A Left Atrial Thrombus Mimic: Value of Ultrasound Enhancing Agents during Transesophageal Echocardiography

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INTRODUCTION

A 62-year-old woman with a medical history significant for malignancy and mesenteric thrombosis who developed atrial fibrillation (AF) and atrial flutter with rapid ventricular response presented for transesophageal echocardiography (TEE) and direct current cardioversion. TEE revealed a masslike structure within the vicinity of the left atrial appendage (LAA). This case highlights the importance of understanding the anatomy of the structures surrounding the LAA and the utility of ultrasound enhancing agents (UEAs) during TEE for differentiating between intracardiac and extracardiac structures.

CASE PRESENTATION

A 62-year-old woman with a history of systemic hypertension, hyperlipidemia, chronic obstructive pulmonary disease, remote bilateral breast cancer status post bilateral lumpectomy and chemotherapy, and recent right hemicolectomy with creation of an ileocolostomy for stage II cecal adenocarcinoma was hospitalized for acute abdominal pain. Computed tomographic angiography on admission revealed acute superior mesenteric vein thrombosis with evidence of ischemic changes of the bowel. She was treated conservatively with bowel rest with total parenteral nutrition and initiated on anticoagulation therapy with intravenous heparin initially followed by subcutaneous enoxaparin. Her hospital course was complicated by mixed hypoxemic and hypercapnic respiratory failure, acute left ventricular (LV) systolic dysfunction (LV ejection fraction 37%), and AF and atrial flutter with rapid ventricular response. Direct-current cardioversion was planned. TEE was performed beforehand to evaluate for intracardiac thrombus because the duration of AF was >48 hours before cardioversion (with <3 weeks of therapeutic anticoagulation), and the patient had an elevated stroke risk (CHA_2DS_2-VASc score = 3).

TEE revealed an echogenic mass measuring approximately 1.5×0.8 cm in the vicinity of the LAA. On certain views, this echodensity appeared to be located within the left atrium, attached to the lateral wall of the LAA (Figure 1, Video 1). Biplane imaging through this structure suggested that it may be extracardiac, though this was not conclusive (Figure 2, Video 2). On real-time three-dimensional

VIDEO HIGHLIGHTS

Video 1: Midesophageal transesophageal echocardiographic clip of the LAA at 88° showing a hyperechoic mass that appears to be attached to the wall of the LAA. It was difficult to definitively determine from standard two-dimensional B-mode images whether this structure was intracardiac or extracardiac.

Video 2: Midesophageal transesophageal echocardiographic clip of the LAA using biplane imaging at 0° and 90°. The echodense structure appears to be located outside of the LAA in the transverse pericardial sinus, though an intracardiac component could not be ruled out.

Video 3: Midesophageal transesophageal echocardiographic clip of the LAA at 0° after the administration of the UEA. There is uniform opacification of the LAA. The mass is apparent in the adjacent echo-free space, confirming its extracardiac location in the transverse pericardial sinus.

Video 4: Midesophageal transesophageal echocardiographic clip of the LAA at 100° after the administration of the UEA. There is uniform opacification of the LAA. The mass is apparent in the adjacent echo-free space, confirming its extracardiac location in the transverse pericardial sinus.

