PVC ABLATION. WHEN SHOULD IT BE RECOMMENDED?

Luis Aguinaga, MD, PhD, FACC, FESC
NO CONFLICT OF INTEREST TO DECLARE
Should we perform ablation in PVCs???
NO...!!
In some patients ???
YES...!!
CATHETER ABLATION
who should it be recommended to?
1-Symptomatic, refractory to AA drugs, or when AA drugs are not tolerated or not desired....
CASE 1

- 16 y/o. Male
- Highly symptomatic.
- Professional soccer player
- Not authorized.
<table>
<thead>
<tr>
<th>Recommendations</th>
<th>Class</th>
<th>Level</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>In patients with frequent symptomatic PVC or NSVT:</td>
<td>IIa</td>
<td>B</td>
<td>64</td>
</tr>
<tr>
<td>- Amiodarone should be considered.</td>
<td>IIa</td>
<td>B</td>
<td>64</td>
</tr>
<tr>
<td>- Catheter ablation should be considered.</td>
<td>IIa</td>
<td>B</td>
<td>341–343</td>
</tr>
<tr>
<td>Catheter ablation should be considered in patients with LV dysfunction</td>
<td>IIa</td>
<td>B</td>
<td>341–343</td>
</tr>
<tr>
<td>associated with PVCs.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Why are some patients with PVCs highly symptomatic?
Mechanical Concealed Bradycardia

HR = 60 bpm
Pulse = 30 bpm

100 mmHg
Fatigue as Presenting Symptom and a High Burden of Premature Ventricular Contractions Are Independently Associated with Increased Ventricular Wall Stress in Patients with Normal Left Ventricular Function.

HIGH PVC BURDEN + WALL STRESS
- NT-proBNP
- Circumferential end-systolic wall stress (cESS)

WALL STRESS (NT-proBNP and cESS) decreased significantly (p<0.001)

Sustained Successful ablation

Circ Arrhythm Electrophysiol. Sept 2015
2-PVC “induced” left ventricular dysfunction
“Clinical impact of catheter ablation in left ventricular cardiomyopathy associated with right ventricular outflow tract premature ventricular complex”

Radiofrequency Catheter Ablation for the Treatment of Idiopathic Premature Ventricular Contractions Originating from the Right Ventricular Outflow Tract: A Systematic Review and Meta-Analysis

**RF Ablation and PVCs**

<table>
<thead>
<tr>
<th>Study</th>
<th>Pre-Post Design</th>
<th>No. of Included Patients</th>
<th>Structural Heart Disease</th>
<th>24-Hour Holter Monitor</th>
<th>Follow-Up (Mean ± SD)</th>
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</thead>
<tbody>
<tr>
<td>Aguinaga et al.</td>
<td>Yes</td>
<td>N = 6</td>
<td>No</td>
<td>Yes</td>
<td>56 ± 15 months</td>
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<tr>
<td>Ardashev et al.</td>
<td>Yes</td>
<td>N = 30</td>
<td>No</td>
<td>No (echocardiogram)</td>
<td>2 months, 6 months, and 12 months (mean unknown)</td>
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<tr>
<td>Chovancik et al.</td>
<td>Yes</td>
<td>N = 19</td>
<td>No</td>
<td>Yes</td>
<td>14 ± 9 months</td>
</tr>
<tr>
<td>Darieux et al.</td>
<td>Yes</td>
<td>N = 24</td>
<td>No</td>
<td>Yes</td>
<td>14.5 ± months</td>
</tr>
<tr>
<td>Kim et al.</td>
<td>Yes</td>
<td>N = 24</td>
<td>No</td>
<td>No (echocardiogram)</td>
<td>10.5 ± 7.1 months</td>
</tr>
<tr>
<td>Läuck et al.</td>
<td>Yes</td>
<td>N = 11</td>
<td>No</td>
<td>Yes</td>
<td>Median = 10 months</td>
</tr>
<tr>
<td>Lauribe et al.</td>
<td>Yes</td>
<td>N = 5</td>
<td>No</td>
<td>Yes</td>
<td>25 ± 8 months</td>
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<tr>
<td>Raungratanaamporn et al.</td>
<td>Yes</td>
<td>N = 15</td>
<td>Unknown</td>
<td>Yes</td>
<td>10.9 ± 7.5 months</td>
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<tr>
<td>Taleb et al.</td>
<td>Yes</td>
<td>N = 2</td>
<td>No</td>
<td>Yes</td>
<td>6 months</td>
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<tr>
<td>Takemoto et al.</td>
<td>Yes</td>
<td>N = 13</td>
<td>No</td>
<td>Yes</td>
<td>8 ± 1</td>
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<tr>
<td>Wijnmaalen et al.</td>
<td>Yes (w/control group)</td>
<td>N = 23</td>
<td>No</td>
<td>Yes (echocardiogram)</td>
<td>Median 13 months</td>
</tr>
<tr>
<td>Yarlagadda et al.</td>
<td>Yes</td>
<td>N = 7</td>
<td>No</td>
<td>Yes</td>
<td>8 ± 10</td>
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<tr>
<td>Yokokawa et al.</td>
<td>Yes</td>
<td>N = 24</td>
<td>No</td>
<td>Yes</td>
<td>12 ± 9 months</td>
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<tr>
<td>Zhu et al.</td>
<td>Yes</td>
<td>N = 9</td>
<td>No</td>
<td>Yes</td>
<td>10 ± 4</td>
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<tr>
<td>Recommendations</td>
<td>Class</td>
<td>Level</td>
<td>Ref.</td>
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<td></td>
<td>341–343</td>
<td></td>
<td></td>
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</table>
3-PVC “worsened” left ventricular dysfunction
Neurohormonal, Structural, and Functional Recovery Pattern After Premature Ventricular Complex Ablation Is Independent of Structural Heart Disease Status in Patients With Depressed Left Ventricular Ejection Fraction
A Prospective Multicenter Study

