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Imaging techniques in electrophysiology and implantable device procedures: results of the European Heart Rhythm Association survey

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The purpose of this European Heart Rhythm Association (EHRA) survey is to assess the implementation and use of imaging techniques in cardiac electrophysiology (EP) and device procedures across European cardiovascular centres. Forty European centres, all members of the EHRA EP research network, responded to this survey. Thirty-one centres (88%) use transthoracic echocardiography (TTE) to evaluate left atrial size and/or volume before atrial fibrillation (AF) ablation. Sixteen centres (46%) perform delayed-enhancement cardiac magnetic resonance imaging (MRI) to guide ventricular tachycardia ablation. Electroanatomical mapping (EAM) systems are available in >65% of responding centres and the use of robotic catheter and remote magnetic navigation systems is limited to <10%. Fusion of EAM data with cardiac computed tomography (CT) and/or MRI is performed in up to 43% of AF ablation procedures. Seventeen out of 35 (49%) responding centres also perform TTE to predict a favourable response to cardiac resynchronization therapy (CRT). Imaging of the cardiac venous system with CT and identification of myocardial scar using CT or MRI, is not routinely performed in the majority of centres [32 (91%) and 26 (75%) centres, respectively) prior to CRT. This EHRA survey shows that several imaging techniques are used to guide catheter ablation and CRT procedures in European centres. Echocardiographic imaging, EAM techniques, and cardiac CT/MRI are commonly used.

Keywords Atrial fibrillation • Ablation • Electrophysiology • Imaging • Electroanatomical mapping • Cardiac resynchronization therapy • EP wire • EHRA survey

Introduction

Cardiac imaging has become a crucial part of evaluating patients before, during, and after a catheter ablation procedure or device implantation. Based on anatomical data obtained, electrophysiologists can perform a better selection of patients and have a more detailed understanding of underlying arrhythmogenic substrates. The purpose of this European Heart Rhythm Association (EHRA) survey (EP Wire) is to provide a snapshot of daily practice regarding imaging techniques used during electrophysiology (EP) procedures and device implantations in Europe.

Methods and results

Characteristics of participating centres and volume of interventions

Forty European centres, all members of the EHRA EP research network, responded to this survey and 35 (87.5%) of them completed the questionnaire in full. Twenty-eight (70%) were university hospitals, and 8 (20%) were private hospitals. During 2012, the number of implantable cardioverter-defibrillator (ICD) procedures (including box change) was <100 in 15 (41%) centres, 100–199 in

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16 (41%), 200–399 in 6 (15%), and ≥400 procedures in 1 (3%). The percentage of patients receiving cardiac resynchronization therapy (CRT) with ICD ranged from 2 to 80%. In the same period, 6 (16%) centres implanted <100 pacemakers (PM) (including replacement), 9 (23%) implanted 100–199, 20 (51%) implanted 200–399, and 4 (10%) performed ≥400 implantations. The percentage of patients who received a CRT-PM device ranged from 0 to 40%.

The total number of endocardial catheter-based ablations performed in 2012 was <100 procedures in 9 (23%) centres, 100–199 in 11 (28%) centres, 200–399 in 9 (23%) centres, and ≥400 ablations in 10 (26%) centres. The percentage of left-sided atrial fibrillation (AF) procedures ranged from 0 to 80%.

Imaging of the left atrium

To evaluate the size and/or volume of the left atrium (LA) before AF ablation, several imaging modalities are currently available. Thirty-one centres (88%) rely on transthoracic echocardiography for this purpose. Transoesophageal echocardiography is used in 29 centres (82%), computed tomography (CT) in 28 (80%), and magnetic resonance imaging (MRI) in 26 (74%). Only two centres (6%) stated they do not use imaging techniques to evaluate size or volume of the LA before ablation. Delayed-enhancement cardiac MRI is mostly performed in patients with persistent AF, structural heart disease, arterial hypertension, and diabetes. Evaluation of the LA function after AF catheter ablation using two-dimensional (2D) or real-time 3D echocardiography is performed in 13 out of 35 (37%) of participating centres.

Guiding transseptal access

To guide the transseptal puncture, fluoroscopy only is most often used in 77% of participating centres. Transoesophageal and intracardiac echocardiography are used for this purpose in 12 and 9% of centres, respectively.

