Thoracicoscopic Surgical Treatment of Atrial Fibrillation With Electrophysiologic End Points

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Since the description of initial surgical treatment of atrial fibrillation (AF) by Cox et al, the original cut-and-sew technique underwent several revisions, culminating in the Cox Maze III procedure, which has been reported to effectively restore sinus rhythm and decrease thromboembolic events in patients with AF.1,2

After the seminal observation that reported initiation of AF by pulmonary vein arrhythmogenicity3 and subsequent contributions on pulmonary vein (PV) and non–PV-dependent mechanisms in the genesis of AF, percutaneous catheter ablation has rapidly evolved to eliminate both paroxysmal and persistent AF over the last decade. Numerous reports from registries and randomized clinical trials demonstrated the efficacy, safety, and feasibility of catheter ablation to eliminate AF in appropriately selected patients through the use of well-defined clinical and ECG end points with rigorous long-term follow-up.

Given the complexity of the classic cut-and-sew Cox Maze procedure and the skill it requires, surgical treatment of AF has also evolved with an emphasis on (1) less invasive approaches that eliminate the need for a sternotomy and cardiopulmonary bypass, (2) tissue ablation using energy sources similar to those commonly used during percutaneous catheter ablation procedures as an alternative to the challenging and more invasive cut-and-sew technique, and (3) ablation strategies that more or less replicate the lesion sets targeted during percutaneous catheter ablation procedures, primarily on the basis of recent advances in the understanding of the mechanisms of AF.4–9

Although commonly referred as “mini-Maze,” most of the currently used surgical approaches utilize energy sources similar to those used in percutaneous catheter ablation procedures and attempt to create lesion sets to isolate the PVs with additional linear lesions between anatomic landmarks. The use of intraoperative electrophysiologic end points has been variable and often limited to assessment of exit block from the PVs. Reports on the efficacy and safety of this approach with meticulous long-term ECG follow-up, particularly in comparison to catheter-based ablation approaches, have been limited.

The study by Krul et al10 in this issue of Circulation: Arrhythmia and Electrophysiology is a timely contribution on surgical ablation of AF. Through a bilateral thoracoscopic approach, PV isolation and ablation of ganglionated plexi (GP) were performed in 31 patients with paroxysmal (n=16) or nonparoxysmal AF (n=15). Antral PV isolation was performed with the use of a bipolar radiofrequency energy clamp. Sites of GP were identified with high-frequency pacing and ablated using bipolar radiofrequency energy. The ligament of Marshall was dissected and ablated in all patients. Additional linear ablation was performed in 13 of 15 patients with nonparoxysmal AF. The left atrial appendage was removed in the majority of patients. Intraoperative electrophysiologic testing was performed to confirm conduction block along these lesion sets and additional ablation was performed to achieve complete block as necessary.

An emergent sternotomy was required in 3 of 31 patients for uncontrolled bleeding during the procedure. The other 4 complications included a pneumothorax in 1 patient, a hemothorax in 1 patient, and pneumonia in 2 patients. There were no perioperative mortality or thromboembolic events. The median procedure duration was 205 minutes, with a range of 136 to 540 minutes, and the median duration of hospital stay was 6 days.

After a blanking period of 3 months, patients were monitored with a 24-hour Holter and an ECG every 3 months. However, no extended ECG monitoring was performed to look for asymptomatic recurrences of atrial arrhythmias. Freedom from AF was defined as the absence of AF, atrial flutter, or atrial tachycardia (>30 seconds in duration). At 1 year of follow-up, 86% of the patients, including 92% of the patients with paroxysmal AF and 80% of the patients with persistent AF, were reported to have remained free from recurrent atrial arrhythmias in the absence of antiarrhythmic drug therapy.

