Relationship Between Outcomes of Catheter Ablation for Premature Ventricular Contractions and Cardiac Magnetic Resonance Scar

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Abstract

Frequent premature ventricular contractions (PVCs; >10,000 per 24 hrs) may result in significant symptoms and PVC-induced cardiomyopathy (PVC-iCMP) with left ventricular (LV) systolic dysfunction (LVSD). Subjects with PVC-iCMP are at risk of developing heart failure and sudden cardiac death. Catheter ablation (CA) is being increasingly used as a first-line therapy to reduce symptoms and reverse PVC-iCMP in subjects with frequent PVCs. Interestingly, previous studies have revealed myocardial fibrosis (scarring) detected by cardiac magnetic resonance (CMR) imaging in some individuals with apparently idiopathic PVCs, unrecognized on routine diagnostic work up. The aim of this study was to investigate the value of CMR to better understand the prevalence of myocardial fibrosis and predict response to CA in subjects with frequent PVCs. **Results:** Three subjects (11%) had evidence of scarring on CMR and did not demonstrate significant reduction in PVC burden post CA. Conversely, 24/27 subjects (89%) without scarring on CMR showed significant reduction in PVC burden after catheter ablation (post CA PVC burden <5%; P-value <0.05). Six subjects (25%), without scarring on CMR, also had LVSD (LVEF <45%) and demonstrated complete normalization of LVEF post CA.

Introduction

- PVCs are abnormal early contractions that begin in the ventricles and occur before the regular heartbeat (Fig. 1).
- The 12-lead electrocardiogram (ECG) is very useful in identifying and characterizing PVC morphologies (Fig. 2).

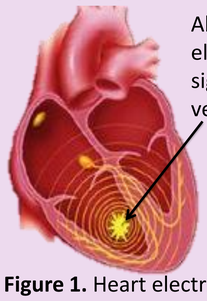

Figure 1. Heart electrical pathway with abnormal electrical signals (PVC origin).

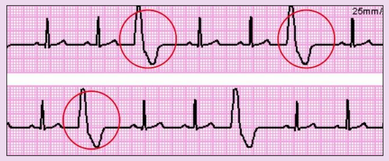

Figure 2. PVC ECG recording.

- Occasional PVCs are common and do not require treatment. They often cause no symptoms, but may result in the sensation of skipped beats in the chest.
- Individuals with high a frequency of PVCs can develop heart disease known as PVC-iCMP. A condition where individuals develop LVSD without prior structural heart disease.
- CA is the gold standard method to prevent and treat PVC-iCMP in individuals with frequent PVCs. It uses radiofrequency to scar small areas of the heart that may be involved with causing the PVCs (Fig. 3).
- Using CMR, previous studies have shown concealed structural abnormalities (myocardial fibrosis) in subjects with idiopathic PVCs, unrecognized on routine diagnostic work up (12-lead ECG, echocardiogram, exercise stress testing, or coronary angiography) (Fig. 4).

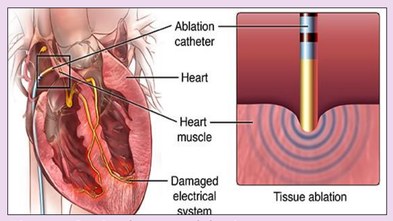

Figure 3. Catheter ablation.

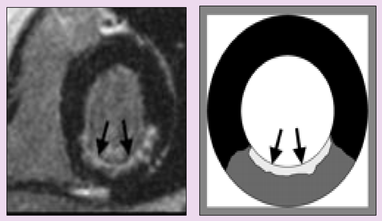

Figure 4. CMR of LV myocardial fibrosis.

- The clinical and prognostic value of detecting myocardial fibrosis by CMR in patients with frequent PVCs is unclear.

