INDIAN PACING AND ELECTROPHYSIOLOGY JOURNAL 15 (2015) 149–151

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New technologies for catheter based treatment of paroxysmal atrial fibrillation – Everything under control?

We have been privileged in the past decades to witness the logic of scientific discovery bringing to light the mechanistic understanding and modern treatment of atrial fibrillation (AF). From being experimental in their early days, catheter-based techniques are now recommended as a Class 1 therapy for treatment of patients with symptomatic AF refractory to at least one membrane active antiarrhythmic medication [1]. However, while catheter ablation using radiofrequency (RF) energy is very efficient in suppression or even cure of many supraventricular and ventricular arrhythmias, it is far from reaching similar outcomes in more complex arrhythmias such as AF, as reflected in reported "re-do" AF ablation procedure rates of up to 50% [2,3]. Certainly, such frustrating numbers may raise the question whether we are doing the right thing, using the right tools and last but not least, understand what we are actually doing by using them. It is well known that reconnection of at least one pulmonary vein (PV) is present in nearly 100% of patients undergoing a "re-do" procedure due to arrhythmia recurrence, and therefore the creation of durable lesions is crucial for a permanent PV isolation (PVI) and freedom of arrhythmic events [4,5]. There is no doubt that successful arrhythmia treatment by RF ablation depends on a critical understanding of the biophysics of lesion creation and its control by e.g. titrating conventional parameters such as power, time and irrigation rate [6]. However, significant variability in lesion size may be responsible for both inefficacy as well as complications. Contact between electrode and tissue and, thus, catheter contact force (CF) has been shown to be a key parameter to control lesion size [7].

In this issue of the *Indian Pacing and Electrophysiology Journal*, Fichtner et al. (REF) report their results on a series of patients who underwent ipsilateral circumferential PVI for drug refractory paroxysmal AF either CF aided using the SmartTouch (N = 30, ST group) or without CF monitoring but using the SurroundFlow catheter (N = 29, SF group) instead of the standard design irrigated catheter. The rationale behind the SF catheter is mainly a qualitatively improved widely distributed over the entire tip electrode surface catheter tip irrigation by compensating for changes in irrigation flow with a changing electrode–tissue contact orientation, as well as a decrease in required irrigation flow rate and delivery of high RF power even in areas of very low blood flow and potentially reduction in the risk of thrombus coagulum formation [4]. These characteristics render the SF catheter a powerful tool, but can result in marked temperature disparities between the catheter tip and the tissue during RF delivery. Of note, tissue temperatures of more than 100 °C can be reached, without the ability to control lesion formation. Initial enthusiasm has been put into perspective after a recently published prospective observational study on steam pop formation with different power and irrigation rate settings suggesting that merely creating efficient lesions may not be the optimal approach when an adequate control and feedback are lacking [8].

In the present study, patients were consecutively included between 2011 and 2012 – a significant detail in view of important lessons we have learned since then. Baseline characteristics were well balanced between the two groups; procedural data comparable without any significant differences and maximal power settings during PVI identical (25–30 W, irrigation rate 30 ml/min in the ST group and 17 ml/min in the SF group). Of note, a CF of 10–20 g was targeted in the ST group during PVI but no data on actual achieved CFs was provided. Complete PVI was validated by an unexcitable ablation line to pacing (10 V, 2 ms) and entry and exit block, although no Adenosine was used. And all patients were discharged on betablockers without any other antiarrhythmic drugs and followed for 6 months using an intensive follow-up regimen, with a strict definition of success: freedom from documented symptomatic or asymptomatic AF or atrial tachycardia after a blanking period of 6 weeks and off drugs after a single procedure.

The authors are to be congratulated for their robust analysis. It allows unequivocal interpretation of gathered results, summarized as a 72% freedom from atrial arrhythmias within 6 months in both groups with low and comparable adverse events, driving the authors to the conclusion that CF guided PVI reaches the same success rate as PVI without CF monitoring using a SF catheter. One may argue that pre-specified complication rates based on the current literature could not

Peer review under responsibility of Indian Heart Rhythm Society.

be met due to the small patient numbers, rendering the actual comparison in terms of safety difficult, however, neither was this the primary aim of the authors, nor could any differences be expected in this regard between the two groups.

Do these outcomes unequivocally indicate that the use of real-time CF monitoring catheters has not been able to improve the efficacy and sustainability of lesion formation and clinical success rates? The possible answer is that outcomes depend on how we use these tools and what they are compared with. Of note, success rates when using novel tools certainly also depend on experience and proficiency of the operator. The recently published SMART-AF trial showed a success rate of 72.5%, perfectly in line with the study by Fichtner et al., however, at 12 months [9], whereas earlier studies using a traditional Navistar Thermocool catheter reached a 66% success rate and perhaps these success rates allow us to acknowledge the improved outcomes of Fichtner et al. with the SF [10]. The better outcomes in SMART-AF on the other hand may be explained by the use of CF monitoring, by a better understanding of efficient lesion formation and its control for a sustained PV isolation and also by effective strategies to improve contact: deflectable sheaths, intracardiac echocardiography, measurement of catheter tip impedance dynamics, general anesthesia. These issues remain unmentioned in the study by Fichtner et al. as does the probably most important information when performing CF guided PVI: the percentage of RF time reaching target CF and FTI values. In the SMART-AF trial, the investigators indeed found that an increased percentage of time within physician-chosen target CF ranges correlated with increased freedom from arrhythmia recurrence, with 84.4% of subjects being arrhythmia-free at 12 months when CF was within the targeted range >82% of the time [9]. The EFFICAS II trial, published this year, prospectively evaluated a set of CF guidelines for ensuring durable isolation of the PVs (target CF of 20 g, range of 10–30 g, minimum FTI of 400 gs) using the TactiCath catheter. Not surprisingly, their use and continuity in deployment of RF lesions along the ablation line resulted in a superior rate of durable PVI [11]. Similarly, the TOCCASTAR study, investigating the primary effectiveness end point consisting of acute electrical isolation of all PVs and freedom from recurrent symptomatic atrial arrhythmia off all antiarrhythmic drugs at 12 months, clearly showed an improved effectiveness and outcome when optimal CF values (≥10 g) were achieved [12].

In conclusion, the analysis by Fichtner et al. adds to the evidence that catheters with real-time CF sensing have become essential for safe and efficient catheter-based treatment of AF and may define new standards of care in order to improve efficacy and guarantee permanent PVI while keeping complication rates low [13]. Significant challenges remain, including how to decrease the incidence of left atrial flutters by avoiding lines and preventing gaps, how to avoid excessive redundant atrial ablation and how to translate these tasks into the patients' freedom of arrhythmic events. Surely, sooner or later more efficient and powerful tools will find their way into our clinical routine, however, after having appreciated the "history of lesion formation" so far one statement will probably hold true even more: "power is nothing without control".

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Mehdi Namdar

Dipen C. Shah*
Hôpitaux Universitaires de Genève, Service de Cardiologie, Geneva, Switzerland

**Corresponding author*. Cardiology Department, Geneva University Hospitals, Rue Gabrielle-Perret-Gentil 4, CH-1211 Genève 14, 1205 Geneva, Switzerland. Tel.: +41 22 372 72 02; fax: +41 22 372 72 29.
E-mail address: dipen.shah@hcuge.ch (D. C. Shah)

Available online 3 October 2015

http://dx.doi.org/10.1016/j.ipej.2015.09.010