A Completely Endoscopic Approach to Microwave Ablation for Atrial Fibrillation

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ABSTRACT

Background: Surgical therapy for atrial fibrillation is extremely effective but not widely applied. Minimally invasive methods may be more attractive. We report a case of complete pulmonary vein isolation performed entirely through a thoracoscopic approach.

Methods: A 74-year-old woman with paroxysmal atrial fibrillation underwent a microwave ablation procedure using 3 access ports in the right pleural space and 3 access ports through the left pleural space.

Results: After the 3-hour procedure the patient was extubated in the operating room and discharged home in sinus rhythm on the second postoperative day.

Conclusions: Endoscopic pulmonary vein isolation is a safe and effective procedure that may be applied to a wide variety of patients.

INTRODUCTION

Atrial fibrillation is the most common cardiac arrhythmia. Pharmacologic therapy, including direct current cardioversion, has met with limited success. Surgical therapy has proven to be quite effective at long-term cure of atrial fibrillation, but its application remains limited because of the substantial complexity and morbidity of the procedure. Recent interest in more limited techniques using simpler methods has been keen. We present the first case of a successful pulmonary vein isolation procedure performed entirely with an endoscopic approach.

PATIENT CHARACTERISTICS

A 74-year-old woman presented with paroxysmal atrial fibrillation. She had experienced recurrent self-limiting bouts of fibrillation for the previous 4 years. During the last year they had become more frequent and more severe; the last 2 incidents resulted in hospitalization for syncope and near-syncope. Multiple drug therapies, including sotalol, quinidine, amiodarone, and dofetilide, had failed. She was considered for a pulmonary vein isolation procedure.

The patient's past medical history included a hysterectomy and basal cell skin cancer. She had no family history of arrhythmia. The results of her physical examination were unremarkable: she was in sinus rhythm at 80 beats per minute; an echocardiogram demonstrated normal ventricular and valve function with a left atrial size of 4.5 cm; and a cardiac catheterization demonstrated normal coronary artery anatomy and left ventricular filling pressures.

METHODS

The patient was brought to the operating room and placed under double-lumen general endotracheal anesthesia. A central venous catheter and a radial artery catheter were placed. The chest, abdomen, and groins were prepared and draped in the usual sterile fashion. The right lung was deflated, and the patient was positioned approximately 15° toward left decubitus with the arms abducted at 90°.

A 5-mm access port was created in the fifth intercostal space in the midaxillary line, through which a camera was introduced. Another 5-mm port was created in the fourth intercostal space in the midaxillary line, and a 10-mm port was made in the sixth intercostal space in the midclavicular line (Figure 1). The right lung was reflected posteriorly, and the pericardium was identified. The pericardium was opened sharply approximately 2 cm anterior to the phrenic nerve, and the incision was extended from the superior vena cava to the inferior vena cava (Figure 2).

The superior vena cava and the inferior vena cava were dissected out circumferentially under direct vision. Of note is that the superior vena cava dissection began at the superior aspect of the right superior pulmonary vein and continued inferior to the right pulmonary artery; this procedure removed most of the fat from the right side of the dome of the left atrium. The inferior vena cava was dissected out where it joined the right atrium.

A 14-French firm rubber catheter was passed under direct vision into each of the sinuses posterior to each caval vein, and steel stylets were used to temporarily stiffen and guide the catheters (Figure 3). The flared ends of the catheters were secured with hemostats to the port sites to prevent dislodgement.

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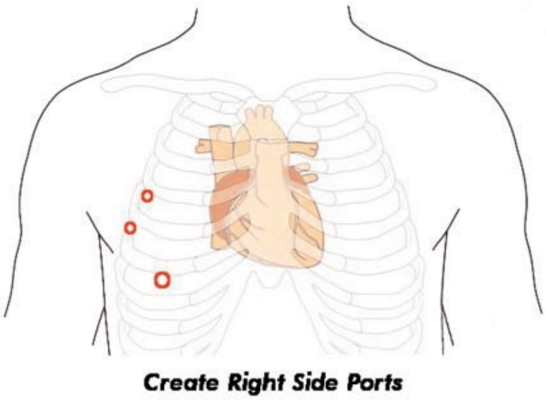

Figure 1. Location of right-sided thoracoscopic ports. The ports in the fourth and fifth intercostal space at the midaxillary line are 5 mm in diameter. The port in the sixth intercostal space at the midclavicular line is 10 mm in diameter.

