Ventricular tachycardia and ischemia

Martin Jan Schalij
Department of Cardiology
Leiden University Medical Center
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- Medtronic
- Biotronik
Sudden Cardiac Death: Impact!

- Sudden cardiac death (SCD) due to coronary artery disease (CAD) is the single most important cause of death in the adult population of the industrialized world.
- VT/VF is frequently the presenting symptom of an acute ischemic event.
- VT/VF may be due to ischemia also in post-MI (scar) patients.
- How to prevent SCD in ischemia patients?
VT/VF in specific populations

Absolute numbers of events or event rates of SCD in the general population and in specific subpopulations in one year.

Mechanism of sudden death

80% ischemic heart disease

Huikuri et al. NEJM 2001
Underlying Causes of Fatal Arrhythmias (LOHCAT trial)

Underlying Etiology:

- N: 417
  - Ischemic Heart Disease: 300 (72%)
  - Dilated Cardiomyopathy: 48 (12%)
  - ARVD: 14 (3%)
  - HCM: 16 (4%)
  - Congenital Heart Disease: 14 (3%)
  - Idiopathic: 20 (5%)
  - Other: 5 (1%)

LV ejection fraction

- IHD: 41 ± 19%
- Excluding AMI pts: 45 ± 22%

Borger vd Burg, Circulation 2003, Heart Rhythm, 2004
Survivors of out-of-hospital sudden cardiac death may have any of a number of etiologies as the cause.

Careful in-hospital evaluation is necessary for providing adequate therapy for such patients. Given the high incidence of recurrence, effective therapy, based on individualized evaluation, must be found.
Patients with VT/VF: first steps

- Treat acute symptoms and stabilize patient
- Reversible cause?
  - Acute MI
  - Ischemia in the setting of coronary artery disease
- Treatment of ischemic heart disease?
- Treatment of valvular disease?
- Role of catheter ablation and ICD?
ICD implantation with and without myocardial revascularisation

- Natale et al. JCE 1994: CABG protects against sudden death in patients with a critical stenosis
- AVID registry AHJ 2002: patients who underwent revascularization had a better survival rate.
- Brockes et al Thor Card Surg 2003: patients after CABG with VT/VF and an ICD have the same rate of device therapy as patients without CABG
Impact of viability, ischemia, scar tissue and revascularization on outcome of aborted sudden cardiac death.

Circulation, 2003
Leiden Evaluation of SCD protocol

Ischemia detection plays a central role:

- Coronary angiography
- Stress-rest perfusion SPECT scintigraphy
  - Symptom limited stress protocol
  - Discontinuation of betablocking/calc. Ant agents
    - Technetium-99m tetrofosmin

Furthermore:

Electrophysiological Testing
Screening Protocol

Life-threatening Ventricular Arrhythmias

Coronary Angiography

CAD +

Nuclear Imaging

Ischemia +

Revascularization

- EP study VA inducible
- EP study VA noninducible

- ICD and/or VT ablation and/or AAD

Ischemia -

- EP study VA inducible

- EP study VA noninducible

- ICD and/or VT ablation and/or AAD

- ICD

Ischemia -

Nuclear Imaging

- EP study VA inducible

- EP study VA noninducible

- ICD and/or VT ablation and/or AAD

- ICD
Study Population

N=142, 117 (82%) male, age 63±10 years
all CAD, 92% previous MI
VF 60%, VT 40%

LVEF 39±18%

Ischemia present in 44 (31%) patients, Group 1
Scar only in 98 (69%) patients, Group 2

All Group 1 patients were revascularized completely

AJC 2003
Recurrence Free Survival

A

Free of Recurrences

Follow-up (months)

P<0.001

Ischemia / revascularised
No ischemia

B

Free of Recurrences

Follow-up (months)

P<0.001

Ischemia / revascularised
No ischemia

Non-inducible
Inducible
Non-inducible
Inducible

Borger vd Burg Circ 2003
All Cause Mortality

A

Cumulative Survival

Follow-up (months)

Ischemia / revascularised

No ischemia

P=0.29

B

Cumulative Survival

Follow-up (months)

Ischemia / revascularised

No ischemia

P=0.18

{Non-inducible

Inducible

P=0.29

P=0.18
Ischemic LV Dysfunction

- Goal:
  - identify patients with viable tissue
  - with potential to recover function
  - to justify enhanced surgical risk
Incidence of Viability
FDG Imaging

N=110 pts
LVEF <35%

54% Viable
46% Nonviable

Schinkel et al. Heart 2002
Ischemic LV Dysfunction

$\Delta$LVEF post-revascularization

- N=355 pts with LVEF <35%
Improvement of LVEF

What’s in the literature?
Weighted means from 28 studies (n=758 pts)

Viable +

Viable -
Screening

• In case of reversible ischemia: outcome is excellent in absence of scar
  – No ICD implantation is necessary
  – LV function improvement?

