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MINI-FOCUS ISSUE ON VALVULAR HEART DISEASE

INTERMEDIATE

CASE REPORT: CLINICAL CASE

Be Prepared for the Unexpected

Importance of Careful Intraprocedural Transesophageal Echocardiography Assessment During MitraClip

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ABSTRACT

Transesophageal echocardiography plays a central role in the evaluation and guidance of mitral valve interventions. Our case highlights the importance of thorough intraprocedural valve evaluation using 3-dimensional and multiplanar reconstruction transesophageal echocardiography, discovering an unexpected mechanism for mitral regurgitation, to guide an alternative intervention strategy by an experienced interventional team. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2020;2:549-54) © 2020 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

A 68-year-old woman presented to the cardiology clinic at an outside hospital with progressive dyspnea on minimal exertion to New York Heart Association functional class III for the last 3 months with 5 kg weight gain and leg swelling. She denied recent chest pain, palpitations, lightheadedness/syncope, and infective symptoms. Her physical examination was significant for blood pressure 92/58 mm Hg, afebrile 36.4°C, body mass index 28 kg/m^2, grade 2/6 pan-systolic murmur at the apex, and bilateral leg edema, although her heart rate was regular at 76 beats/min and lungs were clear to auscultation.

LEARNING OBJECTIVES

- To highlight the critical role of TEE including 3D multiplanar reconstruction techniques for thorough evaluation of mitral valve pathology.
- To illustrate the importance of intraprocedural TEE for guidance of percutaneous mitral valve repair.
- To discuss the potential etiologies for mitral valve regurgitation and perforation.

PAST MEDICAL HISTORY

The patient had known moderate-severe mitral regurgitation (MR) under surveillance since 1 year prior. She had a mixed cardiomyopathy from ischemic heart disease with previous non-ST-segment elevation myocardial infarction, percutaneous coronary intervention to the left anterior descending artery, and implantable cardioverter-defibrillator all in 2010, as well as adriamycin and trastuzumab chemotherapy use for metastatic breast cancer. She also had type 2 diabetes, hypertension, hyperlipidemia, pulmonary

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ABBREVIATIONS AND ACRONYMS

3D = 3-dimensional multiplanar reconstruction

MR = mitral regurgitation

TEE = transesophageal echocardiogram

embolism with an inferior vena cava filter, and osteoarthritis with hip and knee joint replacements. Her cardiac medications included apixaban 2.5 mg twice daily, carvedilol 12.5 mg twice daily, losartan 12.5 mg daily, spironolactone 25 mg daily, furosemide 40 mg daily, and atorvastatin 40 mg daily, as well as ado-trastuzumab emtansine for breast cancer. She was retired and a nonsmoker, and her family history was significant: her father had a stroke, and her sister also had breast cancer.

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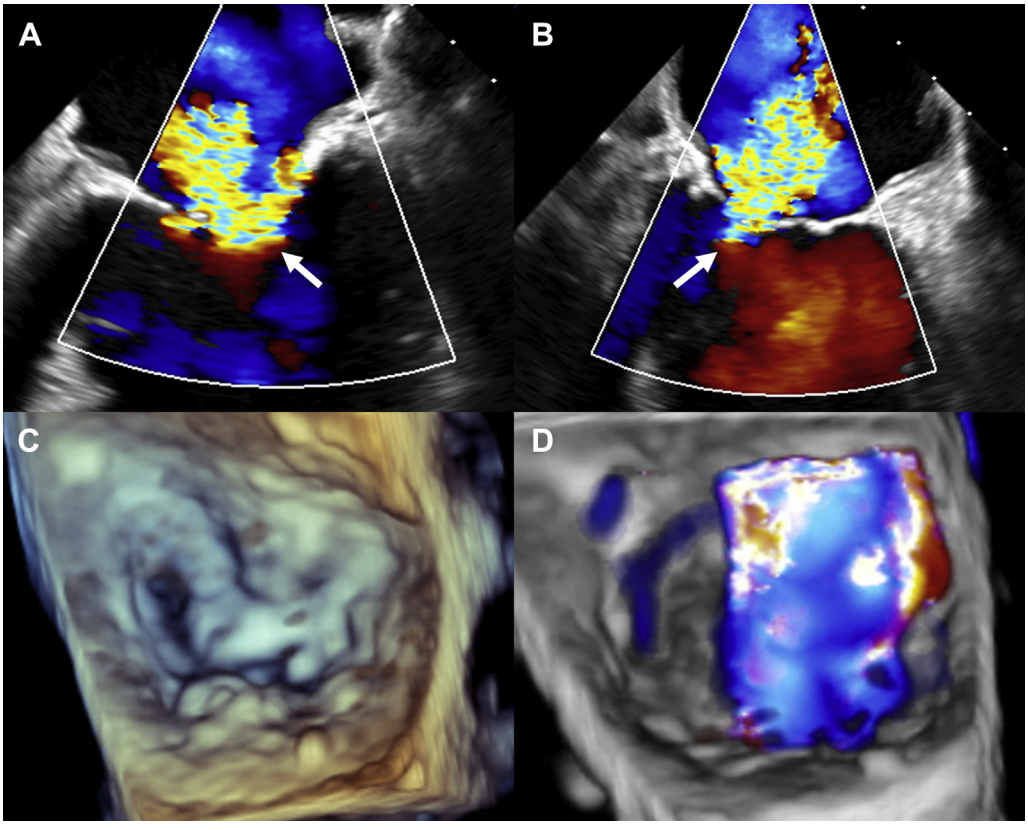
DIFFERENTIAL DIAGNOSIS

