

# Surgical and hybrid atrial fibrillation ablation procedures

**Laurent Pison<sup>1\*</sup>, Nikolaos Dagres<sup>2</sup>, Thorsten Lewalter<sup>3</sup>, Alessandro Proclemer<sup>4</sup>, Germanas Marinskis<sup>5</sup>, and Carina Blomström-Lundqvist<sup>6</sup>, conducted by the Scientific Initiative Committee, European Heart Rhythm Association**

<sup>1</sup>Department of Cardiology, Maastricht University Medical Centre and Cardiovascular Research Institute, Maastricht, PO Box 5800, The Netherlands; <sup>2</sup>Second Cardiology Department, Attikon University Hospital, University of Athens, Athens, Greece; <sup>3</sup>Isar Heart Center Munich, Munich, Germany; <sup>4</sup>Department of Cardiothoracic Science, University Hospital S. Maria della Misericordia, Udine, Italy; <sup>5</sup>Clinic of Heart Diseases, Vilnius University Hospital Santariskių klinikos, Vilnius University, Vilnius, Lithuania; and <sup>6</sup>Department of Cardiology, Institution of Medical Science, Uppsala University, Uppsala, Sweden

## Aims

The purpose of this EP Wire is to survey clinical practice in this rapidly evolving field as the variety of surgical techniques and the heterogeneity of treated patients make the comparison of results and outcomes challenging.

## Methods and results

Twenty-four European centres, all members of the EHRA EP research network, responded to this survey and completed the questions. Of the participating centres, 11 (46%) performed (irrespective of the technique) stand-alone surgical atrial fibrillation (AF) ablation in 2011. Seven hospitals (64%) performed totally thoracoscopic AF ablation procedures off-pump (in 20–100% of their cases). The most commonly used lesion set was only pulmonary vein isolation in five hospitals (46%). Eight centres (73%) performed validation of the surgical lesion set at the time of intervention. The most important indication for performing stand-alone, totally thoracoscopic surgical AF ablation in seven participating hospitals was failed catheter ablation. According to their definition of success, participating centres reported their success rate to be 10–100% for paroxysmal AF and 0–95% for (longstanding) persistent AF. The most frequently encountered complications during stand-alone, surgical AF ablation were pneumothorax and haemothorax in up to 10% of the cases.

## Conclusion

This EP Wire survey shows a wide variation not only in indications for stand-alone, surgical AF ablation, but also in surgical techniques, lesion sets, follow-up, and outcome.

## Keywords

EP Wire • Surgical • Hybrid • Atrial fibrillation • Ablation

## Introduction

Surgical techniques for curative ablation of atrial fibrillation (AF), have evolved from the original cut-and-sew Cox Maze-III procedure to minimally invasive stand-alone procedures with new energy sources and electrophysiological validation of the lesion set which requires close collaboration between cardiologists and cardiac surgeons.<sup>1–4</sup>

The purpose of this EP Wire is to survey clinical practice in this rapidly evolving field as the variety of surgical techniques and the heterogeneity of treated patients make the comparison of results and outcomes challenging.

## Results

Twenty-four European centres, all members of the EHRA EP research network, responded to this survey and completed the questions. Nineteen of them were university hospitals (79%), two non-university, and three private hospitals. The total number of endocardial catheter-based AF ablations performed in 2011 was <50 procedures in 10 centres (42%), 50–99 procedures in 7 centres (29%), 100–199 procedures in 5 centres (21%), and 200 or more procedures in 2 centres (8%). Only three centres (12.5%) indicated that >30% of these transcatheter AF ablations were performed in patients with (longstanding) persistent AF.

\* Corresponding author. Tel: +31 43 3877095; fax: +31 43 3875104, Email: l.pison@mumc.nl

Published on behalf of the European Society of Cardiology. All rights reserved. © The Author 2012. For permissions please email: journals.permissions@oup.com.

Four of the responding centres (16.7%) did not have onsite cardiac surgery.

Of the participating centres, 11 (46%) performed (irrespective of the technique) stand-alone surgical AF ablation in 2011: 6 centres <50 procedures, 4 centres between 50 and 99, 1 centre >100.

