EDITORIAL COMMENTARY

# Cryoballoon ablation for ventricular arrhythmias: Prospects and challenges

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Catheter ablation of ventricular arrhythmias (VAs) can sometimes be challenging. Radiofrequency energy rarely penetrates beyond 7 mm into the endocardium or epicardium, even with a long duration.[1] Therefore, standard unipolar radiofrequency ablation (RFA) may fail to create lesions of sufficient depth to eliminate the intramural substrate. There have been several alternative bail-out strategies suggested for intramural VAs to increase success, including simultaneous unipolar RFA, bipolar ablation, use of lower-tonicity catheter irrigation, needle ablation, transvascular ethanol ablation, and stereotactic radioablation.[2–4] The use of these strategies has, however, been associated with several complications, such as steam pop, cardiac tamponade, complete atrioventricular block, and coronary artery injury. Additionally, a thin septum with an intercatheter distance of less than 5 mm may be contraindicated for bipolar RFA.[5] Moreover, tissue contact and stability of the catheters are frequently limited by mobile endocavitary structures such as the papillary muscles and the right ventricular (RV) moderator band during RFA.

For the above-mentioned scenario, cryoablation is an option. The catheter tip forms an ice crystal that fuses to the myocardial tissue during cryoablation, ensuring consistent contact with the tissue.[2] As a result of improved stability, cryoablation could be able to create a deep lesion. Parvez and colleagues[6] compared lesion sizes created by 8-mm-tip cryoablation catheters and open-irrigated RFA catheters on porcine left ventricular myocardium under controlled conditions. When compared with RFA, cryoablation could create larger and deeper lesions. Thus, focal cryoablation for VAs has been widely reported and is associated with a satisfactory safety profile.[7–10] Despite the above, there is relatively limited evidence supporting cryoballoon ablation for VAs. As far as we are aware, there have only been 2 reports of cryoballoon ablation for VAs.[11,12] Chinitz and colleagues[11] reported the first patient with the use of a cryoballoon to successfully ablate premature ventricular contraction–mediated ventricular fibrillation originating from the moderator band. This case illustrates how a larger ablation catheter, such as the cryoballoon, can overcome issues of stability and allow contact along the entire length of mobile intracardiac structures. A point-by-point cryoablation catheter could have also been used to improve catheter stability, but a larger cryoballoon was chosen to ablate more substrate along the moderator band.

On the basis of this emerging evidence base, Cook and colleagues[12] presented their study in the current issue of *HeartRhythm Case Reports*. The authors retrospectively reviewed 7 cases receiving cryoballoon ablation for VAs that were refractory to RFA. Among them, 4 patients had structural heart disease, including either ischemic cardiomyopathy or nonischemic cardiomyopathy. Except for 1 patient with VA originating from the left fascicle, the VAs originated either from intracavitary foci (2 RV moderator bands, 2 left ventricular papillary muscles) that could be stabilized by cryoballoons or in deep ventricular myocardium, where the cryoballoon may be able to achieve deeper lesions. Five of the 7 patients underwent successful ablation without complication. The present study expands the observational data regarding cryoballoon ablation for idiopathic and substrate VAs, although further large-scale trials are required to establish a definitive conclusion. Furthermore, animal studies are required to test the hypothesis that a cryoballoon could create a deeper lesion.

The current cryoballoon technology has several limitations for ablation beyond the pulmonary vein ostium. First, owing to the absence of electrodes over the balloon surface, the 3D mapping system is unable to visualize the balloon. The cryoballoon could only be positioned using fluoroscopy, intracardiac echocardiography, and the circular mapping catheter. Continuous intracardiac ultrasound is essential for visualizing and ensuring tissue contact. Despite this, it may still be challenging to avoid unwanted contact with the normal myocardium, valvular apparatus, or conduction system. Therefore, a small chamber, a narrow outflow tract, or the paravalvular or para-Hisian region may not be the optimal target. Cryoballoon ablation may, however, be more effective