Availability and use of elecroanatomical mapping

Access to different imaging and electroanatomical mapping (EAM) systems is diverse across Europe (*Figure 1*). Intracardiac echocardiography is available in 17 centres (49%) and 3D echocardiography in 20 (57%). The two most accessible EAM systems are CARTO (Biosense-Webster Inc.) and EnSite NavX (St Jude Medical, Inc.): 23 (66%) and 25 (72%) centres, respectively. Other systems including MediGuide (St Jude Medical, Inc.) (one centre), LocaLisa (Medtronic EP. Systems) (one centre), and the Leuven Augmented Reality Catheter Ablation system (one centre) are not widely used.

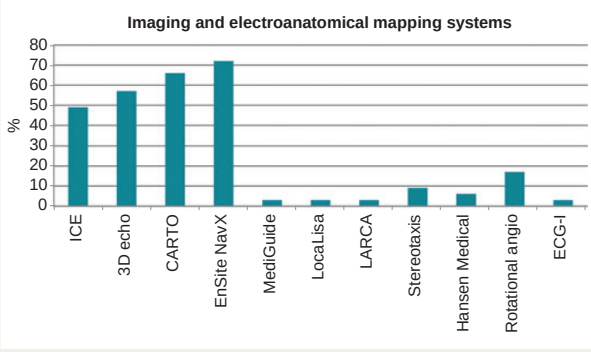

Figure 1 Use of imaging and electroanatomical mapping systems. ECG-I, electrocardiographic imaging; ICE, intracardiac echocardiography; LARCA, Leuven augmented reality catheter ablation.

The use of robotic catheter and remote magnetic navigation systems is limited: Stereotaxis system (Stereotaxis Inc.) is used in three (9%) centres and Hansen Medical system (Hansen Medical) in two (6%). Six (17%) participating centres are using rotational angiography to guide AF catheter ablation. The use of electrocardiographic imaging is not widespread: only one (3%) responding centre relies on this technology to guide their catheter ablation procedures.

There are important differences in the use of EAM systems during catheter ablation for non-AF supraventricular arrythmias. Nineteen (54%) participating centres never use such a system during ablation of typical atrioventricular nodal reentry tachycardia. In 23 (66%) centres, however, EAM is always used when ablation of atrial tachycardia is undertaken. Complex anatomy is the most important reason to use EAM during ablation of an accessory pathway in nine (26%) centres. For the ablation of typical right atrial flutter, 33% of participating centres never use EAM and 24% always do.

Real-time integration of intracardiac echocardiography and EAM is performed in up to 15% of centres during AF ablation. For ablation of ventricular tachycradia (VT), this number decreases to 9%. Fusion of EAM data with cardiac CT and/or MRI, however, is performed in up to 43% of AF ablation procedures.

During catheter ablation for VT, the use of EAM is widespread: in ischaemic and dilated cardiomyopathy it is used in 88% of cases, and in idiopathic VT and congenital heart disease it exceeds 70% among responding centres. To guide VT ablation, 16 centres (46%) perform delayed-enhancement cardiac MRI. In 6% of the centres this is also done in patients with a PM or ICD.

Imaging for cardiac resynchronization therapy device implantation

To predict a favourable response to CRT, several echocardiographic criteria may be useful. Tissue doppler imaging-derived parameters are used as the sole criterion in 1 out of 35 (3%) participating centres. Two centres (6%) rely mostly on speckle tracking strain analysis. The majority of participating centres (17 out of 35) (49%), however, prefer to use a combination of the above-mentioned parameters. Interestingly, 14 (40%) centres state that they do not perform echocardiography to discern responders from non-responders prior to CRT implantation.

Thirty-two (91%) responding centres do not routinely perform cardiac CT before left ventricular (LV) lead implantation to evaluate coronary venous anatomy.

Several imaging techniques are available to identify the presence of myocardial scar and to evaluate local contractility, among others. These data may enable electrophysiologists to choose the most optimal site for LV lead positioning. Four (11%) centres perform cardiac MRI to do so. Cardiac CT is used for his purpose in 5 out of 35 (14%) participating centres. The overall majority (26 centres, 75%), however, do not perform this kind of imaging.

Discussion

In this EHRA EP Wire survey, we have shown a broad diversity of imaging techniques is used to guide catheter ablation and CRT procedures in European centres.

