Utilization of two- and three-dimensional transesophageal echocardiography in successfully guiding transcatheter mitral valve in bioprosthetic mitral valve/mitral ring implantation without complications in patients with thrombus in left atrium/left atrial appendage.

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Abstract

Background. The presence of thrombus in the left atrial appendage (LAA) and/or LA body has so far been considered a contraindication to the transcatheter mitral valve (MV) in bioprosthetic MV/ MV annuloplasty ring implantation. **Objective.** The aim of this study is to describe, for the first time to our knowledge, the utilization of both two-dimensional (2D) and three-dimensional (3D) transesophageal echocardiography (TEE) in successfully performing without any embolic or other complications transcatheter MV in bioprosthetic MV/ mitral ring implantation using the apical approach in a group of 12 patients (pts) with co-existing LAA and/or LA body thrombus. **Patients, Methods and Results.** All pts were severely symptomatic with severe bioprosthetic MV stenosis in 9, severe native MV stenosis with a previous surgically inserted MV annuloplasty ring in 1 and severe MV regurgitation secondary to bioprosthetic cusp rupture in 2 pts. Thrombus in the LAA and/ or LA body was noted in all pts by 2D and 3DTEE. All pts were at high or prohibitive risk for surgery and all refused surgery. Utilizing both 2D and 3DTEE, especially 3DTEE, the guidewires and the prosthesis deployment system could be manipulated under direct vision through the MV bioprosthesis into the LA and left superior pulmonary vein bypassing and avoiding any contact with the thrombus. The transcatheter procedure was successfully accomplished in all patients with relief of stenosis/ regurgitation and amelioration of symptoms with no embolic or other complications during the procedure and over a mean follow-up period of 21 months. **Conclusion.** Our small study demonstrates the feasibility of successfully performing transcatheter MV in bioprosthetic MV/ MV annuloplasty ring procedure in pts with thrombus in LAA and/or LA body without any embolic or other complications.

Introduction

Bioprosthetic valves and atrio-ventricular valve annuloplasty rings are increasingly used because the need for anticoagulants essential for mechanical valves to avoid thrombosis can be obviated. However, these valves are prone to degeneration and significant stenosis and/or regurgitation may occur within a decade of implantation.[1] Annuloplasty rings have also failed resulting in significant valvular or para-ring regurgitation. Repeat surgery in these patients who are often elderly and have other comorbidities such as chronic renal failure carries a high mortality.[2] Because of this, procedures requiring minimal, or no surgery

have come into vogue. One such approach is transcatheter prosthetic mitral valve (MV) implantation in previously surgically implanted degenerated bioprosthetic mitral valves or rings using the transapical or transseptal approach.[3,4]These approaches have proven successful in the short term and in some studies over the long-term.[5,6] It is well known that the presence of intracardiac thrombus is a contraindication to these transcatheter procedures because of fear of thrombus fragmentation and dislodgement resulting in systemic embolization. This represents a challenge for severely symptomatic patients with degenerated mitral prosthetic valves or rings and thrombus in the left atrial appendage (LAA)/left atrium (LA) body who are at high or prohibitive risk for redo MV surgery or refuse surgery. In the present study, we present our experience in these patients in utilizing two-dimensional (2D) and three-dimensional (3D) transesophageal echocardiography (TEE) to carefully bypass the thrombus without disrupting it in any way during transcatheter MV in bioprosthetic MV/mitral ring implantation using the apical approach. This procedure carefully performed under the guidance of 2D and 3DTEE as well as fluoroscopy resulted in no embolic or other complications during the procedure or in the follow up period.

Materials and Methods (Figures 1A-C, 2A-C, 3A-B, 4A-C and 5A-B. Movies 1A-Q, 2A-E, 3A-E, 4A-E, 5A-I).

In our medical center between 2016 and 2021, a total of 80 adult patients have undergone transcatheter MV in surgically implanted bioprosthetic MV with degeneration resulting in severe stenosis or regurgitation (77 patients) or in severely stenotic native MV with a surgically inserted mitral annuloplasty ring for severe MV regurgitation (3 patients) using the apical approach. Of these, 68 patients had no thrombus in the LAA or LA body. The remaining group of 12 patients (8 females, 4 males, mean age 65.6 years, range 55 to 78 years) with thrombus in LAA, LA body or both form the basis of our study. All were severely symptomatic (New York Heart Association, NYHA, functional class III or IV) with severe bioprosthesis MV stenosis in 9 and severe mitral regurgitation in 2 patients by two-dimensional transthoracic echocardiography (2DTTE). The remaining patient had severe native mitral valve stenosis status post a surgically inserted Sorin (Sorin Group USA, Inc. CO, USA) mitral annuloplasty ring for severe MV regurgitation 4 years previously. One of these 12 patients had a second transcatheter MV in bioprosthetic MV procedure following re-development of severe bioprosthetic MV stenosis and thrombus in LAA 2 years and 8 months after the first procedure. Thus, these 12 patients underwent 13 transcatheter MV in valve procedures. All patients had serious comorbidities which presented a high or prohibitive risk for redo surgery and all refused surgery (Table 1).[7] The decision to go ahead with transcatheter MV implantation in these circumstances was made by a multidisciplinary team consisting of cardiologists, anesthesiologists and cardiac surgeons.

