

Making a Molehill out of a Mountain: A Case of Transesophageal Echocardiographic Probe Malfunction



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INTRODUCTION

Transesophageal echocardiography (TEE) plays a vital role in the diagnosis and management of valvular heart disease. Although image quality is superior than on transthoracic echocardiography (TTE), TEE has some limitations and pitfalls.¹ Image quality during TEE depends on several factors, including probe contact, host anatomy, device settings, and provider experience. Technical malfunction is a lesser known reason for poor image quality. Failure to recognize probe malfunction could lead to diagnostic errors.

We report a case of technical malfunction during TEE leading to potential misdiagnosis of mitral regurgitation (MR) severity. TTE in a patient being evaluated for coronary artery bypass surgery showed severe MR. TEE showed trivial MR. Probe malfunction affecting color Doppler was suspected. After second probe insertion, MR was reclassified as severe. Timely recognition of probe malfunction avoided underestimation of MR severity. The patient underwent successful surgical revascularization with mitral valve replacement.

CASE PRESENTATION

A 75-year-old woman with exertional dyspnea was found to have severe multivessel coronary artery disease and moderate (2+) MR during ambulatory cardiac catheterization. TTE demonstrated severe MR with an eccentric jet and preserved systolic function with an ejection fraction of 60% to 65% (Figure 1). Cardiothoracic surgery was consulted for coronary artery bypass grafting (CABG) with possible mitral valve repair. TEE was performed to assess the severity and mechanism of the MR.

After conscious sedation with midazolam and fentanyl, the transesophageal probe was inserted without difficulty. Initial two-dimensional (2D) images of the mitral valve were acquired in zoom mode. The image quality was suboptimal despite probe manipulation and adequate patient sedation. Poor probe contact was suspected, and 2D gain was increased (+20 dB) for better visualization. Mild prolapse of the A2 scallop of the anterior

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VIDEO HIGHLIGHTS

Video 1: Transesophageal images with color Doppler in commissural view showing trivial MR with first transesophageal probe.

Video 2: Transesophageal images with color Doppler in long-axis view showing trivial MR with first transesophageal probe.

Video 3: Transesophageal images with color Doppler (color Doppler gain +6.5 dB) in two-chamber view showing mild MR with first transesophageal probe.

Video 4: Transesophageal images with color Doppler in commissural view showing severe MR with second transesophageal probe.

Video 5: Transesophageal images with color Doppler in long-axis view showing severe MR with second transesophageal probe.

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mitral leaflet was noted (Figure 2). Subsequently, color Doppler analysis of the mitral valve was performed and demonstrated trivial MR in all standard views: midesophageal (four-chamber, commissural, two-chamber, and long-axis) and transgastric (two-chamber and short-axis). Blood pressure was 154/86 mm Hg, similar to that during TTE. Color Doppler gain was increased (+3.5 dB), but MR severity remained trivial (Figure 3, Videos 1 and 2). Probe temperature ranged between 39.5°C and 40.3°C during the color Doppler analysis. A drop in transmission power due to probe heating was suspected, as image quality remained suboptimal despite the increase in gain. Transmission power was increased without any change in MR severity. The remaining views of a complete transesophageal echocardiographic examination were performed. The left upper pulmonary vein was clearly visualized in its long axis just above the Coumadin ridge. Color Doppler was turned on to confirm the pulmonary vein location before pulsed-wave Doppler analysis. No color was noted within the left upper pulmonary vein, but pulsed-wave analysis demonstrated a good pulmonary vein waveform. A problem with color Doppler was suspected. Continuous-wave Doppler analysis of the MR showed a dense signal suggesting at least moderate MR. Color Doppler gain was further increased to +6.5 dB, which showed mild MR (Video 3).

