Case Report

Left Atrial Laceration With Epicardial Ligation Device

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Many new devices and techniques are being developed to attempt a reduction in embolic stroke risk for patients with atrial fibrillation who are either unable or unwilling to maintain long-term anticoagulation. One of these new devices (LARIAT®, SentreHEART Inc., Redwood City, California, USA) employs delivery of an epicardial suture to ligate the left atrial appendage after percutaneous pericardial and transseptal access. This series presents three clinical cases that demonstrate a serious and recurrent complication of left atrial laceration and cardiac tamponade shortly following delivery of an epicardial suture ligation to the left atrial appendage. Three clinical cases are described in detail with pre- and postprocedure angiography and echocardiography as well as illustrations reflecting the surgeon’s findings on direct visualization of the left atrial lacerations postligation. Potential hypotheses of each injury are examined in light of the case timelines and findings at sternotomy. There was no suggestion that tamponade was related to pericardial or transseptal access, but rather a complication with device delivery. These three patients quickly progressed to clinical cardiac tamponade despite attempted drainage, stressing the importance of cardiovascular surgery backup, including a cardiopulmonary bypass pump, when delivering novel, percutaneous ligation devices for the left atrial appendage.

Keywords: left atrial appendage, ligation, cardiac tamponade, laceration, LARIAT

Introduction

The left atrial appendage (LAA) has long been known as a source of embolic thrombi in patients with atrial fibrillation, especially nonvalvular atrial fibrillation.1

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Case Descriptions

Case #1

An 84-year-old woman with permanent atrial fibrillation, hypertension, diabetes, vascular disease and heart failure with normal left ventricular systolic function was contraindicated to chronic anticoagulation due to recurrent high-volume gastrointestinal blood loss. After routine epicardial and transseptal access with baseline TEE imaging of the LAA, successful ligation of the LAA by the snare was confirmed on angiogram (Fig. 2A and 2B). The suture was then pulled using the TenSURE device at 10 lb of force for 5 seconds. A 5-minute observation on TEE was performed, then the suture was again tightened at 10 lb of force for 5 seconds. The LARIAT had been opened and was removed without difficulty or resistance. Following the second tightening, there was almost immediate visualization of blood in the pericardium surrounding the ligated LAA (Fig. 2C), with subsequent hypotension noted on arterial line. The remaining suture was cut, and a large amount of blood was continuously aspirated from the pericardial sheath without resolving the patient’s hypotension and tamponade. A cardiothoracic surgeon, who was present in the hybrid laboratory during the interventional procedure, was scrubbed in for immediate sternotomy, evacuation and cardiopulmonary bypass with direct visualization and repair of a 3-cm left atrial laceration just superior to the base of the fully ligated LAA (Fig. 2D). The surgeon noted this patient had very friable atrial tissue. There was no evidence of a right ventricular tear or other access-related issues. The patient tolerated the repair but had a prolonged hospital stay that was complicated by exacerbation of her heart failure and Dressler’s syndrome. She was discharged home 19 days after surgery.

Case #2

A 63-year-old woman with permanent atrial fibrillation, hypertension, prior stroke and mitral valve thickening without significant stenosis did not feel comfortable taking anticoagulation because of her history of gastric bypass, gastrointestinal blood loss and iron deficiency anemia. After routine epicardial and transseptal access with baseline TEE imaging, the LARIAT was closed over the LAA and exclusion noted on TEE. Angiogram and TEE revealed complete ligation when compared with preligation imaging (Fig. 3A and 3B). In every case, the endocardial FindrWIRZ® magnetic guide wire (SentreHEART Inc.) and EndoCATH® balloon (SentreHEART Inc.) were removed from the appendage prior to initial tightening of the suture, and real-time TEE was utilized throughout and monitored constantly. The rapid accumulation of blood in the pericardium with subsequent hypotension was seen 3 to 5 minutes after use of the TenSURE™ suture tightener (SentreHEART Inc.). In cases 1 and 2, this followed the second tightening that occurred after the initial 5-minute waiting period. In case 3, blood accumulated during the waiting period after initial tightening.
second tightening was performed with identical pull. About 3 minutes following this second tightening and after the opened LARIAT loop had been removed without resistance, the patient was noted to have developed blood in the pericardium flowing from the left atrium (Fig. 3C), followed by clinical tamponade. Aspiration of copious whole blood from the epicardial sheath failed to resolve the hypotension. A cardiothoracic surgeon performed immediate sternotomy, evacuation and cardio-pulmonary bypass. Under direct visualization, two small tears were seen just posterior to the base of the fully ligated LAA (Fig. 3D). The patient tolerated the repair with a return to normal hemodynamics and was discharged home 6 days later.

