See Article page 1515.

Commentary: The curse of missing long-term data in cardiac surgery

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In this month's *Journal*, MacGregor and colleagues¹ present a single-center, retrospective analysis of long-term follow-up of patients undergoing isolated surgical ablation via the Cox-Maze IV procedure (CMP-IV) for atrial fibrillation between 2001 and 2019. Perioperative outcomes were excellent, with 6% of patients requiring new pacemaker implantation, 0% 30-day mortality, and only 1% experiencing postoperative stroke—none of which was associated with permanent deficits. These clinical outcomes appear to be durable as well. No patients were observed to experience late stroke, and at 10 years, 67% of patients with paroxysmal atrial fibrillation and 88% of those with non-paroxysmal atrial fibrillation remained free from anticoagulation. Late mortality occurred in 5% of patients.

Less obvious is how we should interpret the results of freedom from atrial tachyarrhythmia (ATA). Less than one-half of the cohort ($n = 91$ of 227) were available for follow-up at 5 years, and only 14% were available at 10 years. At 5 and 10 years, only 57% (52 of 92) and 52% (16 of 31) of patients available for follow-up had prolonged monitoring (ie, Holter monitoring, pacemaker interrogation, implantable loop recording); the remainder were assessed via intermittent monitoring (ie, electrocardiography). This snapshot of rhythm status might not accurately capture a patient's burden of ATA, especially given that patients who are status-post CMP-IV are overwhelmingly asymptomatic during recurrence of ATA.

Further clouding potential inferences regarding freedom from ATA is the difficulty in analyzing this type of data.

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CENTRAL MESSAGE

Stand-alone surgical ablation was associated with excellent long-term rates of mortality and stroke. Long-term freedom from atrial tachyarrhythmia rates should be carefully interpreted.

Recurrence of ATA is a recursive outcome (ie, the outcome can occur multiple times throughout the study) that ideally would be analyzed with longitudinal mixed modeling, which would capture the burden of ATA over the entire study period. However, due to concerns regarding nonrandom missingness (ie, those in sinus rhythm may be more likely to be lost to follow-up), the authors chose a Fine-Gray regression to assess freedom from first recurrence of ATA. However, the authors already demonstrated that the vast majority of patients who have ATA after CMP-IV remain asymptomatic, making informative censoring less of a concern. A potential solution for future studies would be to use a preplanned sensitivity analysis that addresses missing data via multiple imputation, evaluating the sensitivity of recursive freedom from ATA to the nonrandom missingness assumption of longitudinal modeling.^{2,3}

These limitations are by no means unique to this study, and long-term follow-up for arrhythmia surgery is notoriously difficult. The authors are in fact far ahead of most programs in their long-term tracking of patients, and these criticisms apply to our specialty as a whole. More complete follow-up from a greater number of programs may provide the evidence needed to help increase the adoption of this clearly successful operation. Questions of a statistical nature aside, the authors should be congratulated on this unprecedented, long-term series of patients undergoing isolated surgical ablation for atrial fibrillation. As oft is said in theatre also applies to analysis, namely "perfect is the enemy of good."

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See Article page 1515.

Commentary: The stand-alone Cox maze procedure: Bad marketing or lack of clinical interest?

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CENTRAL MESSAGE

There is an urgent need to improve the education and training of surgeons and electrophysiologists in all types of available surgical procedures for atrial fibrillation.

The role of surgical treatment for stand-alone atrial fibrillation (AF) is a subject of continuing debate. Although the Cox maze procedure with cardiopulmonary bypass (CPB) support has the best single-procedure success rate for any type of AF, >80% of the procedures performed in North America are performed on beating heart with a limited lesion set, probably inferior rhythm control, and higher cost.¹ The report from Washington University demonstrates once again that the Cox maze procedure for stand-alone AF is very safe and effective.² This study also shows that the type of AF did not impact the results of the Cox maze procedure. Despite increasing numbers of minimally invasive procedures, there was no compromise of the results, and long-term rhythm follow-up demonstrated stable results over time for a single-procedure intervention.² The results of the on-CPB Cox maze procedure carry the highest single-procedure success rate and stroke reduction compared with any catheter or

off-pump surgical ablation procedure, especially in patients with nonparoxysmal AF.³

Interestingly, it seems that unlike any other cardiac condition requiring an invasive intervention there is a significant impact of the wrong perception that off-CPB beating heart procedures are safer and less invasive. This perception is replacing the traditional considerations of the recommended surgical approach by our group and the group led by Dr Damiano at Washington University that is based on basic pathophysiology of AF, the primary effectiveness, and the actual safety of these procedures. This unusual approach to surgical ablation of AF is well captured by the recent Society of Thoracic Surgeons database report, which revealed that the majority of surgical ablation procedures for stand-alone AF are performed on the left atrium only, using beating heart procedures (off-CPB), and without elimination of the left atrial appendage.¹ It also suggests alarming rates of death and complications when patients were subjected to surgical conversion of the minimally invasive off-CPB approach to control an intraoperative complication.¹

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