High-risk left atrial appendage occlusion via isoproterenol infusion and carotid filter placement

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Introduction

Left atrial appendage (LAA) occlusion with the Watchman™ device (Boston Scientific, Marlborough, MA) is indicated in patients with a long-term contraindication to anticoagulation and need for stroke prophylaxis. However, the procedure is contraindicated in patients with LAA thrombus to avoid the risk of systemic embolization from clot dislodgement caused by procedural manipulation. Case reports have described spontaneous echo contrast clearing with isoproterenol.[1,2] Also, studies from a transaortic valve replacement population have demonstrated the feasibility of carotid filter placement for cerebral protection in interventional cardiac procedures.[3] We describe a high-risk patient with recurrent LAA thrombus on transesophageal echocardiography (TEE) who underwent Watchman implantation using a strategy of upfront isoproterenol infusion and prophylactic carotid filter placement.

Case report

A 68-year-old man with a history of hypertension, hyperlipidemia, atrial fibrillation, and recent onset of cardiomyopathy presented for evaluation. He had a history of paroxysmal atrial fibrillation for approximately 10 years, for which he was treated with AV nodal agents and anticoagulation. In the previous few months, his atrial fibrillation had become persistent, and his ejection fraction had decreased to 20% on echocardiogram. An angiogram showed nonobstructive coronary disease. Although his ventricular rate was well controlled, it was felt that he might have atrial fibrillation–related cardiomyopathy, and ablation was recommended. However, on TEE, he was found to have an LAA thrombus.

KEY TEACHING POINTS

- Isoproterenol infusion can help for differentiating dense spontaneous echo contrast from thrombus.
- Upfront isoproterenol infusion can be used as a risk stratification tool in high-risk patients.
- It is feasible to use carotid filters for cerebral protection in high-risk patients to deploy left atrial occlusion devices safely.

His apixaban was transitioned to warfarin with an international normalized ratio (INR) goal of 2.5–3.5. He had a repeat TEE 4 months later, which showed a persistent appendage thrombus. A primary prevention defibrillator was implanted given his continued severely reduced ejection fraction and class III heart failure. Three months later, he started to develop gastrointestinal bleeding and was found to have diffuse diverticuli. His anticoagulation was held briefly but then resumed with warfarin with a lower INR goal of 2–3, but he had recurrent bleeding. A Watchman procedure was then considered, but he was felt to be a high risk given his history of appendage thrombus. In order to assess feasibility, he was brought for a repeat TEE to see if his thrombus would clear with isoproterenol infusion. After initial images again demonstrated an apparent LAA thrombus (Figure 1), he was started on isoproterenol at 2 mcg/min. After 5 minutes of isoproterenol infusion, his thrombus was no longer apparent (Figure 1).

He returned 2 weeks later for Watchman (2.5) implantation with a plan for using cerebral protection during the procedure. The Sentinel™ Cerebral Protection System (Boston Scientific) was placed by a vascular surgeon. This is a percutaneously delivered dual-filter embolic protection device that captures and removes any debris before it can embolize to the brain. Right radial arterial access was obtained using real-time ultrasound imaging. A wire was placed into the aorta, and the Sentinel system was advanced until the proximal filter was in the proximal brachiocephalic artery. The filter was

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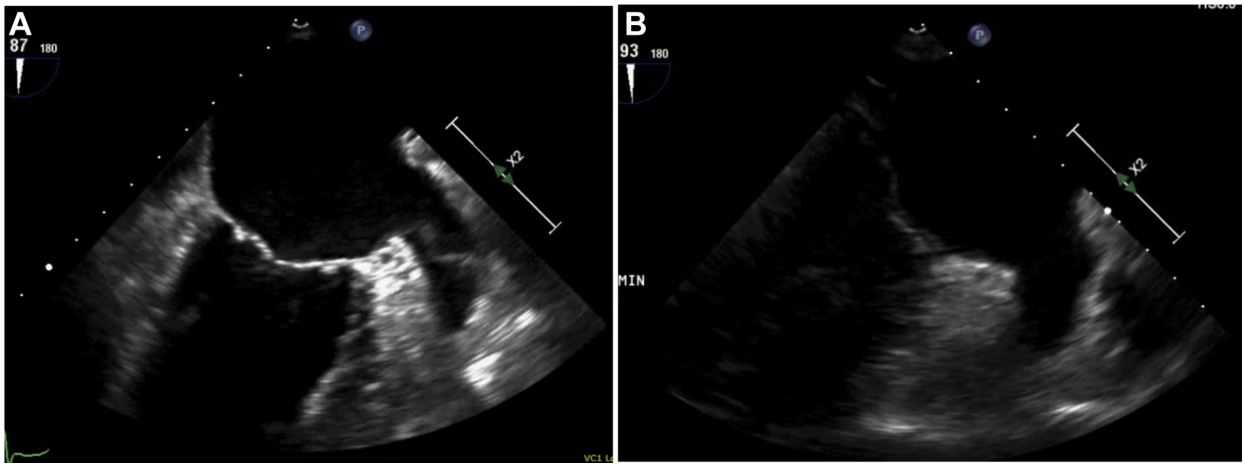

