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Cryoablation to improve catheter stability and ablation success in the right atrioventricular groove

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ABSTRACT

Catheter instability can limit ablation success of arrhythmia substrates at the right atrioventricular groove. We describe cases where cryoablation improved catheter stability, enabling ablation success.

Methods and results: Four patients with supraventricular tachycardia (SVT) substrates at the right atrioventricular groove had radiofrequency ablation procedures limited by poor catheter contact. Cryoablation offered improved catheter stability, and all four patients achieved acute ablation success using cryoablation. Three patients had long-term success and one patient later required repeat radiofrequency ablation.

Conclusions: For patients with arrhythmia substrates at the right atrioventricular groove, cryoablation may be a useful adjunctive technique in cases with catheter instability.

Introduction

Radiofrequency (RF) ablation is a standard therapy for the management of various arrhythmias [1]. Successful RF ablation relies on accurate and stable catheter tip contact with the target tissue for curative energy delivery, and catheter instability commonly limits the success of such procedures [1,2]. Catheter instability is particularly problematic in procedures involving arrhythmias originating from or caused by substrates at the right atrioventricular (AV) groove [3], illustrated by the lower ablation success rate of right-sided accessory pathways compared to left [4,5] and the higher incidence of recurrent accessory pathway conduction on the right compared to left [4,5]. Techniques which optimize catheter stability include the use of pre-formed and deflectable sheaths, contact force sensing and/or cooled-tip ablation catheters which increase the lesion power to compensate for instability [2,6]. Cryo-ablation is an alternative to catheter ablation [7]. While it has predominantly been used in ablating substrates close to the AV node and His bundle, it has also been described in other locations, especially on the right side of the heart [7]. We describe four patients with significant RF catheter instability despite the use of special techniques, in whom cryoablation was successful.

Results

Four patients underwent this type of ablation between 2017 and 2019. All were male, and all were mapped using fluoroscopy and the NAVEX (Abbott Cardiovascular, St Paul MN) three dimensional mapping system. An Agilis sheath (Abbott Cardiovascular, St Paul MN) was used in each of the cases. Other details follow and also are given in Table 1.

Patient 1 was a 17-year-old male with a non-automatic atrial tachycardia from the right lateral tricuspid annulus (7 O'clock on the tricuspid valve clock-face in left anterior oblique (LAO) view) (Fig. 1). The patient initially underwent RF ablation complicated by catheter instability, but acute success was achieved using a contact force sensing cooled-tip catheter (TactiCath Quartz CF ablation catheter, Abbott Cardiovascular, St. Paul, MN) and a deflectable Agilis sheath. One year later, the tachycardia recurred. At the repeat procedure, we initially attempted RF ablation using the stereotaxis magnetic navigation system NaviStar RMT Thermocool catheter (Biosense Webster, CA) with hopes that this catheter's soft body would “ride” the atrioventricular (AV) groove held in place by magnetic tension. This was unsuccessful and so we attempted

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Table 1
Patient Details.

Patient #	1	2	3	4
Age years	17	34	14	15
Type of arrhythmia substrate	Atrial tachycardia	Atrial tachycardia	WPW	WPW
Location of arrhythmia substrate on Tricuspid valve clock-face in LAO	7 O'clock	10 O'clock	9 O'clock	10 O'clock
Number of Cryo lesions	5	12	2	9
Total cryotherapy time (minutes)	20	20	8	15.5
Fluoroscopy time minutes	3.1	20.1	3.4	5.5
Acute Result	Success	Success	Success	Success
Recurrence of arrhythmia	No	No	No	Yes

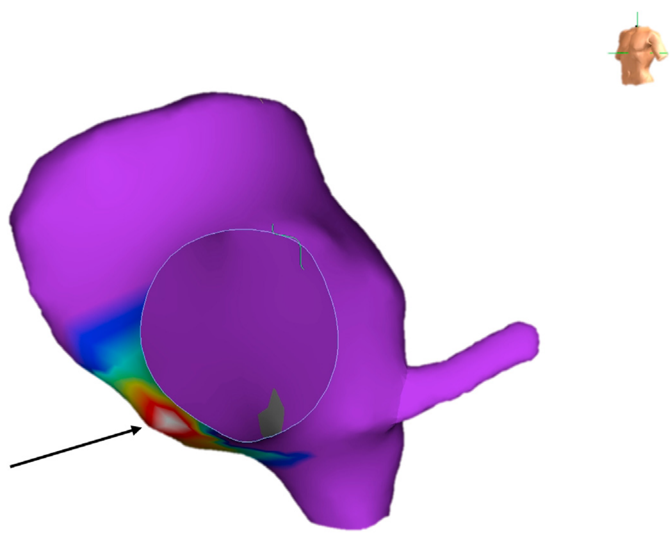

Fig. 1. LAO view of the location of the tachycardia focus in patient 1.

