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Robotic-Assisted Left Atrial Ligation for Stroke Reduction in Chronic Atrial Fibrillation: A Case Report

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ABSTRACT

Patients with atrial fibrillation are at significant risk for sustaining a thromboembolic stroke. More than 90% of thromboemboli form in the left atrial appendage. Ligation of the left atrial appendage to reduce the risk of stroke is often performed in connection with other cardiac surgical procedures. As a stand-alone procedure, however, left atrial ligation has generally been deemed too invasive and has gained little support as an alternative therapeutic option. We report a case of port-access robotic-assisted left atrial ligation as a stand-alone procedure in a patient with chronic atrial fibrillation in whom anticoagulation was a contraindication. To our knowledge, this is the first reported case of stand-alone robotic-assisted left atrial ligation in the literature.

INTRODUCTION

The most prevalent sustained cardiac arrhythmia is atrial fibrillation (AF). Ten percent of people over the age of 80 suffer from AF [Feinberg 1995] with a total incidence of 2.2 million cases per year in the United States [Benjamin 1994]. Furthermore, 25% of all reported cases of stroke are due to AF [Johnson 2000] and 35% of AF patients are expected to have at least 1 stroke in their lifetime [Blackshear 1996]. Finally, strokes resulting from AF are more severe than non-AF strokes [Yamanouchi 1989, Leckey 2000]. With the incidence and prevalence rates for AF doubling each decade beyond the age of 50 and a trend toward a more elderly population, the impact of AF is likely to increase [Kannel 1998].

Although anticoagulation with warfarin therapy is effective for stroke risk reduction in AF patients, studies suggest that more than 25% of AF patients over the age of 65 have contraindications to this form of therapy, emphasizing the need for alternative treatment options [Sudlow 1998].

Surgical ligation of the left atrial appendage (LAA) has long been theorized to reduce the risk of stroke in AF [Guiraudon 1993]. Approximately 75% of all thromboembolic events that occur in AF arise from the atria. Moreover, more than 90% of atrial emboli in AF form in the LAA [Blackshear 1996, Johnson 2000]. Although never proven, it can be hypothesized that removal of the LAA in AF would significantly reduce the formation of embolic thrombi and reduce the incidence of stroke. For this reason, the LAA is often removed during AF surgery or in connection with other cardiac surgical procedures. However, left atrial ligation has never gained wide acceptance as a stand-alone procedure. It is the opinion of the medical community that conventional methods of cardiac surgery utilizing sternotomies and thoracotomies for the sole purpose of removing the LAA are too invasive. For left atrial ligation to be readily accepted as a potential alternative treatment, less invasive techniques need to be assessed.

We report a case of port-access robotic-assisted left atrial ligation as a stand-alone procedure in a patient with chronic AF in whom anticoagulation was a contraindication. Port-access allowed the potential benefits of left atrial ligation to be provided in a minimally invasive manner so as to minimize surgical risk. This approach may increase the acceptance of surgery as an alternative option in treating AF. To our knowledge, this is the first reported case of totally robotic-assisted left atrial ligation in the literature.

CASE REPORT

A 72-year-old man with a 2-year history of atrial fibrillation who had suffered a previous transient ischemic attack presented with an intracerebral bleed secondary to anticoagulation therapy. Prevented from further anticoagulation due to the intracerebral bleed, the patient underwent minimally invasive robotic-assisted left atrial ligation for stroke risk reduction.

Preoperative investigations included a transesophageal echocardiogram where the presence of thrombus in the LAA was ruled out. Next, cardiac gated magnetic resonance imaging (MRI) of the thorax was performed on a 1.5T CVMRI

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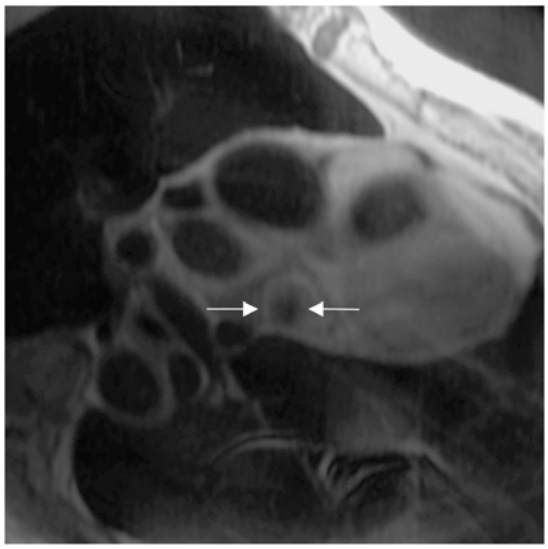

