Cooley/DeBakey Joint Session

Minimally Invasive Surgery for Atrial Fibrillation

Virna L. Sales, MD
Patrick M. McCarthy, MD, FACC

The rapid progression of techniques and technology in minimally invasive surgery for atrial fibrillation (AF) are the focus of 4 approaches for stand-alone and concomitant AF: thoracoscopic endoscopy,[1-3] robotics, minithoracotomies,[4,5] and video-assisted thoracoscopic surgery (VATS).[2,6] Current surgical techniques include 1) on-pump, open left-atrium (LA) procedure with cross-clamping and cardioplegia, performed through a small right thoracotomy, typically using cryoablation (the "CryoMaze procedure")[7,8]; 2) bilateral, totally thoracoscopic pulmonary vein isolation using microwave technology[1,8]; 3) partial sternotomy or off-pump thoracotomy, using high-intensity focused ultrasonography[8]; 4) bilateral VATS with a port-access camera, using bipolar radiofrequency clamps with bilateral working ports positioned directly over the pulmonary vein and over the left atrial appendage (LAA) for direct 3-dimensional visualization[2,6]; and 5) 2-stage "mini-Maze" procedure with hybrid 2nd-stage electrophysiology ablation (the initial stage creates the pulmonary vein isolation lesion and resects the LAA, and 2nd-stage delayed catheter ablation creates additional connecting left and right atrial isthmus lines).[9] Microwave, laser, high-intensity focused ultrasonography, and radiofrequency ablation devices have become more port-access and small-incision-access capable. The CryoMaze device appears also to be well suited to a robotic approach, because it is flexible and linear (4-mm diameter, and available in 6- to 10-cm lengths).[7] As the technology advances with specialized instruments and port-access devices, most of the decision-making will concern the choice of minimally invasive approaches and lesion sets, rather than energy selection. Evolving technology in minimally invasive devices for LAA exclusion, such as polyester-fabric–covered epicardial clips[10] and silicone-band occlusion devices,[11] will be useful in patients who have AF with a history of stroke.

Results for Lone Atrial Fibrillation

Complete endoscopic ablation with microwave energy has been performed with few complications. The largest series was by Pruitt and colleagues[1] in AF patients (33 paroxysmal and 17 permanent) who underwent thoracoscopic or robotic-assisted off-pump epicardial microwave ablation. Those investigations reported no perioperative death, a mean length of stay of 4 days, and a 79.5% success rate overall, with much better cure rates in paroxysmal disease (93.5%) than in permanent disease (69.2%). Ten percent underwent a subsequent open Cox maze III procedure to achieve cure.

Edgerton[3] achieved excellent visualization through the transverse sinus and developed a linear lesion set (the Dallas Lesion Set) that places all of the connecting lesions on the dome of the atrium using bipolar radiofrequency. Early results in this lesion set with partial autonomic denervation and LAA resection in 29 patients (10 persistent and 19 long-standing persistent) showed a 79% freedom from AF at 6 months' follow-up. Later, Edgerton and colleagues[5] reported in 52 symptomatic paroxysmal AF patients a mean length of stay of 5 days; no death or morbidity; 86% and 81% freedom from AF at 6 and 12 months, respectively; 78% and 64% freedom from symptoms at 6 and 12 months, respectively; 89% discontinuation of antiarrhythmic drugs; and 81% discontinuation of anticoagulation. Edgerton and associates[6] recently reported their outcomes in 114 patients (53% paroxysmal, 28% persistent, and 19% long-standing persistent) who underwent bilateral minithoracotomies with video-assisted bipolar radiofrequency. The operative mortality rate was 1.8%. Normal sinus rhythm was achieved at 6 months (87% paroxysmal, 56% persistent, and 50% long-standing persistent). Antiarrhythmic drugs were terminated in 72%, 47%, and 32% of patients with paroxysmal, persistent, and long-standing persistent AF, respectively.