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echocardiography, the LAA appeared free from filling defects, but the echodense structure could not be well visualized (Figure 3A). LAA peak emptying velocity was 43.0 cm/sec by pulsed-wave Doppler (a peak emptying velocity ≤ 20 cm/sec is associated with an increased risk for thromboembolic events [relative risk, 1.7] in patients with AF[1]; Figure 4). Especially in the setting of concomitant malignancy and superior mesenteric vein thrombosis, definitive exclusion of intra-atrial thrombus was felt to be critical. In preparation for the administration of a UEA, harmonic imaging was used, and the output power of the ultrasound beam was gradually reduced until the mechanical index was <0.5. Although very low mechanical index multipulse imaging modes used for imaging with UEAs during transthoracic echocardiography (TTE) are not available on most modern transesophageal echocardiographic machines, an mechanical index < 0.5 and harmonic imaging allow optimal UEA delineation in the LAA at the frequencies used during TEE.[2] Administration of 0.2 mL of Definity (perflutren lipid microsphere; Lantheus Medical Imaging, North Billerica, MA) resulted in uniform opacification of the LAA with no filling defects, and the echogenic mass was observed to be in a contrast-free space, confirming its epicardial location
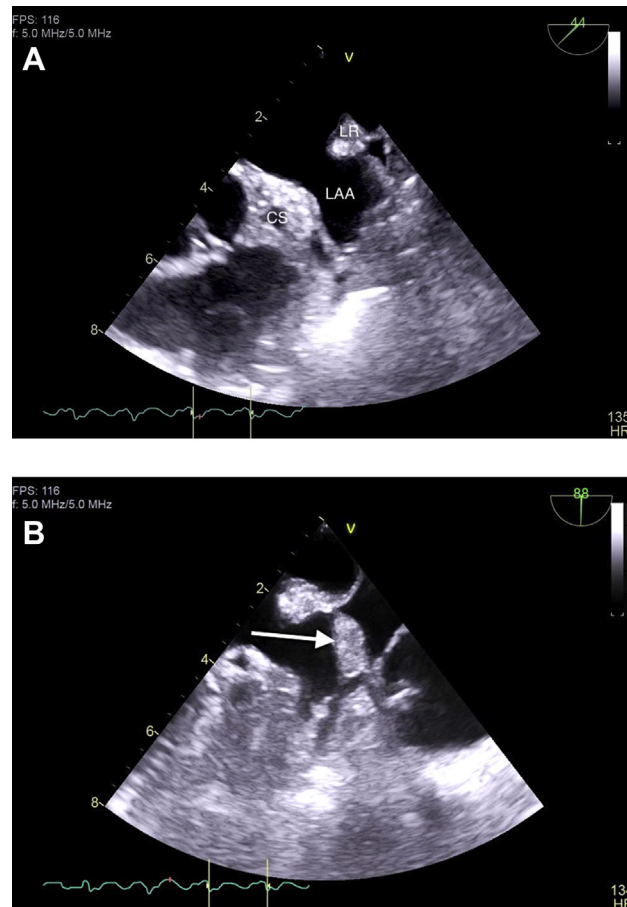
Figure 1 Midesophageal transesophageal echocardiographic views of the LAA at 44° **(A)** with no evidence of mass or filling defect and at 88° **(B)** showing a mass (*arrow*) that appears to be attached to the wall of the LAA. It was difficult to definitively determine from standard two-dimensional B-mode images whether this structure was intracardiac or extracardiac. *CS*, Coronary sinus; *LR*, left lateral ridge (also known as the "Coumadin ridge"; the ligament of Marshall is the epicardial correlate of this structure).
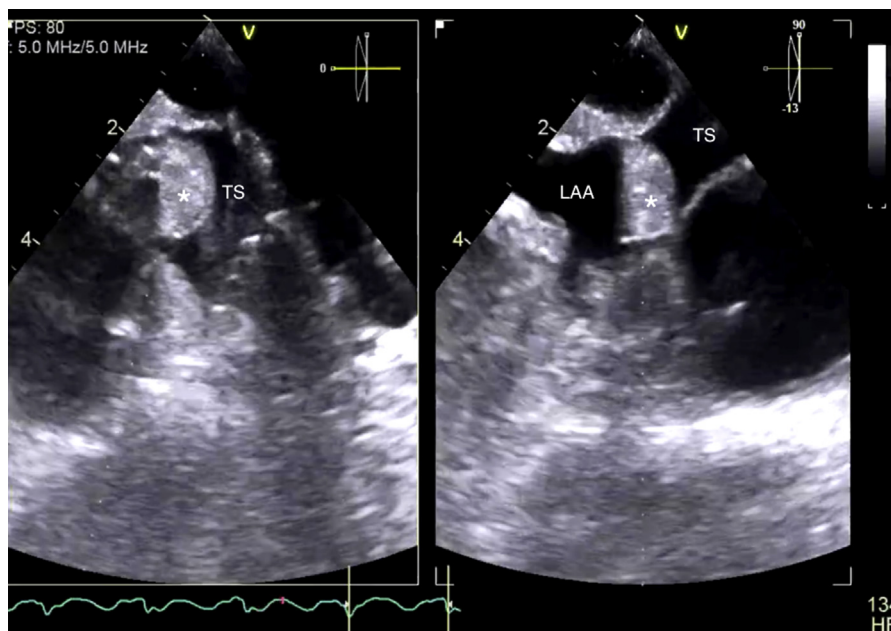

