

Limitations of the study

This study has some limitations which have to be pointed out. The small patient population and the retrospective nature of the study do not allow us to draw any conclusion about the effectiveness of this technique. Furthermore, the follow-up was limited. Larger series with long-term follow-up are needed to confirm the effectiveness of the hybrid approach and to establish whether the monopolar right-sided thoracoscopic hybrid procedure may represent a suitable less-invasive choice for all LAF patients referred to surgery.

Furthermore, while data regarding postoperative AF prevalence were obtained from a large number of observations and this allowed us to compare prevalence by AF type, we could not compare echocardiographic parameters in a subgroup of patients.

Finally, our study did not compare results of the hybrid approach to catheter ablation. However, this will be the subject of ongoing studies.

CONCLUSIONS

Even with the above-mentioned limitations, we can conclude that the hybrid bilateral approach with a bipolar device for the treatment of LAF showed a good 1-year success rate independently of the AF type and seems to be the better choice for LAF fibrillation referred to surgery. In contrast, the hybrid monolateral approach was less effective in long-standing persistent and persistent LAF.

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eComment. Atrial fibrillation ablation - are we approaching an equivalent standard of cure?

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We would like to highlight some important observations in the retrospective observational study by La Meir *et al.* of a minimally invasive hybrid radiofrequency (RF) modified Maze ablation on the beating heart [1]. Common to both groups studied was a left atrial (LA) box ablation as well as a LA isthmus line in 16% to 20% respectively. The bipolar/bilateral group had 46% paroxysmal atrial fibrillation (PAF) patients versus 26% in the monopolar group. Nevertheless, analysis by AF type showed superior results in persistent AF with the bipolar/bilateral technique.

The bipolar/bilateral technique allowed additional excision or closure of the LA appendage in 43% of patients, as well as additional RA lines in 29%, although 20% fewer LA interconnecting lines or complete box lesions were done. Assuming that the secondary hybrid transcatheter endocardial technique ensured that all lesion sets were complete and transmural (by subsequent endocardial gap lesion closure), then one can infer that it was the more extensive ablation pattern used in the bilateral/bipolar approach that was the reason for the superior results. Experimental studies by Cox showed that pulmonary vein isolation (PVI) alone had no effect on the ability to induce or maintain AF, and hence the original Maze procedure was designed to interrupt all potential pathways for atrial macro re-entrant circuits [2].

An important observation though, is the documented higher 'device related' incidence of incomplete, non-transmural 'gap' lesions with the non-irrigated epicardial monopolar RF device (Cobra Adhere XL; Estech) and unidirectional bipolar device

(Coolrail; Atricure) used for the inferior and roof lines. One can therefore conclude that a bipolar bidirectional clamping RF device is a superior tool.

The inability to have guaranteed transmural continuous RF ablation lines is not only a surgical epicardial ablation problem but applies equally to transcatheter endovascular ablation lesions. The Mayo clinic's 5-year freedom from recurrent AF is 87% following the cut-and-sew Maze procedure compared to their poorer 28% 5-year success following catheter ablation [3], which attests to both the validity of both Cox's original concept of interrupting all potential atrial macro re-entrant circuits with the cut-and-sew technique and need for permanent transmural ablation lines compared to subsequent concepts and approaches [2]. It is important to note that the patients in La Meir *et al.*'s study had lone AF [1] and these results may not be reproducible in patients with underlying structural heart disease, who constitute the current predominant surgical group undergoing concomitant AF ablation, having a 75-80% success rate in maintaining sinus rhythm at 1 year [4].

The cut-and-sew Cox-Maze via a median sternotomy using cardiopulmonary bypass remains the 'gold standard' in terms of a 90-95% success without any long-term attrition, but has not been widely accepted because it is a complex open surgical procedure with definite 1-2% perioperative mortality and morbidity risks [5]. La Meir *et al.*'s hybrid minimally invasive approach with a 1-year maintenance of sinus rhythm of 95% in lone AF patients appears to have a similar success rate [1].