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when a structure is identified by intracardiac echocardiography, such as the papillary muscle or the moderator band. Chinitz and colleagues[11] chose to ablate the moderator band using a 23 mm balloon to avoid extensive contact with the RV myocardium and to prevent RV dysfunction. Second, cryoballoon is currently contraindicated and off-label for ablation in the ventricle without the manufacturer's approval. The balloon catheter is much stiffer than a radiofrequency catheter, which limits maneuverability and mapping. As it is likely to be entrapped by the chordae tendinae, care must be taken not to entangle the circular mapping catheter in the subvalvular apparatus. Cook and colleagues[12] suggested using a guidewire to guide the balloon into the ventricle smoothly. In addition, the optimal freezing protocol for the ventricle is unknown. For each of the 2 applications, Chinitz and colleagues angled the balloon to target the septal side and lateral margin of the moderator band for 4 minutes. In contrast, Cook and colleagues empirically placed 1–2 freezes in locations where an acute response was observed, and up to 5 freezes in locations where there was no acute response.

To conclude, although the results are encouraging and major complications do not occur, further large-scale or randomized trials are required to confirm the efficacy and safety of cryoballoon ablation. Considering the lack of an established optimal freeze protocol in the ventricle and the technical challenges associated with balloon positioning, cryoballoon is not currently considered a reliable tool for VA ablation. However, in patients with VA refractory to conventional ablation methods, cryoballoon ablation might be considered a bailout strategy by experienced physicians.

## References


1. Koruth JS, Iwasawa J, Enomoto Y, et al. Chamber-specific radiofrequency lesion dimension estimation using novel catheter-based tissue interface temperature sensing: a preclinical assessment. JACC Clin Electrophysiol 2017;3:1092–1102.
2. Stevenson WG, Sapp JL. Newer methods for ventricular tachycardia ablation and when to use them. Can J Cardiol 2022;38:502–514.
3. Pothineni NVK, Garcia FC, Santangeli P. Radiofrequency ablation strategies for intramural ventricular arrhythmias. Methodist Debakey Cardiovasc J 2021;17:8–12.
4. Dukkipati SR, Nakamura T, Nakajima I, et al. Intramural needle ablation for refractory premature ventricular contractions. Circ Arrhythm Electrophysiol 2022;15:e010020.
5. Della Bella P, Peretto G, Paglino G, et al. Bipolar radiofrequency ablation for ventricular tachycardias originating from the interventricular septum: safety and efficacy in a pilot cohort study. Heart Rhythm 2020;17:2111–2118.
6. Parvez B, Pathak V, Schubert CM, Wood M. Comparison of lesion sizes produced by cryoablation and open irrigation radiofrequency ablation catheters. J Cardiovasc Electrophysiol 2008;19:528–534.
7. Whitaker J, Batnyam U, Kapur S, Sauer WH, Tedrow U. Safety and efficacy of cryoablation for right ventricular moderator band-papillary muscle complex ventricular arrhythmias. JACC Clin Electrophysiol 2022;8:857–868.
8. Gordon JP, Liang JJ, Pathak RK, et al. Percutaneous cryoablation for papillary muscle ventricular arrhythmias after failed radiofrequency catheter ablation. J Cardiovasc Electrophysiol 2018;29:1654–1663.
9. El-Eshmawi A, Pandis D, Miller MA, et al. Surgical cryoablation of papillary muscle PVCs during mitral valve surgery: therapeutic consideration for malignant MVP. J Am Coll Cardiol 2020;76:3061–3062.
10. Rivera S, Ricapito Mde L, Tomas L, et al. Results of cryoenergy and radiofrequency-based catheter ablation for treating ventricular arrhythmias arising from the papillary muscles of the left ventricle, guided by intracardiac echocardiography and image integration. Circ Arrhythm Electrophysiol 2016;9:e003874.
11. Chinitz JS, Sedaghat D, Harding M, Darge A, Epstein LM, John R. Adjuvant use of a cryoballoon to facilitate ablation of premature ventricular contraction-triggered ventricular fibrillation originating from the moderator band. HeartRhythm Case Rep 2019;5:578–581.
12. Cook C, Welter-Frost A, Wilson DR, Herweg B. Cryoballoon ablation for refractory ventricular tachycardia. HeartRhythm Case Rep (in press). DOI: https://doi.org/10.1016/j.hrcr.2022.12.012