The patient's dyspnea was most likely a result of heart failure decompensation from severe MR, and her underlying cardiomyopathy of mixed etiologies also contributed. The MR was most likely functional from her mixed cardiomyopathy, although other possible etiologies included degenerative or myxomatous prolapse, degenerative/calcified restriction of leaflets, rheumatic heart disease, endocarditis, and connective tissue disease.

INVESTIGATIONS

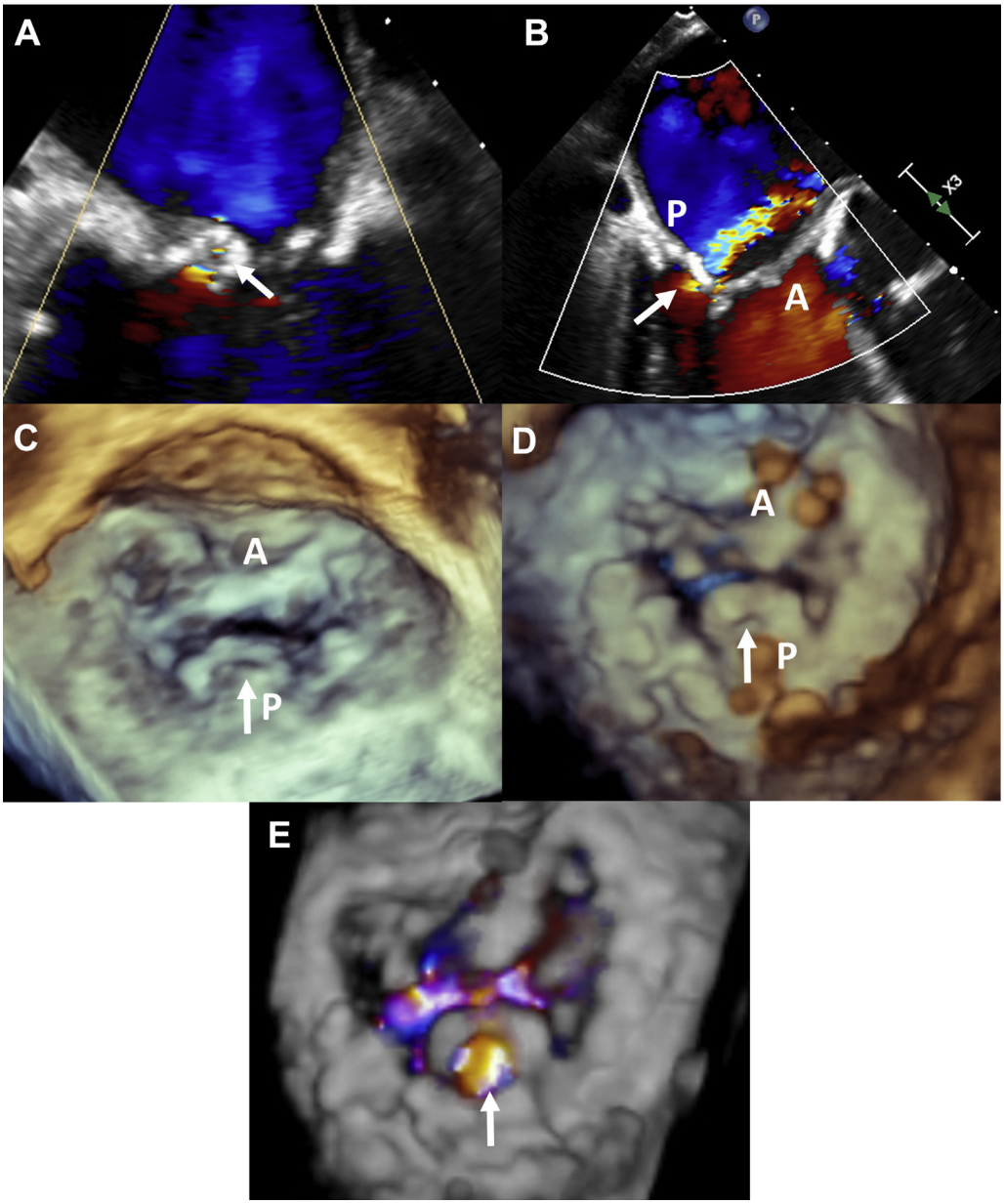
Electrocardiogram showed a regular paced rhythm, and chest x-ray showed cardiomegaly without signs of pulmonary edema or consolidation. Significant blood test findings were N-terminal pro-B-type natriuretic peptide of 2,022 pg/ml, creatinine 1.39 mg/dl (estimated glomerular filtration rate 38 ml/min/1.73 m^2), and negative inflammatory markers (C-reactive protein 0.96 mg/dl, white cells 6.0 $\times$ 10^3/ul). Outside hospital transthoracic echocardiogram found severe MR possibly attributed to restrictive mitral valve leaflets motion, severely dilated left ventricle with ejection fraction 35% and regional wall motion