During the procedure, all patients underwent 2DTEE and 3DTEE using a Philips (Philips Ultrasound Inc, Bothell, WA, USA) EPIQ 7 system and an x7-2t or x8-2t transducer The mean pressure gradient across the degenerated bioprosthetic MV by 2DTEE ranged from 10 and 24 mmHg and the MV orifice area by planimetry using 3DTEE ranged from 0.56 to 1.09 cm^2 in all patients with stenosis. In the 2 patients with bioprosthetic MV regurgitation, the vena contracta areas by 3DTEE were 1.25 cm^2 and 0.44 cm^2, respectively, indicative of severe regurgitation. Eight patients had thrombus by both 2D and 3DTEE in the LAA extending to the adjacent LA body, three patients had thrombus confined to LAA and the remaining patient had thrombus located in the LA body only. In the patient with a second procedure, the thrombus was confined to LAA. In all patients including the patient with a redo procedure, the thrombus was larger by 3DTEE as compared to 2DTEE with the thrombus area ranging from 1.39 to 17.74 cm^2 by 3DTEE. The thrombus volume by 3DTEE calculated using the TOMTEC (TOMTEC Imaging Systems GmbH, Unterschleissheim, Germany) software ranged from 1 to 26 ml. The thrombus was noted to be mobile in 2 patients and another patient with a fixed thrombus had mobile components. These were detected by both 2D and 3DTEE. Areas of echolucencies within the thrombus consistent with thrombus lysis/dissolution were noted in all patients by both 2D and 3DTEE.[8,9] The maximum echolucent area in each thrombus was found to be larger by 3DTEE than 2DTEE (Table 2). Left and right ventricular function and other associated echocardiographic findings in each patient are also listed in Table 2. One patient with a previous successful transcatheter aortic valve replacement was noted to have developed severe prosthetic aortic valve stenosis with a mean pressure gradient of 41 mmHg.

In all patients, systematic and meticulous cropping of 3D datasets was used to comprehensively evaluate as much of the LA and LAA as possible to exclude any additional thrombus or any other structural abnormality which could pose a hazard during the transcatheter procedure. Determination of the size of the prosthetic MV to be implanted and other parameters such as left ventricular outflow tract size were determined using echocardiography and computed tomography scans as described previously.[10]

Procedure and Results

The transcatheter MV implantation procedure was conducted in a standard manner under general anesthesia in all patients using the transapical approach.[11] Under both 2DTTE and 3DTEE vision, a guidewire was inserted into the left ventricle through a small incision in the fifth or sixth intercostal space in the apical area guided by 2DTTE. Using both 2D and 3DTEE guidance in addition to fluoroscopy, the guidewire was advanced into the malfunctioning bioprosthesis/ring. Thereafter, it was very carefully and slowly advanced into the LA body and left upper pulmonary vein making sure there was no contact with the thrombus whose location and size were well displayed by both 2D and 3DTEE. Biplane imaging by 2DTEE and careful and systematic cropping of 3DTEE datasets were most helpful in delineating under direct vision the relationship between the thrombus and guide wires used as well as the larger prosthesis delivery system. Thus, thrombus fragmentation and/or dislodgement were avoided. All transcatheter implantations were successfully performed as previously described using a balloon-expandable transcatheter heart valve (Edward Sapien 3, XT, Edwards Lifesciences, Irvine, CA, USA or Lotus, Boston Scientific, Marlborough, Maryland, USA).[12] The average duration of the procedure was 122.8 minutes, with a range of 54 to 210 minutes. The patient with associated severe prosthetic aortic valve stenosis also underwent successful redo transcatheter aortic valve in valve implantation during the same procedure. In all patients, the newly implanted prosthetic MV in valve showed unrestricted motion with no paravalvular and none or only trivial valvular regurgitation. The mean mitral prosthetic valve gradients following implantation ranged from 2 to 7 mmHg. None of the patients showed any clinical, laboratory or other evidence of embolization during or immediately following the procedure as well as during the follow up period which ranged from 3 to 36 months with a mean of 21 months. Both left and right ventricular function as well as other associated valvular and other findings remained unchanged as compared to before the procedure. All patients also had amelioration of their symptoms.