Methods and Materials

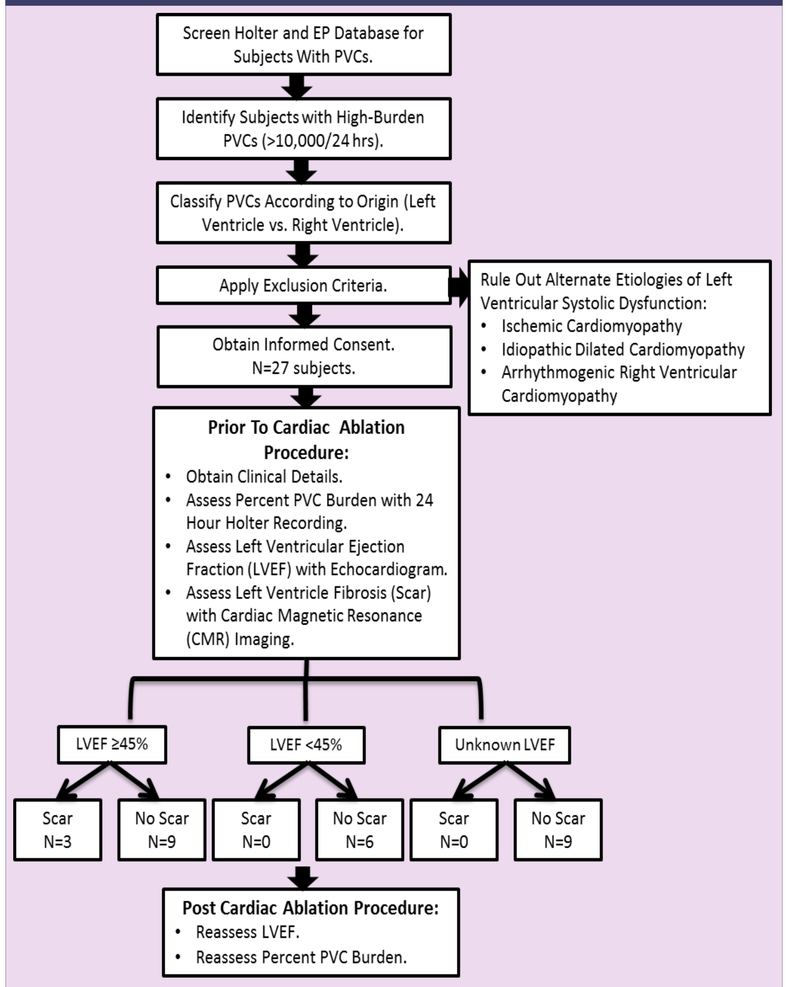

Figure 5. Study design flow chart.

Results

Table 1. Demographical characteristics of subjects with frequent PVCs (PVC; >10,000 per 24 hrs).

Demographics	All Patients (mean ± SE)	No Scar (mean ± SE)			Scar (mean ± SE)
	N=27	LV ≥45 N= 9	LV <45 N=6	Unknown LV N=9	LV ≥45 N= 3
Age (years)	53.44 ± 2.31	54.78 ± 4.39	41.83 ± 4.63	57.56 ± 2.72	60.333 ± 3.53
Number of Males	16	5	4	6	1
Left Ventricular PVCs	10 (37.0%)	4 (44.4%)	2 (33.3%)	3 (33.3%)	1 (33.3%)
Right Ventricular PVCs	17 (63.0%)	6 (66.7%)	3 (50%)	6 (66.7%)	2 (66.7%)
PVC Burden:					
Before CA	16492.04 ± 4734.917 (N=14)	18149.00 ± 9866.33 (N=4)	11045.17 ± 5629.13 (N=3)	26215.63 ± 12127.61 (N=4)	6764.833 ± 5702.33 (N=3)
After CA	3138.778 ± 1990.55 (N=18)	596.38 ± 508.99 (N=4)	379.00 ± 370.14 (N=5)	5040.167 ± 50033.79 (N=6)	7325.50 ± 7271.56 (N=3)
PVC Burden (%):					
Before CA	17.59 ± 2.93 (N=18)	17.12 ± 5.54 (N=6)	14.93 ± 4.35 (N=5)	23.07 ± 6.66 (N=5)	7.99 ± 6.94 (N=3)
After CA	3.71 ± 2.21 (N=17)	0.50 ± 0.42 N=4)	0.37 ± 0.37 (N=4)	5.60 ± 4.83 (N=6)	8.64 ± 8.60 (N=3)
LVEF:					
Before CA	45.66 ± 3.62 (N=11)	56.50 ± 3.46 (N=5)	36.67 ± 2.11 (N=6)	N/A	63.40 ± 0.40 (N=2)
After CA	51.20 ± 1.88 (N=12)	55.50 ± 3.04(N=3)	51.45 ± 2.36 (N=6)	43.00 ± 5.00 (N=2)	53.20 (N=1)