Figure 1 Transesophageal echocardiograms. **A:** The initial image with a left atrial appendage thrombus. **B:** Image after 5 minutes of isoproterenol infusion demonstrating the thrombus had resolved.

deployed in this artery, proximal to its bifurcation into the right subclavian and right common carotid arteries. The wire was pulled back from the aorta, and the tip of the Sentinel system was shaped and turned to the origin of the left common carotid artery. The wire was advanced into the left common carotid artery, followed by the distal filter. The distal filter was then placed and deployed in the proximal left internal carotid artery (Figure 2A). TEE again showed an apparent LAA thrombus, and thus isoproterenol was again infused, and the appendage cleared. If the thrombus had not been resolved, we would have abandoned the procedure owing to the increased risk of embolization. Watchman implantation was then performed using a double-curve sheath. He initially had placement of a 24 mm device; however, it was felt to be undercompressed and rotated, and thus he had full recapture of the device. He then underwent placement of a 27 mm device with adequate compression, seal, position, and stability. The Sentinel system was removed at the end of the procedure. The carotid filters were washed with saline and solution and revealed debris in both filters (Figure 2B). An aortogram with visceral runoff was performed and showed no embolization to the renal and mesenteric arteries (Figure 3A). Bilateral pedal pulses were palpable before and after the procedure. The patient had no neurologic sequelae postprocedure and was discharged the next day. A repeat TEE 45 days postimplant showed normal device location and compression without device-associated thrombus (Figure 3B). Four months after the procedure, the patient had ablation of his now long-standing persistent atrial fibrillation ablation (via pulmonary vein isolation, posterior wall isolation, anterior mitral line, superior vena cava isolation, and cavotricuspid isthmus ablation). He has maintained

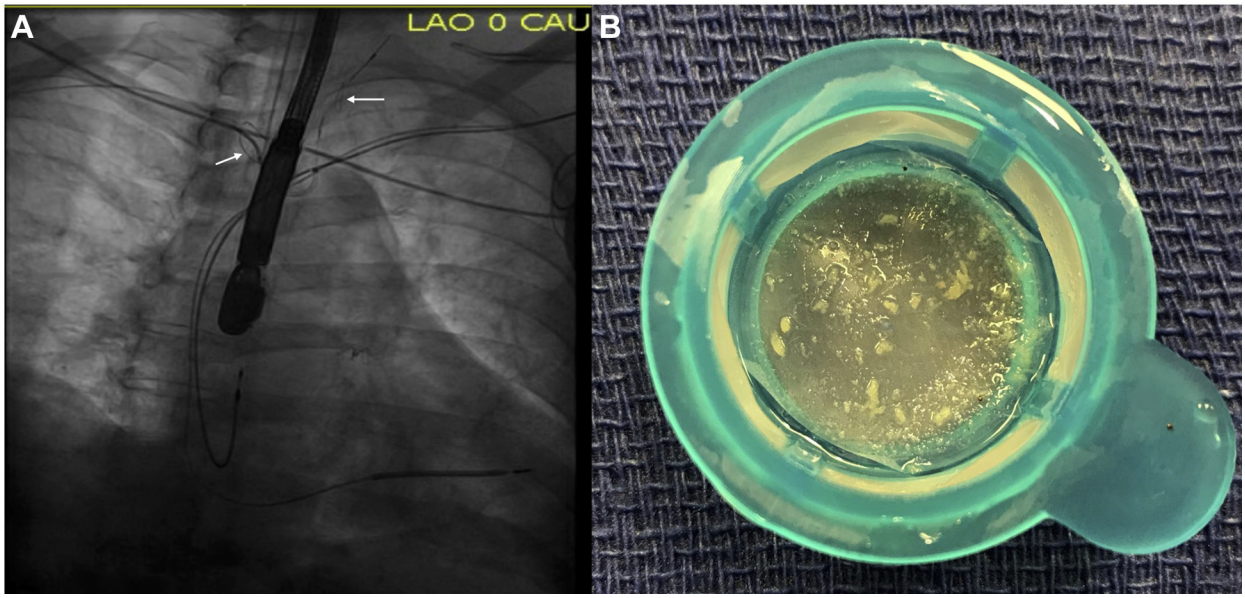

Figure 2 The carotid filter. **A:** Fluoroscopy image of the carotid filter (*arrows*). Inserted via the right radial artery into the bilateral internal carotid arteries. **B:** Bilateral debris that were found after removing the carotid filters.