cryoablation using an Agilis sheath (Abbott Cardiovascular, St. Paul, MN) and a 7-French F-3 cryoablation catheter (Medtronic, Minneapolis, MN). Cryoablation was successful. At 15-month follow up, the patient remains asymptomatic.

Patient 2 was a 34-year-old male with atrial tachycardia from the right antero-lateral tricuspid annulus (10 O'clock on the tricuspid valve clock-face in LAO view) (Fig. 2). During ablation, instability of both medium and large curl Agilis sheaths made initial attempts unsuccessful. The ablation catheter was switched to a F-3 cryoablation catheter (Medtronic, Minneapolis, MN) through an Agilis sheath and stability markedly improved. Cryoablation then rendered the tachycardia non-inducible. The patient remains asymptomatic at two-year follow up.

Patient 3 was a 14-year-old male with Wolff-Parkinson-White (WPW) syndrome with two accessory pathways: a left posteroseptal pathway and a right lateral pathway (9 O'clock on the tricuspid valve clock-face in LAO view) (Fig. 3). RF ablation terminated the left-sided pathway, and despite instability the right-sided pathway was also ablated with an Agilis sheath. Two months later the right-sided pathway recurred. At repeat RF ablation, catheter instability was an issue and we switched to a F-3 cryoablation catheter (Medtronic, Minneapolis, MN) via an Agilis sheath. Stability improved and cryoablation was successful. The patient is asymptomatic 15 months later.

Patient 4 was a 15-year-old male with supraventricular tachycardia (SVT) due to a manifest right anterior accessory pathway (10 O'clock on the tricuspid valve clock-face in LAO view) (Fig. 4). Initial RF ablation with an Agilis sheath and a 4-mm thermistor Celsius catheter (Biosense Webster, CA) was unsuccessful. We switched to a F-3 cryoablation catheter (Medtronic, Minneapolis, MN) via an Agilis sheath to improve stability and cryoablation was acutely successful. Three months later, accessory pathway conduction recurred. At the repeat procedure, instability was still problematic with an Agilis sheath and a contact force sensing TactiCath SE catheter (Abbott Cardiovascular, St Paul MN) were used and finally, with repeated attempts, RF ablation was successful. Two months later, the patient is asymptomatic.

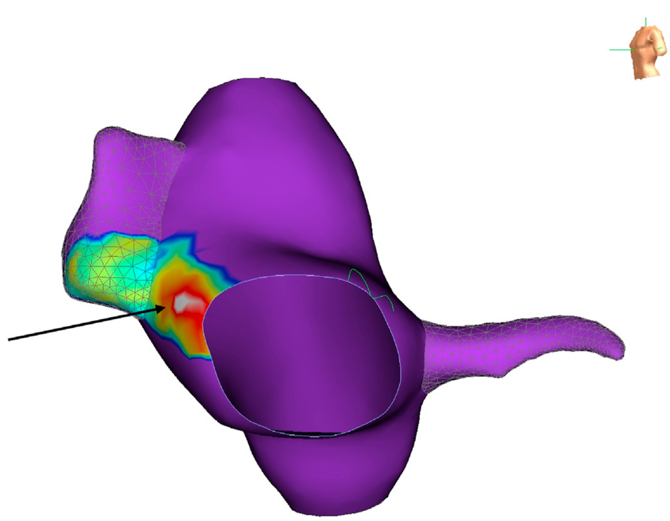

Fig. 2. LAO view of the location of tachycardia focus in patient 2.

