From MAZE to ICE: new concepts and new technologies for surgical ablation of atrial fibrillation

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This editorial refers to 'A randomized double-blind study of epicardial left atrial cryoablation for permanent atrial fibrillation in patients undergoing mitral valve surgery: the SWEDish Multicentre Atrial Fibrillation study (SWEDMAF)' by C. Blomström-Lundqvist et al., on page 2902.

Curative treatment strategies for patients with atrial fibrillation were introduced in the late 1980s by Cox and co-workers. Following extensive animal experimental studies, the Maze procedure was developed and applied clinically. Subsequently, modifications of the initial surgical strategy were introduced, i.e. the Maze II and Maze III procedure. The efficacy of the Maze operation to establish permanent and stable sinus rhythm in >90% of patients treated was impressive. For a long time, the Maze III was cited as the 'gold standard' for the curative treatment of atrial fibrillation, but the extensive and time-consuming nature of this 'cut and sew' procedure prevented its widespread use. However, the curative potential of the Maze operation was recognized and inspired interventional electrophysiologists to attempt to reproduce the Maze procedure by means of transcatheter ablation techniques. Although never published as a full manuscript, the pioneering studies performed by John Swartz which were based on the Maze concept actually opened a new window for interventional electrophysiology, i.e. the development of catheter ablation of atrial fibrillation. Thus, the roots of curative treatment of atrial fibrillation clearly go back to cardiac surgery and it is unlikely that catheter interventional techniques would have made such significant progress without this initial ignition from the surgical theatre. In the late 1990s, the first surgical modifications of the classical Maze procedure using radiofrequency energy were developed. Some of these concepts aimed at the partial or complete reproduction of the Maze III lesion line concept while others introduced new treatment strategies based on the growing pathophysiological understanding of atrial fibrillation. Subsequently, new energy sources such as microwave, cryoenergy, and highly focused ultrasound were introduced to facilitate lesion induction in the atria during cardiac surgery. Recently, Khargi and co-workers published a meta-analysis of a large number of studies reporting the results of surgical ablation of atrial fibrillation using various energy sources for ablation compared with the results of the classical Maze procedure. In that meta-analysis, ablation of atrial fibrillation using ablation energy sources proved to be as effective as the classical Maze operation. Today, the approach most frequently applied for the surgical treatment of atrial fibrillation aims for the induction of contiguous circumferential isolating lesions around the pulmonary veins using radiofrequency, cryoenergy, or microwaves as the energy source. In these operations, ablative energy is delivered to the endocardial aspect of the left atrium during cardiopulmonary bypass. Surgical atrial fibrillation ablation procedures are currently widely used in an increasing number of institutions; however, it seems that indications, treatment concepts, treatment end-points, follow-up strategies, and electrophysiological expertise during follow-up are very inhomogeneous and may not always meet acceptable standards.

Blomström-Lundqvist et al. have presented the results of the SWEDMAF study. This report represents the first double-blinded randomized trial on the efficacy of epicardial left atrial cryoablation to cure patients undergoing mitral valve surgery from atrial fibrillation. It was shown that epicardial cryoablation significantly increased the number of patients in sinus rhythm compared with mitral valve surgery alone (73 vs. 45% sinus rhythm at 12 month follow-up). In addition, two risk factors for failed elimination of atrial fibrillation were identified, i.e. longstanding persistent atrial fibrillation of >4 years and the presence of concomitant coronary artery disease. However, the results of the study also showed a strong trend towards a higher complication rate in the cryoablation group. In general, the authors have to be congratulated for their work for several reasons. First, it is impressive and unusual as well to see that most institutions participating in the study are represented by experts from cardiology and cardiac surgery. As a result of the intense interdisciplinary co-operation and different from multiple reports on the
results of surgical ablation of atrial fibrillation published earlier, the study of Blomström-Lundqvist et al. had well pre-defined study end-points and a high quality treatment strategy in the case of detected arrhythmia recurrence. It is very likely that interdisciplinary patient care with consequent treatment of arrhythmia recurrences contributed significantly to the relatively high sinus rhythm rate of almost 50% observed at 6 months in the mitral valve surgery alone group. On the other hand, however, there are also significant limitations of the study protocol especially with respect to the overall intensity of rhythm follow-up. In the light of current knowledge on the shortcomings of a symptom-based follow-up in atrial fibrillation therapy studies, it is not adequate to perform such trials without a systematic rhythm evaluation using repetitive 24 h or, even better, 7 day Holter monitoring or event recorders. Thus, the weak follow-up may also have influenced the sinus rhythm rates reported. In the literature, up to 30% of patients treated with catheter ablation for atrial fibrillation have been reported to have asymptomatic arrhythmia recurrences only. Projecting these numbers to the current study, the sinus rhythm rate would be significantly lower in the mitral valve surgery alone group but also in the cryoablation-treated patients. In fact, a sinus rhythm rate of ~25% following mitral valve surgery alone would be in better agreement with the results reported in other studies. However, poor follow-up is a common finding in most studies published in the field of atrial fibrillation ablation. The establishment of standards for follow-up and guidelines on how to report the results of clinical studies and trials on atrial fibrillation therapies, developed very recently by the German Network on Atrial Fibrillation in co-operation with the European Heart Rhythm Association of the ESC, will hopefully help to overcome this common problem. These standards will allow the comparison of different treatment modalities, e.g. the results of surgical ablation of atrial fibrillation with the results of catheter ablation procedures or with antiarrhythmic drug therapy.

