

# Successful Percutaneous Left Atrial Appendage Closure in the Presence of a Nonobstructive Appendage Membrane



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## INTRODUCTION

The left atrial appendage (LAA) is a unique structure that arises from the anterolateral wall of the left atrium. During atrial fibrillation, the LAA has been implicated as the primary site of thrombus formation because of loss of LAA contractility and subsequent blood stasis.<sup>1</sup> As a result, this structure has become the target for percutaneous closure in patients with atrial fibrillation, particularly in those intolerant to long-term anticoagulation. Because of marked variation in LAA size, morphology, and anatomic location, a careful imaging assessment is necessary when evaluating candidacy for LAA closure. The presence of an LAA membrane is a rare anatomic variant, with few cases reported in the literature. It is often an incidental finding during transesophageal echocardiography (TEE) and has unknown clinical significance. Here, we describe a patient with a nonobstructive LAA membrane, which modified our approach to the deployment of an LAA occlusion device. To our knowledge, percutaneous intervention of the LAA has not previously been described in the presence of an LAA membrane.

## CASE PRESENTATION

A 77-year-old man with persistent atrial fibrillation not on anticoagulation, because of gait instability and frequent falls, was referred for LAA closure. With a medical history of stroke, hypertension, and diabetes, his CHA<sub>2</sub>DS<sub>2</sub>-VASc score was calculated to be 6, corresponding to an annual ischemic stroke risk of 9.7%.<sup>2</sup> Preoperative TEE showed normal left ventricular systolic function, a dilated left atrium, and no evidence of LAA thrombus. At the LAA orifice, a thin linear membrane was seen that partially covered the os (Figure 1). This membrane was noted in multiple planes and also identified on three-dimensional TEE (Figure 2). Color flow Doppler across the orifice did not show flow acceleration, and pulsed-wave Doppler demonstrated low LAA emptying velocities (Figure 3, Video 1).

The patient subsequently underwent percutaneous LAA closure with a 27-mm Watchman Device (Boston Scientific, Natick, MA). Contrast injection into the LAA with fluoroscopy also made it possible to identify a thin membrane at the LAA os (Figure 4, Video 2).

Although pigtail positioning in the distal LAA was not affected, resistance was encountered when advancing the sheath into the LAA os. Because of the partial obstruction caused by the LAA membrane, a more posterior axis of entry was required to allow a more distal sheath position. To avoid the risk for peridevice leak by impinging on the LAA membrane, the Watchman Device was intentionally deployed slightly distal to the membrane. This resulted in a small (2 mm) residual space between the device and the LAA os, without any leak (Video 3). Repeat TEE 6 weeks later showed the LAA membrane proximal to a well-seated Watchman Device, with no peridevice color flow (Figure 5).

## DISCUSSION

The LAA arises from the primitive left atrium during the third week of embryonic development. This structure contains prominent trabeculations, making it an anatomically distinct structure from the smooth-walled left atrium, which arises from the extension of the primordial pulmonary veins.<sup>3</sup> The elasticity of the LAA allows it to contract in late diastole and relax in early systole as it accommodates blood returning to the left atrium.<sup>1,3,4</sup> In sinus rhythm, these dynamic changes manifest as a quadriphasic flow pattern. Atrial arrhythmias and elevated filling pressures can remodel the LAA and disrupt normal flow patterns, resulting in blood stasis and increased risk for thrombus formation.<sup>4</sup>

Membranes of the LAA are a rare finding, with only 12 reported cases, the first of which was described in 1999.<sup>5-15</sup> Their clinical significance is unknown, and they are almost universally an incidental finding on TEE. Of the 12 previously reported cases of LAA membranes, five were obstructive with evidence of flow acceleration and seven were nonobstructive. All obstructive membranes were located toward the LAA orifice, whereas the nonobstructive membranes were located deeper within the body of the appendage. Our case is unusual in that a nonobstructive membrane was present at the LAA os. Because of the ostial location of the LAA membrane in our case, a strategy of distal deployment was reasonable, as it still allowed minimal distance from the device to the plane of the LAA os. However, this strategy may not be successful for deeper LAA membranes, as distal deployment may result in a large residual "stump" with increased risk for thrombus formation and dislodgement.