Diego Penela, MD,* Carine Van Huls Vans Taxis, MD,† Luis Aguinaga, MD,‡

Barcelona and Tarragona, Spain; Leiden, the Netherlands; and Tucuman, Argentina

Table 1
Baseline Characteristics

<table>
<thead>
<tr>
<th></th>
<th>No SHD (n = 53)</th>
<th>SHD (n = 27)</th>
<th>All Patients (N = 80)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yrs</td>
<td>51.5 ± 11.7</td>
<td>56.6 ± 11.4</td>
<td>53 ± 11.8</td>
<td>0.065</td>
</tr>
<tr>
<td>Male</td>
<td>25 (47)</td>
<td>22 (82)</td>
<td>47 (59)</td>
<td>0.003</td>
</tr>
<tr>
<td>LVEF, %</td>
<td>34.7 ± 7.8</td>
<td>33.5 ± 8.9</td>
<td>34.3 ± 13</td>
<td>0.54</td>
</tr>
</tbody>
</table>
Should we assess the PVC burden in all the patients with left ventricular dysfunction?
4-Improvement of CRT response
Freedom from HF Hospitalization and Death in CRT Patients as a Function of BiV Pacing Percentage

Koplan BA et al. JACC 2009; 53: 355-360
Reasons for < 100% Biventricular Pacing

- Loss of left ventricle (LV) pacing due to dislodgment or lack of capture of the LV lead
- Intrinsic AV conduction “faster” than programmed sensed/paced AV interval
- Arrhythmias
  - Atrial fibrillation
    - Paroxysmal / Persistent
    - Long Standing Persistent / Permanent
  - Ventricular ectopy
Association Between Frequency of Atrial and Ventricular Ectopic Beats and Biventricular Pacing Percentage and Outcomes in Patients With Cardiac Resynchronization Therapy

Martin H. Ruwalid, MD, PhD,† Suneet Mittal, MD,‡ Anne-Christine Ruwalid, MD,† Mehmet K. Aktas, MD,* James P. Daubert, MD,§ Scott McNitt, MS,* Amin Al-ahmad, MD,¶ Christian Jons, MD, PhD,† Valentina Kutyifa, MD, PhD,* Jonathan S. Steinberg, MD,† Paul Wang, MD,¶ Arthur J. Moss, MD,* Wojciech Zareba, MD, PhD*
Radiofrequency Ablation of Premature Ventricular Ectopy Improves the Efficacy of Cardiac Resynchronization Therapy in Nonresponders