Discussion

To the best of our knowledge, this is the first report describing a group of patients in whom transcatheter prosthetic MV implantation utilizing the transapical method was accomplished for a severely degenerated MV prosthesis or severe native MV stenosis status post a surgically inserted mitral annuloplasty ring with co-existing thrombus in the LAA and/or LA body. In a prior publication comparing surgical versus transcatheter MV in prosthetic MV patients, two patients with thrombus in the LA were listed in a table, but there was no further mention and no other details were provided in the published manuscript.[12] Since fluoroscopy does not visualize intracardiac thrombi, use of both 2D and 3DTEE was essential in finding the location and other attributes of the thrombi such as their size and extent in our patients and guiding the transcatheter procedure such that there was no contact with the thrombus at any time. Although in all our patients, the procedure could be successfully performed avoiding any disruption of the thrombus, it may be difficult to avoid it if the thrombus involved the prosthetic valve or was very close to it or was closely related to other anatomic landmarks normally used during the procedure such as the left upper pulmonary vein. However, in all our patients, the thrombus did not involve any of these sites by both 2D and 3DTEE further ensuring a successful outcome without any complications.

3DTEE provided incremental value over 2DTEE in more comprehensively assessing both the LAA and LA body for the presence and exact sites of location of thrombus, its size, shape and mobility characteristics as well as thrombus volume which is a superior parameter of size than thrombus area measured by planimetry.[9,13,14] These findings helped the operator in carefully guiding the guide wire and the prosthesis deployment system as they traversed through the degenerated bioprosthetic MV/native stenotic MV and annuloplasty ring into the left atrium bypassing the thrombus. In all our patients, 3DTEE, unlike 2DTEE,

also facilitated en face view of the degenerated bioprosthetic MV leaflets which permitted accurate measurement of the orifice area by planimetry.[15] In addition, color Doppler en face views of vena contracta of the mitral regurgitant jet facilitated measurement of vena contracta areas permitting more accurate assessment of regurgitation severity.[16] 3DTEE also provided increased confidence level during deployment of the MV prosthesis. Another additive value of 3DTEE was the ability to ensure the absence of any residual valvular or paraprosthetic MR following the procedure with a greater degree of certainty than using 2DTEE alone since the prosthesis could be viewed in multiple projections.

Conclusion

Our series of 12 patients shows the feasibility of successfully performing transcatheter bioprosthetic MV in surgically implanted degenerated MV prostheses or severe native MV stenosis following a surgically implanted mitral annuloplasty ring in patients with thrombus present in the LAA and/or LA body. Utilization of both 2D and 3DTEE especially 3DTEE was essential in avoiding contact with the thrombus and preventing any embolic complications. Our number of cases is small, and a much larger study is needed to assess the safety and efficacy of this procedure in such patients.

Conflicts of Interest

All authors declared that there are no conflicts of interest.

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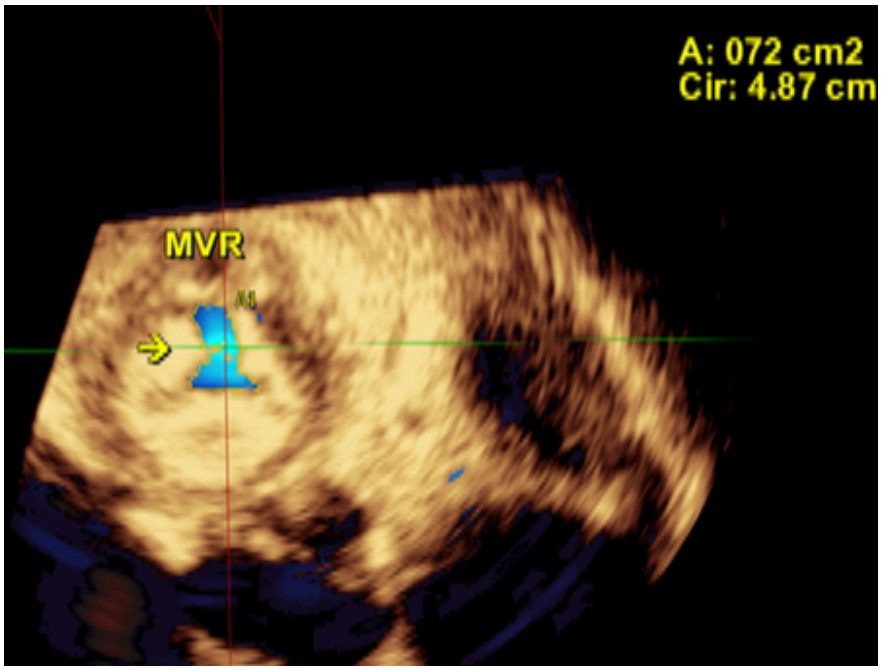

