Purkinje related Arrhythmias

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Purkinje related arrhythmias

• Recent observation shows many kinds of VTs might be related to Purkinje fiber.

Is it true?

To confirm the participation of Purkinje fiber in VT, you must need to compare EPS findings with the pathological findings.

➢ Verapamil-sensiteive VT (Fascicular VT)

Even Verapamil-sensiteive VT is so hard to compare the pathological findings because it is benign disease.
Purkinje related arrhythmias

Today, I will try to clarify direct relationship between the EPS findings and autopsy findings on VT.

- VT with organic heart disease which **may be** related to Purkinje fiber.

Because Purkinje fiber is a special cell which is known to be more **tough** than working ventricular myocardium, you can easily imagine remaining Purkinje fiber in damaged tissue and its arrhythmogeneity.
Macroscopic Findings in OMI

A case with IHD & pleomorphic VTs. It has many false tendons and atrophic papillary muscle around ablation site for one of 3 VTs which is surrounded by dash line.

Macroroscopic Findings in DHCM

Fore site of inner view

Ventricular Aneurysm around Septum~Anterior wall~Apex has many false tendons.
Variation of the cardiac musculature

SA nodal cell

Atrial myocardium

Marshall bundle

Ventricular myocardium and Purkinje cell (↓)
Purkinji fibers are located in near endocardium, bigger and light eosin-staining which means glycogen-rich cell. They are easy to be fed directly from chamber, and tough from ischemic condition.
Representative IHD and DCM cases.

IHD

- **OMI-VT**  Two autopsy cases using CARTO
- **AMI-VT**  Polymorphic VT case using CARTO

DCM

- Bundle Branch Reentry case using CARTO & CT
- **Focal VT in Autopsy case using CARTO**
Purkinje related VT in remote phase of myocardial infarction
<table>
<thead>
<tr>
<th>Age</th>
<th>Event Description</th>
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| 60 yrs | VT with syncope,  
            Asymptomatic posterior-inferior MI,  
            PCI for total occlusion of RCA and circumflex,  
            EF 19%, ICD implantation |
| 63 yrs | Electrical storm  
            VT ablation using CARTO  
            VT abolished even quitting medication of VT |
| 66 yrs | He died of coronary perforation at PCI  
            24 months later after ablation |
Sinus rhythm

HR: 61 /min

VT 1
127/ min

VT 2
138/min

VT 3
160/min
VT1

Good pace map score to VT1 was obtained at white circle site.
VT1

Pre-sistolic sharp potentials during VT1 around white cycle
In sinus rhythm, the pre-systolic potentials still exist in just before ventricular potentials. These findings suggest they are Purkinje potentials.
During VT, we can chase the diastolic potentials on the VT circuit.
Concealed entrainment

PPI 415 ms $\approx$ VTCL 411 ms
VT 1 was terminated by ablation.
Comparison between CARTO mapping and the autopsy heart

VT propagated from infero-posterior, toward anterior wall via lateral wall.

Activation mapping & pacemap showed exit site located in posterior-basal site

S-QRS / VTCL = 0.23
VT2
Exit site located in posterior-basal potion.
Ablation site for VT is shown in surrounding area by yellow dash line and the area surrounding yellow solid line is hewed out and shows figure A, B and C. Black arrows show Purkinje fibers.
As shown by black arrows, Purkinje fibers were degenerated and swollen. Yellow arrows show ablated Purkinje fibers.
Summary

• Purkinje fiber participates in a reentry of VT in chronic phase of myocardial infarction.

• In the ischemic condition, Purkinje fiber configuration was changed, but could be distinguished from ventricular myocardium pathologically.
## Old MI case

82 yrs old Male

<table>
<thead>
<tr>
<th>Age</th>
<th>Event Description</th>
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<tbody>
<tr>
<td>68 yrs</td>
<td>Anteroseptal MI, VT at remote phase, Sotalol effective</td>
</tr>
<tr>
<td>80 yrs</td>
<td>Recurrence of VT, ICD implantation</td>
</tr>
<tr>
<td>81 yrs</td>
<td>Electrical storm</td>
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<tr>
<td></td>
<td>VT ablation using CARTO</td>
</tr>
<tr>
<td></td>
<td>VT abolished even quitting medication of VT</td>
</tr>
<tr>
<td>82 yrs</td>
<td>He died of pneumonia and renal failure</td>
</tr>
<tr>
<td></td>
<td>4 month later after ablation</td>
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</tbody>
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【VT】
VT1 (HR 113/m)  VS2 (HR 160/m)

I  II  III  aVR  aVL  aVF  V1  V2  V3  V4  V5  V6

【Voltage mapping】
< RAO >

Base  Septal  Lateral  Apex
Delayed potential in CARTO & pacemapping to VT1 at the site
Remaining myocardium, Purkinje fiber is suggested from position.