Dhanunjaya Lakkireddy, MD,* Luigi Di Biase, MD, PhD,†‡§ Kay Ryschon, MS,* Mazda Biria, MD,* Vijay Swarup, MD,‖ Yeruva Madhu Reddy, MD,* Arul Verma, MD,¶ Sudharani Bommana, MPH,‖ David Burkhardt, MD,† Raghuviree Dendi, MD,* Antonio Dello Russo, MD, PhD,# Michela Casella, MD, PhD,# Corrado Carbucicchio, MD,# Claudio Tondo, MD, PhD,# Buddhadeb Dawn, MD,* Andrea Natale, MD†‡

Kansas City, Kansas; Austin, Texas; Phoenix, Arizona; Southlake, Ontario, Canada; and Foggia and Milan, Italy
Neurohormonal, Structural, and Functional Recovery Pattern After PVC Ablation in non Responders to CRT

Luis Aguinaga, Antonio Berruezo, et al.

N = 27
CRT
HIGH BURDEN PVC
NON RESPONDER
CRT: Conclusions

• Maximal benefit in CRT is dependent on achieving near 100% Biventricular pacing.
• PVCs are common in CRT patients and puts them at risk of heart failure, ventricular arrhythmias and could be the cause of non-response to CRT.
• Patients with high burden of PVCs may be candidates for catheter ablation
Should we assess the PVC burden in all the patients with CRT?
5-PVC that triggers VF.....
PVC THAT TRIGGERS VF

- Structural Heart Disease
  - Haissaguerre, Circulation 2002

- Myocardial Infarction
  - Baensch, Circulation 2003

- Brugada Syndrome - Long QT
  - Haissaguerre, Circulation 2003

- RVOT
  - Noda, J Am Coll Cardiol 2005

- Idiopathic VF
  - Marchlynski, Heart Rhythm Journal 2014
Location of Idiopathic VF Triggers

PENN Experience

Anatomic Targets
More RV

24 triggers in 21 patients

LVOT = Left ventricular outflow tract (1)
LV PM = Papillary muscle (3)
LV Purkinje (4)
Epi-MV = Mitral valve (1)
RVOT = Right ventricular outflow tract (4)
RV MB/PM = Moderator band (6)/Pap Muscle (3)
Epi RV (1)
TV = Tricuspid valve (1)

50% of VF triggers from the PM and MB

The association between fascicular PVCs and idiopathic VF is now well known.
Spontaneous PVC from Pap Triggering VF

Single Extrastimulus from Pap Triggering VF
Imaging LV Papillary Muscle Trigger for Idiopathic VTVF

ECG
LV POST
PAP

Activation – late pukinje

ICE Imaging to localize

EAM Imaging

6- In patients meeting criteria for Primary Prevention ICD implant

+ High PVC burden
Ablation of frequent PVC in patients meeting criteria for primary prevention ICD implant. Safety of withholding the implant

Diego Penela, Juan Acosta, Luis Aguinaga, et al.

N=62 patients
PP indication ICD implant
High burden PVC

Sustained Successful Ablation
Fup 6-12 months

63% removed the indication for PP-ICD implantation (EF, FC)

Heart Rhythm Journal. September 2015
Should we assess the PVC burden in all the patients with primary prevention ICD implant indication?
The first Latin American Catheter Ablation Registry

Roberto Keegan¹⁰, Luis Aguinaga², Guilherme Fenelon³, William Uribe⁴, Gerardo Rodriguez Diez⁵, Mauricio Scanavacca⁶, Manuel Patete⁷, Ricardo Zegarra Carhuaz⁸, Carlos Labadet⁹, Claudio De Zuloaga¹⁰, Domingo Pozzer¹¹, and Fernando Scazzuso¹² on behalf of the SOLAECE registry investigators†
FIRST LATIN AMERICAN CATHETER ABLATION REGISTRY
<table>
<thead>
<tr>
<th></th>
<th>PVC</th>
<th>%</th>
<th>IVT</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>589</td>
<td></td>
<td>264</td>
<td></td>
</tr>
<tr>
<td>Procedures</td>
<td>628</td>
<td></td>
<td>280</td>
<td></td>
</tr>
<tr>
<td>Right V/Left V</td>
<td>440/138</td>
<td>76/24</td>
<td>163/105</td>
<td>60/40</td>
</tr>
</tbody>
</table>

SUCCESS of VENTRICULAR ARRHYTHMIAS


COMPLICATIONS: 3%
CONCLUSIONS
• Generally the PVCs should not be treated with ablation.