Figure 2 Midesophageal transesophageal echocardiographic view of the LAA using biplane imaging at 0° and 90°. The echodense structure (*asterisk*) appears to be epicardial, attached to the lateral aspect of the LAA in the transverse pericardial sinus (TS), though an intracardiac component could not be ruled out.
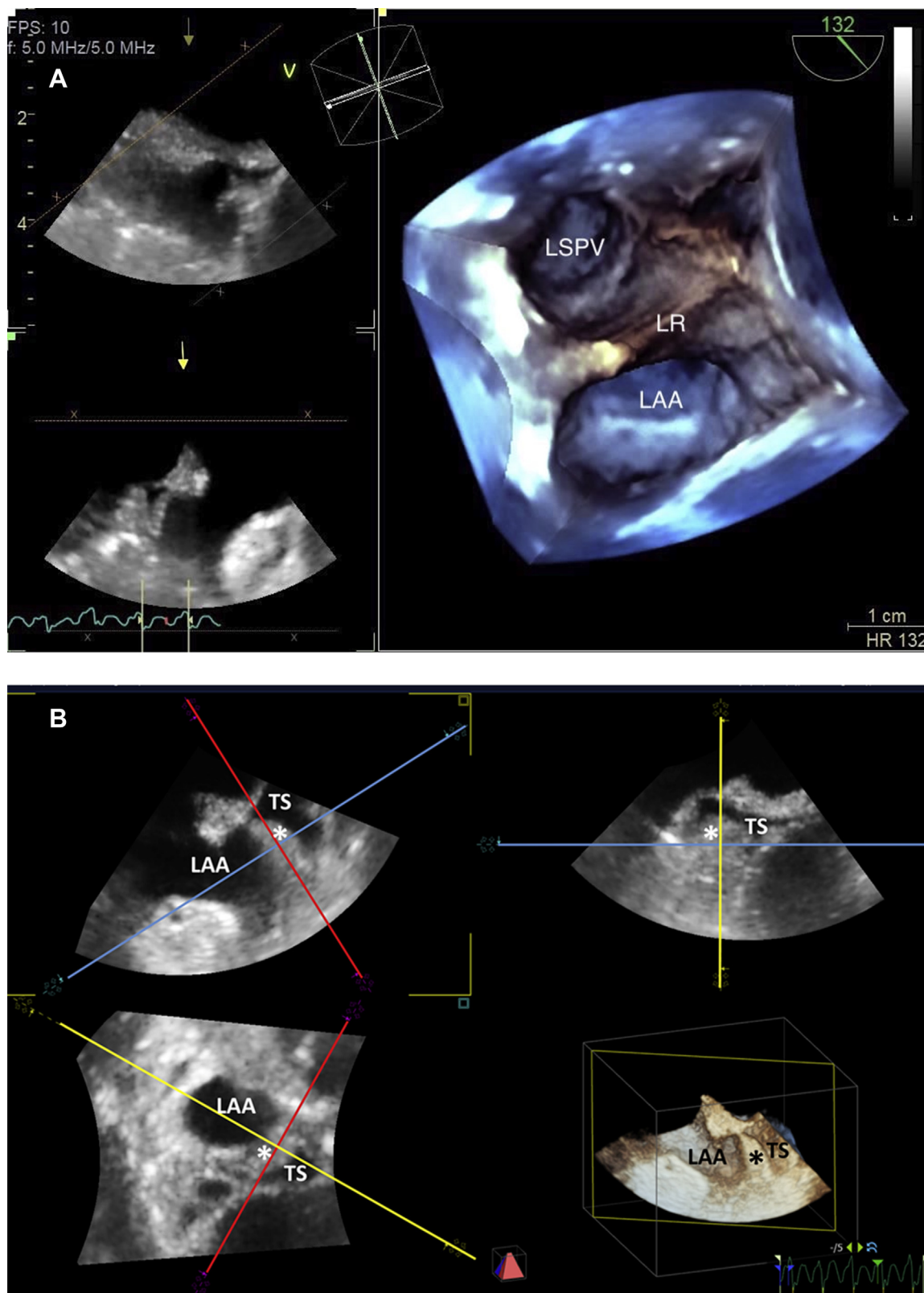
Figure 3 Three-dimensional echocardiography showing the LAA, the left lateral ridge (LR), and the left superior pulmonary vein (LSPV). **(A)** On real-time three-dimensional echocardiography, the LAA appears to be free of a filling