Case #3

Attempts at anticoagulation in a 70-year-old woman with permanent atrial fibrillation, hypertension and advanced chronic kidney disease resulted in gross hematuria. Cystoscopy failed to find a focal source of her bleeding. Due to her advanced kidney disease, this particular patient was unable to receive contrast with her preoperative gated cardiac computed tomography. The images from the noncontrast study in the setting of atrial fibrillation were poor. After baseline TEE, she was felt a reasonable candidate for the ligation procedure. Epicardial and transeptal access were uncomplicated. Left atrial angiography (Fig. 4A) did suggest a bilobed appearance to the LAA, but with a common base. The LARIAT was advanced around and cinched over what was
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felt to be the base of the LAA. In this case, the operators used only a single pull of 2.5 lb of force for 5 seconds with the TenSURE device and visualized the appearance of excellent exclusion to the LAA on angiogram, although the presence of another nonligated lobe was subsequently seen on TEE (Fig. 4B). It was within the 5-minute waiting period that a pericardial effusion was first noted and progressed to tamponade despite withdrawal of blood from the pericardial sheath (Fig. 4C). Sternotomy, cardio pulmonary bypass and subsequent direct visualization revealed that the LARIAT suture was fully ligating the more caudal lobe of a bilobed LAA. The laceration was on the more superior lobe just opposite the knot of the LARIAT. The shared base of the bilobed LAA was oversewn with pledgeted sutures (Fig. 4D). The patient tolerated the surgical repair and was discharged home in 7 days.

Discussion

All of these cases were characterized by the abrupt onset of cardiac tamponade that was unrelated to pericardial access, shortly preceded by suture tightening and unresponsive to immediate pericardial drainage. All three cases demonstrated sites of atrial laceration outside the ligated lobe of the appendage. This type of complication is not reported in previous larger series on percutaneous ligation of the LAA utilizing the same device. The most common intraoperative complication seen in other series and case reports is right ventricular perforation during epicardial access or perforation of the LAA itself. Three other cases at our institution were performed without complication by the same operators using an identical technique. The time course of the first 2 cases suggests that injury occurred with additional tightening of the suture. This may stem from simple traction or pressure placed on friable left atrial tissue (as we suspect in case 1) or epicardial perforation of the delivery device (one possible hypothesis in case 2), which ends up acting as a de facto knot pusher for the Meltzer slip knot even if no forward traction is placed on the delivery device. The suture ligation appeared intact and in place with complete exclusion of the appendage in the first two cases, suggesting the suture itself was unlikely to have caused injury. If risk of the suture knot loosening is low, then one technique alteration includes eradicating subsequent tightenings after initial suture deployment unless incomplete exclusion is seen on TEE or angiogram. Case 3 demonstrated the possibility of selectively ensnaring only one lobe of a multilobed LAA, and also demonstrated the importance of adequate preoperative imaging to ensure proper patient selection and intraoperative imaging to maximize benefit and minimize risk of the procedure. Incomplete exclusion of the LAA can lead to inadequate reduction in embolic stroke risk. However, ligation of only one of the lobes does not explain laceration of the opposite lobe. Ligating a proximal remnant of the LAA has been reported in animal models without complication. Laceration in case 3 may have involved the entrapment of a small portion of the nonligated lobe during tightening. This could produce a cheese-cutter effect through the ensnared portion of the nonligated lobe. One operator felt this could be explained by having an endocardial magnet wire in one lobe while the epicardial magnet pressed against the fully ensnared lobe. Further studies into the delivery design and technique of percutaneous
LAA ligation are warranted, and increased experience with this device has already extended beyond the 137 cases referred to in this report.6–8)

Conclusions

Techniques and devices employed to percutaneously occlude or ligate the LAA are still in their infancy. The risks involved clearly limit the practical use of these measures to patients with significant embolic stroke risk from atrial fibrillation and a contraindication or refractoriness to the standard anticoagulation treatment. Even in appropriate candidates, operators need to be cognizant of the potential safety risks and complications associated with these devices when performing this delicate procedure. The importance of initially performing any of these procedures in a hybrid or operating room with immediate access to both a cardiothoracic surgeon and cardiopulmonary bypass equipment is underlined by the rapid onset of hemodynamic instability in the three patients reported here.

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Disclosure Statement

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References