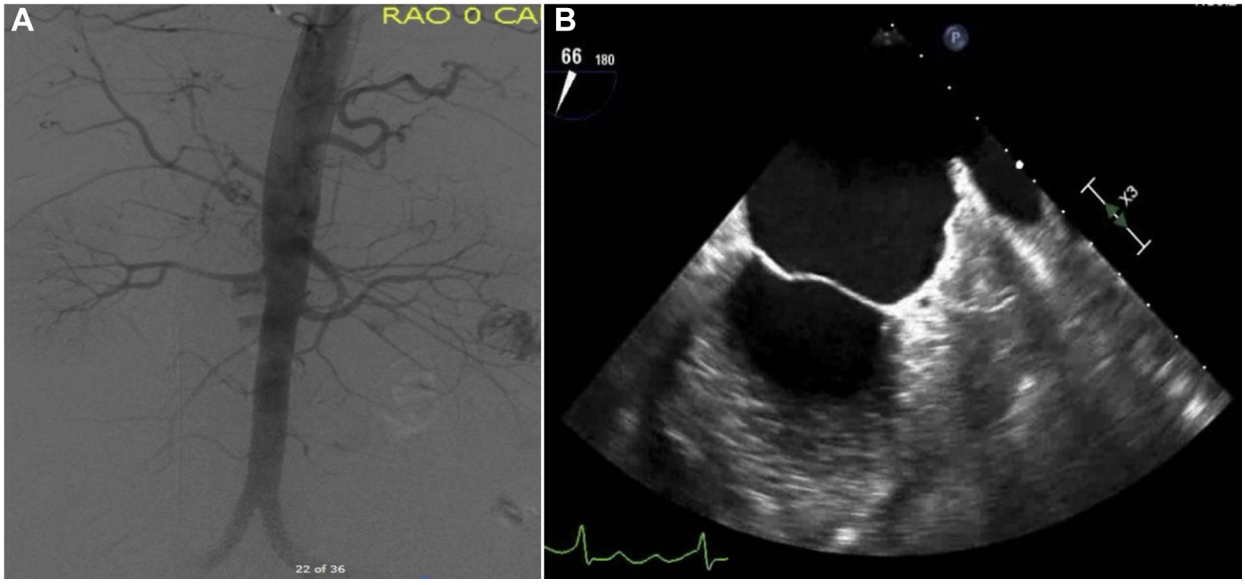

Figure 3 Postprocedure imaging. **A:** An aortogram with peripheral runoff was performed to assess for emboli to the kidneys, spleen, and mesenteric system. None was detected. **B:** Transesophageal echocardiogram 45 days postimplant showed normal device location and compression. No device-associated thrombus.

sinus for 8 months postablation and on follow-up echocardiography, his ejection fraction improved to 45%–50%.

Discussion

Left atrial occlusion carries a risk of procedure-related stroke that was ≤1.1% in the pivotal trials and ≤0.1% in postmarket registry data.[4] In addition, the device is contraindicated in patients with LAA thrombus owing to concern over thrombus dislodgement and stroke. Given the high-risk thrombus in our patient, we decided to use isoproterenol as a risk stratification tool. Isoproterenol infusion may stratify truly dense and organized thrombus from spontaneous echo contrast.[1,2] Prior studies have shown that isoproterenol infusion can increase LAA emptying velocity and decrease spontaneous echocardiographic contrast in the setting of atrial fibrillation.[2,5] Another report describes a case in which spontaneous echocardiographic contrast cleared without significant change in LAA velocity.[1] By increasing local contractility isoproterenol can attenuate atrial stasis. The LAA velocity after using isoproterenol might be influenced by many factors, such as contractility, appendage morphology, and diastolic function of the left atrium. In addition, isoproterenol has a positive inotropic effect on the myocardium via B-1 adrenergic receptor–mediated increase in cytosolic free calcium, which leads to increased force ventricular contraction and improves cardiac output.[6] This resultant improvement in the left ventricular ejection fraction may also contribute to the spontaneous echo contrast clearing from the LAA.

Our patient was still felt to be high risk, and thus carotid filters were deployed. In a case series of 5 patients with LAA occlusion (without appendage thrombus) and carotid filter placement, all patients demonstrated debris.[3] Pathology revealed that the debris contained some combination of acute thrombus, chronic thrombus, and myocardial tissue. We did not send our debris to pathology but suspect the composition was similar to what has been reported. It is possible that acute thrombus could have formed in the filter, but this is less likely, as the patient was adequately anticoagulated with a therapeutic INR of 2.5 and during the procedure, systemic anticoagulation with heparin kept the ACT >300.