The in-hospital complication rate reported by Blomström-Lundqvist et al. was 11.4% in the mitral valve surgery group and 26.5% in the cryoablation group. Due to the relatively small number of patients, the difference in complications was statistically non-significant. Although difficult to compare, the complication rate reported seems to be significantly higher than the complications reported in most other studies on surgical ablation of atrial fibrillation. This high complication rate reported in the SWEDMAF study may be at least in part due to the prospective, multicentre nature of the study with consequent documentation of all adverse events on case reporting forms. However, a complication rate of >25% (excluding pacemaker implantation) in the patients undergoing mitral valve surgery and epicardial cryoablation of atrial fibrillation deserved further attention. As stated by the authors, most of the in-hospital complications that occurred in the cryoablation group such a low cardiac output syndrome, left atrial appendage perforation, and possibly also the development of congestive heart failure and ischaemic events seemed to be connected to the ablation procedure. Although the aortic cross-clamp time was not different between the two groups, there was a significantly longer extracorporal circulation time due to the cryoablation procedure. This prolongation of the surgical procedure may in fact be the main reason for the higher complication rate reported. Considering both the success rate and the incidence of complications reported in the SWEDMAF study, the question arises of whether or not the procedure reported has advantages compared with other more established surgical techniques for atrial fibrillation ablation.

The benefit-to-risk ratio of an intervention certainly has a significant implication for the indications for such procedures. In the SWEDMAF study, persistent atrial fibrillation and mitral valve disease were the main inclusion criteria. Whether or not the patients had symptomatic atrial fibrillation before surgery was not considered as a selection criterion. The same holds true for many studies reporting the results of surgical ablation for atrial fibrillation. While symptoms related to the arrhythmia are a key issue for the selection of patients for catheter ablation procedures according to the current guidelines, the role of symptoms for the indication to perform surgical ablation of atrial fibrillation seems to be less well defined. Thus, the general question of whether the patient with asymptomatic atrial fibrillation and an indication for cardiac surgery is an appropriate candidate for concomitant surgical ablation therapy deserves further attention in the future.

What can be learned from the SWEDMAF study and how do the results influence the current status of surgical ablation of atrial fibrillation? The results obtained by SWEDMAF show for the first time in a prospective randomized study that epicardial cryoablation effectively eliminates atrial fibrillation in a significant number of patients undergoing mitral valve surgery. However, the SWEDMAF data do not prove a benefit-to-risk profile allowing the indication for the procedure to be extended to routine application. Thus, as in many other fields of atrial fibrillation therapies, further and larger high quality studies are needed to define the future role of epicardial cryoablation for the treatment of atrial fibrillation during cardiac surgery.

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References
Clinical vignette

Isolated cardiac hydatidosis

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An apparently healthy 54-year-old man living in a rural area was referred to a cardiologist due to palpitations. A large intramycardial cystic mass was discovered in transthoracic echocardiogram. The patient was admitted to our institution for further study. He was in sinus rhythm and showed Q waves in II, III, and aVF leads. Serologic tests for Echinococcus granulosus were positive. Cardiac magnetic resonance imaging (MRI) confirmed the finding of a large multilocular cystic mass (7 cm diameter), involving inferior septum and inferior wall (Panels A and B, two-chamber and short-axis SSFP cine images) and producing severe thinning of adjacent myocardium up to 3 mm thickness. Other lesions in liver, lung, brain, and kidney were excluded. Operative treatment with resection of the echinococcal cysts and subsequent closure of ventricular septal defect (VSD), which appeared during surgery due to lesion of contiguous septal myocardium was performed without complications (Panel C, intraoperative transesophageal echo (TEE) showing VSD with large left-to-right shunt; Panel D, short-axis image corresponding to cardiac MRI per formed 6 months after surgery). Excised hydatidoid material is shown in Panel D; a microscopic image of E. granulosus can be seen in Panel E. The patient was put on treatment with albendazole and has been followed-up for 2 years without cardiac events, remaining in functional Class I/IV NYHA.

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