defect, though the echodense structure previously seen on two-dimensional imaging could not be visualized. **(B)** Multiplanar reconstruction reveals that the mass (*asterisk*) is indeed epicardial, attached to the outer lateral wall of the LAA and located in the transverse sinus (TS).
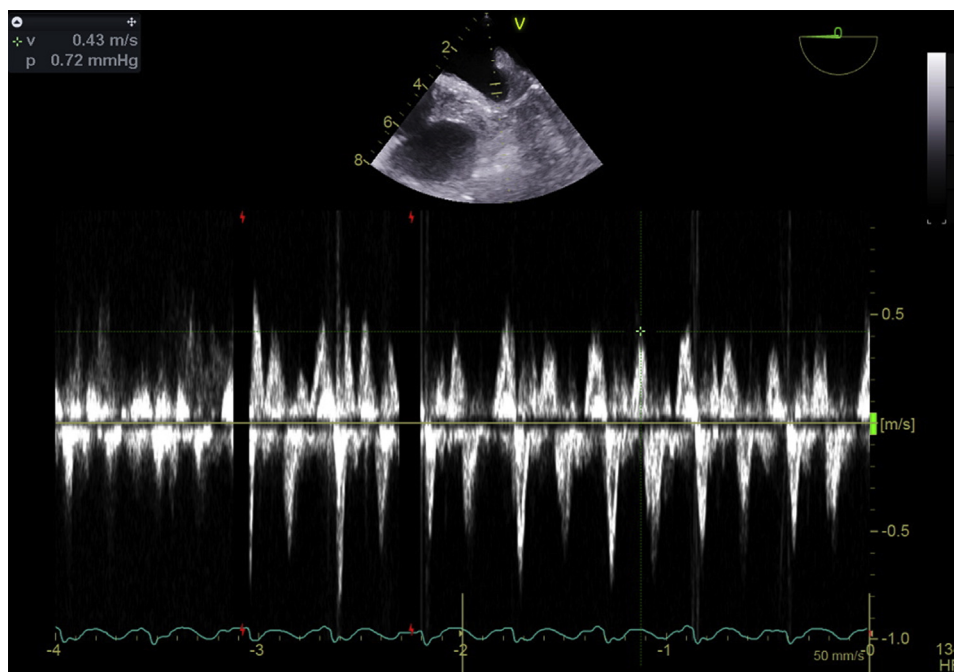
Figure 4 Pulsed-wave Doppler of the LAA outflow showing a peak emptying velocity of approximately 43 cm/sec. A peak emptying velocity of ≤20 cm/sec is associated with a significantly increased risk (relative risk, 1.7) for thromboembolic events in patients with AF.