FIGURE 1 Pre-Procedural Transesophageal Echocardiogram Evaluation of Mitral Regurgitation



(A) Mid-esophageal bicommissural view with color Doppler; **(B)** long-axis view with color Doppler; **(C)** 3-dimensional mitral valve en face view from the left atrium; and **(D)** mitral valve en face view from the left atrium with color. **White arrows** indicate mitral regurgitation. All color Doppler images taken during systole.

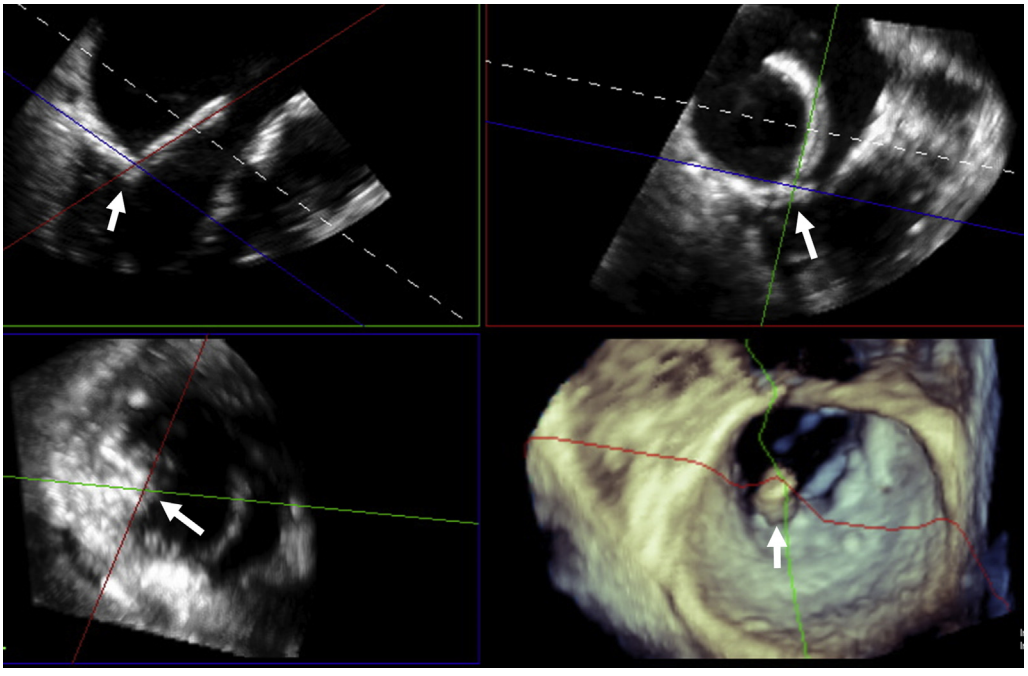
FIGURE 2 **Intraprocedural Transesophageal Echocardiogram Evaluation of Mitral Regurgitation**