The authors should be commended for a meticulously conducted and reported study with attention to detail and consistency in applying the same ablation strategy in similar patients, seeking electrophysiologic criteria as procedural end points, and a follow-up over 1 year. However, there are many questions that remain to be addressed. First, the sample size was very small, limiting the generalizability of the findings to the majority of patients with AF. Second, this was a small, descriptive registry without a control group. Therefore, it is not possible to determine whether each of the specific lesion sets that included ablation of GP, linear ablation, and dissection of the ligament of Marshall was necessary in all patients with AF. It appears that the authors have taken a rather
holistic approach and targeted most of the potential mechanisms of AF, known to date, that were accessible during the procedure. Detailed mapping for ablation of complex fractionated atrial electrograms was not considered and may not have been feasible during surgery. It remains unclear whether ablation of GP in addition to PV isolation had an incremental role and could account for the efficacy of 92% in patients with paroxysmal AF after a single procedure or whether it was the ablation of the ligament of Marshall that was important. Similarly, the key elements of the ablation that was critical in achieving an efficacy of 80% in patients with persistent AF after a single procedure remain unclear. Because PV isolation with only additional linear lesions is rarely associated with a similar efficacy after a single catheter ablation procedure, are GP or ligament of Marshall important targets in patients with persistent AF? Or is it simply the transmurality of the lesions achieved and confirmed during surgical ablation that was critical? Could exclusion of the left atrial appendage have played a role? It should also be noted that extended ECG monitoring was not performed, and it is possible that asymptomatic recurrences were not detected in some patients.

From a procedural perspective, this surgical approach was associated with conversion to sternotomy in 10% of patients and other complications in another 10% of patients. Although the authors suggest that there was a steep learning curve, the period of adoption of the technique by other practitioners could be problematic. Furthermore, surgery took up to 9 hours to perform in some patients.

Concomitant surgical ablation during surgery for valvular or coronary artery disease has a well-established role and should often be preferred in patients with AF. However, time and ultimately randomized studies will determine the role of surgical ablation in patients with AF as a standalone procedure. The morbidity and mortality of the procedure, comparative effectiveness, safety, feasibility and cost of surgical ablation relative to percutaneous catheter ablation, need for repeat ablation procedures, length of hospital stay, effect on subsequent cardiac surgery for coronary or valvular heart disease, and accessibility both by practitioners and patients will be important factors.

Despite the many advances in nonpharmacologic therapy of AF, there are significant challenges that remain: identification of the appropriate target lesion set for the specific patient with AF; achieving durable transmural lesions to minimize the risk of recovery of conduction; and improving the efficiency, feasibility, and safety of the procedure. Collaboration between surgeons and electrophysiologists may provide a unique opportunity to address some of these issues. For example, GP can effectively be ablated during surgery. A well-designed, randomized study of surgical ablation with and without dissection of GP can be helpful to determine whether ablation of GP is incremental. Although a potential role for GP in the genesis of AF has been suggested, clinical data on the role of GP have not been well established and remain conflicting. Similarly, detailed high-density epicardial mapping of the atria can be performed during surgical ablation and may provide helpful data from human subjects to better understand the role of complex fractionated atrial electrograms in ablation of AF.

The present study is a step forward by bringing strict electrophysiologic end points to surgical ablation and carefully assessing of clinical outcomes. This may pave the path to a productive collaborative effort that may facilitate a better understanding of the mechanisms of AF and subsequently improve the outcomes in patients with AF.

Disclosures

Dr Oral received research grants from the Leducq Foundation, St Jude Medical, Inc, Boston Scientific, and Glaxo-Smith-Kline. He is a cofounder of Ablation Frontiers, Inc and is a consultant to Medtronic-Ablation Frontiers.

References


Key Words: Editorials ■ ablation ■ atrial fibrillation ■ surgery
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Circ Arrhythm Electrophysiol. 2011;4:255-256
doi: 10.1161/CIRCEP.111.963843
Circulation: Arrhythmia and Electrophysiology is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 1941-3149. Online ISSN: 1941-3084

The online version of this article, along with updated information and services, is located on the World Wide Web at:
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