attached to the outer lateral wall of the LAA within the transverse sinus of the pericardium (Figure 5, Videos 3 and 4). In post-processing, multiplanar reconstruction of the three-dimensional echocardiographic images confirmed the conclusion reached after UEA administration that this mass was epicardial (Figure 3B). TEE was otherwise remarkable for mild to moderate LV dysfunction (LV ejection fraction visually estimated at ~40%) as well as a highly mobile interatrial septum with significant lipomatous hypertrophy (Figure 6).

The patient underwent successful direct-current cardioversion with conversion to normal sinus rhythm but had recurrence of AF 3 days later. A loading dose of amiodarone was administered with repeat successful direct-current cardioversion, and the patient maintained sinus rhythm until discharge from the hospital. The patient did not experience any thromboembolic complications after cardioversion. Repeat TTE just before discharge revealed normalization of LV systolic function (LV ejection fraction 55%). Computed tomographic pulmonary angiography of her chest from earlier in her admission was reviewed, revealing a prominent interatrial septum corresponding to the finding of lipomatous interatrial septal hypertrophy on TEE (Figure 7). She was also noted to have a prominent epicardial fat pad and calcifications in the thoracic aorta and the epicardial coronary arteries.

DISCUSSION

TEE is an integral tool in the management of patients with AF to evaluate for atrial thrombus before electrical cardioversion or ablation. The use of UEAs has become routine in TTE for endocardial border definition in the setting of suboptimal image quality, evaluation for regional wall motion abnormalities on stress echocardiography, and exclusion of LV thrombus.[2] However, the use of UEAs during TEE is less common than during TTE. Here, we present a case in which a UEA administered during TEE resulted in improved diagnostic precision that a mass was extracardiac when other imaging modalities, including biplane and real-time three-dimensional echocardiography, were less definitive.

Previous reports have also demonstrated that the use of UEAs during TEE can have incremental value over noncontrast imaging for excluding LAA thrombus,[3] as adjacent masses or artifacts can make definitive assessment for the presence of thrombus difficult. There are examples of such thrombus "mimics" in the literature, which can often lead to misdiagnosis and unnecessary delays in definitive therapy for the patient.[4] Given its close proximity to the LAA, one structure that presents a particular diagnostic challenge is the transverse sinus of the pericardium. The pericardium has two "sinuses," the oblique sinus and the transverse sinus, which represent areas where the serosal layers of the visceral and parietal pericardium are reflected on one another, forming a cul-de-sac (Figure 8). The oblique sinus traverses posteriorly in the coronal plane, located behind the left atrium and between the right and left pulmonary veins. The transverse sinus is located just superior to the left atrium, forming a tunnel between the left atrium and the ascending aorta and pulmonary trunk. The transverse sinus is an important anatomic landmark for procedural specialists and is commonly used as a route to perform cross-clamping of the great vessels during cardiothoracic surgical procedures.[7] On echocardiography, the transverse sinus can be mistaken for an aortic dissection as it courses near the proximal ascending aorta (Figure 8C), and masses within the transverse sinus as it passes over the left atrium can be mistaken for LAA thrombus, as illustrated in our case.

