Ablation in Idiopathic Ventricular Fibrillation

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No conflict of interest
Background

• Idiopathic VF accounts for 6.8% survivors of out of hospital cardiac arrest & more prevalent in the young

• One third patients would have a recurrence within 5 years

• It is a diagnosis of exclusion- structural, metabolic and channelopathies needs to be excluded

• IVF is initiated by ventricular ectopics and these ectopics usually originate from the purkinjee fibres

• Other sites of these PVC’s described are- outflow tract, papillary muscles, moderator band
• Result from abnormal automaticity, triggered activities or reentry
• Reentrant and multiple wavelets seems to perpetuate and maintain VF
• Complex myocardial fibre arrangement at the insertion of papillary muscles/moderator band and purkinjeee fibres can maintain VF in the absence of any structural abnormality
• The ectopic inducing the VF and substrate modification is the target for mapping and ablation of VF
• Current guidelines- Class 2b
Mapping and Ablation of Idiopathic Ventricular Fibrillation

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Background—Ventricular fibrillation is the main mechanism of sudden cardiac death. The feasibility of eliminating recurrent episodes by catheter ablation has not been reported.

Methods and Results—Twenty-seven patients without known heart disease (13 men, 14 women, 41±14 years of age) were studied after being resuscitated from recurrent (10±12) episodes of primary idiopathic ventricular fibrillation; 23 had received a defibrillator. The first initiating beat of ventricular fibrillation had an identical electrocardiographic morphology and coupling interval (297±41 ms) to preceding isolated premature beats typically noted in the aftermath of resuscitation. These triggers were localized by mapping the earliest electrical activity and ablated by local radiofrequency delivery. Outcome was assessed by Holter and defibrillator memory interrogation. Premature beats were elicited from the Purkinje conducting system in 23 patients: from the left ventricular septum in 10, from the anterior right ventricle in 9, and from both in 4. The interval from the Purkinje potential to the following myocardial activation varied from 10 to 150 ms during premature beat but was 11±5 ms during sinus rhythm, indicating location at peripheral Purkinje arborization. The premature beats originated from the right ventricular outflow tract muscle in 4 patients. The accuracy of mapping was confirmed by acute elimination of premature beats during local radiofrequency delivery. During a follow-up of 24±28 months, 24 patients (89%) had no recurrence of ventricular fibrillation without drug.

Conclusions—Primary idiopathic ventricular fibrillation is a syndrome characterized by dominant triggers from the distal Purkinje system. These sources can be eliminated by focal energy delivery. (Circulation. 2002;106:962-967.)
• 27 patients underwent ablation for VF
• Origin in the purkinjee network was seen in 23 pts and in 4 pts the trigger was in RVOT
• Runs of PMVT or VF was initiated at the shortest coupling interval (peak of preceding T wave in 16 patients and its descending slope in 11 patients
• A long short initiating sequence was not seen
• Source was localised by the earliest electrogram relative to the onset of the ectopic QRS complex.

• An initial sharp potential (<10 ms in duration) preceding by <15ms the larger and a lower ventricular electrogram during SR represented a peripheral purkinjieee component whereas longer intervals indicated proximal purkinjieee activation.

• 89% of patients were arrhythmia free during a F/U
Haisseguerre M et al, Circulation: 2002;106
Malignant Entity of Idiopathic Ventricular Fibrillation and Polymorphic Ventricular Tachycardia Initiated by Premature Extrasystoles Originating From the Right Ventricular Outflow Tract

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OBJECTIVES The aim of this study was to assess the clinical characteristics and the efficacy of radiofrequency catheter ablation (RFCA) for idiopathic ventricular fibrillation (VF) and/or polymorphic ventricular tachycardia initiated by ventricular extrasystoles originating from the right ventricular outflow tract (RVOT).

BACKGROUND Ventricular fibrillation and/or polymorphic ventricular tachycardia are occasionally initiated by ventricular extrasystoles originating from the RVOT in patients without structural heart disease.

METHODS Among 101 patients without structural heart disease in whom RFCA was conducted for idiopathic ventricular tachyarrhythmias arising from the RVOT, we examined the clinical characteristics and the efficacy of RFCA in 16 patients with spontaneous VF and/or polymorphic ventricular tachycardia initiated by the ventricular extrasystoles originating from the RVOT.

RESULTS Among 16 patients, spontaneous episodes of VF were documented in 5 patients, and 11 patients had prior episodes of syncope. Holter recordings showed frequent isolated ventricular extrasystoles with the same morphology as that of initiating ventricular extrasystoles, and non-sustained polymorphic ventricular tachycardia with short cycle length (mean of 245 ± 28 ms) in all 16 patients. Radiofrequency catheter ablation by targeting the initiating ventricular extrasystoles eliminated episodes of syncope, VF, and cardiac arrest in all patients during follow-up periods of 54 ± 39 months.

