Advanced mapping and ablation of complex arrhythmias: featuring the present and the future

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DISCLOSURES

- **EUROPEAN ADVISORY BOARD**
  Medtronic Inc

- **INTERNATIONAL EXPERT PANEL**
  Biotronik

- **STRATEGIC BOARD MEETING**
  Sorin Group

- **SPEAKER'S BUREAU**
  Sorin Group
  Boston Scientific

- **CONSULTANT**
  St Jude Medical
The role of catheter ablation in the treatment of ventricular arrhythmias has been changing in the last decade.

- Centers with a VT ablation programme
- Patients treated
- Complex substrates
- Severe heart disease and co-morbidities
- Success »» better outcomes

How Do We Manage Patients With Ventricular Tachycardia? An European Heart Rhythm Association Survey

- 45 centers; 20 countries
- Post-MI (55%), DCM (18%), idiopathic VT (11%), ARVD (5%), valvular disease (4%), hypertrophic cardiomyopathy (4%), channelopathies (4%), infiltrative cardiomyopathies (2%)

- Success rate at 1 year follow-up: post MI 68%, DCM 52%, idiopathic RVOT/LVOT 79%
Diaz-Infante, et al. Spanish Catheter Ablation Registry 2012

VT 8%


VT 5.2%

Neuberger, et al. German Survey 2013

Targets for catheter ablation

Supraventricular tachycardias (32%)

Atrial fibrillation (35%)

Ventricular tachycardia (8%)

Atrial flutter (25%)

VT 8%
ICDs improve survival and reduce SD in high-risk pts, but 10%-20% experience repeated appropriated device therapies and “electrical storm”.

AADs efficacy has been considered disappointing and side effects are an important problem.

VT ablation can be lifesaving for pts with incessant or frequent VT.
- Catheter Ablation for the treatment of VT -

Significant developments in mapping and ablation technologies

- 3D-electroanatomic mapping »»» substrate-based ablation during SR.

- 3D-imaging integration (CT, MRI, PET) »» scar maps

- morphology mapping

- multielectrode non-contact mapping »» ability to ablate unstable VT/ non-sustained VT/ VEB or non-reproducible VTs.

- irrigated catheters with contact tools/ needle irrigated RF catheter.

- epicardial mapping/ablation.

- percutaneous LV assist devices during VT ablation
Despite the innovation and options in technology features...

...It begins with the Electrocardiogram and VT morphology.

- RBBB configuration ➔ Left Lateral exit
- LBBB configuration ➔ Septal or Right Ventricular exit
- Superior axis + positive in aVL and aVR ➔ Inferior wall exit
- Positive in inferior leads ➔ Anterior wall exit
- Positive pre-cordial concordance ➔ Basal exit
- Negative pre-cordial concordance ➔ Apical exit

- QS in any lead means the wavefront is moving away from that site
  - V2-V4: anterior wall, V3-V5: apex, V5-V6: lateral wall

- The more wider & more slurred the QRS ➔ more likely to be epicardial
VT Mapping - from conventional to 3D mapping

- **mapping during VT**
  - endocardial activation map
  - low-voltage diastolic potentials (pre-systolic/mesodiastolic)
  - entrainment
  - earliest ventricular activation (focal activity)

- **pacemapping (morphology)**

- **mapping in sinus rhythm**
  - low-voltage potentials (<1.5 mV), longer duration (>70 ms), late-potentials, fraccionated EGMs
ADVANCES IN MAPPING SYSTEMS FOR COMPLEX ARRHYTHMIAS

Integration with 3D-imaging (CT/MRI/PET)
Simultaneous electro-anatomic maps
Hybrid Contact-Non contact Mapping
High-resolution maps
Auto-mapping systems
Multiple Morphologies Match
Reducing radiation exposure

SUBSTRATE MODIFICATION

↑ SUCCESS RATE
↑ SAFETY
↑ CLINICAL OUTCOME
Catheter Ablation of Outflow Tract Ventricular arrhythmias guided by Non-contact System and Morphology Mapping

* In pts without inducible sustained ventricular arrhythmias conventional catheter ablation may be difficult to perform.

* The non-contact mapping system (Ensite-Array) allows ablation guided by a single ventricular ectopic complex, with recognized efficacy in the identification of focal activity that may facilitate the procedure.

9-F multielectrode balloon array (EnSite Array, St. Jude Medical Inc.)
I. 3D reconstruction of ventricular geometry
II. Acquisition of maps during sinus rhythm and ventricular ectopic beats
III. Non-fluoroscopic navigation with the roving catheter
IV. Identify a morphology match ≥11/12 + early activation points

Unipolar High-Density Non-Contact Mapping System
(EnSite 3000; Endocardial Solutions)

- "single beat mapping"
- Endocardial activation

Mapping during spontaneous ectopic activity
Activated clotting time maintained ±300 s
Multiple Morphology Mapping

- compare 12-lead ECGs for faster arrhythmia recognition
- compare current beat to previous beats for faster workflow
- simultaneously view unipole & bipole EGMs for precise timing analysis
- map multiple clinical arrhythmias
Multiple Morphology Mapping
Optimized Multiple Map Capabilities

**Save Frozen Point to any Map 1, 2 or 3**

- Hovering over map name in map list will display reference shadows for that map in the waveform display.
- Helps to identify appropriate map for frozen point using a superimposed comparison to the map shadows.
- Load map into map display maintaining the frozen beat.
Multiple Morphology Mapping

- Load a different map without losing the frozen beat
- Provides efficient mapping for multiple morphologies
- Eliminates discarding a significant beat that doesn’t match the currently opened map
  - Helps to identify appropriate map for frozen point using a superimposed comparison to the map shadows
Multiple Morphology Mapping provides clinical flexibility to change maps quickly with the current beat.