On the basis of the location and appearance on echocardiography, the mass observed here likely represents epicardial fat. Prior reports have referred to any fat observed outside of the cardiac chambers on imaging as "*peri*cardial fat"; however, it is important to be specific when describing extramyocardial fat, as *epi*cardial fat (fat between the myoepicardium and pericardium) is embryologically distinct from *para*cardial fat (fat external to the parietal pericardium).[8,9] Moreover,
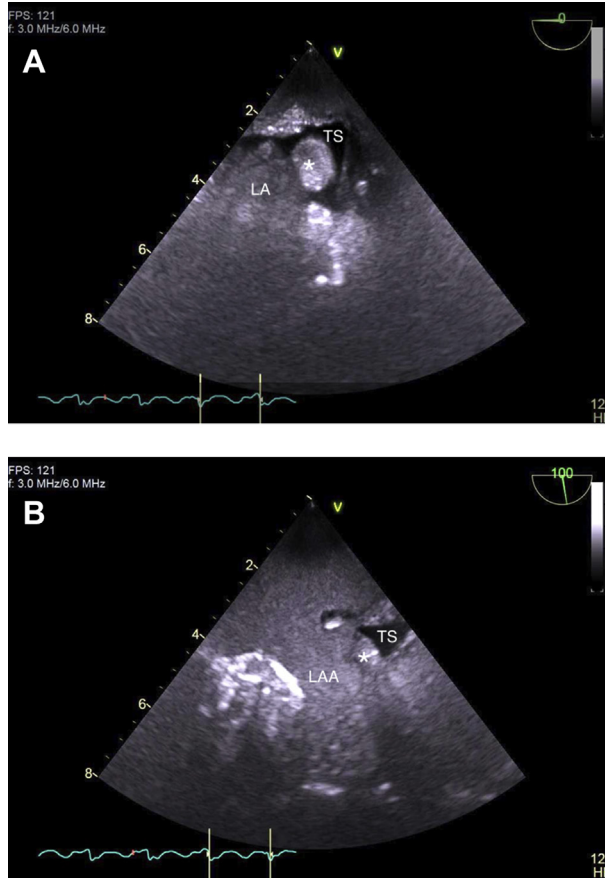
Figure 5 Midesophageal views of the LAA at 0° **(A)** and 100° **(B)** after the administration of the UEA. There is uniform opacification of the LAA. The mass (*asterisk*) is apparent in the adjacent echo-free space confirming its extracardiac location in the transverse peri-cardial sinus (TS). Harmonic imaging was used to optimally visualize the UEA. The mechanical index was lowered to <0.5 to minimize bubble destruction.
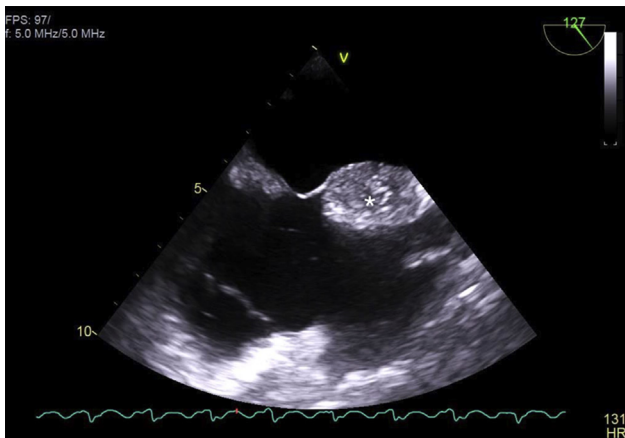

Figure 6 Transesophageal view of the interatrial septum. There is significant lipomatous interatrial septal hypertrophy (*asterisk*).

Figure 7 Computed tomographic angiogram of the chest showing lipomatous hypertrophy of the interatrial septum (*black arrows*) as well as a prominent epicardial fat pad (*red arrows*).

these two sources of adipose tissue have distinct circulations, with epicardial fat sharing the same microcirculation as the coronary arteries. Epicardial fat is not an entirely benign finding. The presence of epicardial fat is independently associated with prevalent AF, which makes differentiating between epicardial fat within the transverse si-