• In case of reversible ischemia: in the presence of scar: consider ICD (according to guidelines)

• In case of absence of ischemia: ICD in all (combined with ablation procedure)
Post MI patients

- PCI is standard treatment of patients with MI
- In general excellent outcome after successful PCI in the acute phase
- VT occurrence in these patients?
  - More patchy infarcted area
  - Surviving layers
  - CL of VT?
Non-Wavefront Phenomenon in the collateral-deficient heart

Infarct distribution with increasing ischemic time

Viable subendocardial myocardium:
6h of ischemia

# Reperfused vs. Non-reperfused patients: Spontaneous VT

<table>
<thead>
<tr>
<th>Baseline characteristics</th>
<th>All n=36</th>
<th>Reperfused n=14</th>
<th>Non-Reperfused n=22</th>
<th>p=</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>32(89)</td>
<td>13(93)</td>
<td>19(86)</td>
<td>1.0</td>
</tr>
<tr>
<td>Age (year)</td>
<td>63±15</td>
<td>60±11</td>
<td>65±16</td>
<td>0.3</td>
</tr>
<tr>
<td>Time after AMI (year)</td>
<td>13±9</td>
<td>8±5</td>
<td>16±10</td>
<td>0.01</td>
</tr>
<tr>
<td>Anterior AMI</td>
<td>22(60)</td>
<td>10(71)</td>
<td>11(50)</td>
<td>0.3</td>
</tr>
<tr>
<td>LVEF (%)</td>
<td>30±13</td>
<td>33±16</td>
<td>28±11</td>
<td>0.5</td>
</tr>
<tr>
<td>Echo anterior aneurysm</td>
<td>18(40)</td>
<td>7(50)</td>
<td>11(50)</td>
<td>1.0</td>
</tr>
</tbody>
</table>

## AAD at referral

<table>
<thead>
<tr>
<th>AAD at referral</th>
<th>All n=36</th>
<th>Reperfused n=14</th>
<th>Non-Reperfused n=22</th>
<th>p=</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amiodarone</td>
<td>14(38)</td>
<td>4(29)</td>
<td>10(45)</td>
<td>0.5</td>
</tr>
<tr>
<td>Sotalol</td>
<td>6(17)</td>
<td>4(29)</td>
<td>2(9)</td>
<td>0.13</td>
</tr>
<tr>
<td>Class I</td>
<td>2(6)</td>
<td>2(14)</td>
<td>0</td>
<td>0.2</td>
</tr>
<tr>
<td>B-Blocker</td>
<td>24(67)</td>
<td>10(71)</td>
<td>14(64)</td>
<td>0.7</td>
</tr>
</tbody>
</table>

## Spontaneous VT

<table>
<thead>
<tr>
<th>Spontaneous VT</th>
<th>All n=36</th>
<th>Reperfused n=14</th>
<th>Non-Reperfused n=22</th>
<th>p=</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number distinct VT</td>
<td>1.6±1.7</td>
<td>1.4±1.3</td>
<td>1.7±1.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Mean CL (ms)</td>
<td>356±84</td>
<td>301±54</td>
<td>383±82</td>
<td>0.001</td>
</tr>
<tr>
<td>Mean CL pts with amiodarone (ms)</td>
<td>385±91</td>
<td>320±51</td>
<td>418±90</td>
<td>0.006</td>
</tr>
<tr>
<td>Mean CL pts without amiodarone (ms)</td>
<td>323±61</td>
<td>281±52</td>
<td>343±55</td>
<td>0.01</td>
</tr>
</tbody>
</table>
## Non-reperfused patients vs thrombolysis vs PCI
### VTCL and EA mapping