Figure 1. Axial double inversion recovery black blood image through the base of the left atrial appendage showing the round, narrow origin of the left atrial appendage in short axis (arrows).

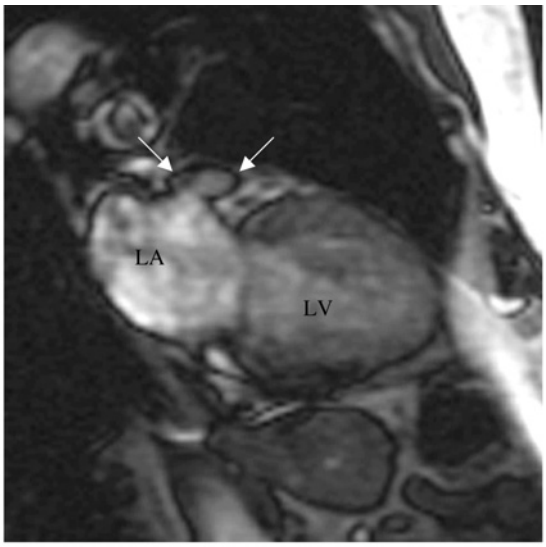

Figure 2. Vertical long axis fast gradient echo bright blood image through the left atrium (LA) and left ventricle (LV) demonstrating the narrow point of attachment of the finger-like left atrial appendage (arrows).

scanner (General Electric, Milwaukee, WI, USA). Double inversion recovery black blood axial images of the chest were done to assess the left thoracic cavity and ensure adequate intrathoracic space (Figure 1). In addition, fast gradient echo bright blood vertical long axis images of the left atrium were obtained to assess anatomic suitability of surgical appendage ligation (Figure 2).

In the supine position, the patient was given a general anesthetic and intubated using a double lumen endotracheal tube. Intercostal port placement positions were determined and marked. The patient was then positioned in the 30° right lateral decubitus position. Under single-lung ventilation, a 12-mm port was placed over the fifth intercostal space (ICS) anterior to the anterior axillary line. Under direct visualization 3 additional 7-mm ports were inserted. One port was placed in the second ICS at the midclavicular line and 2 ports were placed in the third and seventh ICS anterior to the anterior axillary line. All endoscopic ports were then adapted to the da Vinci robotic system (Intuitive Surgical, Sunnyvale, CA, USA). The left phrenic nerve was identified and the pericardium was opened anterior to the phrenic nerve. This opening in the pericardium was extended along the pericardial sac until the entire LAA was visualized. An endoloop was inserted through the third intercostal port and placed around the LAA. The appendage was ligated using no-touch technique. Intraoperative transesophageal echocardiography was then used to ensure complete ligation of the appendage with no evidence of blood flow within the appendage. A thorough inspection of the ligation and the pericardial opening showed no evidence of bleeding. A chest tube was inserted into the pleural cavity through the seventh intercostal port under direct visualization with the endoscope. There were no complications and the patient went home on postoperative day 3.

The patient is doing well at 2 months follow-up. A repeat echocardiogram showed no evidence of flow within the LAA. The patient is to undergo repeat MRI to further assess flow within the LAA at 6 months.

DISCUSSION

Minimally invasive surgery involves acquiring surgical access in the least invasive manner possible while maintaining superior surgical technique. Atrial ligation for stroke risk reduction is well suited to the concepts of minimally invasive surgery. Invasive surgical access has been the main deterrent to investigating the benefits of left atrial ligation as a stand-alone procedure. Port-access eliminates the need for invasive access to the thoracic cavity by removing the sternotomy or thoracotomy incision from the surgical procedure.

