Multidirectional Blood Flow During Cardiopulmonary Bypass Mimicking an Iatrogenic Aortic Dissection During Transesophageal Echocardiographic Examination

John C. Foster, MD, Maxwell Kilcoyne, MD, Lucas Witer, MD, and George Whitener, MD, *Charleston, South Carolina*

INTRODUCTION

Iatrogenic aortic dissection (IAD) is a rare and potentially fatal complication of cardiac surgery, with an incidence of approximately 0.06% during cannulation of the ascending aorta for cardiopulmonary bypass (CPB).[1] IAD is usually identified intraoperatively and, if not identified early, can lead to significant perioperative morbidity and mortality.[1] Transesophageal echocardiography (TEE) is essential for the early diagnosis of an IAD. Despite the high sensitivity and specificity of TEE for diagnosing an aortic dissection, the thoracic aorta is prone to numerous artifacts that might mimic aortic pathology, potentially leading to incorrect diagnoses.[2,3]

This case illustrates how multidirectional blood flow in the thoracic aorta while on CPB resembled an IAD during intraoperative TEE. We discuss how our multidisciplinary team concluded that the findings on TEE were due to multidirectional flow and not the result of an IAD necessitating immediate intervention.

CASE PRESENTATION

The patient was a 69-year-old man with a medical history of coronary artery disease. They presented to the hospital with a non–ST-segment elevation myocardial infarction, with coronary angiography showing severe multivessel coronary artery disease. The patient was taken to the operating room for a four-vessel coronary artery bypass operation.

Pre-CPB TEE revealed normal biventricular systolic function, no significant valvular disease, normal ascending aortic and aortic arch anatomy, and grade 2 atheromatous disease of the descending thoracic aorta (DTA). The ascending aorta was cannulated for CPB with a 20-Fr straight-tip arterial cannula with its tip located in the distal aortic arch. Following cannulation, the cardiothoracic surgery team noted an adventitial hematoma along the inner curvature of the distal ascending aorta and proximal aortic arch. Because of concerns about acute aortic pathology presented by the cardiothoracic surgery team, repeat TEE of the thoracic aorta was performed before the initiation of CPB. There was no evidence of an IAD, and the aortic cannula was well positioned, with the tip in the distal aortic arch. At this time, CPB was initiated with real-time transesophageal echocardiographic monitoring of the DTA.

After initiation of CPB, findings on TEE in the distal aortic arch and DTA resembled an IAD with what appeared to be an intimal dissection flap separating two distinct lumens on two-dimensional and color flow Doppler assessments (Figure 1, Videos 1-4). The perfusion team reported no increase in extracorporeal line pressure or decrease in venous blood return, and the left radial arterial line showed no evidence of waveform changes. Because of clinical concern for an IAD potentially originating from the cannulation site in the ascending aorta, CPB was immediately terminated. However, after termination of CPB, the transesophageal echocardiographic findings suggestive of an IAD were no longer visualized (Figure 2, Videos 5 and 6). Complete TEE of the thoracic aorta revealed no evidence of acute aortic pathology.

Upon reviewing the findings on TEE, the echocardiographer suggested that the apparent structures resembling an intimal dissection flap and two distinct lumens were generated by multidirectional blood flow within the distal aortic arch and DTA during CPB. The lack of evidence for an IAD after terminating CPB supported this reasoning. Additionally, the apparent intimal dissection flap appeared hypoechoic relative to the intima, had poorly demarcated borders, and had dispersion features near the aortic wall, suggesting that it was not a solid tissue flap. CPB was reinitiated with real-time monitoring of the DTA with TEE, and findings resembling a dissection flap with two distinct lumens reappeared.

After determining that the transesophageal echocardiographic findings were due to multidirectional flow on CPB rather than an IAD, the team decided to proceed with the planned surgical procedure. The patient underwent a four-vessel coronary artery bypass operation on CPB without complications. The post-CPB findings on TEE were unchanged from the pre-CPB findings, without evidence of an IAD. Because of the high morbidity and mortality associated with the delayed diagnosis of an IAD, postoperative computed tomographic angiography of the aorta was performed and revealed no evidence of acute aortic pathology (Figure 3, Video 7).

DISCUSSION

The diagnosis of an aortic dissection by TEE requires the identification of an intimal dissection flap that divides the aorta into both true and false lumens.[4] TEE has reported sensitivity and specificity

From the Department of Anesthesiology, Medical University of South Carolina, Charleston, South Carolina.

