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Transcatheter mitral valve replacement in severe mitral annular calcification and atrial septal defect closure☆

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Patients with mitral annular calcification (MAC) are typically elderly high-risk patients with multiple comorbidities and prohibitive surgical risk. Therefore, transcatheter procedures, such as transcatheter heart valve (THV) in MAC may be considered. We present a patient with pre-existing Transcatheter Aortic Valve Replacement (TAVR), who underwent percutaneous transcatheter mitral valve replacement (TMVR) using an aortic THV with subsequent closure of the iatrogenic atrial septal defect (ASD), due to the presence of thrombus in the right atrium.

A 79-year-old gentleman was referred due to progressive dyspnoea and recurrent heart failure admissions. His past medical history included transfemoral TAVR with a 26 mm Edwards XT prosthesis for severe aortic stenosis (2015). Echocardiogram demonstrated good left ventricular function and heavily calcified mitral valve (MV) annulus. The patient had severe mitral stenosis with a mean gradient 11 mm Hg and a 3-dimensional MV area of 0.8 cm^2 with concomitant moderate mitral regurgitation. Retrospectively gated cardiac computed tomography (CT) imaging demonstrated a well seated TAVR and heavy calcification of the MV annulus (Fig. 1A&B) with a minimum MV perimeter of 69 mm, maximum MV perimeter of 94 mm, and MV annulus area of 528 mm^2. Further analysis revealed that implantation of a 29 mm Edwards SAPIEN 3 valve would result in a mean aorto-mitral angle of 115° and remaining left ventricular outflow tract (LVOT) surface area of 298.2 mm^2 with low risk of LVOT obstruction, following discussion at the Heart Team Meeting it was decided that he would be best treated with percutaneous TMVR using an aortic THV.

The patient underwent transesophageal echocardiogram (TEE) guided TMVR via femoral venous access with transseptal puncture. A

Abbreviations: MAC, mitral annular calcification; TAVR, transcatheter aortic valve replacement; TMVR, transcatheter mitral valve replacement; THV, transcatheter heart valve; TEE, transesophageal echocardiogram; LVOT, left ventricular outflow tract; ASD, atrial septal defect; MV, mitral valve; CT, computed tomography.

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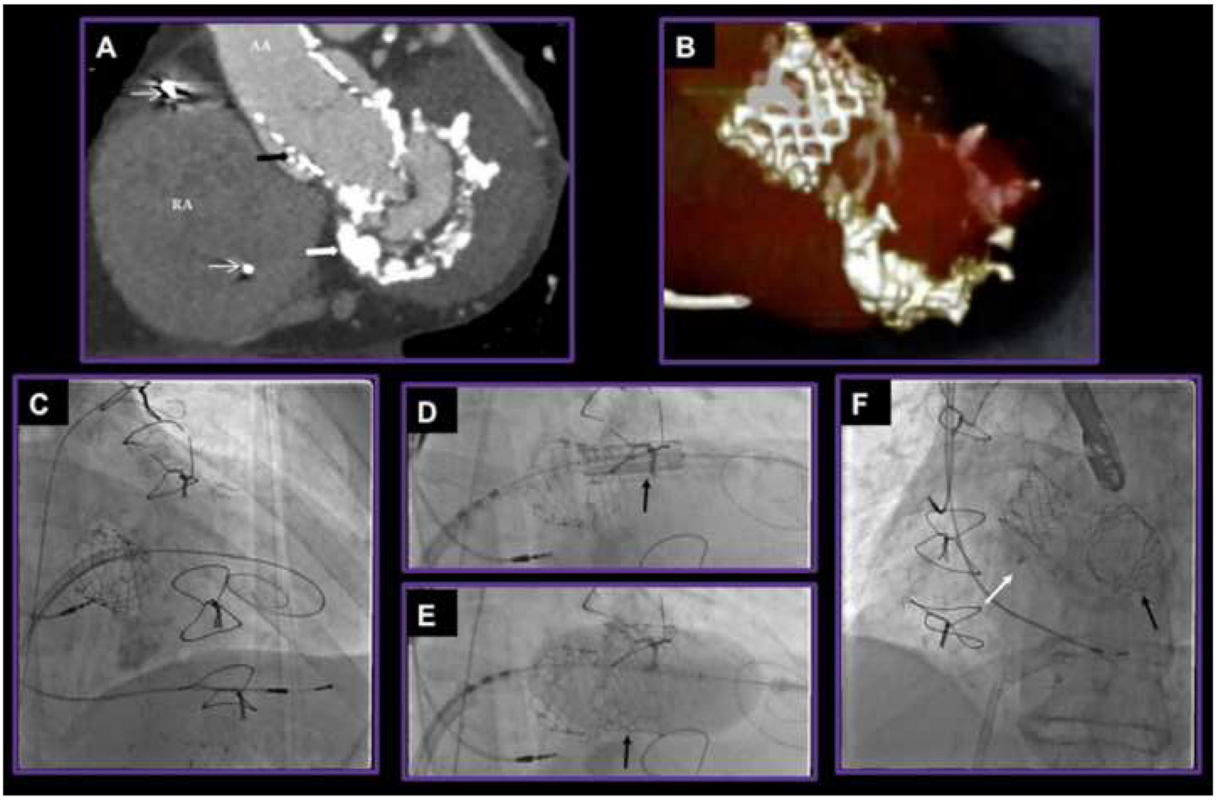