<table>
<thead>
<tr>
<th></th>
<th>Non Reperfused n=22</th>
<th>Thrombolysis n=5</th>
<th>PCI n=8</th>
<th>p=</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spontaneous VT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean VT CL (ms)</td>
<td>383±82</td>
<td>317±59</td>
<td>269±22</td>
<td>0.002</td>
</tr>
<tr>
<td><strong>EPS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean induced VT CL (ms)</td>
<td>391±98</td>
<td>342±88</td>
<td>237±23</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>EA mapping</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Points voltagemap</td>
<td>211±56</td>
<td>202±40</td>
<td>232±48</td>
<td>0.5</td>
</tr>
<tr>
<td>Surface area map (cm²)</td>
<td>242±55</td>
<td>254±70</td>
<td>232±32</td>
<td>0.9</td>
</tr>
<tr>
<td>Surface area scar (cm²)</td>
<td>85±46</td>
<td>71±65</td>
<td>50±33</td>
<td>0.2</td>
</tr>
<tr>
<td>Surface area dense scar (cm²)</td>
<td>42±21</td>
<td>33±35</td>
<td>10±12</td>
<td>0.02</td>
</tr>
<tr>
<td>Borderzone % of scar</td>
<td>54±21</td>
<td>64±19</td>
<td>85±12</td>
<td>0.006</td>
</tr>
<tr>
<td>Patchy pattern of scar</td>
<td>3(14)</td>
<td>2(40)</td>
<td>7(88)</td>
<td>0.001</td>
</tr>
</tbody>
</table>
Chronic occluded RDA

Small rim viable myocardium

Homogeneous scar

Slow VT

RDA occlusion

After pPCI

Midwall viable myocardium

Patchy pattern

Large borderzone

From advanced reperfusion strategies to challenging VTs?
Conclusions

• In patients after MI (especially in the PCI treated patients) surviving cell layers may be present: ischemia may trigger VT/VF
• VT CL shorter then in patients without PCI
• Catheter ablation+ ICD implant
• PCI in selected patients
• Surgery/Dor’s procedure
Patient vdb

- 42 yr, male
- myocardial infarction 7-14 days before admission
- admission: sustained MVT recognized as SVT
- initially hemodynamically stable
- treatment: procainamide
Patient vdb

- Recurrent VT/VF
- Deterioration of hemodynamical situation
- Angiography:
  - three vessel disease
  - femoral artery obstruction
  - LV ejection fraction < 30%
Patient vdb

- Maximal inotropic support
- Amiodarone 1200 mg daily
- Bloodpressure < 100 mmHg
- Recurrent VT/VF

**Treatment:**
- IABP
- temporary pacing lead

**Screening HTX:**
- not accepted because of femoral artery disease
Patient vdb

– First step: RF ablation procedure:
  • after ablation no VT’s for 48 hours
  • improved hemodynamic situation
  • stabilized rhythm

>48 hours: recurrent VF
Treatment:
  PTCA/ Stent procedure of all arteries
  continuation of amiodarone
Patient vdb

- No VT/VF anymore
- stabilized hemodynamics
- rehabilitation program
- ICD implant
- discharge from hospital
- Follow-up (2 mos): stable, no arrhythmias
- Cholesterol 8.5!
Patient vdb

– 2 years after procedure: progressive heart failure:
  • Implantation of a CRT-D

– 6 years after procedure: despite OMT and CRT-D: progressive heart failure ➔ HTX

– During follow-up: no ventricular tachycardia anymore.
Patient

- Male 61 year
- No cardiac history
- Admitted aborted sudden cardiac death
- Signs of Ischemia:
  - Coronary angiography
Ambulance tracings
ECG after PCI procedure
Follow-up

- 3 days after initial event:
  Cardiac arrest
Cardiac arrest 3 days after event
4 Days after event
4 Days after event
Ergonovine testing
Ergonovine testing
Patient

• Despite treatment with calcium antagonists: still severe spasm inducible

• Treatment: ICD implantation!
Life-threatening Ventricular Arrhythmias

Coronary Angiography

CAD +

Nuclear Imaging

Ischemia +
Revascularization

EP study VA inducible

ICD and/or VT ablation and/or AAD

Ischemia -

EP study VA inducible

ICD and/or VT ablation and/or AAD

EP study VA noninducible

ICD

Ischemia -

Nuclear Imaging
Conclusions

- 70-80% of patients with VT have ischemic heart disease
- VT may be the only symptom of ischemia

- Always screen patient according to structured protocol

- VT in the setting of myocardial ischemia: if possible treat cause of ischemia aggressively: If ischemia can be prevented no ICD is indicated (unless LVEF is low). Consider ablation in monomorphic VT.

- If ischemia cannot be prevented: consider implantation of an ICD (regardless of the LVEF).