The instruments were removed from the right chest, and the right lung was placed back on the ventilator.

The patient was rotated back across the midline to approximately 15° right decubitus. The left lung was deflated, and the same port pattern was established on the left chest (Figure 4). The left lung was reflected posteriorly, and the pericardium was entered approximately 2 cm anterior to the phrenic nerve with an incision just long enough to expose the left atrial appendage. The two rubber probe catheters were retrieved and delivered outside the chest, where they were sutured together to form a completely encircling guide around the pulmonary veins (Figure 5). The catheters were replaced into the left chest.

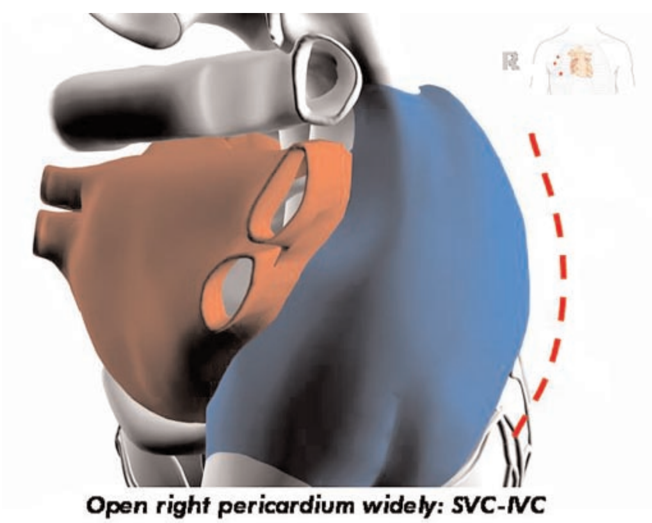

Figure 2. Opening in the right side of the pericardium, exposing the right atrium and superior and inferior vena cavae. The incision extends from the junction of the superior vena cava (SVC) and right atrium inferiorly to the junction of the inferior vena cava (IVC) and right atrium. It is located approximately 2 cm anterior to the phrenic nerve.

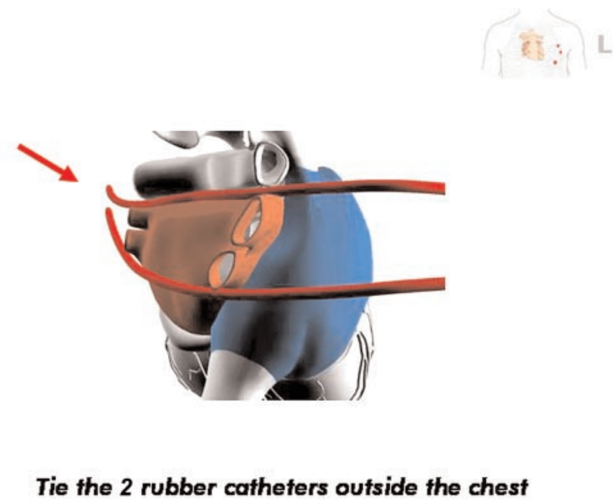

Figure 3. Guide catheters into transverse and oblique sinuses under the caval veins. The catheters are passed under each caval vein and into the sinus. The flared end remains at the level of the skin, where it is secured to prevent loss.

The leader of the Flex 10 microwave ablation probe (AFx, Fremont, CA, USA) was sutured to the flared end of the upper rubber catheter. Traction was then placed on the flared end of the lower rubber catheter, thereby guiding the Flex 10 into the right chest and around the pulmonary veins (Figure 6).