nus and LAA thrombus an important clinical problem in patients with AF.[10] Epicardial fat has also been associated with obesity, the metabolic syndrome, LV systolic dysfunction, and epicardial coronary
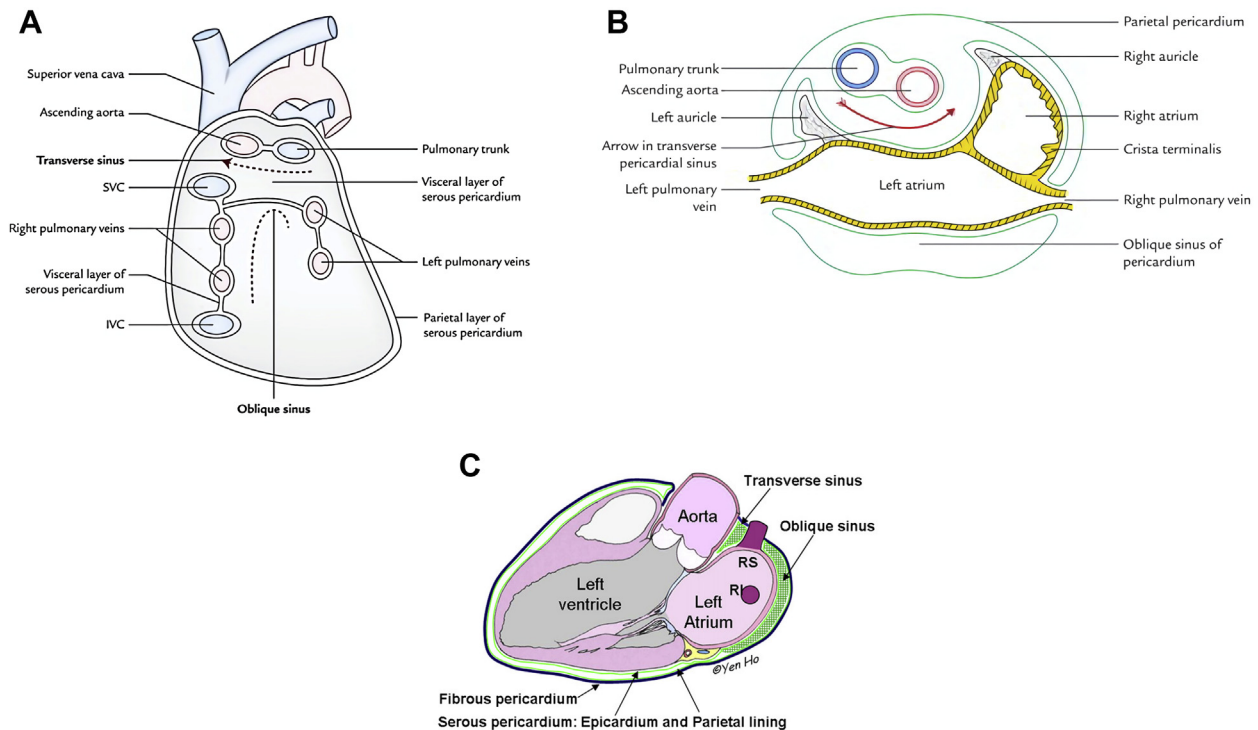
Figure 8 Coronal **(A)**, axial **(B)**, and long-axis **(C)** cuts showing anatomic landmarks related to the transverse and oblique pericardial sinuses. Figures 8A and 8B are reproduced with permission from Volker.[5] Figure 8C is reproduced with permission from Ernst *et al.*[6]

disease.[11-13] Although this patient had no known history of atherosclerotic cardiovascular disease, review of the computed tomographic angiogram of her chest during her admission revealed calcific atherosclerosis of the thoracic aorta and coronary arteries. Interestingly, this patient was also found to have significant lipomatous hypertrophy of the interatrial septum (LHIS). LHIS spares the fossa ovalis (or true interatrial septum), and the adipocyte hyperplasia seen in LHIS is actually also epicardial in origin.[14] It is no surprise then that LHIS has also been associated with arrhythmias, sudden cardiac death, and heart failure.[15]

CONCLUSION

This case demonstrates the utility of echocardiographic enhancing agents during TEE. When performing TEE before cardioversion or ablation for AF, an adequate understanding of the relevant anatomy in the proximity of the LAA is essential, and care must be taken to thoroughly investigate the LAA to differentiate between intracardiac and extracardiac structures. Multiplanar reconstruction with three-dimensional echocardiography is helpful for more clear delineation of these anatomic structures. Epicardial fat is more common in patients with AF and can present as a mass within the transverse pericardial sinus, mimicking LAA thrombus. Administration of UEAs can provide diagnostic clarity in instances in which clinical equipoise exists.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at https://doi.org/10.1016/j.case.2020.04.005.

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