Technical malfunction leading to underestimation of MR severity was suspected. The transesophageal probe was disconnected from the ultrasound system and connected to a new system without any significant change in image quality or MR

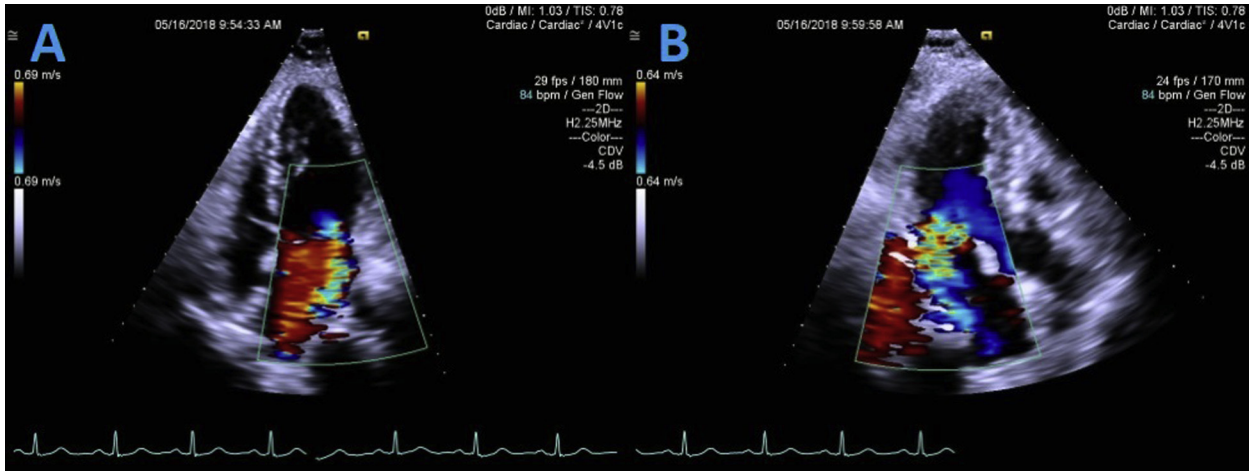


Figure 1 Transthoracic images with color Doppler showing severe MR with eccentric posteriorly directed jet. **(A)** Apical four-chamber view. **(B)** Apical three-chamber view.

severity. The patient was extubated, and a new probe was inserted. Color Doppler evaluation (color Doppler gain -0.5 dB) of the mitral valve with the new probe showed significant MR

with an eccentric, posteriorly directed jet (Figure 3, Videos 4 and 5). The effective regurgitant orifice area was 0.33 cm², and regurgitant volume was 67 mL (Figure 4). The patient successfully