In the lone AF population, especially if only mildly symptomatic apart from the thromboembolic risk, a hybrid ablation procedure with a mortality risk approaching 0%, minimized surgical incisions, short in-hospital stay, and with similar long-term 95% success rates to the 'cut-and-sew' Cox-Maze may well become the future standard of care.

Conflict of Interest: None declared

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eComment. Hybrid treatment of lone-standing atrial fibrillation

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We read with interest the article by La Meir and colleagues about minimally invasive thoracoscopic hybrid treatment of lone atrial fibrillation, via the use of either a monopolar or bipolar radiofrequency device [1]. Following their early institutional experience, they conclude that the use of a bipolar device is associated with a

better outcome compared to a unipolar device, especially in patients with persistent and long-standing persistent AF.

Although the study deals with a topic of vivid interest and controversial debate, the article has several major limitations. First, the authors claim that the described approach is a hybrid technique. However, the paper does not define any true hybrid approach, merging surgical and electrophysiological (EP) techniques as previously proposed by several other groups, including ours [2]. In fact, no systematic protocol was described and from the paper it is possible only to infer that patients underwent a surgical ablation and a concomitant EP evaluation which was targeted at addressing potential gaps or additional right-sided lesions (IVC, SVC, intercaval). However, those right-sided lesions were almost exclusively delivered in the group undergoing bipolar RF ablation and patients with persistent and long-standing AF could have robust benefits from such additional ablations on the right atrium. Of note, it is important to stress that there was a major difference, almost significant ($p = 0.054$), among the two groups with respect to the presence of paroxysmal AF preoperatively (unipolar RF = 26.3% vs bipolar RF = 45.7%). Ablation for paroxysmal AF is obviously associated with a significantly better outcome regardless of the type of lesion set and energy source. This bias is even more significant given the small sample size (unipolar = 19 vs bipolar = 35) which are further divided into even smaller subgroups (paroxysmal, persistent, long-standing persistent).

Furthermore, the authors evidenced the need for endocardial touch-up due to gaps, in particular following unipolar RF ablation (with the site of such gaps not being disclosed). Nevertheless, they report (as outlined in the Discussion section) a device setting of 60°C and 120 s which is clearly not the recommended one. In fact, the proper settings of the monopolar device used in the study should be 75°C and 120 s with at least a double application per segment (the device has 2 segments, proximal and distal) which means that ablations must be delivered at least 4 times, and not 2.8 as reported by the authors themselves. This implies that the monopolar device may have been used improperly in terms of inadequacy of either temperature or number of applications, therefore leading to absence of conduction block in the whole series of patients undergoing ablation with the monopolar device.

Moreover, the timing between the surgical and electrophysiological procedures is a matter of utmost importance. In fact, simultaneous surgical/EP procedures may be associated with false negative results (such as acute demonstration of a bidirectional block which could be only transient and not potentially confirmed in the chronic setting), as well as with false positive results in terms of early inducible arrhythmias, which usually require further "maturation" of the ablative lesions [3]. It is also debatable whether the excision of the left atrial appendage (which occurred once again exclusively in the group undergoing bipolar RF ablation) could have contributed to a significant volume reduction or potentially to different rhythm outcome as well.

In conclusion, besides specific technical issues, such as incorrect device settings for the monopolar device or an extensive lesion set with right-sided lesions only in the bipolar group, the current study deals with a limited number of patients, therefore leading to consistent statistical quirks which can severely jeopardize the reliability and the interpretation of the results. Further studies, enrolling larger and comparable populations receiving similar left and right atrial lesion sets, are warranted in order to further elucidate the real impact of different types of energy sources in the clinical outcome of patients undergoing minimally invasive AF surgical ablation.

Conflict of Interest: Claudio Muneretto and Gianluigi Bisleri disclose a financial interest with Estech.

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