Fig. 1. A. Pre-procedure CT Coronal reformat demonstrates the TAVR in aortic position (black block arrow) and the dense calcification in the mitral annulus (white block arrow). Also note the presence of pacemaker lead (thin white arrows) in the right atrium (RA). AA: Ascending Aorta. B. Pre-procedure 3D CT coronary reconstruction demonstrating TAVR in aortic position and heavy ring of calcium around mitral annulus. C. Fluoroscopy of transseptal puncture using an Agilis Steerable Sheath with Safari wire in the left ventricle and Amplatz Support Wire in the pulmonary artery to support valve deployment. D. Fluoroscopy of 29 mm Edwards SAPIEN 3 aortic THV prosthesis positioned in calcified mitral annular ring (Black arrow). E. Fluoroscopy of 29 mm Edwards SAPIEN 3 aortic THV prosthesis deployed within calcified mitral annular ring (Black Arrow). F. Fluoroscopy of deployed TMVR (black arrow). ASD closure device (visible next to TAVR) deployed (white arrow).

Safari wire was placed in the left ventricle with the help of an Agilis sheath. A second wire, stiff Amplatz Support Wire was placed in the left upper pulmonary vein as a support wire, and for further dilatation of the atrial septum in the event the valve delivery system would not cross into the left atrium (Fig. 1C). At this stage, likely thrombus was noted in the right atrium (Fig. 2A), with a mobile mass adherent to the in-situ right atrial pacemaker lead. This was not apparent after review of previous echocardiographic and CT imaging but was present in spite of the patient having been adequately anti-coagulated for the preceding three months with vitamin K antagonists. Activated clotting time (ACT) was checked and was >250 s. It was decided that the case would proceed as planned, in view of the risk to the patient of abandoning the procedure and no further intervention that could be offered to make the procedure safer.

The interatrial septum was dilated with a 12-mm balloon, and an Edwards E sheath placed over the Safari wire. An Edwards 29 mm SAPIEN 3 THV prosthesis was mounted with the skirt on the left atrial side, positioned using both fluoroscopy and TEE (Figs. 1D & 2C), and deployed (Figs. 1E & 2D). The Safari wire was withdrawn, but the stiff Amplatzer wire left in position. The iatrogenic atrial septal defect was closed with a Figulla Flex II device to avoid the right atrial clot moving to the left side, via an Occlutech 9F delivery sheath (Fig. 2E). TEE demonstrated a well seated TMVR with no transvalvular or paravalvular regurgitation (Figs. 1F & 2D). At 1-month follow-up, the patient was doing well, and echocardiogram demonstrated a well-functioning mitral prosthesis (mean MV gradient: pre-procedure 11 mm Hg; immediately post-procedure 3.7 mm Hg; and 1-month post-procedure 3.9 mm Hg) and no paravalvular or transvalvular regurgitation. In addition, there was no increase in the left ventricular tract outflow peak gradient following the procedure (pre-procedure 3.9 mm Hg, immediately post-procedure 3.7 mm Hg and 1-month post-procedure 3.3 mm Hg).

This case illustrates successful deployment of TMVR-in-MAC using an aortic THV and good short-term outcome. Whilst the use of a second support wire is not mandatory, in our experience when utilising the transseptal approach, we have found that the use of a single wire alone has on occasion made the delivery of the THV device across the septum, in spite of adequate pre-dilatation, challenging, and in one case not possible. The second wire also assists in co-axialising the device in the mitral orifice. However, the use additional wires can in itself be associated with higher rates of complication, it could predispose patients to increased risk of thrombus formation or pulmonary vein perforation. It is therefore important to always ensure the ACT is around 300 s. There is no data on the routine closure of septostomy following transseptal procedures and indeed this would preclude the majority of future transseptal procedures. It should be considered during the procedure if there is thought to be a high risk of paradoxical embolus (e.g. in the setting of right sided thrombus) or if there is a large residual shunt demonstrated at follow-up.

The possibility of a right atrial thrombus was identified intraprocedurally on TEE and was not adherent to procedural material (catheters or guidewires) but to previously implanted pacemaker wires. In cases where it is related to hardware introduced to perform the procedure, then it should be removed, flushed with the ACT checked prior to proceeding prevent further thrombus formation and risk of embolus.