(A) Mid-esophageal mitral bicommissural view with color Doppler; **(B)** long-axis view with color Doppler; **(C)** 3-dimensional mitral valve en face view from left atrium; **(D)** from the left ventricle; and **(E)** from left ventricle with color Doppler. **White arrows** indicate mitral valve perforation site. All color Doppler images taken during systole. A = anterior leaflet; P = posterior leaflet.

abnormalities (akinesis of the anteroseptum and apex, hypokinesis elsewhere), normal right ventricular size and function, and moderate pulmonary hypertension (estimated pulmonary artery systolic pressure of 58 mm Hg). Transesophageal echocardiogram (TEE) was reported as severe MR from restricted thickened mitral valve leaflets (Figure 1), with similarly moderate left ventricular systolic impairment and normal right ventricular function, mild tricuspid regurgitation, and mild aortic stenosis. Coronary angiography showed her previous left anterior descending artery stent, but otherwise

FIGURE 3 3-Dimensional Transesophageal Echocardiogram With Multiplanar Reconstruction Guidance of Mitral Valve Perforation Closure



White arrows indicate mitral valve perforation site.

showed mild nonobstructive diffuse coronary artery disease. She was referred to our center for consideration of mitral valve repair.

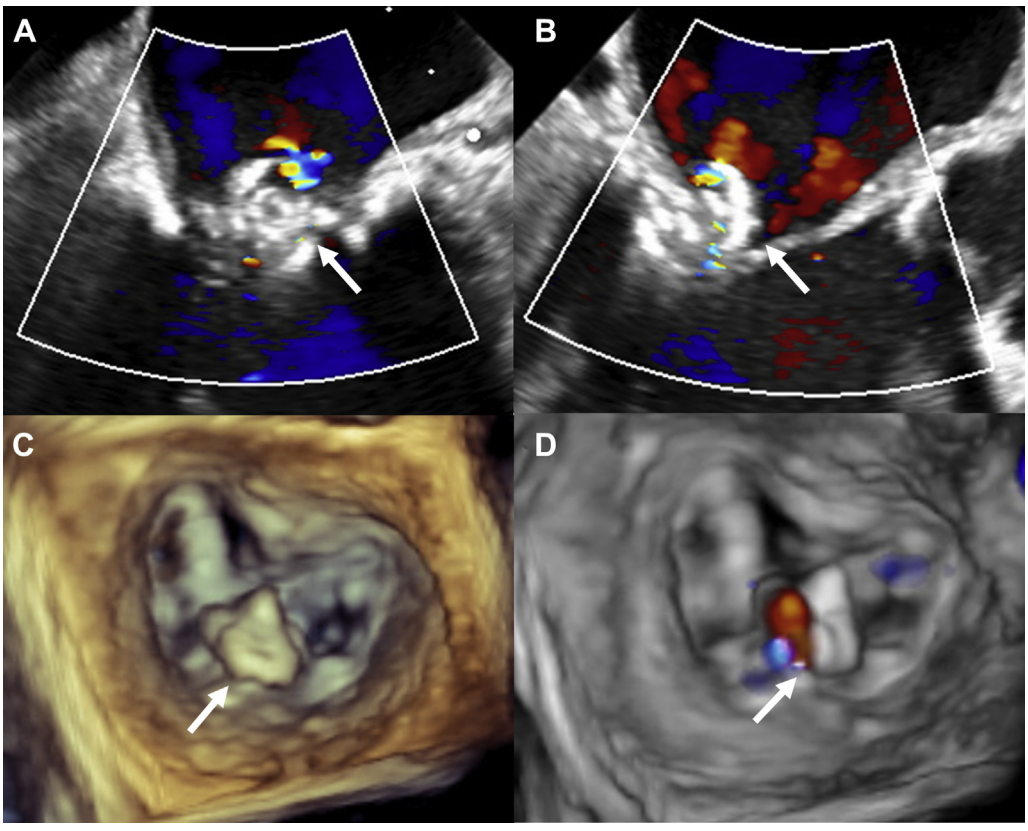
MANAGEMENT

Upon review of the outside hospital clinical data and the patient's high surgical risk, our multidisciplinary team's decision was to proceed with elective percutaneous MitraClip (Abbott, Abbott Park, Illinois) repair in the hybrid cardiac theater. General anesthesia induction was administered, followed by TEE evaluation on table. The MR jet was anteriorly directed and appeared to pass through the middle of the posterior mitral valve leaflet rather than commissures (**Figures 2A and 2B**, Video 1). Three-dimensional (3D) multiplanar reconstruction of the mitral valve was performed, revealing a perforation of the P_2 scallop of the mitral valve, measured at 5 × 4 mm (12.5 mm^2 area), as the mechanism for severe MR (**Figures 2C to 2E**, Video 2). The intervention plan was therefore switched from MitraClip to closure of mitral perforation under TEE and fluoroscopy guidance. After the transseptal puncture, an Agilis 8.5-F sheath (Abbott) crossed to the left atrium for delivery of the Amplatzer (Abbott) occluder 5 × 6 mm device. Under 3D multiplanar reconstruction, the catheter with the device was directed toward the mitral valve and crossed through the mitral leaflet perforation, followed by deployment with sealing of the perforation (**Figure 3**). This was successfully undertaken, with mild MR on post-procedure TEE, peak/mean transmitral gradients of 4/2 mm Hg, and no procedural complications (**Figure 4**).

DISCUSSION

Percutaneous mitral valve repair has gained popularity over the last decade and is considered for severe symptomatic degenerative or functional MR in high-risk surgical candidates, with proven efficacy from randomized trials (1–3). TEE continues to be the modality of choice in MR evaluation, to quantify severity, understand mechanism and etiology, and for guiding percutaneous mitral interventions (4,5). Our case illustrates the importance of thorough echocardiographic evaluation including 3D imaging prior to intervention, with the unexpected mitral leaflet perforation seen altering the strategy for treatment from MitraClip to Amplatzer occlusion

FIGURE 4 Mitral Valve Perforation Closure Result on Transesophageal Echocardiogram



