Successful Cryoablation of Left Ventricular Summit Premature Ventricular Contractions via the Coronary Sinus

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Conflicts of interest:

William Reichert, MD: None

Zeshan Ahmad MD: None

Wilber Su MD: St. Jude Medical (honorarium)

Abstract:

The left ventricular summit (LVS) is a challenging location for catheter-based percutaneous ablation due to its anatomical location. There have been case reports of cryo-ablations performed in this region, but the technique may be underutilized when radiofrequency ablation fails. A 45-year-old male was found to have 25,000 PVCs a day despite previous ablation and a reduced ejection fraction of 40% despite medical therapy. Coronary sinus epicardial mapping revealed the coronary sinus distal region generated activations earlier than the QRS onset by 28ms. Two separate, four minute cryo-ablations were delivered which suppressed the PVCs within five seconds. Alternate energy modalities such as cryo may offer a safer and more viable approach for ablation of LVS in select patients.

Manuscript:

Background:

The left ventricular summit (LVS) is a challenging location for catheter-based percutaneous ablation due to its anatomical location. Radiofrequency (RF) ablation is often limited by high impedances and damage to surrounding structures while surgical approaches are often limited by epicardial fat.[1-4] There have been case reports of cryo-ablations performed in this region, but the technique may be underutilized when radiofrequency ablation fails. We present a case of successful ablation of summit premature ventricular contractions (PVC) using focal cryoablation epicardially via the coronary sinus approach.

Clinical vignette:

A 45-year-old male who previously underwent cryoablation for sustained ventricular tachycardia was referred for recurrent arrhythmias and palpitations. The prior focus was mapped to the endocardial region of the aortic root near the aorto-mitral continuity. Despite this treatment, work-up noted greater than 25,000 PVCs a day and a reduced ejection fraction of 40% despite medical therapy. On EKG, the PVCs progressed high to low through the ventricle, had significantly delayed intrinsicoid deflection, and right bundle branch block morphology (Figure 1).

During the EP study, the right ventricle and right ventricular outflow tract were mapped and the earliest site on the right was noted to be 50ms behind the earliest surface QRS activation. The initial coronary sinus catheter was also tied with the surface QRS at Mitral annulus 1-2 o’clock position. Therefore, the origin of the arrhythmia was likely left sided, and trans-septal access was obtained utilizing intracardiac ultrasound guidance to access the left ventricular outflow tract for ongoing mapping. Trans-septal access was utilized to avoid arterial access for safety.

Intracardiac echocardiography (ICE) as well as the EnSite system (St Jude, Little Canada, MN) was used to reconstruct the right and left ventricle. The earliest ventricular activation was near the mitral valve 12 O'clock position, however it was only tied with the surface QRS. Therefore, extensive mapping in the aortic root, around the aortic and mitral valves, and the coronary sinus along the anterior septal region was performed. Coronary sinus epicardial mapping revealed that the coronary sinus distal region generated activations earlier than the QRS onset by 28ms (Figure 2a).

A 5 Fr quadri-polar catheter was used to create an additional timing map epicardially via the coronary sinus to the great cardiac vein, which revealed a focus 35ms ahead of the surface PVC and was confirmed with a 12/12 pace-map (Figure 2b). ICE was used to monitor the relationship of the ablation catheter to the left coronary artery throughout the procedure. Coronary sinus venography (Figure 3a) was performed and irrigated RF ablation was performed at 20 Watts, however, it was limited by the impedance cutoff of 300 Ohms despite power and contact modulation. We did not attempt other methods to alter impedance profile during ablation, such as irrigation rate, saline concentration, or removing the impedance limits, as it could cause an unpredictable injury pattern, especially important near the left main and left anterior descending arteries. Cryoablation was decided on for its safety in close proximity to critical vasculature.

The catheter was exchanged for an 8mm focal cryoablation catheter, Freezor Max (Medtronic, Fridley, MN) (Figure 3b). Two separate, four minute ablations were delivered (with the focal tip temperature nadir reaching -82 °C) which suppressed the PVCs within five seconds. No surface ECG ST-segment changes were noted during the cryoablation cycle. The patient was then able to be discharged after observation without complication. No further PVCs and a normalized ejection fraction were noted at one-month follow-up without use of antiarrhythmics. At 3 years of follow up, the patient remained asymptomatic with no palpitations or heart failure symptoms.