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Correspondence: John C. Foster, MD, 167 Ashely Avenue, Suite 301, MSC 912, Charleston, SC 29425 (E-mail: *jof49@musc.edu*).

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VIDEO HIGHLIGHTS

Video 1: Two-dimensional TEE, upper esophageal distal aortic arch short-axis (75°) view during CPB, demonstrates spontaneous echocardiographic contrast (SEC) resembling an intimal dissection flap dividing the aorta into two lumens. The hypoechoic appearance of the SEC relative to the intima, poorly demarcated borders, and dispersion features help differentiate this from a true intimal dissection flap.

Video 2: Two-dimensional TEE, upper esophageal distal aortic arch short-axis (75°) view with color flow Doppler during CPB, demonstrates spontaneous echocardiographic contrast (SEC) resembling intimal dissection flap dividing the aorta into two lumens, and the multidirectional flow within the aortic lumen creates the appearance of two distinct spaces resembling true and false lumens. The formation of SEC at the interface of the opposing columns of blood flow creates the appearance of an intimal dissection flap.

Video 3: Two-dimensional TEE, midesophageal DTA short-axis (0°) view during CPB, demonstrates spontaneous echocardiographic contrast (SEC) resembling an intimal dissection flap dividing the aorta into two lumens. The hypoechoic appearance of the SEC relative to the intima, poorly demarcated borders, and dispersion features help differentiate this from a true intimal dissection flap.

Video 4: Two-dimensional TEE, midesophageal DTA short-axis (0°) view with color flow Doppler during CPB, demonstrates spontaneous echocardiographic contrast (SEC) resembling an intimal dissection flap dividing the aorta into two lumens, and the multidirectional flow within the aortic lumen creates the appearance of two distinct spaces resembling true and false lumens. The formation of SEC at the interface of the opposing columns of blood flow creates the appearance of an intimal dissection flap.

Video 5: Two-dimensional TEE, midesophageal DTA short-axis (0°) view after discontinuation of the CPB circuit, no longer demonstrates evidence of an intimal dissection flap or multiple lumens in the thoracic aorta.

Video 6: Two-dimensional TEE, midesophageal DTA short-axis (0°) view with color flow Doppler after discontinuation of the CPB circuit, no longer demonstrates evidence of an intimal dissection flap or multiple lumens in the thoracic aorta.

Video 7: Contrast-enhanced thoracic computed tomographic angiogram, axial stack cine display of the maximal intensity projections obtained on postoperative day 1, confirms no evidence of an IAD.

View the video content online at www.cvcasejournal.com.

for the diagnosis of an aortic dissection of 86% to 100% and 90% to 100%, respectively.[4] Complicating the diagnosis of acute aortic pathology by TEE is the prevalence of artifacts that might mimic aortic pathology.[2,3]

We suggest that the findings on TEE in this case are explained by multidirectional blood flow within the thoracic aorta that occurred after the initiation of CPB. Experiments with both curved- and straight-tip aortic cannulas at varying flow velocities show evidence of multidirectional flow on CPB that is most evident in the aortic arch and the proximal DTA.[5-7] In our case, the aortic cannula tip in the distal aortic arch led to multidirectional flow throughout the distal aortic arch and DTA. The multidirectional flow generated two columns of blood flowing in opposite directions, creating the appearance of two distinct lumens. The apparent intimal dissection flap was due to the formation of spontaneous echocardiographic contrast at the interface between these opposing columns of blood flow. The transesophageal echocardiographic findings presented in this case report illustrate how multidirectional flow on CPB could be mistaken for an IAD in the operating room setting and lead to incorrect diagnoses and unnecessary procedures.

CONCLUSION

IAD is a rare complication of cardiothoracic surgery, and its significant morbidity and mortality mandate rapid intraoperative diagnosis. However, TEE is neither perfectly sensitive nor specific for the diagnosis of aortic dissection, because of potential artifacts and areas of the aorta that cannot be visualized reliably with TEE. As demonstrated in this case report, multidirectional blood flow within the thoracic aorta during CPB can resemble an IAD, which further complicates the diagnosis.

ETHICS STATEMENT

The authors declare that the work described has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans.

CONSENT STATEMENT

The authors declare that since this was a non-interventional, retrospective, observational study utilizing de-identified data, informed consent was not required from the patient under an IRB exemption status.