(A) Mid-esophageal bicommissural view with color Doppler; **(B)** long-axis view with color Doppler; **(C)** 3-dimensional mitral valve en face view; and **(D)** en face view with color. **White arrows** indicate Amplatzer device. All color Doppler images taken during systole.

device. The exact pathological MR mechanism may be missed even with all of the tools available, necessitating careful assessment. The ability for 3D TEE with multiplanar reconstruction enables precise spatial delineation of the MR mechanism. It also provides real-time imaging guidance of the entire procedure from transseptal puncture to, most importantly, device positioning and orientation relative to the mitral valve pathology for intervention.

Speculating the underlying etiology for the patient's mitral valve perforation is also fascinating. Although infective endocarditis is the commonest cause, other possibilities limited to case reports include iatrogenic from cardiac surgery or interventions, connective tissue disease, aortic regurgitation jet, congenital mitral valve malformations, and spontaneous perforation (6,7). The etiology in our case was not immediately obvious, in the absence of previous diagnosis of all of the previously listed conditions or left heart surgery. On further review of her history from an outside hospital, she had an admission with Staphylococcus aureus bacteremia, attributed to pneumonia with negative TEE for vegetation and endocarditis almost 1 year prior. Being immunocompromised on chemotherapy does make her susceptible to severe infections. We therefore suspect previous infective endocarditis as the most likely cause for her mitral valve pathology. Mitral valve perforation is uncommon overall, where management should be individualized because percutaneous closure with Amplatzer device is off-label and rarely performed, and was successful here only because of the combination of an expert interventional team and accurate 3D-TEE guidance.

FOLLOW-UP

Repeat transthoracic echocardiogram at day 1 after the procedure continued to show mild MR with stable findings otherwise compared with pre-procedural echocardiogram, and the patient was discharged on

day 4. At the 1-month follow-up clinic appointment, her dyspnea significantly improved to at most New York Heart Association functional class II with no reported dyspnea, orthopnea, and leg swelling, and transthoracic echocardiogram showed trivial MR with otherwise similar results to the past—severe left ventricle dilation, ejection fraction 35%, and moderate pulmonary hypertension. She remained on the same dose of furosemide to continue with other cardiac medical therapy, for further clinical and echocardiographic follow-up in 12 months.

CONCLUSIONS

This case illustrates the importance of careful evaluation of mitral valve etiology and mechanism prior to intervention. Unexplained or uncertain findings on 2-dimensional transthoracic echocardiography and TEE can be clarified with 3-dimensional TEE and multiplanar reconstruction. Thorough intraprocedural valve evaluation on the table is mandatory to guide the best strategy for mitral valve intervention. Mitral valve perforation is uncommon, and percutaneous closure with the Amplatzer device is feasible by experienced interventional and cardiac imaging teams working together.

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KEY WORDS mitral regurgitation, percutaneous mitral repair, three-dimensional echocardiography, transesophageal echocardiogram

APPENDIX For supplemental videos, please see the online version of this paper.