Discussion:

LVS arrhythmias are difficult to ablate due to proximity to critical structures and potential for severe complications. Surgical RF ablation in this area is limited due to epicardial fat and the left atrial appendage preventing energy delivery, while catheter RF ablation is limited by high impedances and critical surrounding structures.[1,2] Potential complications of RF ablation in this region include damage to external vessels/nerves, disruption of coronary flow that may present with EKG changes or may be electrically silent, cardiac perforation, and other traditional complications of RF ablation.[1-4] Direct visualization and surgical dissection has been reported but this also carries risk associated with invasive dissection.[5] Alternate energy modalities such as cryo have been utilized in the great cardiac vein and may offer a safer and more viable approach for ablation of LVS and the coronary sinus approach may allow sufficient access to this location in certain patients.[6,7] Animal studies and case series have looked at the relative safety of cryoablation within small distances (<5 mm) from coronary arteries with only very rare cases of post-ablation stenosis.[8-14] This may be in part due to the stability of the cryo catheter on myocardial tissue during energy delivery as well physiology of tissue damage. Even though rare, when coronary damage does occur, it has most commonly been described as coronary spasm not only during cryo-ablation, but also with RF ablation.[7,15-17] Therefore, continuous monitoring of vitals and ST segments, with readiness for coronary intervention is standard while intervening around the coronary arteries, regardless of energy modality. Medical therapy, particularly for vasospasm with calcium channel blocker or nitroglycerin, should be readily accessible.[18-20] In addition, other imaging modalities such as ICE have been shown to be beneficial in identifying critical structures such as the left coronary artery during ablations.[21,22] Technique limitations include ablation catheter stiffness/size and the potential for recurrence. Larger cohort experience is needed to develop an accepted methodology.

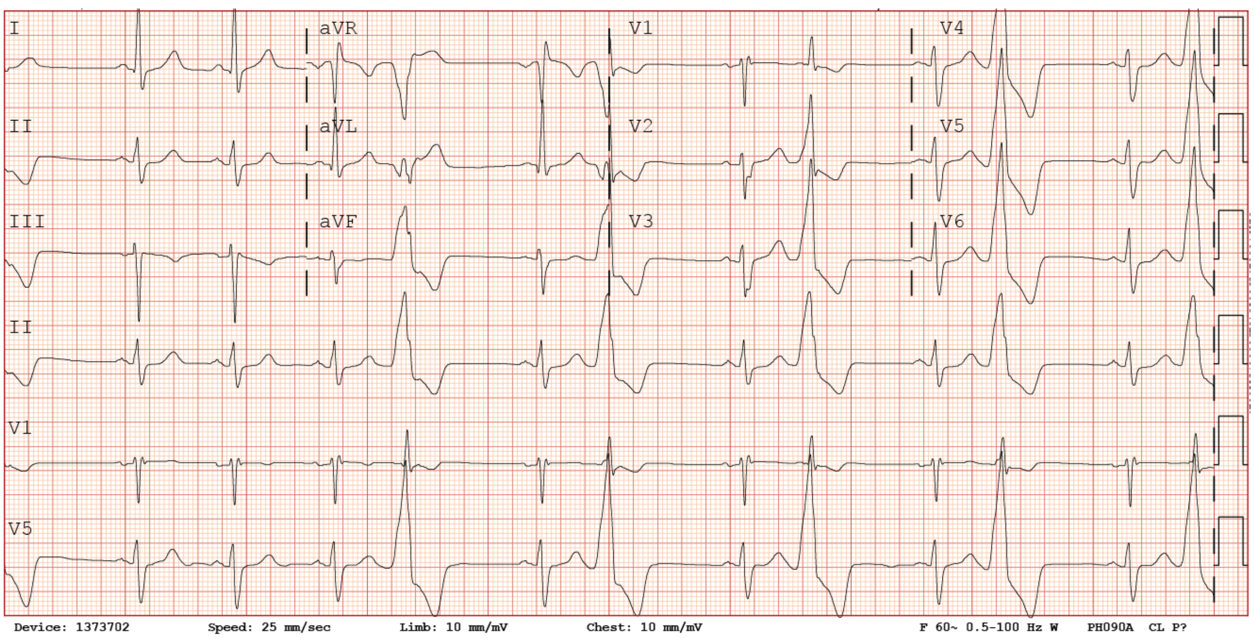

Figure 1. Pre-ablation 12 lead electrocardiogram showing PVCs progressing from high to low through the ventricle with significantly delayed intrinsicoid deflection and right bundle branch block morphology.

