Surgical ablation of lone atrial fibrillation on the beating heart: the chaos continues

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This editorial refers to ‘Feasibility and outcome of epicardial pulmonary vein isolation for lone atrial fibrillation using minimal invasive surgery and high intensity focused ultrasound’ by T.J. Klinkenberg et al., Europace 2009, 1624–1631.

This small case series from Dr Klinkenberg and colleagues' epitomizes the present challenges for the development of an effective minimally invasive surgical approach to lone atrial fibrillation. Over the last decade, a plethora of new ablation technology and new surgical approaches have been introduced. Despite thousands of clinical cases, we remain far from a standardized surgical approach. This has led to a wide variability in success rates obtained by different groups around the world and a great deal of confusion among both cardiologists and surgeons regarding the appropriate surgical treatment for a given patient.

The surgical treatment of lone atrial fibrillation was introduced in 1987 at our institution by Dr James Cox. The Maze procedure, which he developed, was extremely effective at restoring sinus rhythm. At 10 years, the freedom from symptomatic recurrence which he developed, was extremely effective at restoring sinus rhythm. At 10 years, the freedom from symptomatic recurrence was over 90% in our series. However, this procedure was technically complicated, and required cardiopulmonary bypass and prolonged cross-clamp times to perform the entire biatrial lesion set. Because of this, it was performed at only a few centres around the world.

The surgical treatment of atrial fibrillation has undergone dramatic changes over the last decade. The introduction of new ablation technologies has greatly simplified the performance of the Maze procedure and allowed for the development of minimally invasive approaches. Unfortunately, virtually all of these devices were released onto the market with little or no experimental verification of their efficacy. Few of the devices were tested in independent laboratories before their clinical release. The over-enthusiastic embrace of these devices by the surgical community without sufficient pre-clinical testing has led to both poor procedural outcomes and the removal of a number of these devices from the market. For instance, the widespread use of microwave devices on the beating heart continued until they were shown to experimentally be incapable of creating chronic conduction block and transmural lesions in this setting and that the clinical results at 1 year were poor. It is important to remember that the biophysics of ablation is dramatically different, when one is performing endocardial ablation on the arrested heart (as is often the case with concomitant surgery) compared with epicardial ablation on the beating heart (as is the case with most minimally invasive approaches). The challenge of performing transmural lesions on the beating heart with a unipolar device cannot be overestimated. In fact, after almost a decade of experimental work in our laboratory, we have not found one unipolar device which consistently performs transmural ablation on the beating heart. There are several reasons for this, including the variability of atrial wall thickness, the presence of epicardial fat in many patients and, most importantly, the heat sink of the circulating endocardial blood pool. The only device that has been capable of performing reproducible transmural lesions on the beating heart has been the bipolar radiofrequency clamp.

To add to the technological chaos that has been introduced with the various new devices and energy sources, these new technologies also have enabled surgeons to develop a plethora of new minimally invasive procedures, few of which have undergone careful testing. Most of these new procedures, as is the case in this report, attempt to replicate the results of transvenous pulmonary venous isolation with surgical techniques. The extremely poor results that the authors had in this small case series with only 2 of 15 patients (13%) free of antiarrhythmic drugs and atrial fibrillation at 6 months illustrates the present procedural and technological shortcomings of minimally invasive, beating-heart approaches.

There were several procedural shortcomings of the approach reported described by Klinkenberg et al. First, and most importantly, they did not perform any testing of their pulmonary vein isolation. In my opinion, this is required in any surgical procedure for lone atrial fibrillation. Its omission is unforgivable. It is possible that the device used by these authors was not able to create
transmural lesions. They would have been able to perhaps perform further ablation, if they had been unable to demonstrate acute exit and/or entrance block. Another procedural shortcoming in this study was the use of a unilateral thorascopic approach. Although this is clearly the goal of an ideal minimally invasive approach, I would argue that present technology has not evolved to the point of allowing this to be performed without the risk of either performing an inadequate lesion set or creating inadequate lesions. The Epicor™ Medical Ablation System described in this report is bulky and difficult to position thorascopically. Moreover, while the authors claim to have checked the position under direct vision, this was only possible on the right side. The positioning around the back side of the left atrium, including under the left atrial appendage and coronary sinus, could not be verified. The authors were also able to create only a single box lesion around the pulmonary veins with this approach. This would leave the patient clearly at risk for recurrent atrial flutters around the box. It is interesting that most of the failures were atrial flutters. This could be prevented by creating a left atrial isthmus lesion. However, this was not attempted in this study. Finally, by using a unilateral endoscopic approach, the authors could not eliminate the left atrial appendage (LAA). The extraordinarily low incidence of stroke following a Maze procedure has been attributed in part to the amputation of the LAA. Our group strongly feels that removing the LAA is a unique advantage of a surgical approach and should be added to all operative procedures. The theoretical advantage of a unilateral vs. a bilateral thorascopic approach does not seem to outweigh the clear advantages of removing the LAA in patients with atrial fibrillation.

This case series also documents the shortcomings of our present technology. High-frequency ultrasound has theoretical advantages. Unfortunately, it has not been subjected to independent experimental verification of its efficacy. The transducers are sensitive to positioning, and this may have been a challenge with this thorascopic approach. Moreover, there is a fixed depth of penetration. The wide variation of atrial wall thickness in pathological atrium may increase the difficulty of creating a successful box lesion in most patients. The only technology that has been independently verified in the beating heart has been bipolar radiofrequency ablation. Interestingly, recent reports using this technology to perform pulmonary vein isolation have shown much better results with freedom from atrial fibrillation off antiarrhythmic drugs at 6 months exceeding 60% in patients with paroxysmal atrial fibrillation. Regardless of the technology used, the success rate in most series has been worse in patients with persistent atrial fibrillation, emphasizing the inadequacy of pulmonary vein isolation as a sole procedure in these patients, similar to published results from the electrophysiology laboratory. It is imperative that surgeons begin to develop a more standardized approach to atrial fibrillation. This would involve avoiding the use of untested technology and always verifying lesion integrity in the operating room when possible. At the present time, only pulmonary vein isolation can be performed with any confidence on the beating heart due to the limitation of present surgical ablation devices. Surgeons should not wholly embrace a thorascopic, beating-heart approach in all patients, particularly in those with long-standing AF, until technology can catch up with our procedural aspirations. Surgeries are reminded that superb results can be had in patients with persistent and long-standing atrial fibrillation with the full Cox-Maze lesion set. Our present variation, the Cox-Maze IV, which is performed principally with bipolar radiofrequency ablation, requires only a small, right mini-thoracotomy. Although cardiopulmonary bypass is still required, our success rates at 12 months have been a 70% freedom from atrial fibrillation and antiarrhythmic drugs, and an over 90% freedom from atrial fibrillation with the use of antiarrhythmic drugs. We have now performed over 100 consecutive cases without mortality. On the other hand, surgical pulmonary vein isolation on the beating heart remains a very reasonable approach in selected patients with paroxysmal atrial fibrillation. However, it is imperative that surgeons perform adequate intraoperative testing of their ablation. Hopefully, with better clinical data and more consistent reporting of results in accord with the recent HRS/EHRA/ECAS consensus statement, we will be able to restore some order to the present chaos in the surgical treatment of lone atrial fibrillation.

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**References**