Inspection of the left side of the pericardial space revealed that the Flex 10 was overlying ("superficial to") the left atrial appendage. The Flex 10 was grasped and positioned appropriately inside and posterior to the appendage and against the left atrium. Orientation of the microwave antenna toward the heart was confirmed by visualizing the black shield line on the outside convex surface of the probe. The Flex 10 was activated in 2-cm increments at 65 W and 90 seconds per lesion to create 11 lesions that completely encircled the pulmonary

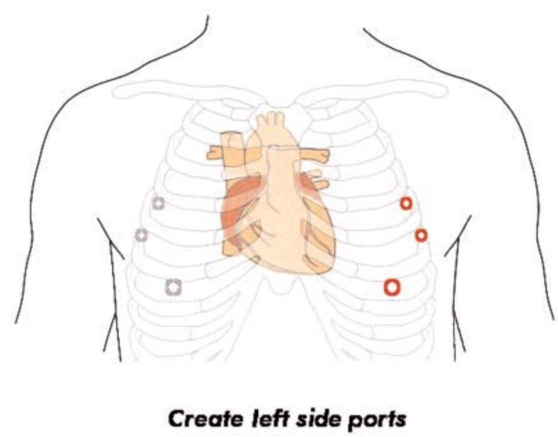

Figure 4. Location of left side thoracoscopic ports. The ports are located exactly as on the right side.

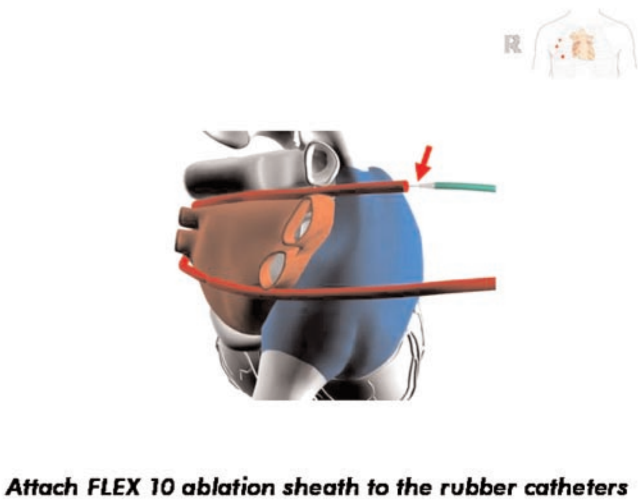

Figure 5. Guide catheters tied together and completely encircling pulmonary veins. The catheters are retrieved from the pericardial space through the left pericardiotomy and tied together outside the chest. They are then replaced, and tension is placed on the flared ends to tightly encircle the pulmonary veins.

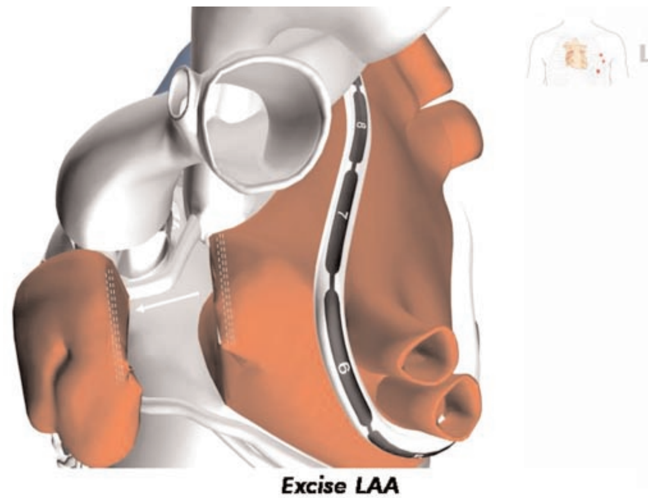

Figure 7. Left atrial appendage (LAA) is amputated. An EndoGIA stapler is placed across the base of the appendage as it is held on traction.

veins. Visual inspection of the resulting lesions confirmed successful ablation.

The Flex 10 was then removed from the chest with gentle traction. No sticking or char was noted on the probe. An EndoGIA-45 endoscopic stapler (Ethicon, New Brunswick, NJ, USA) was introduced into the 10-mm midclavicular port on the left side. The left atrial appendage was then placed on traction and amputated with the stapler (Figure 7). No bleeding was seen.

