Editorial

Catheter ablation: an ongoing revolution

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The field of interventional electrophysiology has progressed significantly over the last decades as the techniques and technologies have become increasingly complex. Catheter ablation has been established as an effective, durable, and safe method to manage arrhythmias. In some cases, catheter ablation has become the preferred strategy compared to life-long medical treatment.

Our knowledge surrounding catheter ablation is based on multiple levels of evidence, ranging from case series all the way up to randomized controlled trials (RCT). While RCTs represent the pinnacle of evidence, the external validity of RCTs can at time be problematic when these trials are limited to highly selected populations. "Real-world" observational studies are a useful means to fill the gap between these clinical trials and every-day clinical practice.

In a study published in the *European Heart Journal*, Holmqvist *et al.* (1) report "real-world" data regarding the efficacy and safety of various catheter ablation procedures. The study was performed using the Swedish Nation Registry, and identified cases between January 1 2006 and December 31, 2015. Over this 10-year period the volume of ablations increased 138% (from 1,953 in 2006 to 4,648 in 2015). Although the numbers increased for all ablation procedures, the majority of growth occurred in atrial fibrillation (AF) ablation procedures, a technique that has greatly evolved since it was first described in 1998 (2). The absolute number of AF ablation per year increased by 430% over the ten years study period. In 2015, the last year of the study, 40% of all ablations performed were for the treatment of AF. A similar trend, although less marked, has been observed by Pallisgaard *et al.* (3) through a Danish registry of 5,392 patients undergoing AF ablation between 2005 and 2014. They reported a 171% increase in the number of first-time AF ablation procedures over the study period.

In the Holmqvist study, the cavotricuspid isthmus (CTI) ablation group had the highest prevalence of concomitant cardiac disease with more than 30% of patients presenting with various types of cardiomyopathy. Conversely, there was a low burden of comorbidities in the supraventricular tachycardia (VT) ablation groups. Unfortunately, the health profiles of the VT, premature ventricular contraction (PVC), and atrioventricular node (AVN) ablation groups were not reported. As pacemaker implantation and AVN ablation is usually considered a strategy of last resort for refractory rapid AF, this population tends to be older and presents with multiple co-morbidities (4,5). Patients referred for VT ablation are known to be a heterogenous population varying from idiopathic VT in a structurally normal heart to VT associated with severe structural cardiac disease, such as prior infarction (6).

Over the study period it was observed that procedural time, fluoroscopy time, and radiation dose have all decreased significantly. This may be due to operator experience, changing technique, as well as the widespread use of electroanatomic mapping. The STAR-AF II trial (7), published in 2015, demonstrated that for persistent AF, an ablation strategy consisting of additional left atrial linear ablation or complex fractionated electrograms ablation was not superior to pulmonary vein isolation (PVI) alone. This "simplified" approach may have contributed to the decrease in procedural time of AF ablation since 2015. However, the role of substrate ablation is still a subject of interest for persistent and long-standing persistent AF (8).

In addition, the Swedish data has reaffirmed the fact that catheter ablation is a safe procedure. The total adverse events rate for atrioventricular nodal re-entrant tachycardia (AVNRT), CTI, AVN, atrial tachycardia (AT) and atrioventricular re-entrant tachycardia (AVRT) are 0.75%, 0.82%, 0.87%, 1.2% and 1.5% respectively. The VT ablation group had a 4.5% rate of any adverse events and a 2.53% mortality at 90 days post procedure. Although not described in this study, the higher complication rates in the VT population is likely related to the comorbidity burden and the procedure complexity. The same phenomenon probably explains the 1.99% mortality rate at 90 days post AVN ablation. The total adverse events rate reported post AF ablation is 2.8% including 1.3% related to pericardial effusion. A German registry reported a similar pericardial effusion rate of 1% post AF ablation (9).

Acute success rates, defined by the operator's assessment at the end of the procedure, are relatively elevated and present a bimodal distribution. They vary from 95% to 97% for CTI, AVN, AVNRT and AF ablations. Acute success rates for AT, PVC, VT and AVRT are respectively 80%, 83%, 86% and 91%. Brachmann *et al.* (9) reported similar acute success rates for SVT ablations using a German registry of 12,566 patients enrolled between 2007 and 2010. In the German report, all types of SVT had success rates above 94% except for AT, which had an 84.3% success rate. Tilz *et al.* (6) reported similar acute success rates for VT ablation, defined as no arrhythmia inducibility at the end of the procedure (75.8% for patients with structural heart disease and 82.1% for patients with a structurally normal heart).