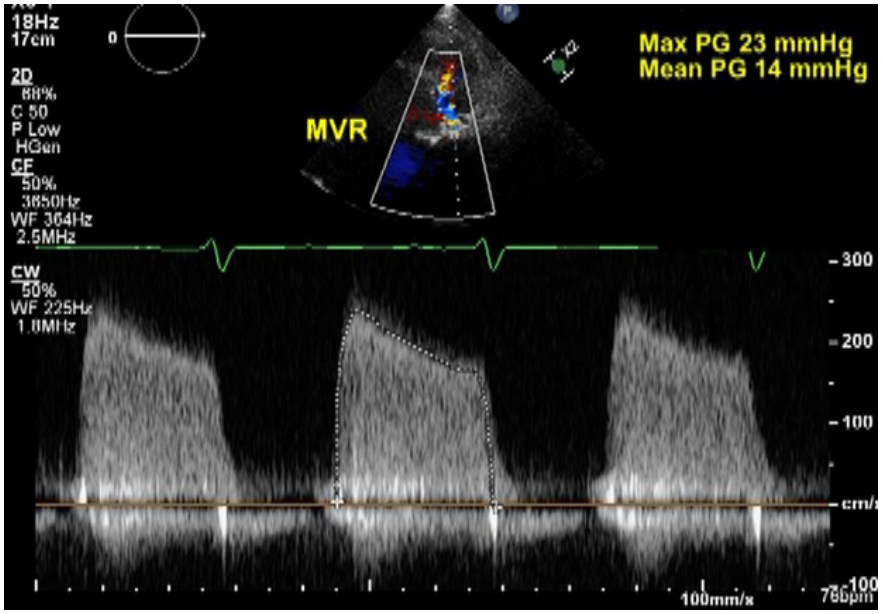

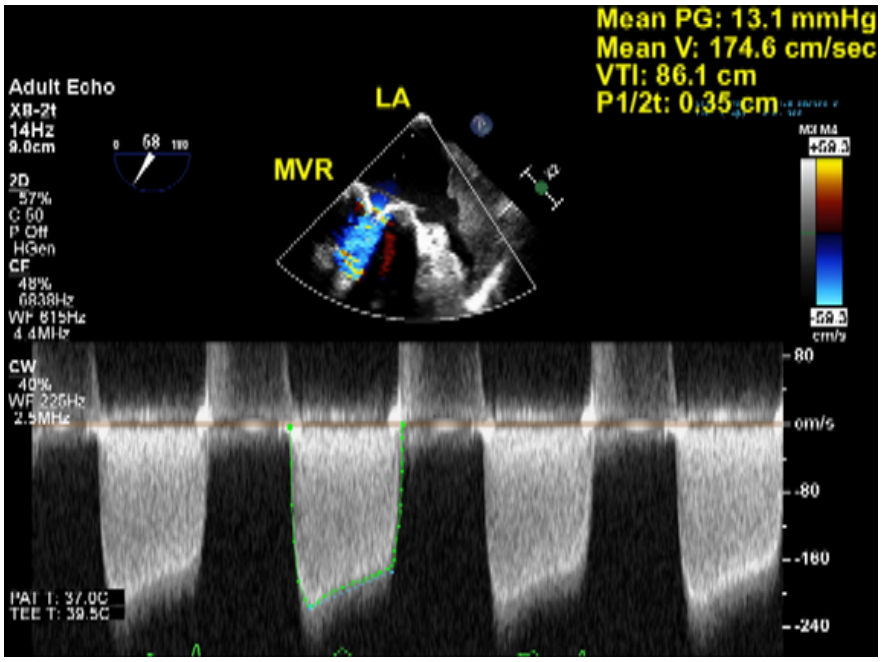

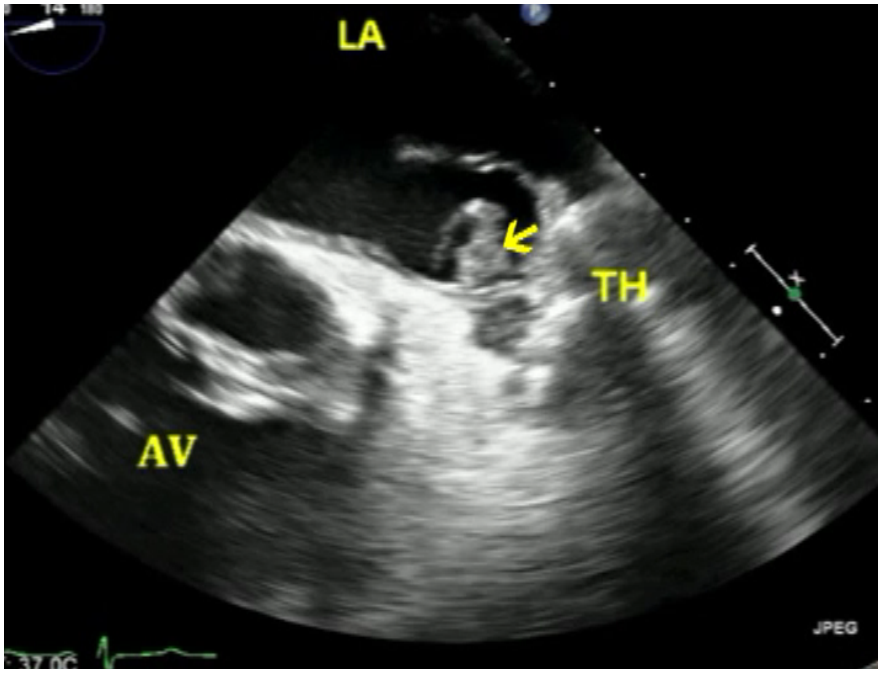

