echocardiography may unveil myocardial dysfunction in the otherwise nonhypertrophied segments seen on conventional 2-dimensional echocardiography and CMR imaging. The major limitation of this study is the small number of patients; thus, these findings need to be further validated. Although we continue to try to solve the Rubik's Cube that is the left ventricle in normal and diseased states (5), especially with regard to HCM, further insights provided by myocardial mechanics in these patients could help guide our moves.

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De-Novo Thrombus Formation and Latent Ligation Failure Following LAA Exclusion

Left atrial appendage (LAA) exclusion is becoming a popular alternative for patients with atrial fibrillation who are ineligible for long-term anticoagulation. The LAA exclusion system (Lariat Suture Delivery Device, SentreHEART Inc., Redwood City, California) was evaluated in a non-randomized single-center study with an immediate closure success rate (<1 mm of residual flow) of 95%, which was maintained up to 90 days as assessed by transesophageal echocardiography (TEE). The recent data has demonstrated safety and efficacy up to 1 year following the procedure with the success rate of up to 98% with no reported late device-associated thrombi (1,2). We report 3 cases of importance with respect to management of antiplatelet and anticoagulation therapy.

Patient #1. The first patient is a 63-year-old man with paroxysmal atrial fibrillation and prior splenic infarct who was ineligible for long-term anticoagulation because of underlying coagulopathy secondary to cryptogenic cirrhosis with a history of esophageal variceal bleed. Intraoperative TEE confirmed closure of the LAA with no evidence of residual leak immediately following the Lariat procedure (Fig. 1A). The patient received no post-operative antiplatelet or anticoagulant therapy. Routine follow-up TEE 3 months later showed that the LAA remained obliterated; however, there was a new mobile thrombus in the LAA remnant attached to the atrial wall (Fig. 1B). Despite his bleeding risk, the patient was started on warfarin and remained asymptomatic with no neurologic sequelae. Repeat TEE 2 months later showed complete resolution of thrombus.

Patient #2. The second patient is a 75-year-old woman with persistent atrial fibrillation and history of ischemic stroke who had extreme difficulty in maintaining a therapeutic international normalized ratio on warfarin. During the LAA exclusion procedure, it was difficult to obtain complete ostial closure of the LAA. Intraoperative imaging with angiography and TEE showed a small pouch remnant, but suggested most of the distal trabeculated appendage was closed (Fig. 1C). This patient also received no post-operative antiplatelet or anticoagulant therapy. Routine follow-up by TEE 3 months later revealed a thrombus in the LAA, which no longer appeared to be closed, suggesting latent ligation failure (Fig. 1D).

Patient #3. Finally, a 76-year-old man also with persistent atrial fibrillation was referred for the LAA exclusion procedure because of a history of intracerebral hemorrhage in addition to gastrointestinal bleed while on warfarin. Intraoperative TEE and angiography confirmed complete closure of the LAA with no residual leak (Fig. 1E). At discharge, the patient was maintained on aspirin and clopidogrel only. Follow-up TEE 3 months later demonstrated thrombus formation in the LAA, which was no longer ligated (Fig. 1F). Because of the presence of thrombus, aspirin and clopidogrel were discontinued, and the patient was started on warfarin.

Initially, the role of post-procedure antithrombotic therapy was largely unknown, although it was suggested the Lariat device would allow freedom from warfarin, especially immediately following the procedure. This is a contradistinction to another LAA closure device (Watchman, Boston Scientific, Natick, Massachusetts), which requires warfarin post-operatively for at least 45 days while the device endothelializes (3). Initially, the role of anticoagulation immediately following the Lariat procedure was unclear and a nonsystematic approach was applied. Recent data showing long-term results for thromboembolic event reduction are confounded by the high proportion of patients (61%) on warfarin at the time of last follow-up (approximately 1 year). Because this data can not confirm freedom from thrombus formation without anticoagulation, recent recommendations by Bartus et al. (2) now suggest that patients with a $CHADS_2$ (congestive heart failure; hypertension >140/90 mm Hg, or on hypertension medication; age ≥75 years; diabetes mellitus; and prior stroke, transient ischemic attack, or thromboembolism) score of 2 or higher who can tolerate anticoagulation continue warfarin.

As noted in this report, we present a case series of 3 patients who at 3-month follow-up TEE, had evidence of de novo thrombus formation: 1 adjacent to the ligated LAA; and 2 within the LAA that no longer appeared to be ligated. One patient received antiplatelet therapy; however, none were initiated on anticoagulant therapy immediately after the procedure. Based on

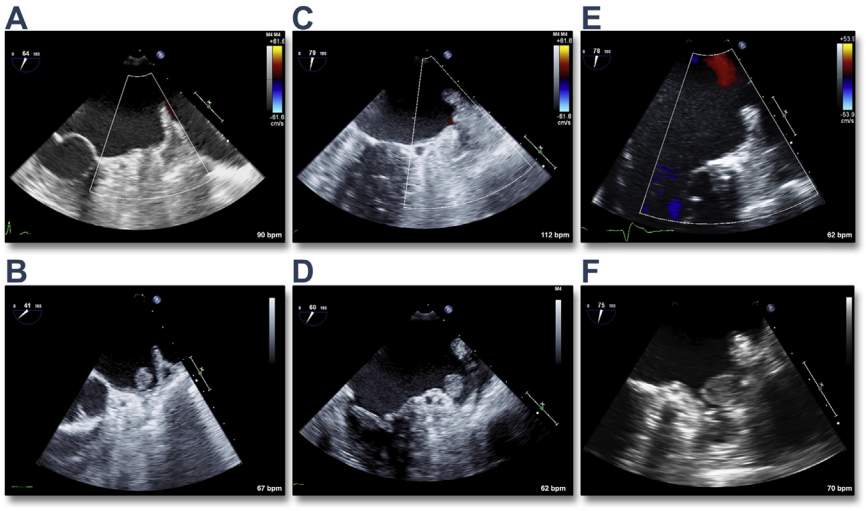

Figure 1. Patient TEE Images

Immediate post-operative and 3-month follow-up transesophageal echocardiography (TEE) images from the 3 patients. Patient 1 immediately following the Lariat procedure showing no residual leak **(A)**, with follow-up TEE showing thrombus in the ligated appendage **(B)**. Patient 2 showing less than 1 mm residual flow immediately after the procedure **(C)**, with follow-up TEE showing ligation failure with thrombus **(D)**. Patient 3 immediately post-procedure showing no residual flow **(E)**, with follow-up TEE showing ligation failure and thrombus formation **(F)**.

our findings, we agree that antiplatelet or anticoagulant therapy is advisable following the LAA exclusion procedure until routine follow-up TEE can be performed to confirm LAA closure and absence of thrombus. Our center is now using short-term anticoagulation immediately following the Lariat procedure, unless absolutely contraindicated, until follow-up TEE confirms the LAA remains ligated and free of thrombus. The ideal length of anticoagulation treatment is unknown. Additionally, as evidenced by our first patient, thrombus formation was discovered adjacent to a successfully ligated LAA, suggesting latent thrombosis is still possible in patients who have short- and intermediate-term closure success.

Ongoing, randomized clinical trials will be needed not only to provide short- and long-term evidence that LAA exclusion would prevent thromboembolic events, but these trials also need to develop a protocol for discontinuing anticoagulation at a pre-specified time point to assess the risk of intra-atrial thrombus formation.

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