FUNDING STATEMENT

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DISCLOSURE STATEMENT

The authors report no conflict of interest.

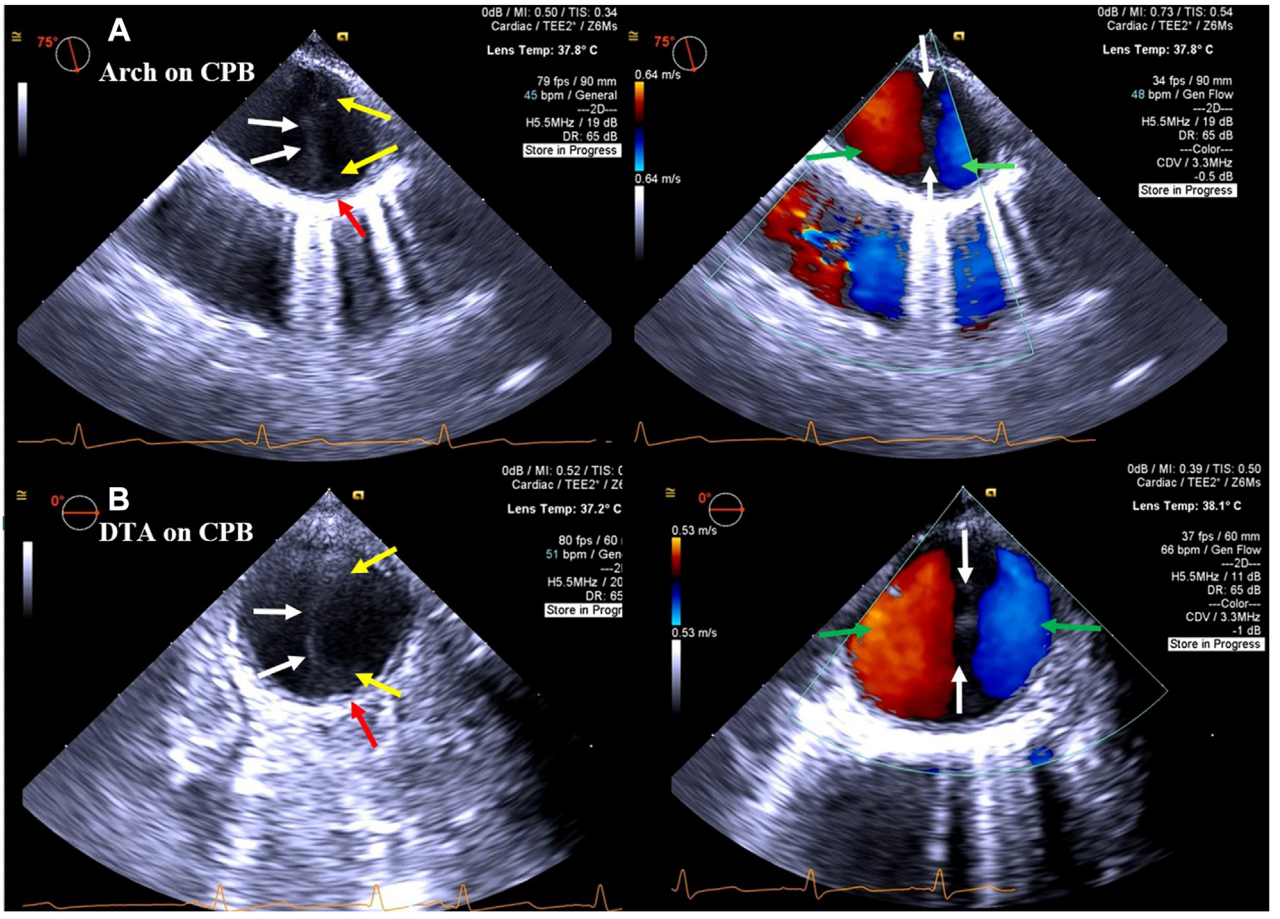

Figure 1 Two-dimensional TEE, upper esophageal distal aortic arch short axis **(A)** and midesophageal DTA short-axis **(B)** views during CPB without (left) and with (right) color flow Doppler, demonstrates spontaneous echocardiographic contrast resembling an intimal dissection flap (*white arrows*) dividing the aorta into two lumens (*green arrows*). The hypoechoic appearance of the spontaneous echocardiographic contrast relative to the intima (*red arrow*), poorly demarcated borders, and dispersion features (*yellow arrows*) help differentiate this from a true intimal dissection flap.