Three of these centres indicated that they apply the Cox Maze on-pump technique using radiofrequency (RF) or cryoablation to create linear lesions in 100% of the cases. Seven hospitals perform totally thoracoscopic AF ablation procedures off-pump (in 20–100% of their cases). The original cut-and-sew Cox Maze-III procedure is still used in three centres (from 1 to 10% of their procedures). The minimally invasive Cox Maze-IV procedure is used in two hospitals and the simultaneous totally thoracoscopic epicardial and transvenous endocardial AF ablation in one.

The most commonly used lesion set was only pulmonary vein isolation (PVI) in five hospitals. Three centres applied PVI in combination with a box lesion (roof and inferior line) and two centres PVI with the Cox Maze-III linear lesion set only on the left atrium. Just one centre used PVI with the Cox Maze-III linear lesion set on both atria. Only two centres performed off-pump PVI with a box lesion and ablation of complex fractionated atrial electrograms (CFAE). The combination of PVI, box lesion, and left atrial appendage (LAA) line was done in two centres.

Eight centres (73%) performed validation of the surgical lesion set at the time of intervention, that is, checked conduction block of the pulmonary veins and bidirectional block across linear lesions. In three centres this was done epicardially and endocardially.

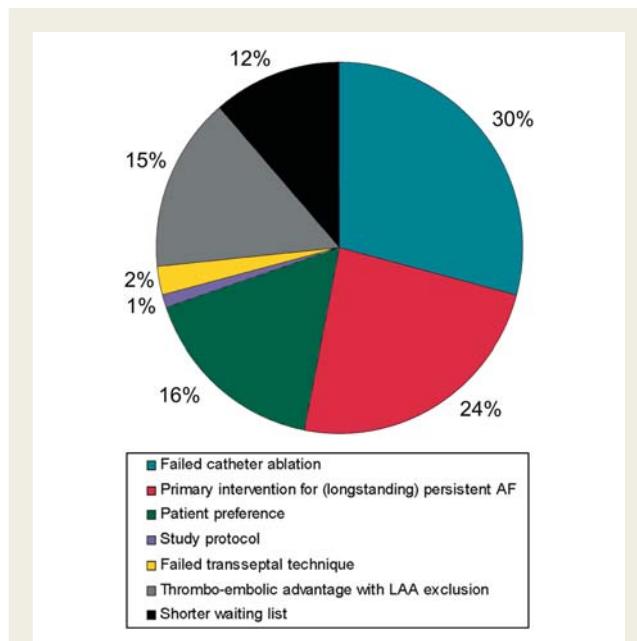
Among the six centres performing mostly off-pump stand-alone surgical AF ablation (i.e. at least 90% of the procedures are totally thoracoscopic epicardial ablations or simultaneous totally thoracoscopic epicardial and transvenous endocardial ablations), the LAA was always removed (stapling) or closed (epicardial clip) during this procedure in three of them (50%). One hospital (17%) never removed or closed the LAA and the remaining two centres (33%) only did so when the CHA2DS2-VASC score was  $\geq 2$ .

Nine hospitals (82%) used exclusively RF during their stand-alone AF ablation procedures. One centre used only cryoenergy and another one a combination of microwave and RF.

The most important indication for performing stand-alone, totally thoracoscopic surgical AF ablation in seven participating hospitals was failed catheter ablation (Figure 1). The other indications were (in descending order of importance) primary intervention for longstanding persistent AF, patient preference, thrombo-embolic advantage with LAA exclusion, shorter waiting list, failed transseptal technique, and study protocol.

Nine of the 11 centres performing stand-alone surgical AF ablation reported how they perform monitoring after surgery. Two hospitals planned sporadically 24 h Holter, two relied on implantable loop recorders, two performed 7 days Holter at 3, 6, 9, and 12 months post-procedure, two monitored their patients clinically only depending on symptoms and one centre used telemetry.

Successful therapy was defined as absence of symptoms and complete absence of AF defined as episodes lasting  $>30$  s, in seven centres (64%). One centre defined success as absence of



**Figure 1** Indications for stand-alone, surgical atrial fibrillation ablation. AF, atrial fibrillation; LAA, left atrial appendage.