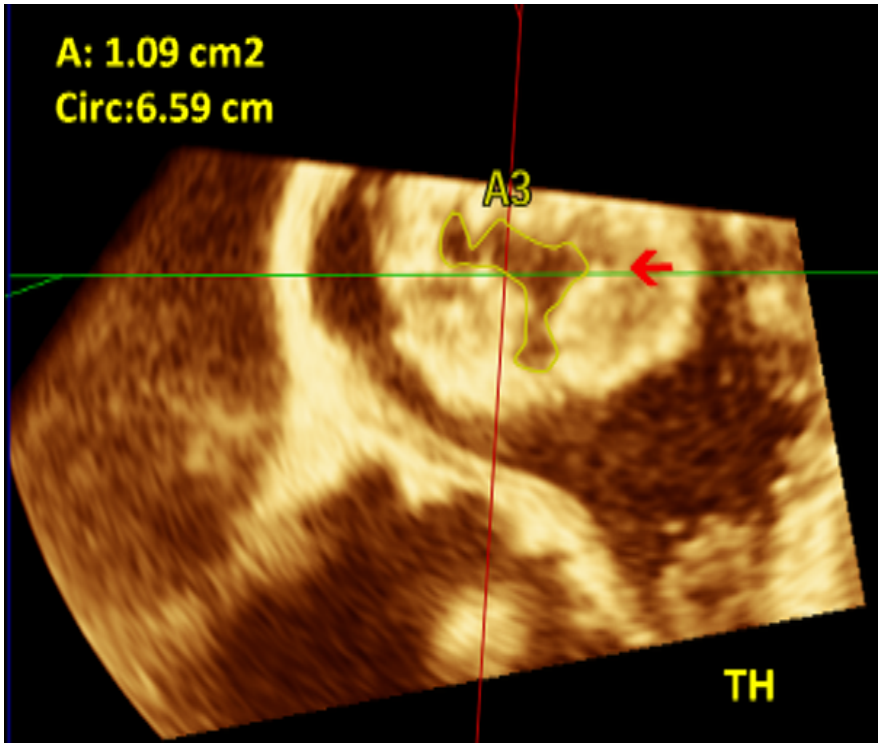

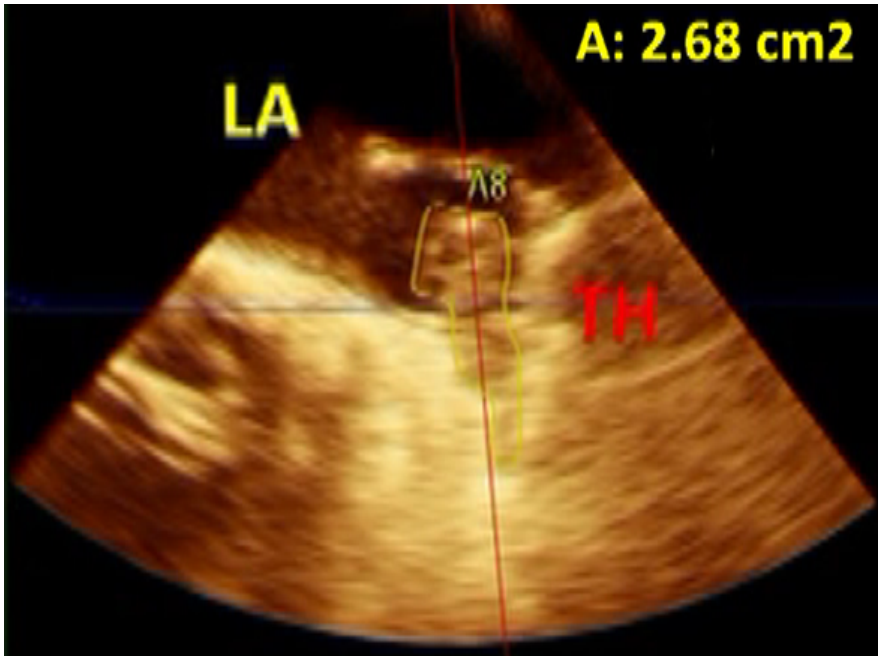