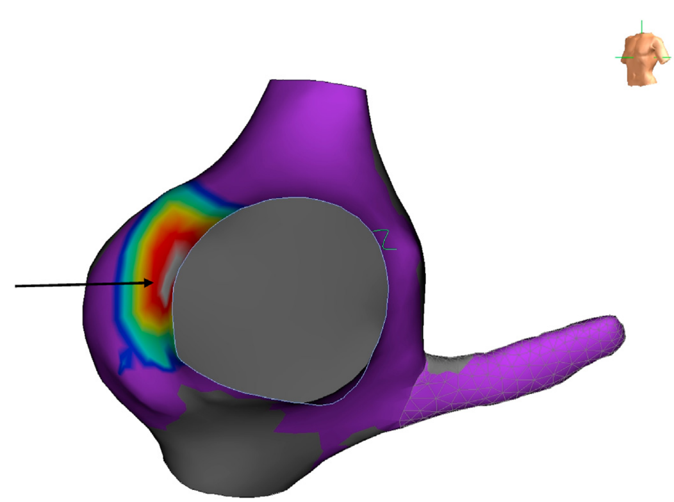

Fig. 3. LAO view of accessory pathway location in patient 3.

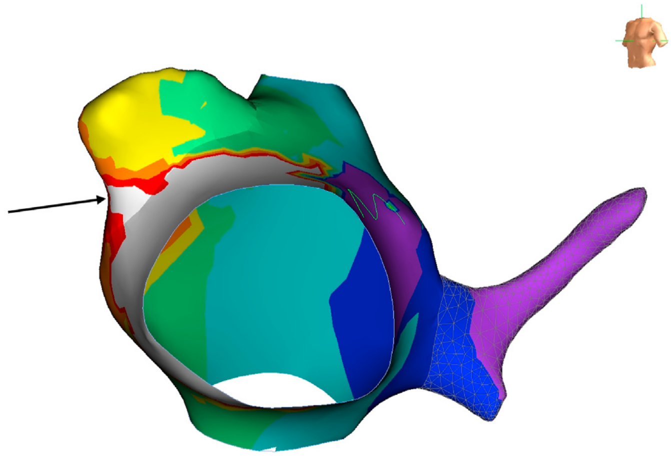

Fig. 4. LAO view of the accessory pathway location in patient 4.

Discussion

Our experience suggests a potential role for cryoablation of arrhythmia substrates on the right AV groove where RF ablation fails primarily due to catheter instability. RF catheter ablation is a proven therapy for various cardiac arrhythmias but it relies on adequate energy delivery to the target tissue, and therefore catheter tip stability at this desired location is key for ablation success [2]. Catheter instability is particularly problematic at the right AV groove [3] and around the left ventricular papillary muscles [6]. Instability not only limits ablation success, but it contributes to collateral tissue damage [1].

To facilitate successful substrate ablation in areas with catheter tip instability, various techniques have been described. Electroanatomic mapping systems localize the ablation catheter tip in real-time using an electromagnetic field and extrapolate spatial data to construct maps [2]. Paired with electrogram voltage, this aids to guide the catheter [2]. Contact force sensing catheters measure the “force” of catheter contact, which indirectly measures catheter stability and approximates lesion quality [2]. Deflectable and preformed catheter sheaths have uniquely designed curvature to improve access to target substrates [8]. Stereotaxis robotic navigation enables remote catheter guidance to improve catheter orientation and position, and improve user and patient safety [9].

Cryotherapy employs freezing temperatures to form discrete tissue lesions and it was first applied to cardiac surgery in the 1970s [8,10]. It offers a quality of freeze-mediated tissue adhesion (cryo-adherence) which lends stability at the point of contact, holds contact at sites where contact can be difficult to maintain, and reduces surrounding tissue damage [1,10]. It can be used to ablate substrates close to the native conducting system to reduce the incidence of AV node damage [4,8]. Drago et al. described a large experience of using cryo-ablation in 71 ablations in 66 children [8]. While most of their cases were lesions close to the AV node and His bundle, they also had 8 substrates in the lateral aspect and 6 on the posterior aspect of the tricuspid valve [8]. However, in their experience, cryoablation was used as the initial technique. Hence, the issue of catheter instability during RF ablation was not part of their report [8]. Cryotherapy to improve ablation catheter stability (via cryo-adherence) has been described [1,6,11], and we propose a use for cryoablation in cases where RF ablation fails due to catheter instability.