Freeze a beat of PVC2 → instantly start a new map
32 symptomatic pts (27 ♀; 47±17 years)
Sustained VT (n=4)
Nonsustained VT / Frequent VEB - 16293±10511/24 h - (n=27)

29P without structural heart disease
1P with atrial septal defect surgically corrected
1P had a previous acute myocardial infarction submitted to PCI
1P had hypertension (with LV hypertrophy)

Medication:
B-blocker or verapamil - 26
Amiodarone – 2
Sotalol - 3
Flecainide - 1

Sustained VT with origin in the RVOT
NAVX ENSITE »» CONTACT-NON CONTACT TO MAP DIFFERENT ECTOPIES

MULTIPLE MORPHOLOGIES
Idiopathic RVOT VEB Ablation

New ectopies in different locations...

Potential for Morphology Match...
multiple foci in the same area...

... slightly differences in VEB morphology

a potential role for Morphology Match...
**Origin of the arrhythmia:** RVOT in 26P (81%) and LVOT in 6P (19%)

**Radiofrequency:** 11±5 RF applications (50w, 60°C, 60s)

**Total duration of the procedure:** 120 ± 30 mn; **Fluoroscopy time:** 18 ± 3 min

**Acute success:** the index arrhythmia was eliminated in 28P (88%)  
– no inducibility under isoprenaline perfusion.

**Complications:** — 2 pericardial effusion, 1 pseudo-aneurysm of the femoral artery
Ablation of ventricular tachycardia in patients with severe left ventricular dysfunction and frequent appropriate ICD shocks: potential benefits of arrhythmogenic substrate modification

Oliveira M, et al. Rev Port Cardiol, 2014

- 18 men (ischemic cardiomyopathy 82%, 65±12 yrs, LVEF 27±7%)
- recurrent episodes of VT and/or arrhythmic storms despite AAD

**EPS/mapping** - ventricular programmed stimulation (600 ms/S3) to obtain baseline VT documentation and confirm hemodynamic intolerance.

**SR voltage map** - 3D electroanatomic mapping (*Ensite NavX*) - bipolar and unipolar voltage maps - to delineate areas of scarred myocardium

(BIPOLAR: ventricular bipolar voltage ≤0,5 mV – dense scar; 0,5-1,5 mV – border zone; ≥1,5 mV – healthy tissue; UNIPOLAR: scar tissue <25% of the maximum voltage)

**Substrate modification**
- catheter elimination of abnormal LV electrograms during SR (*fractionated, splited, low-amplitude/long-lasting, late potentials, pre-systolic*)
- linear ablation based on the findings of scar areas and proximity to anatomic obstacles.
- pace-mapping + morphology match mapping techniques
♂, LVEF <20%
ICD + arrhythmic storm
Substrate modification
+ NSVT / VEB elimination

Pacing was attempted at these sites looking for morphology match with any induced VT or spontaneous VEB and stimulus-paced QRS interval >40 ms
NON-CONTACT HD UNIPOLAR VOLTAGE MAP

cut-off 25% of peak negative voltage
UNIPOLAR VOLTAGE MAP DURING VT
Early Activation Zone of NSVT in the transition area of the unipolar voltage map

UNIPOLAR VOLTAGE NON-CONTACT MAP DURING SR

BIPOLAR VOLTAGE CONTACT MAP DURING SR
RF applications
- early activation + morphology match + scar contour + early potentials inside the scar tissue area
Results

VT induced in all P (1-7 morphologies; cycle 300-600 ms)
LV access via transeptal catheterization (3P) or aortic retrograde approach (15P).
Pace-mapping match with the induced VT ≥11/12 ECG leads obtained in 50%.
Abnormal electrograms were identified and ablated in all P.
Non-inducibility was achieved in 71% of the cases (not performed in 4 cases)
One pericardial tamponade drained successfully.

Total duration of the procedure - 130±45 mn.
Fluoroscopic time - 16±11 mn.
RF application time - 23±11 mn.
Advanced Mapping - featuring the future

- RAPID AQUISITION OF MAPS
- AUTO-MAPPING SYSTEMS
  (criteria to accept or eliminate points…)
- MULTIPLE MORPHOLOGY MATCH ("QUICK REVIEW")
- SIMULTANEOUS HIGH-RESOLUTION MAPS
- REDUCE RADIATION EXPOSURE

AUTOMATIC RECONSTRUCTION OF SIMULTANEOUS MAPS
  HIGH ACCURACY + LESS TIME-CONSUMING
  NO NEED OF REFERENCE CATHETER »» EASY
THE PROGNOSTIC IMPACT OF RECURRENT VT REPRESENTS AN IMPORTANT CHALLENGE IN HEALTH CARE.

THE ROLE OF CATHETER ABLATION TO CONTROL RECURRENT VT HAS BEEN INCREASING IN THE LAST DECADE.


SIGNIFICANT DEVELOPMENTS IN MAPPING AND ABLATION TECHNOLOGIES

MAPPING DECISIONS SHOULD BE INDIVIDUALIZED ACCORDING TO THE PATIENT CHARACTERISTICS AND EXPERIENCE OF THE CENTER.

MULTIPLE MORPHOLOGY MAPPING AND 3D ELECTRO-ANATOMIC HIGH-DENSITY SISTEMS MAY BE AN EFFECTIVE ALTERNATIVE FOR THE ANALYSIS AND TREATMENT OF VTs

NEW STRATEGIES COMBINING DIFFERENT INNOVATIVE TOOLS (QUICK-AUTOMATED-ACCURATED) MAY CONTRIBUTE TO IMPROVE VT MAPPING/ABLATION SUCCESS AND SAFETY.