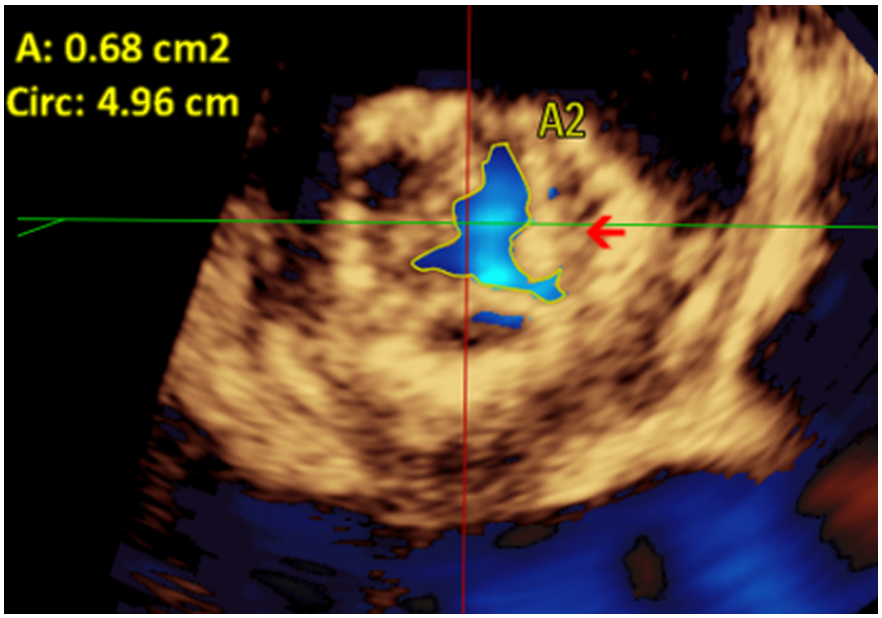

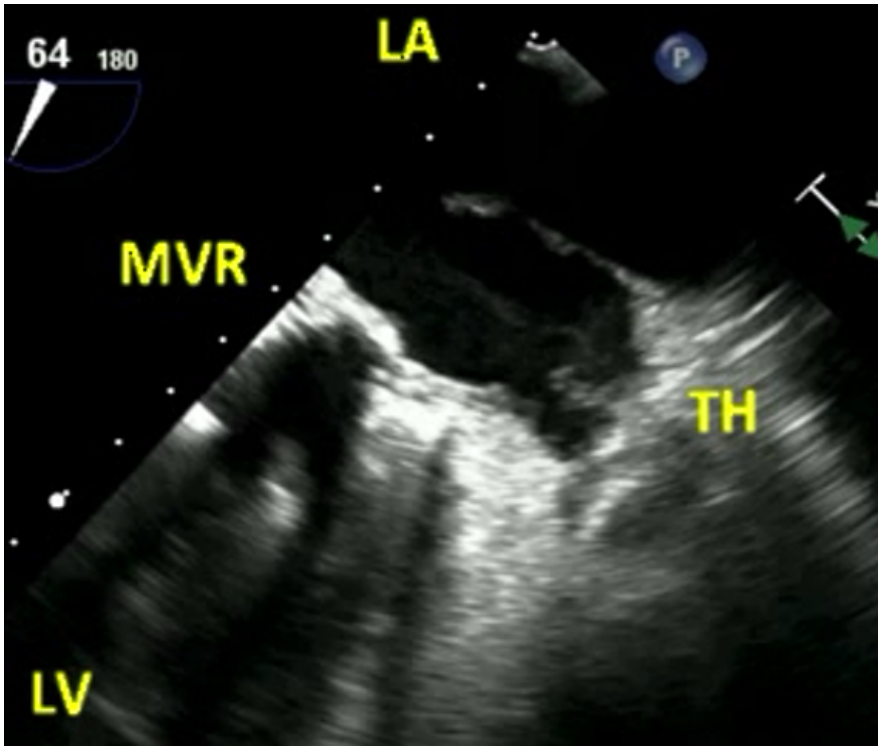

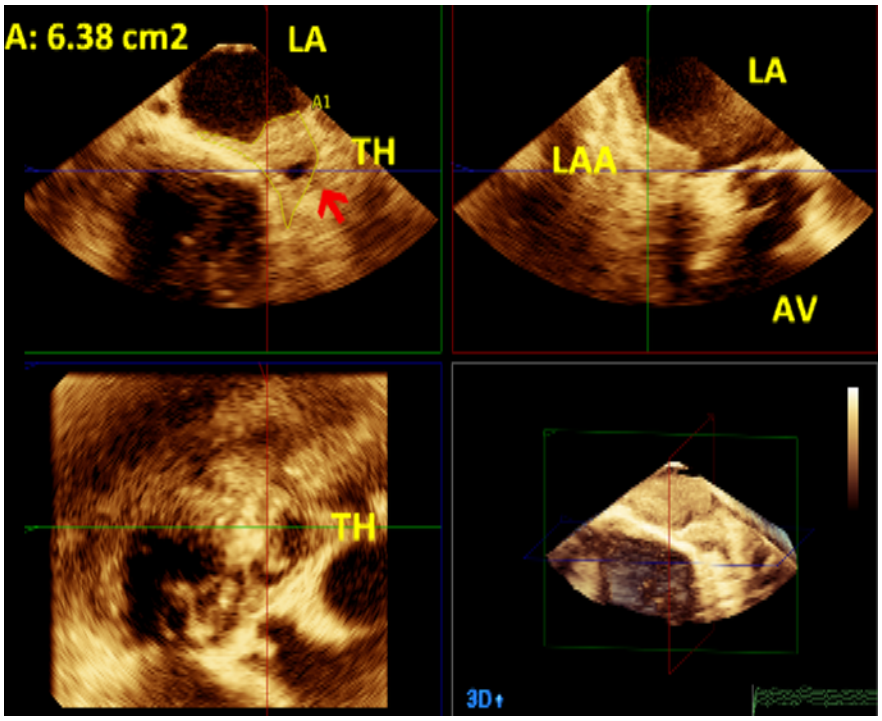