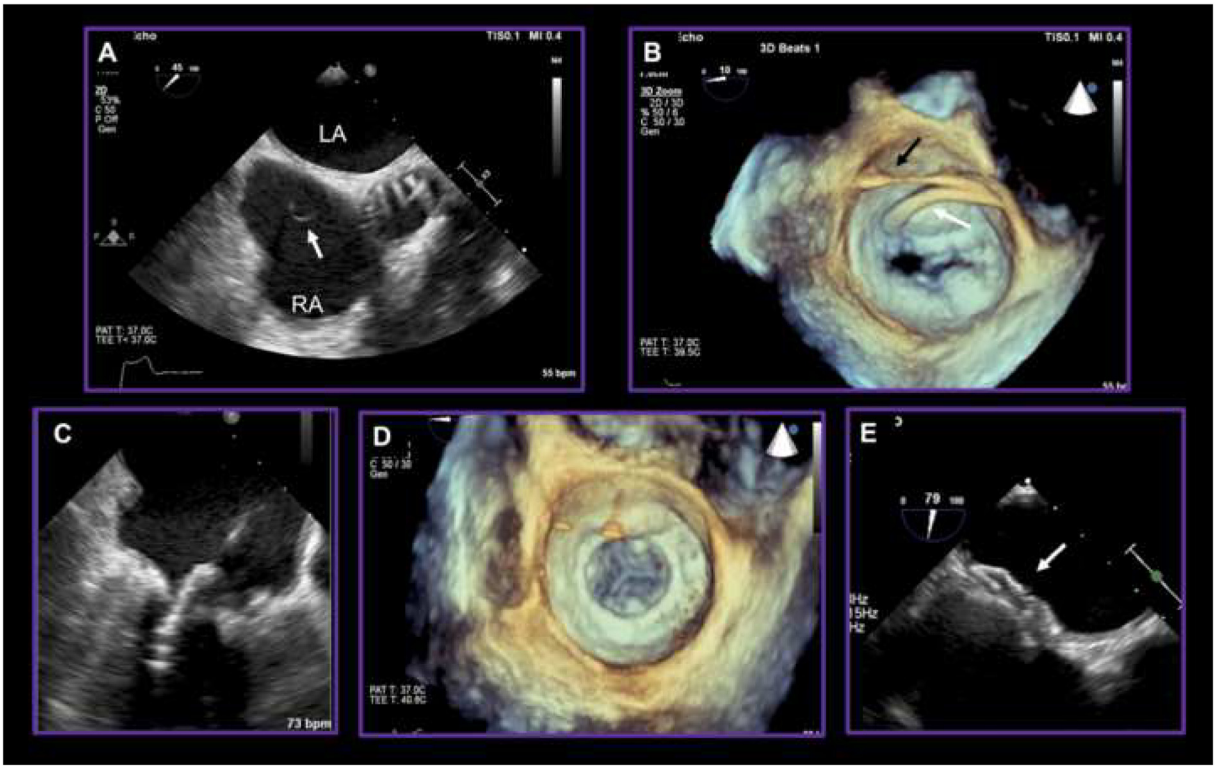

Fig. 2. A. Transesophageal (TEE) imaging demonstrating thrombus (white arrow) in right atrium (RA). B. 3D TEE reconstruction imaging demonstrating mitral stenosis with Agilis sheath directed from transseptal position to left atrium across mitral valve (white arrow). The Amplatz wire is seen in the Pulmonary vein (black arrow). C. TEE demonstrating positioning of TMVR prosthesis in mitral annular calcification (MAC). D. 3D TEE imaging of deployed TMVR. E. TEE imaging of successfully deployed Figulla Flex II device to close iatrogenic ASD (white arrow).

TMVR procedures are associated with a high risk of complication. A multicentre global registry reported rates of 6.25% for valve embolization, 17.2% need for second THV implantation in mitral position, a 9.3% of LVOT obstruction and a 30-day all-cause mortality of 29.7% [1]. In our case, we calculated that the mean aorto-mitral angle was relatively obtuse (115°) and with residual LVOT surface area of 298.2mm^2, both these parameters suggest a low risk for obstruction. Acute aorto-mitral angles (>120°) and reduced residual surface areas (<280 mm^2) have been associated with higher risk of obstruction with a significant proportion of patients considered for TMVR-in-MAC being excluded due to high risk of LVOT obstruction [2].

Therefore, careful patient selection, with particular attention to the size of the mitral annulus (perimeter, diameter and area), extent of annular calcification (circumferential ideally), and characterisation of the aorto-mitral angle pre-procedurally in addition to peri-procedural multi-modality imaging (TEE and fluoroscopy) is essential to achieving a good outcome.

Disclosures

Dr. Ghada W. Mikhail has one conflict of interest: Edwards Lifesciences is one of the major financial sponsors of the annual Imperial Valve and Cardiovascular Course (IVCC) of which she is Course Director.

None of the other authors have any conflicts of interest.

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