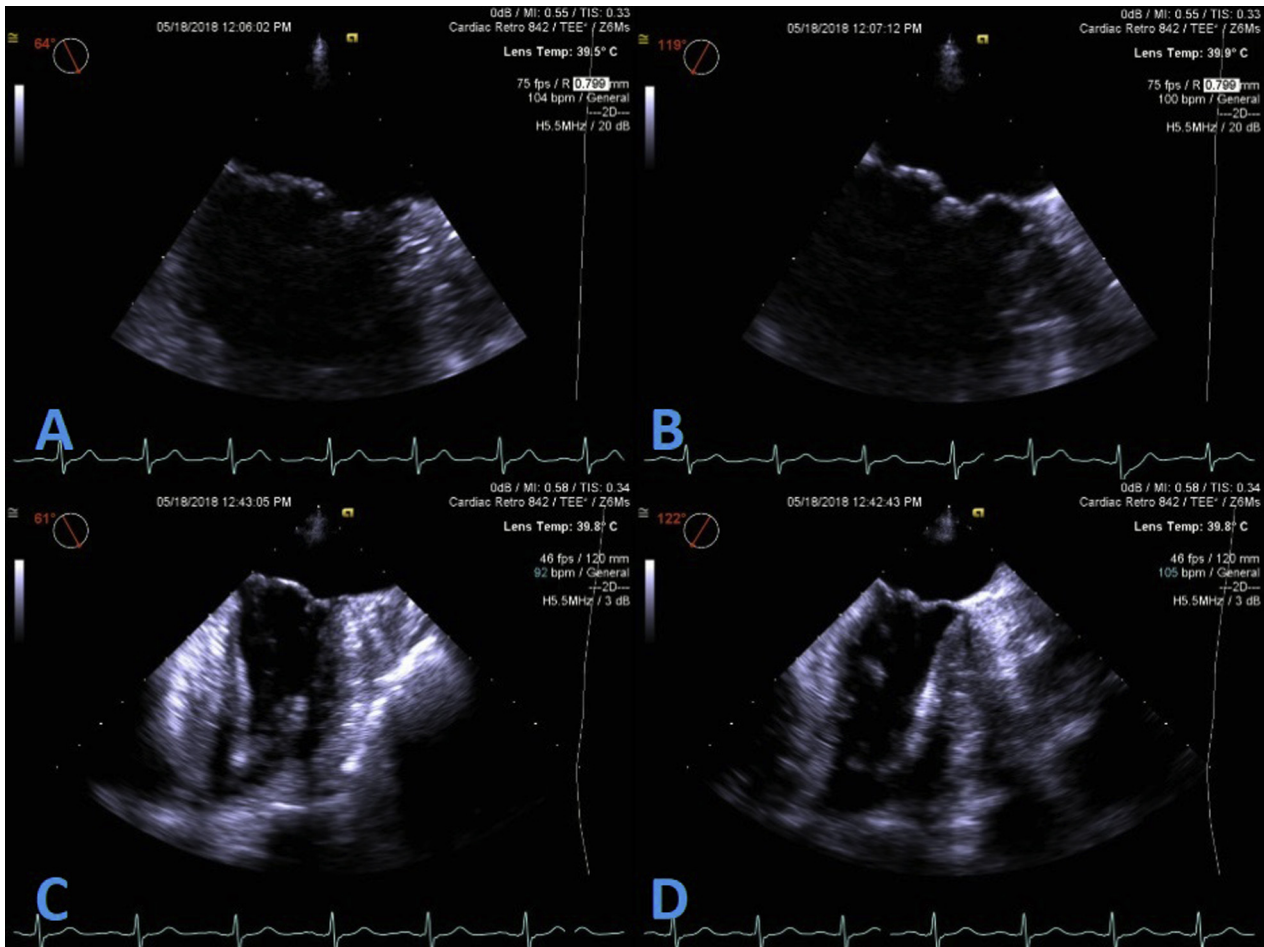


Figure 2 Transesophageal 2D images showing mild A2 prolapse in commissural and long-axis views with first transesophageal probe **(A, B)** and second transesophageal probe **(C, D)**.