Long-term procedural success is adequate for most arrhythmias, but remains an issue for PVC, VT and especially AF. As mentioned by the authors, an apparent discordance still persists between the AF ablation acute procedural success, defined as complete PVI, and the longer-term procedural success, defined in this study as the absence of repeat ablation. Although the incidence of repeat ablation has continuously decreased from 25% at 1 year in 2009 to 15% in 2016, it is still significantly high despite an acute success rate of 97%. Of note, the proportion of paroxysmal, persistent and permanent AF among the cohort was not reported. The Danish registry observed a similar trend with a reduction of repeat ablation at 1 year from 11% in 2005–2006 to 5% in 2013–2014 (3). In the latter study, AF recurrence at 1 year (defined as hospital admission for AF, anti-arrhythmic medication introduction, AF cardioversion or repeat AF ablation) decreased from 45% in 2005–2006 to 31% in 2013–2014 (3). The AF Ablation Long-Term Registry is an international registry of 3,630 patients who underwent AF ablation between 2012 and 2015 (10). They reported a 1-year repeat AF ablation incidence of 9.5 and a 1-year AF recurrence of 26.3%, with or without the use of anti-arrhythmic medication (10). Data is scarce regarding the very long-term procedural success of AF ablation and some studies have brought skepticism on the matter (11). The current study reported a 41% rate of repeat ablation at 3 years post ablation (1).

Novel ablation technologies and strategies may have contributed to the undeniable improvement in AF ablation efficacy and safety over the last decade. Real-time assessment of catheter electrode-tissue contact force may have improved lesion durability, resulting in better procedural efficacy (12,13). The use of adenosine to reveal dormant pulmonary vein (PV) conduction and guide further ablation may have reduced PV reconnection, resulting in better arrhythmia-free survival (14). Cryoablation was used for PVI in 13% of patients in the Holmqvist registry. Cryothermal energy has been shown to be comparable to radiofrequency energy for PVI procedures and associated with a shorter procedural time (15,16). Balloon-based technologies continue to evolve and recent studies have demonstrated improved arrhythmia-free survival with the second-generation cryoballoon compared to the first generation cryoballoon (17). These advancements should help to further reduce the gap between acute procedural success and long-term arrhythmia-free survival after AF ablation.

Catheter ablation for AF is currently mainly indicated for symptomatic patient's refractory to anti-arrhythmic drugs (18). While the objective of ablation is to alleviate symptoms, the definition of success has historically been focused on the complete suppression of AF. However, recent evidence has suggested that AF elimination may not be necessary. These studies have demonstrated that a reduction in AF burden has been associated with reduced risk of stroke, heart failure, and mortality (19).

Furthermore, evidence is slowly mounting regarding the fact that catheter ablation might have a favourable impact on prognosis in patients with heart failure (20). This has been demonstrated in the ATAAC-AF (21) trial and more recently in the CASTLE-AF (22) trial. In CASTLE-AF the ablation group had a lower rate of mortality from any cause or hospitalization for worsening heart failure compared to the medical treatment. The ablation group AF burden only went from 51% to 27% at 60 months post randomisation (and from 51% to 64% in the medical treatment group), but still resulted in a favorable prognosis. Therefore, when contemplating AF ablation for prognostic reasons, should the definition of long-term success be oriented toward a burden reduction? This hypothesis might be a way to reconciliate acute success and long-term success.

A similar phenomenon has been observed regarding PVC ablation. Among PVC-induced cardiomyopathy patients, an 80% arrhythmic burden reduction post ablation seems to be associated with significant LV recovery (23,24). Although interesting, this concept of arrhythmic burden reduction remains to be formally proven though.

Overall, Holmqvist *et al.* (1) have made a remarkable summary of the rapid and dramatic evolution of "real-world" catheter ablation over the last decade. Procedural time and fluoroscopic time are diminishing. Complications rate remains low despite increasing procedure complexity. Acute and long-term success are already high for simple ablations and are rapidly improving for complex ablations. For all these reasons, catheter ablation has become a first-line therapy for many arrhythmias and the number of procedures keeps going up. This registry reports data up to the end of 2015. In the meantime, multiples new advancements have already been made and a myriad of trials currently in progress should contribute to this ongoing revolution. The next decade 2015–2025 has begun and already looks as exciting and promising as the last one.

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Footnote

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