus MV repair. We described the role of 3D echocardiography in guiding the procedure and selecting the device for closure. This patient was a moderate surgical risk for reoperation for MV repair.

**Timeline**

| Event                          | Details                                                                 |
|--------------------------------|-------------------------------------------------------------------------|
| Twenty months ago              | A 60-year-old male, diabetic and hypertensive, presented with inferior ST-elevation myocardial infarction. |
| Investigations at that time    | His coronary angiography revealed multivessel disease. His transthoracic echocardiogram (TTE) showed inferior and inferolateral akinesia with an ejection fraction (EF) 45% and moderately severe ischaemic mitral regurgitation (MR). |
| Procedure done                 | He underwent coronary artery bypass surgery with four grafts plus mitral valve repair with a radiolucent band. |
| Presentation                   | Presented to our centre with shortness of breath New York Heart Association (NYHA) class III of 12 months duration and progressive course. |
| TTE and transoesophageal echocardiogram (TOE) | Transthoracic echocardiogram revealed akinetic inferior and inferolateral walls with EF 45% and severe MR through the body of anterior mitral leaflet (AML). Transoesophageal echocardiogram confirmed that severe MR jet was originating at the anteromedial commissure and 3D zoom surgical view showed the perforation at the base of AML at A3. |
| Heart team meeting             | The surgeon accepted the patient for surgical MV repair with a patch or suture of the AML perforation. The patient refused reoperation. The team decided to do transcatheter closure of AML perforation. |
| Day of the procedure           | Under general anaesthesia and TOE guidance a successful deployment of an atrial septal occluder 6 mm done with complete closure of the perforation. |
| Next day                       | The patient discharged in a good condition. |
| After 6 months                 | The patient had no more SOB, he returned to his daily activity. Follow-up TTE showed no MR, the closure device was stable in place. |

**Case presentation**

A 60-year-old male, diabetic and hypertensive, presented to our centre with shortness of breath (SOB) New York Heart Association (NYHA) class III of 12 months duration, with a progressive course. Twenty months ago, the patient presented with inferior ST-elevation myocardial infarction. His coronary angiography revealed multivessel disease. His transthoracic echocardiogram (TTE) showed inferior and inferolateral akinesia with a left ventricular ejection fraction (LVEF) 45% and moderately severe ischaemic mitral regurgitation (MR). He underwent coronary artery bypass surgery with four grafts plus MV repair with a radiolucent band.

There was pansystolic murmur grade IV/IV with maximum intensity at the apex propagating to the axilla. He had fine bilateral crepitations up to the mid chest.

A case of decompensated heart failure due to severe MR mostly as a result of failed surgical MV repair. There was no clinical evidence to suggest AML perforation.

Transthoracic echocardiogram (TTE) revealed akinetic inferior and inferolateral walls with LVEF 45% and severe MR through the body of AML (Supplementary material online, Video S1). Transoesophageal echocardiogram (TOE) confirmed that severe MR jet was originating at the anteromedial commissure (Figure 1A, B and Supplementary material online, Video S2). Three-dimensional zoom surgical view showed MV repair band and perforation at the base of AML at A3 (Figure 1C and Supplementary material online, Video S3). Surgical view 3D full volume with and without colour confirmed that the MR jet was only through this perforation (Figure 1D, E and Supplementary material online, Video S4). In the Bicommissural view, there was no MR from either commissure (Supplementary material online, Video S5). There was an apparent systolic reversal in the left upper pulmonary vein indicating the MR severity (Figure 1F). There was no evidence of current or previous infective endocarditis. Further investigations revealed a normal white blood cell count, no fever, normal erythrocyte sedimentation rate, and negative blood cultures.

The case was discussed in the heart team meeting, the calculated Society of Thoracic Surgery (STS) score was 2.3% for mortality and 16.5% for both morbidity and mortality. The surgeon accepted the patient for surgical MV repair with a patch or suture of the AML perforation. The patient refused reoperation. Percutaneous closure of AML perforation was performed successfully in our centre before. After explaining the surgical and percutaneous options to the patient, highlighting that there is no evidence for long-term outcome for transcatheter option, he again selected not to have surgery. The team decided to do transcatheter closure of AML perforation.

The percutaneous closure plan was to cross the AML perforation from the left ventricular side. The wire from the aorta had easier crossing and more precise localization of the defect. The catheter in the ventricular side of the MV always faces the mitral leaflets and does not lose continuous navigation if compared with crossing from the left atrial side. The systolic flow of MR to the left atrium makes the wire crossing easier with the direction of blood flow. Device selection was based on a double disc device with larger disc towards the LV side to give both better closure and stability. The distance between the two discs is better to match the leaflet thickness (1–3 mm), so, an amplatzer septal occluder (ASO) device was selected. The venacontracta of the perforation was 6 mm, an ASO device 6 mm was considered appropriate for closure of this hole. TOE confirmed there is enough...
distance between the perforation and the edge of AML to support the device.