• .......

PVC ABLATION
• Some groups of patients have high potential benefit with catheter ablation.....
  – PVC symptomatic, drug refractory.
  – PVC induced left ventricular dysfunction.
  – PVC worsened left ventricular dysfunction.
  – Improvement of response to CRT.
  – PVC that triggers VF
  – In patients meeting criteria for Primary Prevention indication ICD implantation and frequent PVCs
Thank you!!
<table>
<thead>
<tr>
<th>Idiopathic VT/PVC Origin</th>
<th>Idiopathic VF Triggers - 24</th>
</tr>
</thead>
<tbody>
<tr>
<td>• RVOT - 296</td>
<td>• RVOT - 4</td>
</tr>
<tr>
<td>• LVOT - 231</td>
<td>• LVOT - 1</td>
</tr>
<tr>
<td>• LV Purkinje - 62</td>
<td>• LV Purkinje - 4</td>
</tr>
<tr>
<td>• RV Pap Muscle/Mod Band -3</td>
<td>• RV Pap Muscle/Mod Band - 9</td>
</tr>
<tr>
<td>• LV Pap Muscle - 51</td>
<td>• LV Pap Muscle - 3</td>
</tr>
<tr>
<td>• Mitral Annulus - 49</td>
<td>• Mitral Annulus - 1</td>
</tr>
<tr>
<td>• Tricuspid Annulus - 28</td>
<td>• Tricuspid Annulus – 1</td>
</tr>
</tbody>
</table>

MB/Pap Muscle 7.5%  
50%
LV Papillary Muscle Trigger for Idiopathic VTVF

PVC morphology
- RBBB – precordial transition V3-5
- qR in V1
- QRS >140ms

Van Herendael H et al  Heart Rhythm  2014:11:566-73
Papillary Muscle /Moderator Band VF Triggers

**Anatomy**

*RBB and LBB- Purkinje system (traverses the moderator band on R) ends distally in RV Pap and LV Ant and Post Pap*

**Perfect storm:**
- Branching anatomy/Purkinje rich
- Rich neural innervation

↓

- Triggered activity - (EADs)
- Inhomogeneity in refractoriness

*Modified from: The Heart and Coronary Arteries. McAlpine. 1972*
Why Papillary Muscle/Fascicular PVC?

- Mechanical irritation from MVP
  - Traction related
  - Endocardial friction lesions
- Likely focal in origin
- Papillary muscle PVC may originate from:
  - Myocardium
  - Adjacent conduction system

The association between fascicular PVCs and idiopathic VF is now well known.

Madhavan M, and Asirvatham S J
Circ Arrhythm Electrophysiol 2010;3:302-304
<table>
<thead>
<tr>
<th></th>
<th>XI SPANISH REGISTRY</th>
<th>I SOLAECE REGISTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDIOPATHIC VT</td>
<td>N=349</td>
<td>N=280</td>
</tr>
<tr>
<td>EFFICACY</td>
<td>79%</td>
<td>86%</td>
</tr>
<tr>
<td>COMPLICATIONS</td>
<td>3.4</td>
<td>3%</td>
</tr>
</tbody>
</table>

Spanish registries
• N= 27 pacientes con TRC
• TRC <97%
• Carga de EV > 5%
• No respondedores
• Refractarios a FAA
• Ablación de EV

• Futuros estudios confirmarán estos datos y posiblemente ayuden a modificar las Guías.
• Alta carga de EV es una potencial causa de no respuesta a TRC
• Ablaciòn de EV en pacientes No-R a TRC mejora FEY, CF y biomarcadores.
• Una carga mayor al 11% está asociada con una mejor respuesta a TRC, FEY, CF y PNA.
• Los beneficios de ablacion de EV están directamente relacionados a un incremento del % de estimulaciòn biventricular
Variability in Triggering Event

- **Isolated VF trigger**
- **PVC VF trigger during bigeminy**
- **Short coupling Interval= No VF**
- **Shorter coupling Interval= VF**
7-Qué nos dicen las Guías?
Table 2  Indications for catheter ablation of ventricular tachycardia

