Vital Role of Transesophageal Echocardiographic Surveillance of a Left Atrial Appendage Perforation Complicating Attempted Percutaneous Appendage Occlusion

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INTRODUCTION

In patients with atrial fibrillation (AF) unable to tolerate systemic anticoagulation, left atrial appendage (LAA) occlusion is one potential alternative strategy for stroke risk reduction. The Watchman device (Boston Scientific, Marlborough, MA) is one such LAA occlusion device demonstrating a stroke risk reduction comparable with long-term anticoagulation.1–3 The procedure, however, is not without risk, as cardiac perforation is a rare but potentially lethal complication that can occur during device implantation, occasionally leading to pericardial tamponade.4–6 In a recent post–US Food and Drug Administration (FDA) approval experience study, 1.31% of patients developed pericardial effusion, and 1.02% of these patients ultimately required pericardiocentesis or surgery.7,8 Given this concern and the need for accurate LAA sizing and device guidance during implantation, procedural transesophageal echocardiographic (TEE) imaging has been a mainstay of implantation. Concurrently, the alternative use of intracardiac echocardiography and the ability to avoid general anesthesia has raised the question of the net benefit of both procedural TEE imaging and the additional attending imager during implantation. We present a case in which skilled TEE imaging was a vital procedural addition enabling the quick visualization, evaluation, and active monitoring of a potentially severe complication of Watchman implantation.

CASE PRESENTATION

An 82-year-old man with a history of permanent AF on warfarin, hypertension, coronary artery disease, heart failure with reduced ejection fraction, prior ischemic stroke without residual neurologic deficits, and type 2 diabetes mellitus presented for LAA occlusion. The patient’s calculated HAS-BLED score was 8, yielding an annual stroke risk potentially >10%,9 the patient and physician reached a shared decision to proceed with LAA occlusion.

Preprocedural TEE imaging demonstrated no LAA thrombus and a relatively shallow appendage with a superiorly directed chicken wing. LAA measurements (width × depth) at 0°, 45°, 90°, and 135° were 20.0 × 21.4 mm, 19.2 × 21.7 mm, 18.5 × 23.0 mm, and 20.4 × 24.0 mm, respectively. Right femoral venous and transseptal access in addition to delivery sheath placement within the LAA were uneventful (Figure 1, Video 1). A 27-mm Watchman device was selected with a plan to use some of the superior chicken wing for added depth.

After three failed attempts to seat the device in the LAA, because of the feet of the device slipping inferiorly and the shoulder of the device falling into the distal chicken wing (Figure 2, Video 2), the procedure was aborted. Efforts included two partial recaptures and two device exchanges of a 27-mm and a 24-mm device, respectively. Following the third attempt, the interval development of a circumferential mild to moderate pericardial effusion was noted following the third attempt of Watchman device placement.

VIDEO HIGHLIGHTS

- Video 1: Midesophageal TEE image of guiding catheter in the LAA, which has a chicken-wing morphology.
- Video 2: Midesophageal TEE image of the Watchman device malpositioned and incompletely expanded upon attempted deployment in the LAA.
- Video 3: Midesophageal TEE image of the developing pericardial effusion noted following the third attempt of Watchman device placement.
- Video 4: Midesophageal TEE images of LAA perforation visualized by color Doppler flow from the LAA into the pericardial space, seen in 135°.
- Video 5: Midesophageal TEE images of LAA perforation visualized by color Doppler flow from the LAA into the pericardial space, seen in 68°.
- Video 6: Midesophageal TEE images of LAA perforation resolving, evidenced by decreased flow on color Doppler.

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with hemopericardium (Figure 4, Videos 4 and 5). Cardiothoracic surgery was notified, and a pericardial drain was quickly placed, yielding approximately 300 mL of bloody fluid. In the interim, further investigation with TEE imaging allowed the proceduralist to monitor flow from the LAA to the pericardium, which slowly decreased over 30 min. The size of the effusion, extent of perforation flow, and development of pericardial thrombus were monitored in real time (Figure 5, Videos 6 and 7) as treatments were administered to achieve hemostasis. Ultimately, 1 U of fresh-frozen plasma, 100 mL of protamine, and the application of negative pressure via the pericardial drain were required. Although 1,415 mL of bloody fluid was removed from the patient’s pericardium, the patient’s blood pressure remained stable. In this case, procedural TEE imaging and skilled imaging helped avoid major surgical intervention given the ability to visualize and monitor the resolution of the LAA perforation. At the conclusion of the procedure, there was a trivial to small, stable pericardial effusion, LAA-to-pericardial flow had ceased, and a thrombus was visualized in the pericardial space at the site of the perforation (Figure 6, Videos 8 and 9).