Several studies have demonstrated that LA volume is one of the strongest predictors for outcome after AF ablation.[1,2] The results of this survey show that the majority of responding centres perform imaging to assess this parameter using a variety of techniques. Ablation for AF results in significant decrease in LA diameter and LA volumes post-ablation.[3,4] These changes remain significant in those without AF recurrence but not in those with AF recurrence. Left atrial ejection fraction and LA active emptying fraction seem not be influenced by ablation. Evaluation of these parameters is performed in 37% of responding centres using echocardiography. Left atrial size and volume remain important predictors of cardiovascular outcomes such as increased risk for AF recurrence after LA ablation and congestive heart failure.[5]

The ability to locate myocardial scar using cardiac MRI, may serve as an additional method to guide VT ablation.[6–9] Nearly half the responding centres already have adapted this strategy and in some of them cardiac MRI is also performed in patients with a PM or ICD.

Electroanatomical mapping

Electroanatomical mapping systems combine anatomical and electrical information and the use of these systems has several advantages. By visualization of the catheter position in a 3D environment without ionizing radiation, they help in reducing fluoroscopy duration.[10,11] They may be helpful for the analysis of arrhythmia mechanisms and for guidance during ablation procedures in patients with complex arrhythmia substrates. However, one must keep in mind that the use of these systems results in added expense. Although the vast majority of responding centres have access to EAM systems, the use of this technology seems, besides AF, to be reserved for more complex non-AF supraventricular arrhythmias or in case of unusual anatomy. For VT catheter ablation, EAM has become an integral part of the procedure across responding European centres as it is used in almost 90% of those interventions.

Real-time integration of intracardiac echocardiography and electroanatomical mapping is only applied in a small number of participating centres. On the other hand, real-time integration of cardiac CT or MRI and EAM has been adopted in >40% of responding centres during their AF ablation procedures. The integration of intracardiac echocardiography, however, results in a similar degree of accuracy as CT or MRI.[12]

Remote navigation

Robotic catheter and remote magnetic navigation systems are present in a minority of responding centres. Both techniques have been successfully applied in catheter ablation for AF and VT.[13–16] The main advantage of such systems is the significant reduction in X-ray exposure time. Their superiority to manually performed procedures in terms of safety and efficacy needs further investigation in larger prospective and randomized trials.[17]

Other imaging modalities

In electrocardiographic imaging, a multielectrode vest records over 200 body-surface electrocardiograms. These data are then reconstructed on the heart surface using information from cardiac CT and a mathematical algorithm.[18] This promising technology has already been applied successfully in supraventricular and ventricular arrhythmias, but so far there is no prospective randomized data available.[19] Only one responding centre in the survey has already incorporated this technology in its ablation procedures.

The use of rotational angiography of the LA to guide AF ablation is limited to 17% of responding centres. This is somewhat surprising as up to 80% of participating centres state to perform cardiac CT before AF ablation and as rotational angiography has an anatomical accuracy comparable with that of CT with significantly lower radiation dose, in less time and at less financial expense.[9,20]

Imaging for cardiac resynchronization therapy

According to recommendations on cardiac pacing and CRT, the selection of heart failure patients for CRT based on LV mechanical dyssynchrony assessed with imaging techniques is uncertain and therefore those imaging techniques should not be used as a selection criterion for CRT.[21,22] This guideline is applied in 40% of responding centres. Only a small minority of responding centres perform cardiac CT before LV lead implantation to visualize the cardiac venous system. This technique, however, has the potential to identify complex cardiac venous anatomies that are more suitable for an alternative lead placement technique rather than a transvenous approach.[23,24]

The majority of responding centres do not perform imaging to evaluate the presence of scar or local contractility before LV lead placement. Although it seems logic to avoid placing the LV lead tip in a zone of myocardial scar, the results of the studies that looked at the effect of posterolateral scar (an important target for LV lead placement) on CRT outcomes are not uniform.[25] Further research is required to better understand the relationship between localized myocardial scar, LV dyssynchrony, and the effect of LV pacing.

Conclusions

This EP Wire survey shows that several imaging techniques are used to guide catheter ablation and CRT procedures in European centres. Echocardiographic imaging, EAM techniques, and cardiac CT/MRI are commonly used.

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