The embryologic origin of the LAA membrane is unknown, with age at time of diagnosis ranging from 22 to 79 years.<sup>6,8</sup> It is thought to be a congenital variant unrelated to cor triatriatum sinistrum, the latter being a congenital defect with a membrane separating the superior and inferior aspects of the left atrium. To make the diagnosis of an LAA membrane, it is important to have a complete medical history and thorough echocardiographic assessment. In a case series, Katz *et al.*<sup>15</sup> described multiple instances of incomplete surgical LAA ligation during mitral valve surgery, which can mimic obstructive LAA membranes. In another case described by Correale *et al.*,<sup>7</sup> what

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## VIDEO HIGHLIGHTS

**Video 1:** Color Doppler of the LAA without evidence of flow acceleration, suggesting that the membrane is nonobstructive.

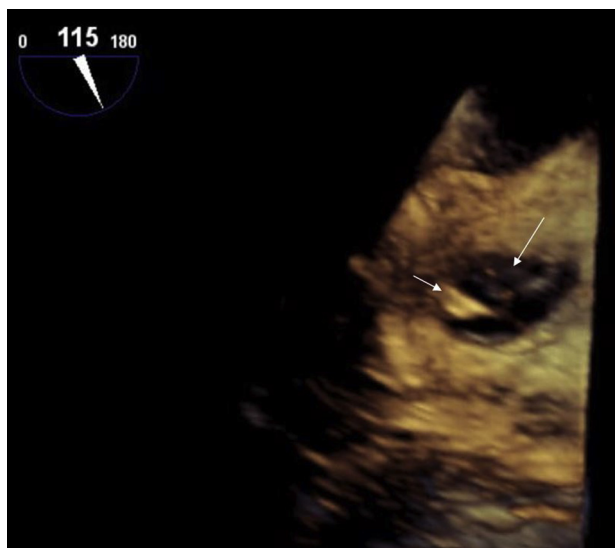
**Video 2:** Contrast injection into the LAA before Watchman placement demonstrating a thin membrane at the LAA os.

**Video 3:** Color Doppler of the LAA after Watchman deployment showing a small (2 mm) residual space between the device and LAA os without peridevice leak.

View the video content online at [www.cvcasejournal.com](http://www.cvcasejournal.com).

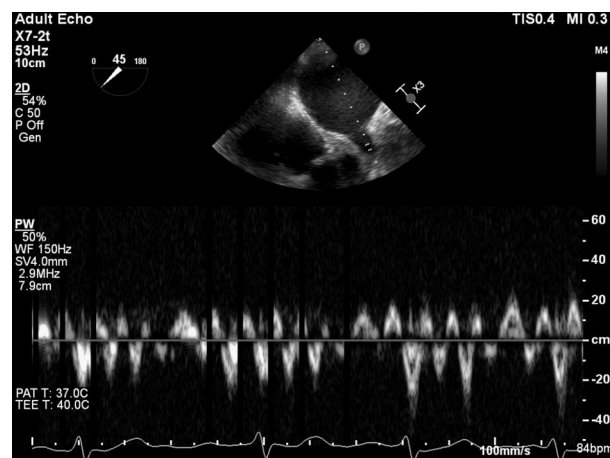


**Figure 1** Midesophageal short-axis view demonstrating a thin membrane at the LAA (arrows) os.



**Figure 2** Three-dimensional TEE showing membranous structures at the LAA (arrows) os.

appeared to be a membrane in the body of the LAA was simply the roof of the LAA surrounded by a small localized pericardial effusion noted only in transgastric views. Thus, a broad differential diagnosis