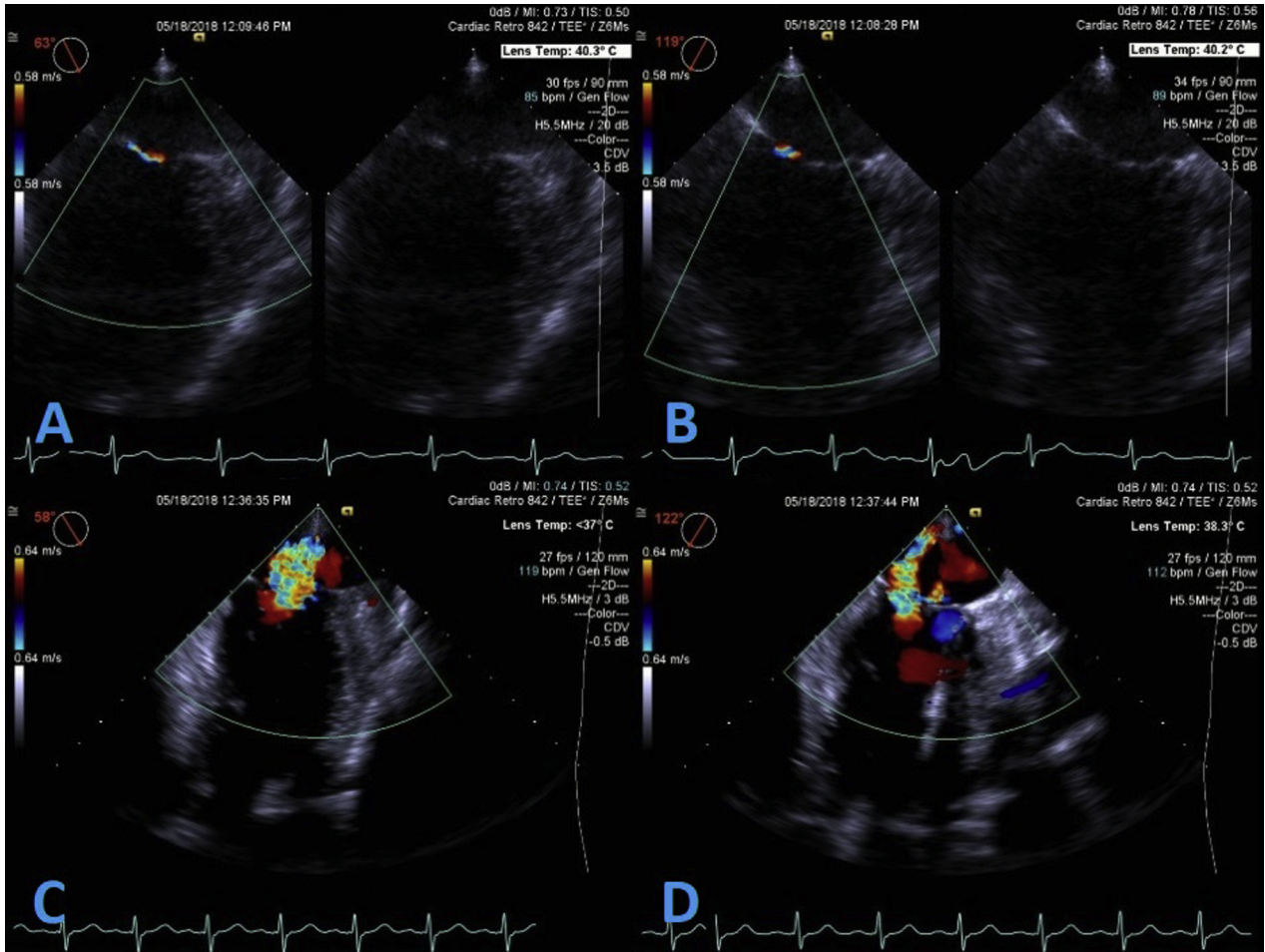


Figure 3 Transesophageal images with color Doppler in commissural and long-axis views showing trivial MR with first transesophageal probe (A, B) and severe MR with second transesophageal probe (C, D).

underwent CABG with mitral valve replacement with a 27-mm Magna Mitral Ease pericardial tissue prosthesis (Edwards Lifesciences, Irvine, California). The malfunctioning probe was replaced by the manufacturer.

DISCUSSION

MR severity was significantly underestimated on TEE in our patient with the initial probe. Timely identification of probe malfunction

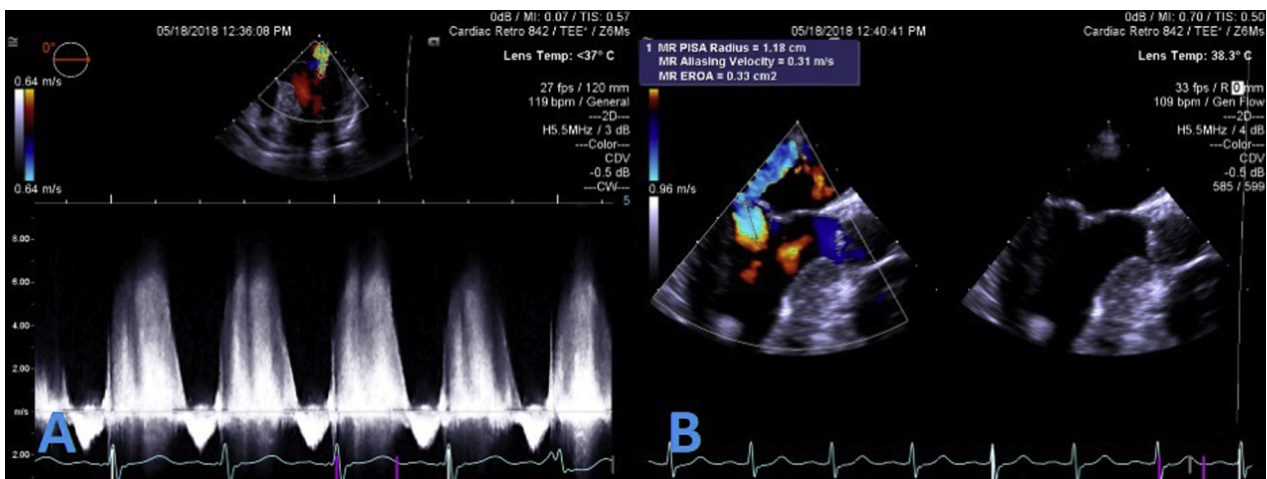


Figure 4 Quantification of MR. (A) Continuous-wave Doppler. (B) Proximal isovolumetric surface area measurement.

