



Pulmonary vein isolation using the cryoballoon: is “real-time” really important?

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Pulmonary vein isolation (PVI) using the cryoballoon (CB) has seen widespread clinical acceptance with robust randomized data supporting its long-term efficacy [1]. A subset of patients will experience recurrent atrial fibrillation (AF) commonly attributed to electrical pulmonary vein (PV) reconnection [2, 3]. During CB PVI, a spiral mapping catheter (Achieve, Medtronic Inc., Minneapolis, USA) is advanced through the inner lumen of the catheter shaft, allowing safe over-the-wire placement of the balloon into the target PV. Electrodes on the Achieve mapping catheter facilitate real-time recording of PV potentials while their sudden disappearance during cryoenergy delivery signifies acute PVI. The time to PVI has evolved as a strong predictor of long-term success with higher AF recurrence rates seen at durations > 43 s [4, 5]. The shorter muscle bundles penetrating the inferior PVs often require the Achieve mapping catheter to be retracted to the most proximal aspect of the PV ostium. Despite all operator efforts, in a subset of patients, PV potentials may not be recorded and acute PVI can only be confirmed after completion of the freeze cycle. Would these patients experience worse long-term outcome?

In this journal issue, De Greef and colleagues report the results of a single-center observational study of 803 patients undergoing CB PVI for paroxysmal and persistent AF using the second-generation CB (Arctic Front Advance, Medtronic Inc.) in combination with the first-generation Achieve spiral mapping catheter. The authors assessed the relationship of CB PVI recorded in real-time and long-term freedom from AF. Overall, the rate of recurrent AF at 3 years was 279/803 (34.7%), while 188/803 (23.4%) patients underwent a repeat ablation procedure.

Long-term freedom from AF in patients with real-time isolation of all PVs was 77.4%. The study demonstrated a gradual decline in long-term success that correlated with the number of veins ablated without real-time PVI. Lack of real-time PVI in 3–4 PVs was associated with a long-term success rate of only 48.9%. This correlation existed for paroxysmal and persistent AF patients alike, albeit being more pronounced in the latter. Multivariate analysis confirmed a statistically significant higher rate of AF recurrence (HR = 1.275; 95%CI 1.134–1.433; $p < 0.01$) in patients without real-time PVI.

De Greef et al. further noted that in patients with recurrent AF undergoing a repeat ablation procedure using radiofrequency energy and a 3-dimensional mapping system, varying degrees of PV electrical reconnection were seen (the right inferior PV showed the highest rate of electrical reconnection). Only the right inferior PV demonstrated a statistically significant difference in reconnection rate depending on presence (29.7%) or lack (43.7%) of real-time PVI ($p = 0.047$) during the initial CB ablation procedure.

A main limitation of the study by De Greef et al. stems from the use of the older, second-generation CB in combination with the first-generation Achieve catheter which resulted in lack of real-time PVI in nearly one-third (31.7%) of ablated veins. As many operators strive for an individualized ablation strategy which is contingent upon PV signal acquisition to determine time to isolation, efforts have focused on changes to the design of the older-generation CB. The shorter distal tip of the latest, fourth-generation CB (Arctic Front Advance Pro, Medtronic Inc.) allows more proximal positioning of the Achieve catheter along the LA-PV junction and a high rate of real-time PVI (85%) was noted in a study by Straube et al. [6]. In the absence of PV signals, surrogate procedural markers of success have been proposed, e.g., reaching a CB temperature of $-30\text{ }^{\circ}\text{C}$ at 30 s or $-40\text{ }^{\circ}\text{C}$ within 60 s [5]. However, failure to record real-time PVI during cryoenergy delivery may increase

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the probability of delayed or incomplete isolation which in turn may negatively affect long-term lesion durability and outcome.

De Greef and colleagues, in a previous study, demonstrated the utility of adding a 3-dimensional mapping system to the CB ablation procedure [7]. Using the Achieve mapping catheter to create a voltage map before and after second-generation CB PVI was cost-effective and significantly increased detection of residual PV potentials by 12% compared to conventional Achieve-guided CB ablation. In a second study, high-density mapping detected residual PV potentials in 7.6% of veins ablated with the older-generation CB, versus 1.4% using the fourth-generation CB in combination with the latest-generation Achieve Advance catheter [8].

In summary, the study by De Greef et al. informs the operator of the importance of real-time PVI to improve long-term freedom from recurrent AF. Use of the latest-generation CB and Achieve catheter is supported by data demonstrating a significant increase in the rate of real-time PVI. A dedicated high-resolution mapping system may not always be available or desired, but its use adds an additional layer of reassurance if real-time PVI cannot be accomplished.

Declarations

Competing interests Gursukhman DS Sidhu has no competing interests, while Erik Wissner is a consultant at Medtronic.

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