Endocardial Right and Left Ventricular Cryo Balloon Ablation as a Bailout Strategy for Refractory Ventricular Tachycardia

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Abstract

We report seven patients who underwent bail out cryoballoon ablation of ventricular arrhythmias refractory to conventional endocardial radiofrequency ablation. Ablated arrhythmia substrates included right ventricular moderator band (n=2), left ventricular (LV) papillary muscle (n=2), left fascicular (n=1) and deep LV myocardial (n=2). Cryoballoon ablation was successful in 5/7 patients. Advantages of cryoballon ablation include adhesive stability on endocavitary structures and creation deep homogeneous myocardial lesionds. Newer balloon technologies designed to improve myocardial contact that incorporate high density mapping on the balloon surface may expand utility of this technology for ablation of ventricular arrhythmias.

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We report seven patients who underwent bail out cryoballoon ablation of ventricular arrhythmias refractory to conventional endocardial radiofrequency ablation. Ablated arrhythmia substrates included right ventricular moderator band (n=2), left ventricular (LV) papillary muscle (n=2), left fascicular (n=1) and deep LV myocardial (n=2). Cryoballoon ablation was successful in 5/7 patients. Advantages of cryoballon ablation include adhesive stability on endocavitary structures and creation deep homogeneous myocardial lesionds. Newer balloon technologies designed to improve myocardial contact that incorporate high density mapping on the balloon surface may expand utility of this technology for ablation of ventricular arrhythmias.

Introduction

Ventricular arrhythmias (VAs) may arise from the endocardium including mobile endocavitary structures (papillary muscles and the right ventricular moderator band), midmyocardium, or epicardium. Radiofrequency ablation of VAs is limited by lesion depth, catheter contact, and stability, particularly with mobile endocavitary structures. Focal cryoablation of VAs has been performed using the Freezor Max (Medtronic, Minneapolis, MN) via an endocardial approach[1] or utilized intraoperatively at the time of cardiac surgery[2]. There are currently 2 reports of cryoballoon ablation of VA arising from endocavitary structures in the right ventricle (RV)[3,4]. We present a series of seven cases where cryoballoon ablation was utilized as a bail out ablation strategy for therapy refractory VAs arising from the right and/or left ventricle (LV).

Case Series

Case 1

A 60 year old male with ischemic cardiomyopathy (ICMP) (EF 30-35%), apical MI, presented with ventricular tachycardia (VT) and multiple ICD shocks. Two previous ablations failed. An epicardial substrate was suspected. He was referred for reablation. An endocardial voltage map demonstrated apical scar (see figure 1). An apical VT was induced but extensive endocardial ablation failed to terminate the VT. Epicardial mapping was not attempted due to adhesions. The cryoballoon was used to create transmural apical lesions. The cryoballon was placed in an apical LV location (Figure 1) and four overlapping freezes were performed covering the apical scar. VT was not inducible at the conclusion of the procedure and has not recurred during a follow-up of 18 months.

Case 2

A 55 year old male with a structurally normal heart was referred for fatigue and frequent premature ventricular contractions (PVC) with a 34% PVC burden. Activation mapping of the PVCs showed a diffuse area of early activation in the RV moderator band. Despite extensive RF ablation, suppression did not occur. Cryoballoon ablation was performed in the apical septal RV, positioning the balloon using intracardiac echocardiography guidance. This resulted in a change in PVC morphology indicating a more lateral exit site. The residual PVCs were ablated with RF energy resulting in a low burden of multifocal PVCs at the conclusion of the procedure. Repeat EM showed an unchanged PVC burden.

Case 3

A 49 year old male with nonischemic cardiomyopathy (NICMP) (EF 35-40%) and VT with multiple ICD shocks was referred for ablation. Endocardial voltage mapping showed only a small territory of heterogenous voltage in the basal inferior and lateral LV walls. Activation mapping and ECG morphology suggested epicardial VT. Extensive endocardial ablation did not terminate the VT and attempts at epicardal access were unsuccessful due to adhesions. Cryoballoon ablation was performed with delivery of a single freeze in the basal lateral LV. The PVCs were suppressed after a single application and did not recur during a follow-up of 17 months.