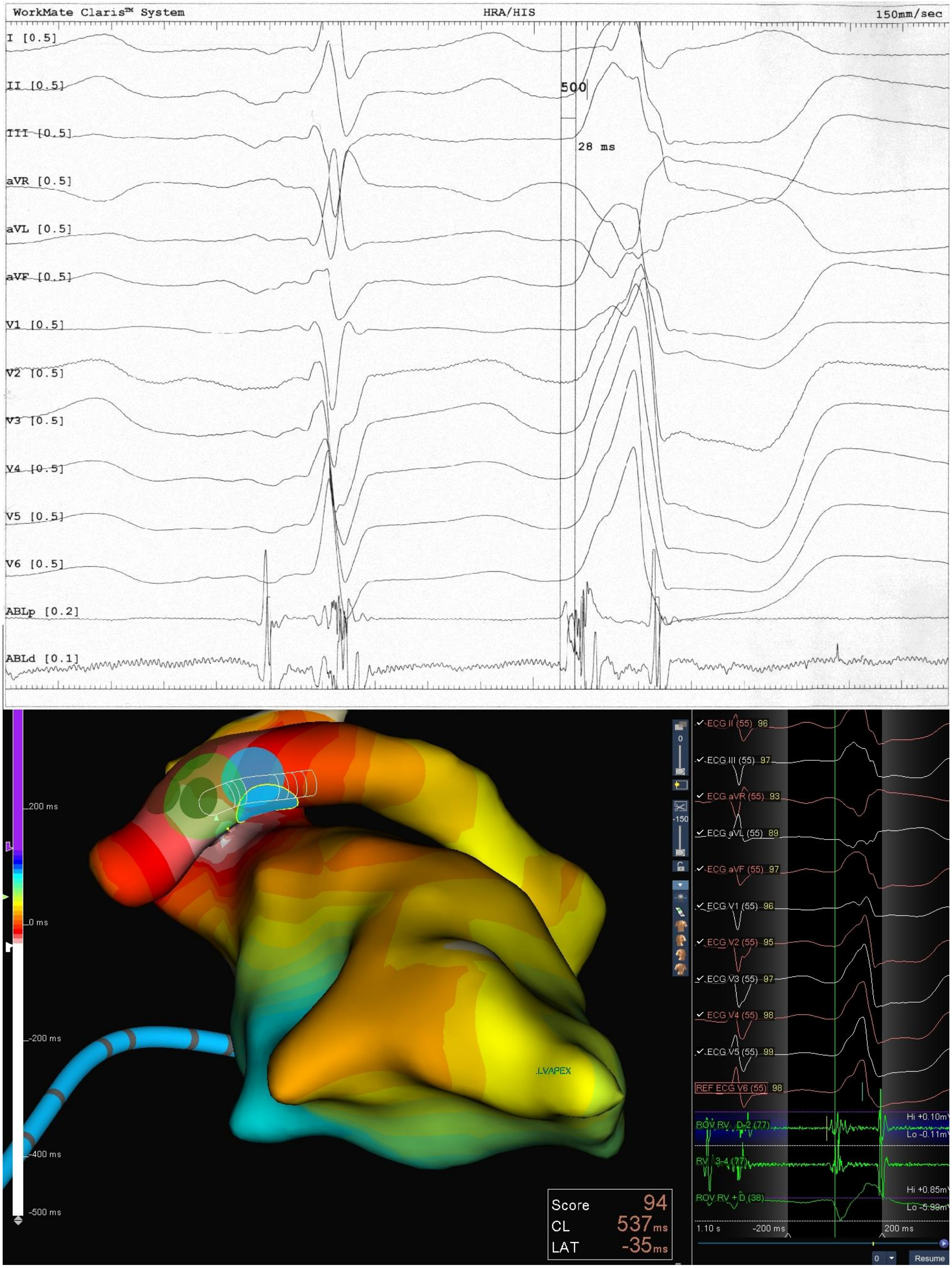
WorkMate Claris™ System
HRA/HIS
150mm/sec
I [0.5]
II [0.5]
III [0.5]
aVR [0.5]
aVL [0.5]
aVF [0.5]
V1 [0.5]
V2 [0.5]
V3 [0.5]
V4 [0.5]
V5 [0.5]
V6 [0.5]
ABLp [0.2]
ABLd [0.1]
500
28 ms
200 ms
0 ms
-200 ms
-400 ms
-500 ms
LVAPEX
Score 94
CL 537 ms
LAT -35 ms
ECG II (55) 96
ECG III (55) 97
ECG aVR (55) 93
ECG aVL (55) 89
ECG aVF (55) 97
ECG V1 (55) 96
ECG V2 (55) 95
ECG V3 (55) 97
ECG V4 (55) 98
ECG V5 (55) 99
REF ECG V6 (55) 98
ROV RV D-2 (77)
RV 3-4 (77)
ROV RV + D (38)
Hi +0.10mV
Lo -0.11mV
Hi +0.85mV
Lo -5.99mV
1.10 s
-200 ms
200 ms
Resume