AF and one as significant reduction of AF burden. Two centres did not disclose on their definition of a successful therapy.

According to their definition of success, participating centres reported their success rate to be 10–100% for paroxysmal and 0–95% for (longstanding) persistent AFs.

The most frequent encountered complications during stand-alone, surgical AF ablation were pneumothorax and haemothorax in up to 10% of the cases. The majority of those pneumothoraces were post-operative findings on X-ray without clinical consequences. Participating hospitals mentioned also tamponade (1–2%), transient ischaemic attack/stroke (1–5%), rib fracture (2%), sternotomy for bleeding (1–5%), pneumonia (3–4%), and pacemaker implantation (1%). Six centres reported to have no complications during their most commonly performed stand-alone, surgical AF ablation procedure.

The percentage of atrial tachycardia (excluding cavoconuspid isthmus-dependent atrial flutter) after surgical AF ablation, ranged from 10 to 40%.

## Discussion

In this EP Wire survey, we have shown that stand-alone, surgical AF ablation is not yet widely applied and mainly indicated after failed catheter ablation. Several surgical techniques and lesion sets are used for this purpose and there is a great variance in success rates.

For more than two decades, the cut-and-sew Cox Maze-III procedure was the gold standard for the surgical treatment of AF and has proven to be effective at eliminating this arrhythmia. Despite its proven efficacy, the Cox Maze-III procedure did not gain widespread acceptance owing to its complexity and technical difficulty.<sup>1</sup> To simplify the procedure, groups have replaced the incisions of

the Cox Maze-III with linear lines of ablation.<sup>5–8</sup> New ablation technologies using, among others, RF energy and cryoablation, have been introduced as alternatives to the cut-and-sew surgical treatment of AF with the ultimate goal to perform a curative lesion set epicardially on the beating heart, without the need for cardiopulmonary bypass. This is also reflected in this survey: only a minority of responding centres still use the cut-and-sew Cox Maze-III procedure. Most centres perform less invasive procedures as the totally thoracoscopic AF ablation procedures off pump, the minimally invasive Cox Maze-IV procedure or the simultaneous totally thoracoscopic epicardial and transvenous endocardial AF ablation.

Although PVI remains essential for most catheter and surgical ablation procedures, the role of substrate modification has taken on increasing importance.<sup>9</sup> The majority of hospitals participating in this survey, perform PVI in combination with substrate modification which can be the creation of linear lesions and/or ablation of CFAEs. To minimize the risk of reconnection after PVI and the occurrence of macro-reentry circuits due to incomplete linear lesions, >70% of centres do perform validation of the surgical lesions set. It is not clear from the results of this survey, whether the type of AF influenced the technique or lesion set that was used.

According to the latest European guidelines for the management of AF, minimally invasive surgical ablation of AF without concomitant cardiac surgery may be performed in patients with symptomatic AF after failure of catheter ablation (class of recommendation IIb, level of evidence C).<sup>10</sup> The results of this survey confirm that this is the case in clinical practice among participating centres as failure of catheter ablation is the most important indication for stand-alone, surgical AF ablation.

In the consensus statement of 2007, it was recommended to perform a 24 h Holter monitoring at 3- to 6-month intervals for 1–2 years after catheter AF ablation.<sup>11</sup> Clinical practice seems to be quite different: two centres adhere to this guideline but the others use implantable loop recorders, 24 h Holter sporadically or only symptom triggered monitoring. However, the majority of centres define success according to current guidelines: absence of symptoms and complete absence of AF defined as episodes lasting >30 s. The success rates of stand-alone, surgical AF ablation among participating centres are very disparate: ranging from 10 to 100% for paroxysmal AF and 0–95% for (longstanding) persistent AF. Nevertheless, it remains difficult to compare results given the fact that different techniques and lesion sets are used and the non-uniformity in monitoring of the patients. The authors do believe that those findings should prompt the initiation of prospective registries and trials, in order to standardize these procedures and hence make it possible to compare procedural data and outcomes.

The complication rate revealed in this survey was comparable with the recently published FAST trial data.<sup>12</sup> Pneumothorax and hematothorax were the most frequent complications in up to 10% of the procedures.