Case 4

A 57 year old woman with a history of valvular heart disease (EF 50-55%, bioprosthetic mitral valve replacement) presented with LV anterolateral papillary muscle PVCs (burden 16%) after failed ablation. Activation mapping showed earliest activation in the anterolateral papillary muscle and RF energy delivery in this territory failed to suppres the PVCs. The cryoballoon was advanced into the LV over a guidewire and positioned at the location of the anterolateral papillary muscle (Figure 2). Two cryoballoon freezes were delivered at this location with successful PVC suppression. The patient reported markedly reduced palpitations at follow up.

Case 5

A 33 year old female with a structurally normal heart presented with highly symptomatic PVCs refractory to eight prior ablation attempts (burden 8.5%). Endocardial activation mapping showed the area of earliest activation to be the anterolateral papillary muscle. RF energy delivery at this site did not suppress the PVCs. The cryoballoon was positioned at the failed ablation site on the anterolateral papillary muscle, and five freezes were delivered, with marked reduction in PVC frequency. A repeat event monitor was obtained after the procedure which showed a reduced PVC burden of 4.4%.

Case 6

A 46 year old male with idiopathic VF (EF 60-65%) was transferred for VT storm after failed ablation of RV moderator band PVCs. He had received >40 ICD shocks in the prior three days. PVC morphology was consistent with moderator band origin. Under intracardiac echocardiographic guidance, the cryoballoon was positioned on the RV moderator band. Five freezes were delivered which eliminated the triggering PVC. During a follow-up of 6 months, VT has not recurred.

Case 7

A 29 year old female with a history of non-ischemic cardiomyopathy (EF 20-25%) and prior catheter ablation presented with drug refractory VAs. Repeat ablation was performed with mechanical support. A voltage map showed only a small territory of mid-septal scar. Fascicular PVCs originating in this area incessantly triggered VF. RF energy delivery did not suppress the PVCs. The cryoballoon was placed against the mid septum in this area and four freezes were delivered. The patient remained free of sustained VAs at a follow up of four weeks.

Discussion

We are reporting a series of seven patients who underwent bail out cryoballoon ablation of VAs refractory

to endocardial RF ablation. Cryoballoon ablation was used in a spectrum of arrhythmia substrates: endocavitary structures in 4 patients (2 RV moderator band, 2 LV papillary muscle), left fascicular in 1 patient and deep LV myocardial in 2 patients. Cryoballoon ablation was successful in 5/7 patients. Our report expands the limited observational data published about the use of cryoballoon technology for VAs, and includes patients with LV arrhythmia substrates. Advantages of cryoballon ablation include adhesive stability on RV and LV endocavitary structures and the ability to deliver a deeper, more homogeneous myocardial lesion. Major complications did not occur. Technical challenges during cryoballoon positioning limit its application as an ablation tool for VA. Care must be taken not to entangle the Achieve mapping catheter in the subvalvular apparatus. The use of a guidewire can help to overcome this limitation. Newer balloon technologies modified to improve contact with the myocardial surface that incorporate high density mapping on the balloon surface may improve applicability of this technology during ablation of VA and will require further study.

Table 1. Clinical Characteristics and Outcomes of Cryoballoon Ablation in Seven Patients