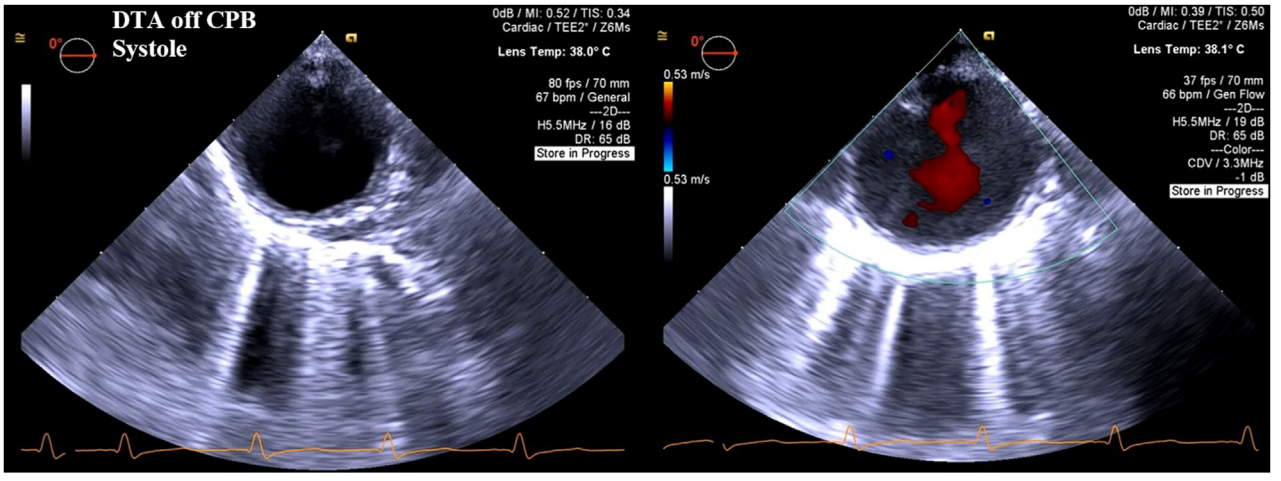

Figure 2 Two-dimensional TEE, midesophageal DTA short-axis systolic view without (left) and with (right) color flow Doppler after discontinuation of the CPB circuit, no longer demonstrates any evidence of an intimal dissection flap.

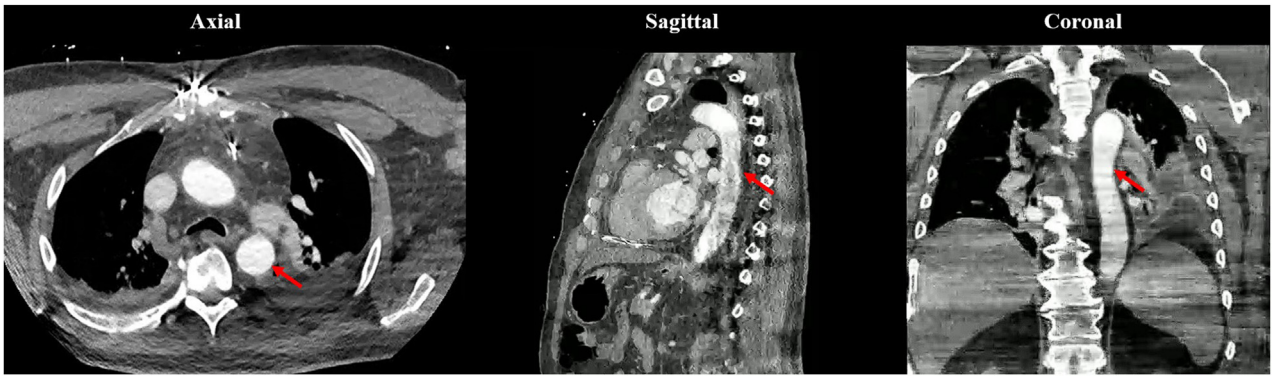

Figure 3 Contrast-enhanced thoracic computed tomographic angiogram, axial, sagittal, and coronal maximal intensity displays of the DTA (*red arrows*) obtained on postoperative day 1 confirm no evidence of an IAD.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at https://doi.org/10.1016/j.case.2024.05.012.

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