## Conclusions

This EP Wire survey shows a wide variation not only in indications for stand-alone, surgical AF ablation, but also in surgical techniques, lesion sets, follow-up, and outcome.

## Acknowledgements

The production of this EP Wire document is under the responsibility of the Scientific Initiative Committee of the European Heart Rhythm Association: Carina Blomström-Lundqvist (chairman), Maria Grazia Bongiorni, Nikolaos Dagres, Dan Dobrea, Isabel van Gelder, Thorsten Lewalter, Gregory YH Lip, Philippe Mabo, Germanas Marinskis, Laurent Pison, Alessandro Proclemer, Jesper Hastrup Svendsen.

The authors acknowledge the EHRA Research Network centres participating in this EP Wire. A list of the Research Network centres can be found on the EHRA website.

**Conflict of interest:** none declared.

## References

1. Lönnérholm S, Blomström P, Nilsson L, Oxelbark S, Jideus L, Blomström-Lundqvist C. Effects of the maze operation on health-related quality of life in patients with atrial fibrillation. *Circulation* 2000;101:2607–11.
2. Wolf RK, Schneeberger EW, Osterday R, Miller D, Merrill W, Flege JB et al. Video-assisted bilateral pulmonary vein isolation and left atrial appendage exclusion for atrial fibrillation. *J Thorac Cardiovasc Surg* 2005;130:797–802.
3. Krul SP, Driessens AH, van Boven WJ, Linnenbank AC, Geuzebroek GS, Jackman WM et al. Thoracoscopic video-assisted pulmonary vein antrum isolation, ganglionated plexus ablation, and periprocedural confirmation of ablation lesions. *Circ Arrhythm Electrophysiol* 2011;4:262–70.
4. Pison L, La Meir M, van Opstal J, Blaauw Y, Maessen J, Crijns HJ. Hybrid thoracoscopic surgical and transvenous catheter ablation of atrial fibrillation. *J Am Coll Cardiol* 2012;60:54–61.
5. Khargi K, Hutton BA, Lemke B, Deneke T. Surgical treatment of atrial fibrillation: a systematic review. *Eur J Cardiothorac Surg* 2005;27:258–65.
6. Damiano RJ Jr. Alternative energy sources for atrial ablation: judging the new technology. Invited editorial. *Ann Thorac Surg* 2003;75:329–30.
7. Shen J, Bailey MS, Damiano RJ. The surgical treatment of atrial fibrillation. *Heart Rhythm* 2009;6:S45–50.
8. Bagge L, Blomström P, Nilsson L, Einarsson GM, Jidéus L, Blomström-Lundqvist C. Epicardial off-pump pulmonary vein isolation and vagal denervation improve long-term outcome and quality of life in patients with atrial fibrillation. *J Thorac Cardiovasc Surg* 2009;137:1265–71.
9. Katrasis D, Merchant FM, Mela T, Singh JP, Heist EK, Armandas AA. Catheter ablation of atrial fibrillation. The search for substrate-driven end points. *J Am Coll Cardiol* 2010;55:2293–8.
10. Camm AJ, Kirchhof P, Lip GYH, Schotten U, Savelieva I, Ernst S et al. Guidelines for the Management of Atrial Fibrillation. The Task Force for the Management of Atrial Fibrillation of the European Society of Cardiology (ESC). *Europace* 2010;12:1360–420.
11. Calkins H, Brugada J, Packer DL, Cappato R, Chen SA, Crijns HJ et al. HRS/EHRA/ECAS expert consensus statement on catheter and surgical ablation of atrial fibrillation: recommendations for personnel, policy, procedures, and follow-up: a report of the Heart Rhythm Society Task Force on Catheter and Surgical Ablation of Atrial Fibrillation. *Europace* 2007;9:335–79.
12. Boersma LV, Castella M, van Boven WJ, Berruezo A, Yilmaz A, Nadal M et al. Atrial Fibrillation Catheter Ablation Versus Surgical Ablation Treatment (FAST). A 2-center randomized clinical trial. *Circulation* 2012;125:23–30.