The patient was admitted to the cardiovascular intensive care unit for overnight monitoring. Serial transthoracic echocardiography performed to monitor for recurrence of hemopericardium demonstrated continued stability of the effusion. The pericardial drain was removed on postprocedural day 2 without recurrence of the effusion, and the patient was safely discharged on postprocedural day 3.

**DISCUSSION**

Echocardiography is critical in both the planning and safe execution of complex intracardiac procedures. Our case highlights this fact...
while providing a valuable example of TEE findings during a procedural complication. Intraoperative TEE imaging was crucial to confirming the diagnosis of the LAA perforation and safely monitoring the perforation while the patient received definitive and, fortunately, nonsurgical treatment for pericardial tamponade.

Several cohort studies have investigated the efficacy, safety, and complications related to the use of the Watchman device. In the first half of the PROTECT-AF (Watchman Left Atrial Appendage System for Embolic Protection in Patients With Atrial Fibrillation) trial, the complication rate was nearing 10%. However, postmarket surveillance has demonstrated that the rate lies closer to 4%, with a 95% successful placement rate. This rate of complications is similar to the rate of complications during AF ablation procedures. Although the incidence of complications from the Watchman procedure is relatively low, the consequences of these complications pose potentially severe risks to patients. There are several case reports describing the use of intraoperative TEE imaging to identify a pericardial effusion and signs of tamponade. Other reports have described the use of fluoroscopy to visualize contrast transit from cardiac chambers to the pericardium through a perforation. However, to our knowledge, this report is the first to publish images of color Doppler identification and surveillance to resolution of active LAA-to-pericardial flow.

This case highlights the importance of continuous intraoperative TEE imaging and the presence of a skilled imager as a standard of care with placement of these devices. TEE imaging was able to quickly diagnose the pericardial effusion, prompting the concern for

Figure 4 TEE images of LAA perforation visualized by color Doppler flow from the LAA into the pericardial space (red arrows), seen in two midesophageal imaging planes, 129° and 68°. LV, Left ventricle.

Figure 5 Midesophageal TEE images of LAA perforation resolving, evidenced by decreased flow on color Doppler (red arrow) as well as the presence of a small thrombus (orange arrow) visualized at site of perforation.
perforation when the patient's blood pressure started to drop. Although cardiac surgery was notified, surgical intervention was fortunately avoided because of the swift action of the proceduralist and the team's confidence in the ability to visualize the perforation resolving with time. Had continuous, active TEE monitoring not been in place for this patient, there is a significant likelihood that he may have required emergent cardiac surgical intervention, including a possible midline sternotomy. In a prior published case with a more severe LAA perforation, TEE imaging was crucial in preventing significant morbidity and mortality as well. In this case, gross LAA perforation with the catheter in the transverse pericardial sinus was visualized on TEE imaging following attempted deployment of a Watchman device. However, the authors' primary focus in that case was the management of the perforation by subsequently deploying the Watchman device into the perforation, controlling the expanding pericardial effusion. In our case, placement was not an option in this acute situation due to the challenging anatomy of the LAA, and the perforation was small enough to allow the possibility of transesophageal echocardiography–guided minimally invasive management. In our experience, TEE imaging was able to both localize and evaluate the severity of the LAA perforation. Furthermore, after reversal of anticoagulation, TEE imaging also monitored the resolution of the effusion and demonstrated slowing and ultimate cessation of LAA-to-pericardial flow, thus reassuring the care team of likely patient stability.

The use of TEE imaging in this case was vital to ensuring this patient’s excellent outcome after a procedural complication. The detailed images and video obtained during this case may serve as an example of how to identify, monitor, and treat this relatively rare complication of an increasingly common procedure.

**CONCLUSION**

This report describes the use of procedural TEE imaging to identify and monitor the treatment of LAA perforation complicating attempted LAA occlusion. Imaging of the leak itself enabled real-time monitoring that assisted in titration of therapies and helped avoid escalation to more aggressive surgical intervention, highlighting the importance of skilled TEE imaging. This case offers a valuable example of the utility of procedural TEE imaging and the value of color Doppler surveillance of LAA perforation.

**SUPPLEMENTARY DATA**

Supplementary data related to this article can be found at https://doi.org/10.1016/j.case.2020.09.007.

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