(color Doppler) avoided inaccurate estimation of MR severity. Failure to recognize probe malfunction during the procedure would have affected the eventual surgical approach, as CABG only would have been performed instead of CABG and mitral valve replacement. Although intraoperative TEE could have been another opportunity to evaluate the severity of MR, intraoperative hemodynamic changes may affect the reliability of MR severity assessment.^{2,3}

Several important clues were present during TEE with the initial probe, warranting further investigation. There was a significant discrepancy in MR severity between TTE and TEE despite similar hemodynamic and volume status. Review of initial 2D images showed that image quality was suboptimal despite a cooperative patient and 2D gain being maximized at +20 dB. No color was noted in the left upper pulmonary vein despite a good 2D image and pulsed-wave signal. There was a significant discrepancy between color Doppler and continuous-wave Doppler analysis of the MR. In addition, the mitral valve was structurally abnormal (mild prolapse of the A2 scallop).

The severity of MR during TEE depends on several factors. Changes in hemodynamic status and volume status could affect the assessment of severity.^{4,5} Intermittent conduction abnormality (left bundle branch block) and resultant left ventricular dyssynchrony can lead to varying severity of MR. Change in Doppler gain, transducer frequency, frame rate, pulse repetition frequency, wall filter, and transmission power can increase or decrease jet size, leading to under- or overestimation of MR severity.^{6,7} Transducer malfunction is an underrecognized factor that can affect the diagnostic accuracy of MR evaluation by TEE. This can be easily overlooked, and clinicians should be aware of this. Early recognition of clues for probe malfunction will avoid misdiagnosis during TEE. Although technical malfunction has been reported with endoscopy probes⁸ and ultrasound probes,⁹ reports of malfunction during TEE are very limited.^{10,11} Saluja *et al.*¹¹ reported probe shutdown during TEE in a patient with hyperthermia. TEE device malfunctions have been reported to the US Food and Drug Administration's Manufacturer and User Facility Device Experience database.^{12,13} McLeod *et al.*¹⁰ recommend a quality assurance program for transesophageal probes incorporating visual, electric, and image quality tests.¹⁰ It is important to identify malfunctioning probes before the procedure, as this may lead to reintubation, which significantly increases risk for complications. In a reported incident of probe malfunction, placement of a second transesophageal probe led to esophageal tear requiring surgical repair and cancelation of the planned cardiac surgery.¹³

Transesophageal echocardiographic transducer malfunction could involve the piezoelectric crystals, electronic circuitry, or mechanical components. Elevated transducer temperature both from heat generated during the procedure and from elevated host temperature in a febrile patient could play a role in image quality.¹¹ Transducers are designed to reduce power output if the transducer temperature exceeds a certain level, and power output is completely shut down if probe temperature exceeds a certain set limit (42°C–44°C). This is to prevent thermal complications such as esophageal burns. In our case, the maximum temperature reached with the initial probe was 40.3°C, and according to manufacturer specifications, power output should not have dropped until a temperature of 42.5°C. Power output was manually increased with the initial probe without improvement in image quality. High transducer temperature, in addition to causing tissue heating, can affect the function of piezoelectric crystals as well. Temperature changes have been shown to affect the resonant frequency of piezoelectric elements.¹⁴

CONCLUSION

Technical malfunction during TEE is an underrecognized and underreported problem that can significantly affect image quality and procedural success. Lack of physician awareness and failure to promptly recognize during the procedure could lead to misdiagnosis or missed diagnoses. Quality assurance programs should be considered to identify malfunctioning probes before their use in patients.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.case.2020.06.007>.

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