Figure 2.

Figure 2a. Intracardiac recording of the mapping catheter distal 28ms ahead of the surface ECG.

Figure 2b. Ensite 3-dimensional timing map recorded epicardially via the coronary sinus to the great cardiac vein with early focus 35ms ahead of the surface PVC.

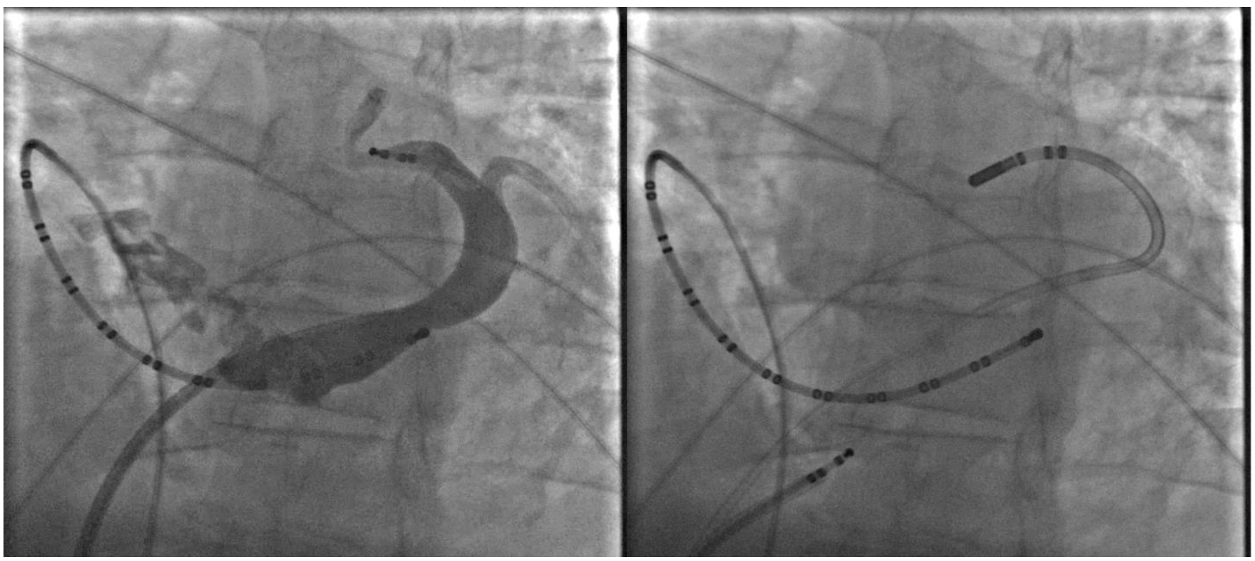

Figure 3.

Figure 3a. Coronary sinus venogram.

Figure 3b. Freezor Max cryoablation catheter located in the distal coronary sinus.

Author contributions:

William Reichert MD – Case writeup/editing

Zeshan Ahmad MD – Case writeup/editing

Wilber Su MD – Attending/operator

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