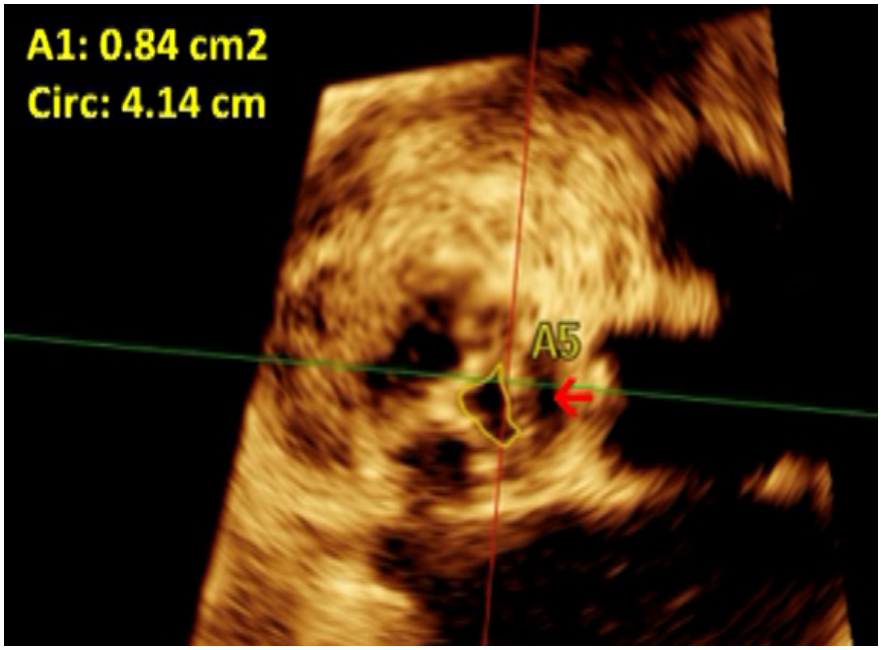

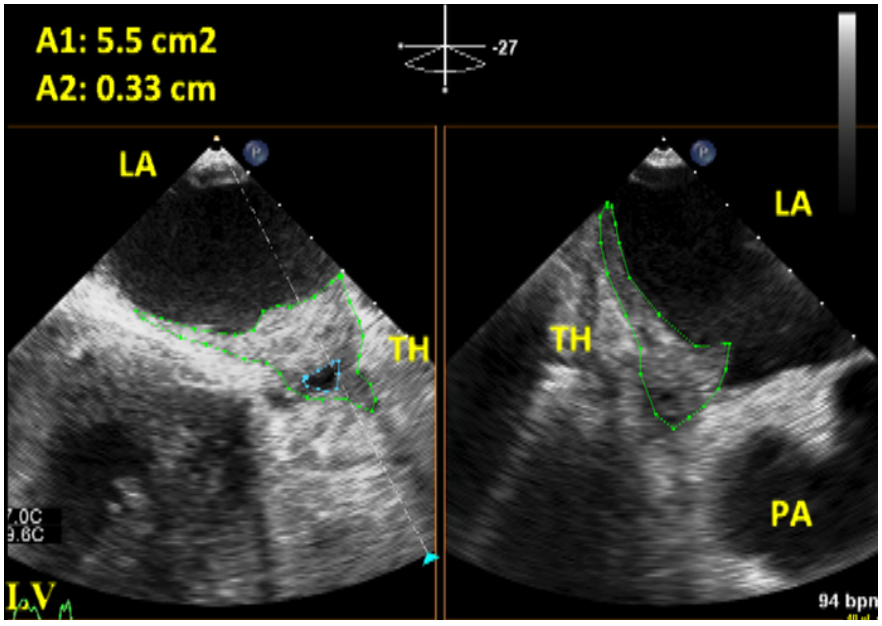

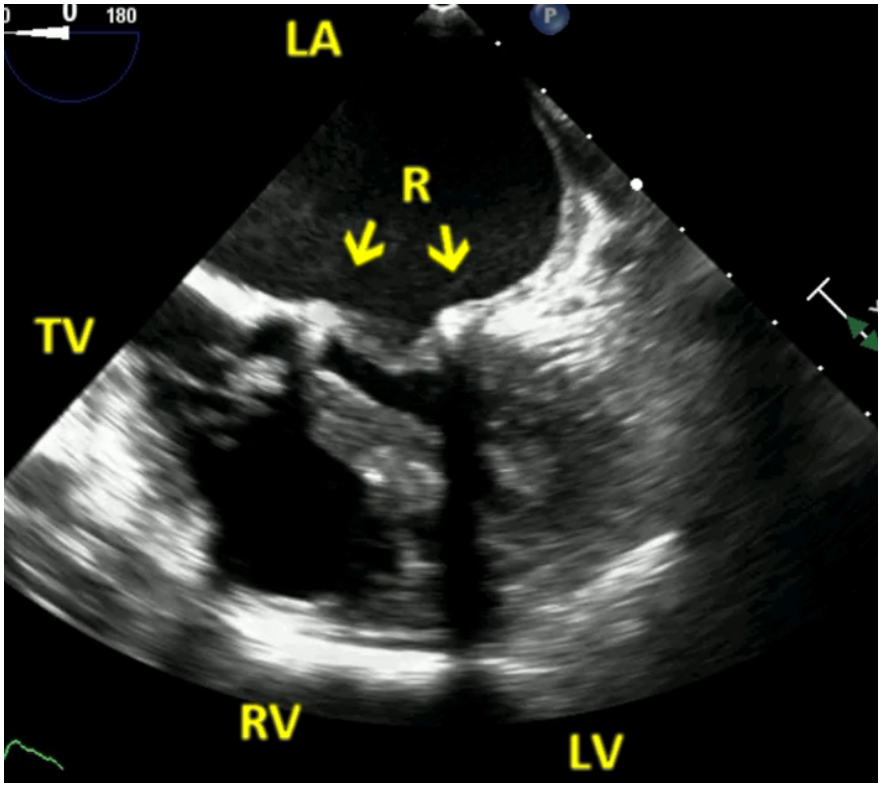