Presented at the Joint Session of the Denton A. Cooley Cardiovascular Surgical Society and the Michael E. DeBakey International Surgical Society; Austin, Texas, 10–13 June 2010

Section Editor: *Joseph S. Coselli, MD*

From: *Division of Cardiac Surgery, Bluhm Cardiovascular Institute, Northwestern University Feinberg School of Medicine, Chicago, Illinois 60611*

Address for reprints: *Patrick M. McCarthy, MD, FACC, Feinberg School of Medicine, Division of Cardiac Surgery, Northwestern University, Suite 11-140, 201 E. Huron St., Chicago, IL 60611*

E-mail: *pmccart@nmh.org*

Beyer and colleagues[4] performed a multicenter study of 100 AF patients (39 paroxysmal, 29 persistent, and 32 permanent) who underwent bilateral minithoracoscopic, video-assisted, pulmonary vein ablations using bipolar radiofrequency, ganglionic mapping and ablation, and LAA resection. Early results showed a mean operative time of 253 minutes, a mean length of stay of 6.5 days, and a 13% rate of complication (pacemaker implantation, phrenic nerve injury, postoperative hemothorax, pulmonary embolus, and transient ischemic attack) over a mean follow-up time of 13.6 months. There was an 86% overall success rate (93% paroxysmal, 96% persistent, and 71% permanent), 62% discontinuation of antiarrhythmic drugs, and 65% discontinuation of anticoagulation.

The initial experience at East Carolina Heart Institute[7] in 41 patients undergoing the CryoMaze procedure via a small right infra-mammary incision showed no deaths or early or late strokes, restoration of normal sinus rhythm (discontinuation of antiarrhythmic drugs) in 88% of patients at 6 months and beyond a year of follow-up, and no sternotomy conversions.

In summary, there are currently many promising innovations using minimal-access procedures, instrumentation, and devices for stand-alone and concomitant AF. It is prudent to say that within a few years, surgeons will be performing a number of surgical ablations with minimal complexity and maximum effectiveness, using port-accessed, video-assisted, and robot-assisted surgical techniques with the aid of hybrid approaches, less invasive devices, and specialized navigation instruments.

References

1. Pruitt JC, Lazzara RR, Dworkin GH, Badhwar V, Kuma C, Ebra G. Totally endoscopic ablation of lone atrial fibrillation: initial clinical experience. Ann Thorac Surg 2006;81(4):1325-31.
2. Wolf RK, Schneeberger EW, Osterday R, Miller D, Merrill W, Flege JB Jr, Gillinov AM. Video-assisted bilateral pulmonary vein isolation and left atrial appendage exclusion for atrial fibrillation [published erratum appears in J Thorac Cardiovasc Surg 2006;131(4):772]. J Thorac Cardiovasc Surg 2005;130(3):797-802.
3. Edgerton JR. Total thoracoscopic ablation of atrial fibrillation using the Dallas lesion set, partial autonomic denervation, and left atrial appendectomy. Op Tech Thorac Cardiovasc Surg 2009;14(3):224-42.
4. Beyer E, Lee R, Lam BK. Point: Minimally invasive bipolar radiofrequency ablation of lone atrial fibrillation: early multicenter results. J Thorac Cardiovasc Surg 2009;137(3):521-6.
5. Edgerton JR, Brinkman WT, Weaver T, Prince SL, Culica D, Herbert MA, Mack MJ. Pulmonary vein isolation and autonomic denervation for the management of paroxysmal atrial fibrillation by a minimally invasive surgical approach. J Thorac Cardiovasc Surg 2010;140(4):823-8.
6. Edgerton JR, McClelland JH, Duke D, Gerdisch MW, Steinberg BM, Bronleewe SH, et al. Minimally invasive surgical ablation of atrial fibrillation: six-month results. J Thorac Cardiovasc Surg 2009;138(1):109-14.
7. Rodriguez E, Cook RC, Chu MWA, Chitwood WR. Minimally invasive biatrial CryoMaze operation for atrial fibrillation. Op Tech Thorac Cardiovasc Surg 2009;14(3):208-23.
8. Wolf RK. Minimally invasive surgical treatment of atrial fibrillation. Semin Thorac Cardiovasc Surg 2007;19(4):311-8.
9. Lee R, Kruse J, McCarthy PM. Surgery for atrial fibrillation. Nat Rev Cardiol 2009;6(8):505-13.
10. Salzberg SP, Gillinov AM, Anyanwu A, Castillo J, Filsoufi F, Adams DH. Surgical left atrial appendage occlusion: evaluation of a novel device with magnetic resonance imaging. Eur J Cardiothorac Surg 2008;34(4):766-70.
11. McCarthy PM, Lee R, Foley JL, Phillips L, Kanayinkal T, Francischelli DE. Occlusion of canine atrial appendage using an expandable silicone band. J Thorac Cardiovasc Surg 2010;140(4):885-9.