A recent publication assessed the feasibility of Watchman placement in patients with an LAA thrombus.[7] Cerebral protection devices were used in 29% of patients, and there was no procedure-related stroke but 1 late stroke a year later. The thrombi were distally located, and patients with proximal thrombus were excluded from the study. Although varying regimens of oral anticoagulation were used, isoproterenol use was not performed. In addition, a more proximal delivery method and minimal LAA instrumentation was deployed, which may be less feasible with the Watchman but more feasible with other devices and the Watchman FLX. In our case, we had a proximal thrombus and instrumented the appendage, and deployed the Watchman device without procedural modifications.

The prevalence of thrombus in patients with atrial fibrillation ranges between 10% and 20%.[3] Both procedure-related strokes and silent microemboli have been reported in interventional cardiac procedures, including LAA closure.[8] Microemboli may lead to long-term cognitive decline.[9] Thus, strategies to reduce stroke and embolic risk are of interest in an appendage closure population. In a transaortic valve replacement population, placement of a carotid filter did not reduce clinical stroke or cognitive decline. However, it did reduce the number of brain lesions and lesion volume seen on magnetic resonance imaging.[10,11] The lack of reduction in hard endpoints may be due to more delayed embolic events that occur after the procedure. The utility of cerebral protection with LAA occlusion remains to be determined.

In our patient, we also assessed for peripheral emboli with an aortogram and did not find evidence of gross embolism. Distal aortic protection has been described but was not utilized in our case.

Given our patient's medical history, specifically his previous LAA thrombus and reduced ejection fraction, we considered him at high risk for device-associated thrombus.[12] Thus we elected to increase surveillance for device-associated thrombus with imaging at 45 days, 6 months, and 1 year, as in the PROTECT trial.

Conclusion

We report a strategy of upstream isoproterenol infusion to risk-stratify LAA thrombus and potentially differentiate organized thrombus from spontaneous echo contrast. It is feasible to use carotid filters for cerebral protection in high-risk patients to deploy left atrial occlusion devices safely.

References

1. Pandey AC, Smith MR, Olson N, Price MJ, Gibson DN. When smoke does not always mean there is fire: using isoproterenol for better visualization of the left atrial appendage prior to transcatheter closure. JACC Clin Electrophysiol 2019; 5:136–137.
2. Enomoto Y, Hara H, Makino K, et al. Usefulness of an isoproterenol infusion to differentiate a left atrial appendage thrombus in a patient with nonvalvular atrial fibrillation. Pacing Clin Electrophysiol 2021;44:192–193.
3. Meincke F, Spangenberg T, Kreidel F, et al. Rationale of cerebral protection devices in left atrial appendage occlusion. Catheter Cardiovasc Interv 2017; 89:154–158.
4. Reddy VY, Gibson DN, Kar S, et al. Post-approval U.S. experience with left atrial appendage closure for stroke prevention in atrial fibrillation. J Am Coll Cardiol 2017;69:253–261.
5. Sanders P, Morton JB, Kistler PM, Vohra JK, Kalman JM, Sparks PB. Reversal of atrial mechanical dysfunction after cardioversion of atrial fibrillation: implications for the mechanisms of tachycardia-mediated atrial cardiomyopathy. Circulation 2003;108:1976–1984.
6. Ahlquist RP. Isoproterenol in cardiology. Am Heart J 1973;86:149–151.
7. Sharma SP, Cheng J, Turagam MK, et al. Feasibility of left atrial appendage occlusion in left atrial appendage thrombus: a systematic review. JACC Clin Electrophysiol 2020;6:414–424.
8. Majunke N, Eplinius F, Gutberlet M, et al. Frequency and clinical course of cerebral embolism in patients undergoing transcatheter left atrial appendage closure. EuroIntervention 2017;13:124–130.
9. Rivard L, Khairy P. Mechanisms, clinical significance, and prevention of cognitive impairment in patients with atrial fibrillation. Can J Cardiol 2017; 33:1556–1564.
10. Kapadia SR, Kodali S, Makkar R, et al. Protection against cerebral embolism during transcatheter aortic valve replacement. J Am Coll Cardiol 2017;69:367–377.
11. Haussig S, Mangner N, Dwyer MG, et al. Effect of a cerebral protection device on brain lesions following transcatheter aortic valve implantation in patients with severe aortic stenosis: the CLEAN-TAVI randomized clinical trial. JAMA 2016; 316:592–601.
12. Dukkipati SR, Kar S, Holmes DR, et al. Device-related thrombus after left atrial appendage closure: incidence, predictors, and outcomes. Circulation 2018; 138:874–885.