Under general anaesthesia and TOE guidance arterial 6 and 10 F venous femoral access obtained. Transeptal access using 8.5 F SL0 sheath and BRK0 needle targeted posterior–inferior puncture site to avoid angulation or traction to the leaflet.

Judkin’s Rt 5 F 3.5 (Terumo) and glide wire 0.035/260 (Terumo) in the RAO projection crossed from the LV to the LA through the perforated AML (Figure 2A and Supplementary material online, Video S6). Surgical view 3D zoom from left atrial side showed the catheter from AML hole to LA (Figure 2B) and from LV side showed enough distance between the hole at A3 and the edge of AML (Figure 2C). A snare catheter size 25 mm through the SL sheath snared the wire and exteriorized creating arteriovenous loop (Supplementary material online, Video S7).

Torque Vue sheath 7 F quickly crossed from the venous side across the IAS and LA to the perforated A3 segment of the MV to the ascending aorta.

An ASO device 6 mm was loaded to the delivery system till larger disc (left-sided) opened safely and freely below the MV apparatus (Figure 2D and Supplementary material online, Video S8). The disc was not interfering with the closure mechanism of the MV and away from the aortic valve. Once the left ventricular side disc opposed the ventricular surface of AML, the waist and left atrial disc were gently released (Figures 2E, F and 3A and Supplementary material online, Video S9).

After a meticulous and extensive assessment of the MV closure mechanism, left ventricular outflow tract (LVOT) gradient, leaflets movements, MV diastolic function and absence of any residual mitral incompetence (Figure 3B and Supplementary material online, Video S10), the device was released in a stable position (Figure 3C and Supplementary material online, Video S11). Pulsed Doppler at left upper pulmonary vein showed normalization of S/D ratio after perforation closure (Figure 3D). The patient was discharged the next day.

After 6 months, the patient had no more SOB, he returned to his daily activity. Follow-up TTE showed no MR, the closure device was stable in place (Figure 3E and Supplementary material online, Videos S12–S15).

Discussion

Sareyyupoglu et al.3 reported 26 patients with AML perforation who underwent MV repair. Twenty-four (92%) patients had endocarditis. For anterior leaflet repair, a patch was used in 11 (42%) patients and primary suture closure in 15 (58%). Patient survival was 95% at 1 year and 90% at 5 years. In a review of 475 cases after repair of aortic valve insufficiency,
two cases of perforation of the base of the AML were reported.7 Transcatheter repair of AML is only reported in sporadic cases.1,4–7 Abuelatta et al.1 reported a 2-year follow-up for a 20-year-old patient with iatrogenic AML perforation at A2 after a mechanical aortic valve replacement. The follow-up was good with no MR, and the AML tolerated the weight of an ASD 4-mm device nicely. Sengun et al.7 used an AMPLATZERTM Duct Occluder II 6 mm to close an iatrogenic AML perforation in a 19-year-old patient. Czerny et al.8 reported a similar case of percutaneous closure of MV leaflet perforation after surgical repair. In this case, we described a successful percutaneous closure of AML perforation in a moderate surgical risk patient. The decision for closure was based on patient preference and the availability of an expert team in structural heart disease intervention. Live 3D TOE during the procedure is mandatory to decide the type, size of the device as well as any complications. Further research is needed to establish mid- and long-term follow-up of this approach and its use in lower-risk patients.

Conclusion

Transcatheter closure of AML perforation is feasible in selected patients. More research is required for safety and long-term follow-up. Transoesophageal echocardiogram 3D is essential for accurate diagnosis and procedure guidance.

**Lead author biography**

Dr Hesham Abdo Naeim, MD, FASE, graduated from Faculty of Medicine, Al-Azhar University in December 1997; was granted MSc degree in cardiovascular diseases in December 2002; MD degree in 2006. He was a Diplomate—Adult Comprehensive Echocardiography from National Board of Echocardiography, United States at June 2014. He was a resident and assistant lecturer of cardiology in Al-Azhar University hospitals from June 1997 to February 2006. He was also a Cardiology consultant in Madina National Hospital Saudi Arabia from January 2007 till April 2013. He is an Adult cardiology consultant in Madina Cardiac Center, Saudi Arabia from June 2013 till now. He is expert in the field of echocardiography in structural heart disease.
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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, videos and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: none declared.

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