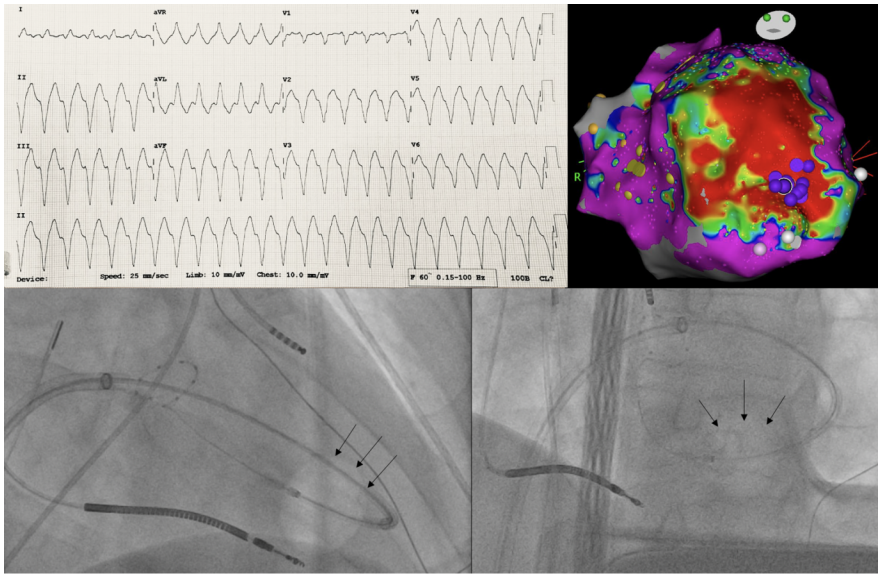
Patient Age Sex	Structural disease	Arrhythmia substrate	EF	Prior failed therapies	Number of cryoballoon freezes	Total freeze duration (s)	Minimum temperature achieved (Celsius)	Result	Su
Patient 1 60 Male	ICMP	LV apical ischemic scar	30-35%	Endocardial RF ablation x2, amiodarone, metoprolol	4	1410	-38	No VA recurrence	Ye
Patient 2 55 Male	None	RV papillary muscle, moderator band, fascicular system	50-55%	Carvedilol	5	1172	-33	PVC Recurrence	No
Patient 3 49 Male	NICMP	LV basal lateral epicardial scar	35-40%	Endocardial RF ablation x2, amiodarone, metoprolol	1	219	-27	No VA recurrence	Ye
Patient 4 57 Female	Valvular NICMP	LV papillary muscle PVCs	50-55%	Endocardial RF ablation, could not tolerate medical therapy	2	418	-32	Improved PVC burden with reduced palpitations	Ye

Patient Age Sex	Structural disease	Arrhythmia substrate	EF	Prior failed therapies	Number of cryoballoon freezes	Total freeze duration (s)	Minimum temperature achieved (Celsius)	Result	Su
Patient 5 33 Female	None	LV papillary muscle PVCs	60-65%	Endocardial RF ablation x8, flecainide, propafenone, metoprolol, amiodarone, sotalol, and propranolol	5	812	-31	PVC recurrence	No
Patient 6 46 Male	None	Idiopathic VF due to RV moderator band PVCs	60-65%	Endocardial RF ablation, amiodarone, mexiletine, quinidine	5	1570	-37	No VA recurrence	Ye
Patient 7 29 Female	NICMP	LV fascicular PVCs	20-25%	Endocardial RF ablation, amiodarone, mexiletine	4	1260	-31	PVC recurrence	Ye

ICMP, ischemic cardiomyopathy. NICMP, nonischemic cardiomyopathy. LV, left ventricle. RV, right ventricle. EF, ejection fraction. VA, ventricular arrhythmia. PVC, premature ventricular complex. RF, radiofrequency.

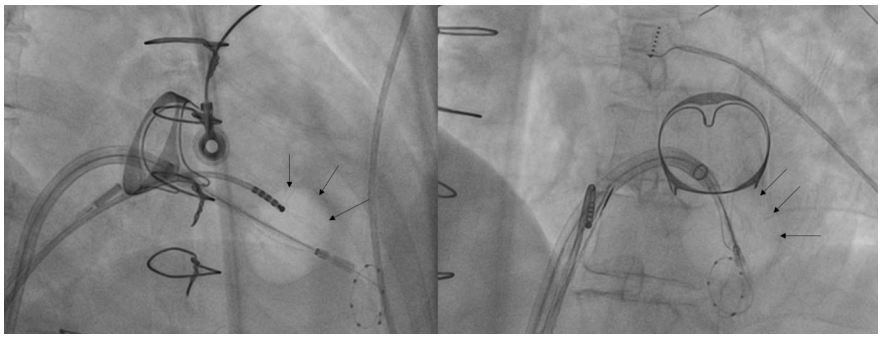
VF, ventricular fibrillation.

Figure 1



(Top left) 12-lead ECG showing VT originating from the apical LV. (Top right) Electroanatomic voltage map showing dense apical LV scar. (Bottom left and right) RAO and LAO fluoroscopic views showing the location of cryoballoon placement in the LV apex.

Figure 2



RAO and LAO views showing cryoballon placement through the bioprosthetic mitral valve.

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