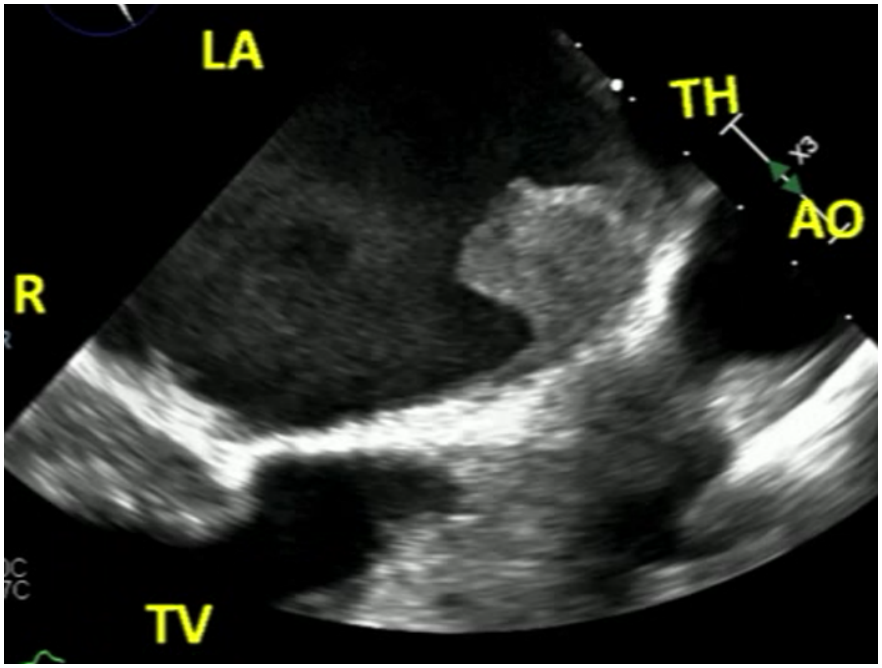

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