CONCLUSIONS Our data suggest that the malignant entity of idiopathic VF and/or polymorphic ventricular tachycardia was occasionally present in patients with idiopathic ventricular arrhythmias arising from the RVOT. Radiofrequency catheter ablation was effective as a treatment option for this entity. (J Am Coll Cardiol 2005;46:1288–94) © 2005 by the American College of Cardiology.
Comparison of clinical parameters between VF/PMVT and RVOT-VT

<table>
<thead>
<tr>
<th></th>
<th>VF/PVT Group (n = 16)</th>
<th>RVOT-VT Group (n = 85)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>7/16 (44%)</td>
<td>25/85 (29%)</td>
<td>0.26</td>
</tr>
<tr>
<td>Age (yrs)</td>
<td>39 ± 10</td>
<td>43 ± 14</td>
<td>0.19</td>
</tr>
<tr>
<td>FH</td>
<td>1/16</td>
<td>1/85</td>
<td>0.29</td>
</tr>
<tr>
<td>Duration from onset of symptom to RFCA (months)</td>
<td>80 ± 103</td>
<td>69 ± 79</td>
<td>0.71</td>
</tr>
<tr>
<td>History of syncope</td>
<td>11/16 (69%)</td>
<td>15/85 (18%)</td>
<td>0.0001</td>
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<td>Holter ECG findings</td>
<td></td>
<td></td>
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<tr>
<td>Isolated PVC (/day)</td>
<td>17,554 ± 11,338</td>
<td>15,506 ± 16,053</td>
<td>0.58</td>
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<tr>
<td>CI of VE (ms)</td>
<td>409 ± 62</td>
<td>428 ± 65</td>
<td>0.27</td>
</tr>
<tr>
<td>QRS duration of VE (ms)</td>
<td>148 ± 8</td>
<td>142 ± 12</td>
<td>0.03</td>
</tr>
<tr>
<td>CL of VT (ms)</td>
<td>245 ± 28</td>
<td>328 ± 65</td>
<td>&lt;0.0001</td>
</tr>
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Localized Structural Alterations Underlying a Subset of Unexplained Sudden Cardiac Death

• 24 survivors of IVF were assessed with multielectrode body surface recordings to identify the drivers maintaining VF
• Electrograms were assessed in the driver regions using endocardial and epicardial catheter mapping during sinus rhythm
• VF mapping demonstrated reentrant (87%) and focal activities in 13% patients
• During sinus rhythm areas of abnormal electrograms were identified in 15/24 patients (62.5%) revealing localized structural alterations and 76% of these collocated with the VF drivers
• In patients with no local structural abnormalities (9), 7 had high incidence of purkinjee triggers
• Catheter ablation resulted in arrhythmia-free outcome in 15/18 patients at 17±11 months follow-up

Haisseguerre M et al. Circ Arrhythm Electrophysiol. 2018;11
Mapping and ablation of the VF triggers

• 12 lead ECG and holter monitor
• Far field EGM’s from defibrillators
• Activation map
  : Fluoroscopy with multipolar catheters
  : Contact 3D mapping with multipolar catheters
  : Non-contact mapping
• Pace map
• Electrocardiographic imaging (ECGi)
• Intracardiac echo and image integration
Ablation targets and end points

• **Target**
  - Earliest electrogram site preceding PVC
  - Local purkinjee potentials in area of interest
  - Site of best match to PVC by pace mapping
  - Sites of abnormal electrogram during mapping

• Lesion to be consolidated by ablating in the surrounding 1-2 cm²

• **Endpoint**
  - Elimination of culprit PVC
  - Elimination of local purkinjee potentials
  - Elimination of localised substrate
A: Left posterior, B: left anterior, C: right Purkinje, D: ROVT

Knecht et al, JACC 2009;54: 522
Electrocardiographic imaging

- 252 electrode vest is applied to the patient torso to record surface potentials

- Following a non-contrast, low-dose thoracic computed tomography (CT) scan, the heart and vest electrodes are segmented

- The electrode positions and the three-dimensional epicardial biventricular geometry are used by the ECVUE system to reconstruct epicardial potentials and unipolar electrograms for each beat of interest

Cheniti G etal, Frontiers in Cardiovascular Medicine; 2018, September
Non-contact mapping

- Ensite catheter- Array balloon
- Able to record entire cardiac chamber activation at 0.83 ms and produce isochronal maps and virtual unipolar electrograms
- Ideal for patients with infrequent PVC or nonsustained tachy of focal origin

Betts T et al, JCE 2004;15:957
VF from RV purkinjee:
VF from papillary muscles
Herendael HV et al, Heart Rhythm 2014;11:566
Ectopics from LVOT
38 year old female

Recurrent syncope with PMVT

ECHO – LV dysfunction

MRI: No late gadalonium enhancement

Primary prevention ICD

Recovery of LV function post ectopic ablation
Cartosound merge with MRI
Long term follow up of idiopathic VF ablation

- 38 consecutive patients
- Median F/U 63 months
- 7 (18%) had recurrence at a median F/U of 4 months
- 5 of the 7 patients had repeat ablations and did not have any further recurrences and 2 treated with medications
- In patients who had recurrence of sx the median no. of therapies had significantly reduced
• The ectopics were not necessarily the same as during the initial procedure
• Absence of spontaneous ectopy at the time of the procedure did not predict the outcome
• Recurrence of VF was predicted only by the occurrence of transient bundle branch block during the mapping
• Some people had recurrence of ectopy but no further VF

*Knecht et al, JACC 2009;54: 522*
Conclusions

• Ectopic ablation and substrate modification is effective in preventing recurrent VF
• Improvement in mapping and ablation techniques could further improve outcomes
• Ablation should be considered as an adjunct to medications and ICD implantations in patients with recurrent VF
• Although the long-term results are very encouraging, ablation of triggering VPBs for VF does not replace ICD implantation.