Patients with structural heart disease (including prior MI, dilated cardiomyopathy, ARVC/D)

Catheter ablation of VT is recommended
1. for symptomatic sustained monomorphic VT (SMVT), including VT terminated by an ICD, that recurs despite antiarrhythmic drug therapy or when antiarrhythmic drugs are not tolerated or not desired;*
2. for control of incessant SMVT or VT storm that is not due to a transient reversible cause;
3. for patients with frequent PVCs, NSVTs, or VT that is presumed to cause ventricular dysfunction;
4. for bundle branch reentrant or interfascicular VTs;
5. for recurrent sustained polymorphic VT and VF that is refractory to antiarrhythmic therapy when there is a suspected trigger that can be targeted for ablation.

Catheter ablation should be considered
1. in patients who have one or more episodes of SMVT despite therapy with one of more Class I or III antiarrhythmic drugs;*
2. in patients with recurrent SMVT due to prior MI who have LV ejection fraction >0.30 and expectation for 1 year of survival, and is an acceptable alternative to amiodarone therapy;*
3. in patients with haemodynamically tolerated SMVT due to prior MI who have reasonably preserved LV ejection fraction (>0.35) even if they have not failed antiarrhythmic drug therapy.*
Patients without structural heart disease

Catheter ablation of VT is recommended for patients with idiopathic VT
1. for monomorphic VT that is causing severe symptoms.
2. for monomorphic VT when antiarrhythmic drugs are not effective, not tolerated, or not desired.
3. for recurrent sustained polymorphic VT and VF (electrical storm) that is refractory to antiarrhythmic therapy when there is a suspected trigger that can be targeted for ablation.

VT catheter ablation is contra-indicated
1. in the presence of a mobile ventricular thrombus (epicardial ablation may be considered);
2. for asymptomatic PVCs and/or NSVT that are not suspected of causing or contributing to ventricular dysfunction;
3. for VT due to transient, reversible causes, such as acute ischaemia, hyperkalaemia, or drug-induced torsade de pointes.
Catheter ablation of ventricular fibrillation: Importance of left ventricular outflow tract and papillary muscle triggers

• CONCLUSION  Catheter ablation of VPD-triggered VF/PMVT

• Left ventricular outflow tract and papillary muscles are common and are previously unrecognized sites of origin of these triggers in patients with and without structural heart disease.

Marchlinsky F. Heart Rhythm Journal 2014
• EV EMPEORA DISF VENT
• EV CAUSA DISF VENTR
• SOLAECE REGISTRO
• DEBEN ABLACION : NO
• ALGUNAS: SI
• EN QUE CASOS.....
• GUIAS...
• TABLA CARDIOP DEL ARTICULO JACC
CHALLENGES OF ABLATING OUTFLOW TRACT PVCs/VT

5-Còmo las ablacionamos??
4-Qué es importante conocer para indicar ablación a un paciente con EV.....?
ABLACION DE EV

A-CLÌNICO
Disfunción ventricular inducida por arritmia
ABLACION DE EV

B-ECG
Adapted from Hutchinson M, García F. J Cardiovasc Electrophysiol 2013
Pacientes con Cardiopatía

• 27 pacientes (34%) tenían cardiopatía estructural.
• 17 enf. Coronaria
• 4 miocardio no compactado
• 2 valvular
• 1 hipertensiva
• 1 periparto
• 2 displasia
Paciente index

- Mujer
- 64 años
- MCDI
- FEY 27%
- IC CFIII
- BCRI
- 2009 TRC-CDI
- No respondedora
- EV Holter: 22,321........FAA (-) ARF
Odds Ratio for Achieving Low BiV Pacing<97%

Percentage Ectopy of all Beats During Pre-implantation 24h-Holter

Using [+0.01 percent ectopy as the reference group]

95% CI: [0.22-5.20] [0.40-10.06] [0.85-17.36] [1.40-34.57] [1.86-37.54] [3.85-83.22] [8.08-186.66]

Ruwald M. J Am Coll of Cardiol 2014
FIGURE 4  Echocardiography-Measured Changes at 1-Year Follow-Up by Ectopic Burden During Pre-Implantation 24-h Holter Monitoring in Cardiac Resynchronization Therapy Patients