Cryoablation comes with disadvantages. Because of catheter-tissue adhesion, the catheter tip must be in precisely the correct place for effective energy delivery [1]. Compared to RF ablation, cryoablation has a lower acute and long-term success rate, with a higher recurrence rate of the arrhythmia substrate, however, the efficacy of cryoablation is often related to the substrate location [12]. Also, cryoablation catheters are stiffer and less maneuverable than RF catheters [11] which poses a challenge to the electrophysiologist, including the higher likelihood for “bumping’ and mechanically affecting the substrate which can prevent further mapping and ablation. Lastly, cryoablation may not be available in all electrophysiology laboratories and their cost may be a factor in limiting their use in some centers.

There is an element of luck involved in optimal catheter adherence to its moving target. In our cases, we used steerable sheathes (Agilis, Abbott Cardiovascular, St Paul MN) to guide the cryoablation catheters. Additional considerations are the time required for the catheters to achieve goal freezing temperatures, and the unpredictability of where the catheter tips will adhere. Careful observation with either three-dimensional mapping or fluoroscopy is of utmost importance to ensure the catheter tip has frozen to the correct location.

We had one case (Case 4) where there was success after using a contact force catheter at a subsequent session after the pathway recurred after acutely successful cryo-ablation. This aspect shows that cryo-ablation is not a fool-proof method and that ablators have to be versed in multiple techniques and be prepared to use multiple methods to achieve success in difficult cases.

Conclusion

When ablation failure is due to unstable RF catheter position in the right AV groove, cryoablation may improve catheter stability through cryo-adhesion, and should be considered as an alternative approach.

Commercial or industrial associations and individual affiliations

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References

[1] Bastani H, Insulander P, Schwieler J, Tabrizi F, Braunschweig F, Kenneback G, et al. Cryoablation of superoparaseptal and septal accessory pathways: a single centre experience. Europace 2010;12(7):972–7.
[2] Constantinescu M, Lee S, Ernst S, Hemakom A, Mandic D, Yang G. Probabilistic guidance for catheter tip motion in cardiac ablation procedures. Med Image Anal 2018;47:1–14.
[3] Sternick EB, Faustino M, Correa FS, Pisani C, Scanavacca MI. Percutaneous catheter ablation of epicardial accessory pathways. Arrhythmia Electrophysiol Rev 2017;6(2):80–4.
[4] Buddhe S, Singh H, Du W, Karpawich P. Radiofrequency and cryoablation therapies for supraventricular arrhythmias in the young: five-year review of efficacies. PACE (Pacing Clin Electrophysiol) 2012;35:711–7.
[5] Xie B, Heald SC, Camm AJ, Rowland E, Ward DE. Radiofrequency catheter ablation of accessory atrioventricular pathways: primary failure and recurrence of conduction. Heart 1997;77:363–8.
[6] Rivera S, Tomas L, Ricapito M, Nicolas V, Reinoso M, Caro M, et al. Updated results on catheter ablation of ventricular arrhythmias arising from the papillary muscles of the left ventricle. Journal of Arrhythmia 2018;35(1).
[7] Drago F, Righi D, Placidi S, Russo MS, Di mambro C, Silvetti MS, Prosperi M. Cryoablation of right-sided accessory pathways in children: report of efficacy and safety after 10-year experience and follow-up. Europace 2013;15:1651–6.
[8] Shandling A, Rieders D, Edwards M. Use of a unique long pre-curved sheath to facilitate femoral placement of coronary sinus catheters. Indian Pacing Electrophysiol J 2009;9(5):247–50.
[9] Da Costa A, Guichard JB, Romeyer-Bouchard C, Gerbay A, Isaaz K. Robotic magnetic navigation for ablation of human arrhythmias. Med Dev Evid Res

2016;9:331–9.

[10] Andrade J, Khairy P, Dubuc M. Catheter cryoablation. Circ-Arrhythmia Elec 2013;6:218–27.

[11] Gordon J, Liang J, Pathak R, Zado E, Garcia F, Hutchinson M, et al. Percutaneous cryoablation for papillary muscle ventricular arrhythmias after failed radiofrequency catheter ablation. J Cardiovasc Electrophysiol 2018;29(12).

[12] Bravo L, Atienza F, Eidelman G, Avila P, Pelliza M, Castellanos E, et al. Safety and efficacy of cryoablation vs. radiofrequency ablation of septal accessory pathways: systematic review of the literature and meta-analyses. EP Europace 2018;20(8):1334–42.