**Figure 3** Pulsed-wave Doppler of the LAA demonstrating low LAA emptying velocities.

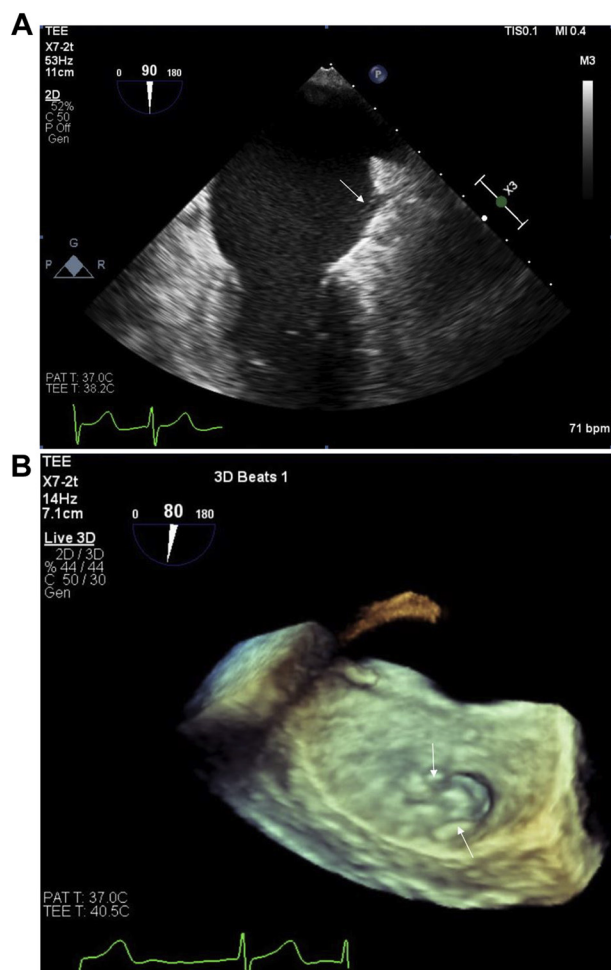


**Figure 4** Contrast injection into the LAA (arrow) before Watchman placement, which redemonstrates a thin membrane.

must be considered when evaluating linear echodensities in the LAA (Table 1).

The clinical significance of the LAA membranes and their contribution to thromboembolism is unclear. Some have postulated that these membranes increase thrombus risk by impeding flow within the LAA, while others have suggested that these membranes can be protective by serving as a barrier that prevents large thrombi from exiting the LAA.<sup>8-10</sup> Of the 12 reported cases of LAA membranes, three patients had histories of stroke and five had atrial arrhythmias. The patient described in our case had a history of both atrial fibrillation and stroke. However, because these medical conditions often necessitate TEE as part of a medical evaluation, they may be confounding factors as opposed to representing a true causal relationship.

In our preprocedural planning, we preferred to use the Watchman over the Amulet (St. Jude Medical, St. Paul, Minnesota), an alternative LAA occlusion device, for two theoretical reasons. First, the Amulet device is introduced into the LAA in a “ball” form, in which the distal portion of the device protrudes from the sheath. Because this “ball” is significantly larger than the diameter of the sheath, the LAA



**Figure 5** Midesophageal two-chamber view **(A)** and three-dimensional TEE **(B)** of the LAA membrane (arrows) 6 weeks after Watchman deployment.

**Table 1** Differential diagnosis of linear echodensities in the LAA

Prominent pectinate muscle
Artifact
Thrombus
Incomplete surgical ligation
Localized pericardial effusion
LAA membrane

membrane may limit its ability to enter. Second, the Amulet is a “disk and lobe” device. Once the distal lobe is appropriately positioned in the landing zone, the disk is unsheathed. The presence of an LAA membrane may affect disk position itself or cause deflection of the control wire tethering the disk to the lobe.

Given the increasing prevalence of TEE-guided catheter-based therapies such as LAA occlusion, transcatheter mitral valve repair, and catheter ablation, the discovery of these uncommon membranes is likely to increase. Although it has been unclear how this anatomic structure will affect these percutaneous therapies, here we describe the first case of attempted LAA occlusion in the presence of such a membrane. By appreciating the presence and location of this structure

by TEE and fluoroscopy, we were able to guide deployment of a Watchman Device distal to the LAA membrane to ensure adequate seal with a good result.

## CONCLUSION

An LAA membrane is a rare anatomic entity incidentally discovered on TEE that requires comprehensive multiplane imaging of the LAA with Doppler flow analysis and supplemental three-dimensional imaging. We have described a case of a rare nonobstructive membrane at the orifice of the LAA and its significance during the deployment of an LAA closure device.

## SUPPLEMENTARY DATA

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.case.2020.03.008>.

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