Following the lead of Johnson and Blackshear, who recently published an early and successful series on port-access thoracoscopic LAA obliteration [Blackshear 2003], we now report on a case of port-access robotic-assisted LAA ligation for stroke risk reduction. The mention of robotic-assistance for performing minimally invasive surgeries is often justly met with the challenge of explaining the purpose of using robotics when the same procedure can be performed minimally invasively using a thoracoscopic approach. At our institution we feel that the increased precision and improved visibility provided by the robotic system allows the procedure to be performed more safely. The robotic system is equipped with 3-dimensional high-resolution imaging as opposed to 2-dimensional imaging used with the thoracoscopic approach. Also, robotic assistance replicates the motions of the human hand with 7 degrees of freedom. In contrast, long-shafted thoracoscopic instruments provide only 4 degrees of freedom. The increase in degrees of freedom when employing robotic assistance enhances instrument maneuverability within the thorax and gives the surgeon more control over the procedure. Moreover, robotic

arms are tremor-free. This reduces the chance of tearing the left atrial appendage and allows the ligation to be accomplished with more precision. Finally, the robotic system is equipped with an additional arm. This enables optimal positioning of the atrial appendage with 1 arm and leaves 2 arms free to perform the surgical procedure. It is our belief that the features of robotic-assisted surgery discussed above provide the safest possible setting for ensuring patient safety. In theory, a safer procedure decreases the risk of incurring a complication. By reducing the risk of incurring a complication during a minimally invasive procedure, the conversion rate to invasive conventional access is reduced.

Along with the robotic-assisted and thoracoscopic techniques, a percutaneous approach to occluding the left atrial appendage has also been reported [Sievert 2002]. Of note, the percutaneous technique involves implementation of a lifelong foreign body to the system, is dependent on intracardiac access, and still requires antithrombotic therapy. For the subset of patients discussed in this report, where anticoagulation was a contraindication, the percutaneous approach may have less appeal.

Finally, although we are reporting on our initial clinical experience, it should be emphasized that to date there are no data to substantiate the value of left atrial ligation for stroke risk reduction in AF patients. At this stage, the indications for this type of procedure are purely based on supposition. As an experimental procedure, it may or may not prove beneficial. Still, in theory, it seems logical that left atrial ligation should provide protection from stroke-related morbidity in AF patients. Therefore, the robotic-assisted, thoracoscopic, and percutaneous techniques, all of which provide a minimally invasive approach to the potential reduction in AF related strokes, all warrant further evaluation.

CONCLUSION

Robotic-assisted left atrial ligation as a stand-alone procedure is feasible. More experience with a larger patient subset is necessary.

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REVIEW AND COMMENTARY

1. Editorial Board Member NR514 writes:

This is innovative surgery for a complex patient. I question the risk of "avulsion" with the endoloop. What other methods could be employed to achieve ligation or prevent possible complications?

Author's Response by Dr. Bob Kiaii:

In terms of "avulsion" with the endoloop, this definitely is a very serious complication and could very easily occur. At our institution we have frequently used the endoloop for such applications, even in open sternotomy cases, and fortunately we have not had an avulsion. If the endoloop is applied extremely cautiously, this entity can be avoided. With the application of robotics for these procedures, the placement of the endoloop can be made even more precisely and hence an avulsion can be avoided.

Another method we have used to achieve ligation has been stapling the appendage using an endoscopic stapler. We feel that an avulsion can more easily occur during the stapling and, in addition, we have had incidences where bleeding from the staple line occurred where the appendage was resected that have required us to place sutures. Although stapling may sound better in theory, we feel that the stapling technique can result in more possible complications. Therefore, we prefer to use the endoloop.

2. Editorial Board Member KK138 writes:

Life-threatening bleeding has occasionally been reported following left atrial appendage ligation. Do the authors feel comfortable endoscopically managing such complications or do they think that a conversion is required?

Author's Response by Dr. Bob Kiaii:

We agree that life-threatening bleeding is a very serious complication following left atrial appendage ligation. At our institution we perform an adequate volume of endoscopic procedures and feel comfortable in endoscopically managing such a bleeding complication. However, if we think that the patient's safety may be compromised by endoscopically managing this complication, then we will convert if required.