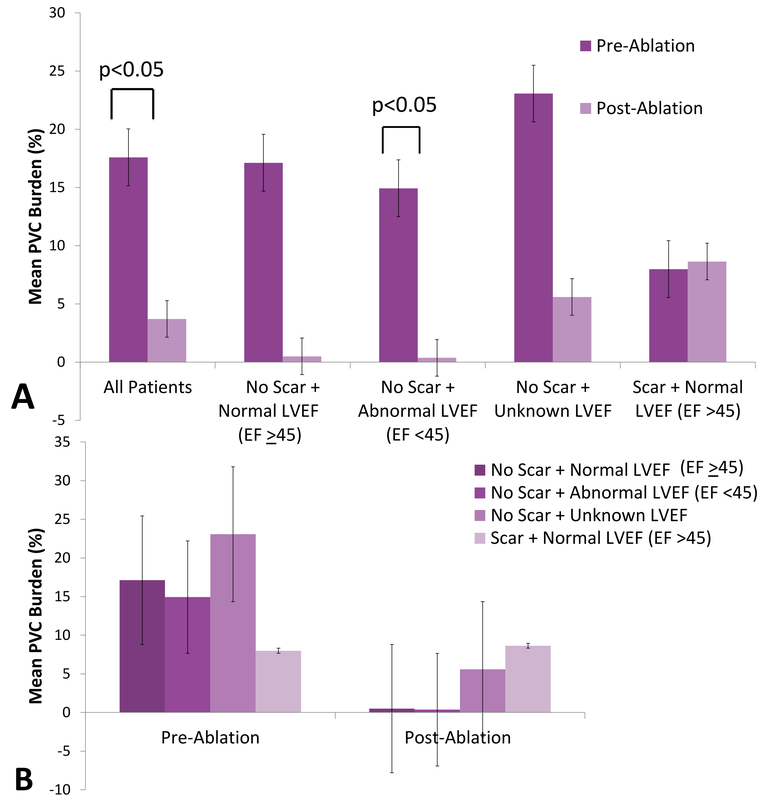

Figure 6A and 6B. Scarring on CMR and response to catheter ablation in subjects with frequent PVCs.
Data are mean ± SE (N = 27).
A. Data were analyzed using a Pair-Samples T-Test (p <0.05).
B. Data were analyzed using a S-N-K Post-Hoc Test (p <0.05).

Discussion

- We evaluated the utility of CMR in subjects with frequent PVCs to better understand the prevalence of myocardial fibrosis and predict response to CA.
- Subjects with frequent PVCs and scarring on CMR are unlikely to respond to CA.
- Subjects with PVC-iCMP (LVSD <45) and no evidence of scarring on CMR are more likely to recover completely after CA compared to patients without PVC-iCMP (LVSD ≥45).
- This study demonstrates that LV scaring may be an important predictor of success in rhythm control for subjects with high burden PVCs.

Clinical Implications

The results of this study have an important impact on clinical decision making when managing patients with problematic frequent PVCs:

- For the patient, satisfactory CA outcomes can be more precisely predicted.
- For the arrhythmia specialist, better patient counselling and selection based on expected CA outcomes.

References

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