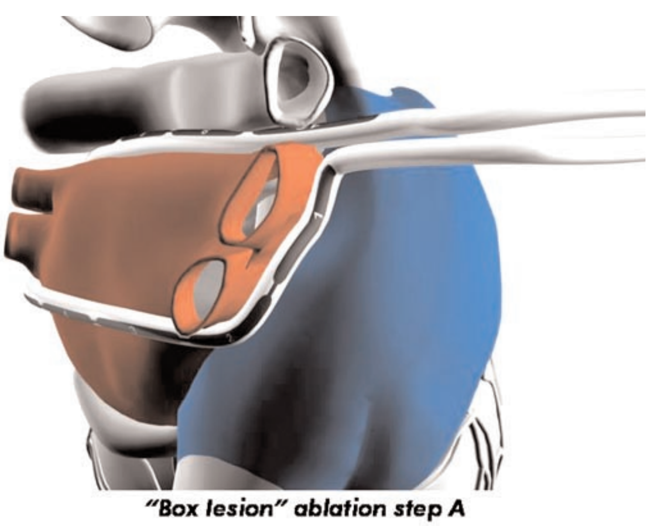

Figure 6. Flex 10 in position around the pulmonary veins. The Flex 10 is pulled around the pulmonary veins by using the catheter "loop" as a guide. Position is visually confirmed by inspecting the left atrial appendage, the superior vena cava, and the inferior vena cava.

A 32-French chest drain was placed in each pleural space through the 10-mm access ports. Both lungs were placed on ventilation. The 5-mm ports were repaired. The patient received a loading dose of 150 mg of intravenous amiodarone, followed by a continuous infusion at 1 mg/min. Her anesthetic was reversed. The patient was then extubated uneventfully in the operating room and transferred to the intensive care unit.

RESULTS

The patient remained in sinus rhythm overnight. The amiodarone was continued as a continuous infusion until the patient's oral intake was resumed. She was then given 400 mg 3 times a day until discharge.

The chest drains were removed on the first postoperative morning. Later that day the patient experienced atrial fibrillation with a controlled ventricular rate. The fibrillation terminated spontaneously after approximately 8 hours. She remained in sinus rhythm for the next 24 hours and was discharged to home.

On follow-up 1 month later, the patient remained in sinus rhythm without complaints of tachycardia or palpitations. Her wounds are healed. Continuous Holter recording is pending.

DISCUSSION

Atrial fibrillation is the most common cardiac arrhythmia and has significant associated morbidity, mortality, and cost of care [Wolf 1998]. To date, pharmacologic and nonpharmacologic therapies have met with limited success and many complications [Prystowsky 2000]. Recent evidence has suggested that patients with paroxysmal atrial fibrillation harbor sites of early activation in or near the pulmonary veins [Shah 2001, Jais 2002a, Jais 2002b, Shah 2002], observations that engendered much interest in their ablation and influenced our decision to perform an isolation procedure.

Microwave technology represents one of the methods by which many tissues can be ablated. In the heart, microwave technology is used to heat the myocardium to 50°C to 70°C, rendering it electrically inactive yet preserving most of its structural integrity [Lin 1999]. The Flex 2 and Flex 4 microwave probes (AFx) have been used in more than 2500 patients to date to ablate atrial tissue in patients with atrial fibrillation [Knaut 1999, Spitzer 1999, Gillinov 2002, Maessen 2002], and success rates at maintaining the sinus rhythm range have varied from 60% to 80% at 6 months after surgery [Knaut 1999, Spitzer 1999, Gillinov 2002, Maessen 2002].

Widespread application of this promising technology has been hampered by the need to expose the heart through a sternotomy, making it less appealing to patients and physicians for the treatment of lone atrial fibrillation. The newer Flex 10 device permits complete encirclement of the pulmonary veins in one maneuver, as well as insertion through a 10-mm port. These qualities permit the Flex 10 to be used in several minimally invasive approaches, such as thoracoscopy.

We have detailed in this report what we believe to be the first successful application of microwave ablation in a human patient, solely for treatment of atrial fibrillation and solely with the use of standard thoracoscopic techniques and instruments. Further refinement of this procedure will allow surgeons to treat patients with atrial fibrillation with minimally invasive, well-tolerated techniques and thereby permit early return of function with low morbidity.

Although this report focuses on the application of microwave technology in the treatment of paroxysmal fibrillation, there are even more patients who suffer from persistent or permanent fibrillation. Because the Flex 10 is easily manipulated and positioned, it can be used to create lesions elsewhere on the heart, not just around the pulmonary veins. For patients with the more chronic forms of fibrillation who demand a more complete ablation set, this probe will allow the surgeon to create lesions more closely approximating those of the classic cut-and-sew maze procedure.

The application of this technology marks a significant advance in our ability to treat this very troublesome arrhythmia, and although it is only a first application, the technology warrants further investigation and development.

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