Red = collagen fiber
Yellow = myocardium

Ablation site

Healthy myocardium

fibrosis

Remaining myocardium, Purkinje fiber is suggested from position.
Sharp deflection looks like Purkinje fiber
Ablation site

Remaining myocardium

Purkinje fiber is suggested from its position.

Delayed potential in CARTO & microscopic finding

Endocardial site

Calcification

Remaining degenerated ventricular myocardium is located in epicardial site.

Summary

1. The sites shown as sharp deflection and delayed potential were located in border of ventricular aneurysm and in endomyocardial site, which suspected Purkinje potentials.

2. On the other hand, the wide and low frequency potentials mainly located in scar area and epicardial site, which must be from working residual myocardium.
DHCM Case

VT due to Bundle Branch Reentry
60 yrs Male

In 2005, he suffered from ventricular fibrillation and was resuscitated. At the time, he was diagnosed as Dilated phase of HCM with low EF32%. Then, ICD was implanted.

In 2011, he had electrical storm with VT. He admitted and had catheter ablation for VT.
Sinus Rhythm

- AP 60/min
- QRS width 175msec

Clinical VT

- HR 140/min
- QRS 180msec
EPS main findings

• HH preceded by VV in VT
• Sequence of intracardiac erectlograms during VT
  • HBE~ RBB ~LVPF electrograms
• H-RBB block and VT termination simultaneously
• RBB & LVPF pacing showed concealed entrainment
• LVAF pacing did not showed concealed entrainment

Diagnosis

Bundle branch reentry of which the circuit included RBB and LVPF

Catheter Ablation

LV posterior fascicular ablation abolished VT
A20 Catheter Position
Proximal 20-Distal 1

RV catheter

PA

False tendon & papillary muscle

LAO

RAO
Intracardiac Electrogram of VT1
A20 1-2~19-20~HBE~RBB

HV 58ms
H-RBp=40msec, RBp-V=27msec
VT-Reentry Circuit

- RV-HBE
- LV-HBE
- RBB
- LBB-PF

- HBE recording site
- Pacing site
PVA pacing (near RBB) during VT
RV pacing PCL390ms, VTCL=403, PPI=407ms HH proceeded by VV
H-RBB block and VT termination at a time during RBB map cath manipulation

H-RBp=40msec, RBp-V=27msec
Concealed entrainment from LV posterior fascicular pacing
Concealed entrainment at LV posterior fascicular pacing
PCL= 375ms, VT=400ms, PPI =400ms,
PQRS=76ms,DPQRS=76ms
LV anterior fascicular pacing
PCL=375, VTCL=400, PPI=520
Ablation point #2
Ablation point #4
Ablation point #5
Summary

If you use not only CARTO system but also cardiac CT, you can easily find out false tendons and they become useful benchmarks at ablation of fascicular site.
DHCM case

Focal VT from Purkinje fiber
DHCM Case: 68 yrs old Male

43 yrs First, he diagnosed as HOCM (Mid ventricular obstruction). After that, cardiac function was getting worse and LV volume was getting bigger. So he suffered from dilated phase of HOCM.

65 yrs He had VT and ICD was implanted.

67 yrs First ablation for symptomatic VPCs were performed.

4 months later Second ablation for sustained VT was performed.

One month He died from heart failure.
Chest XP & ECG before First ablation

CTR  58.5 %

HR = 64/m
Macroscopic Findings

Ventricular Aneurysm around Septum~Anterior wall~Apex

Matsuyama T,
Jpn J Electrocardiology 2007; 27:167
First ablation for symptomatic VPCs from RV
Orange dots: HBE

Brawn dots: ABL sites
Macroscopic findings & CARTO

Activation mapping

RA, RV, RVOT, TV, HIS, ABL

RAA, RVOT, HI, CS, TV, RV

Microscopic findings of ABL site

<5 months later>

Holter ECG PVC: **8370** beats/day (4/30) → PVC: **681** beats/day (5/16)
Summary

- Purkinje fiber plays an important role of VT occurrence not only in idiopathic VT but also in VT with organic heart disease.

- Nowadays, we can confirm the involvement of Purkinje fiber in mechanism of VT using electro-anatomical mapping system and cardiac CT.

- Catheter ablation can be performed by guiding Purkinje potentials successfully.
Backup slides
Ablation point #1