Identifying Reentry as a Cause of Clinical Arrhythmias

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Disclosure

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Mechanisms of tachycardia

Focal tachycardia
- Automaticity
- Triggered activity

Reentrant tachycardia
- Microreentry
- Macroeentry
How to distinguish tachycardia

Focal Tachycardia

- Activation emanates from small area with centrifugal spread

- Clinical setting
  - Multiple short burst
  - No structural heart disease or prior ablation

- Response to overdrive pacing
  - Automaticity: overdrive suppression
  - Triggered activity: overdrive acceleration
  - Microreentry: concealed entrainment
How to distinguish tachycardia

Reentrant Tachycardia

- Activation proceeds from the exit of large electrical circuit
- **Clinical setting**
  - Infrequent, sustained episodes
  - Prior ablation/surgery
- **Response to overdrive pacing**
  - Entrainment (manifest/concealed)
However, the \textit{Dx of tachycardia} can be \textit{established with certainty only by an EP study}
Tools for the DDx of tachycardia

- Activation mapping

- Entrainment mapping
Tools for the DDx of tachycardia

- Activation mapping
- Entrainment mapping
Critical Components of the activation mapping with 3D mapping system

- Appropriate electrical reference
- Window of Interest
- Annotation
Appropriate Reference

- **Atrial tachycardia**
  - P wave can be indistinct
  - Stable intracardiac EGM (usually CS)
  - RA: screw-in electrode

- **Ventricular tachycardia**
  - Large, reproducibly identifiable component of QRS

- **Avoiding EGM with multicomponent signals**
  - Automatically select a different EGM peak for different beats
  - Maximum; minimum; down slope; up slope
Window of Interest

Focal tachycardia
- Shows activation typically ≤ 50% of the TCL: WOI does not have to be precisely chosen
- A true early site of activation is rarely earlier than 50 ms from the onset of the surface ECG (P wave or QRS)
- Appreciate the red color is not the earliest spot

Macreentrant tachycardia
- WOI is chosen to be 10 or 20 ms < TCL
- Too short: too much early spots
- Too long: 2 activations @ 1 site
Window of Interest

- Early meets late: Red meets Purple
  - where the “tail” of the arrhythmia collides with the “head”
  - depends on where the offset and onset of the window are defined: arbitrary
  - defining critical sites of ablation may require the additional use of entrainment or other maneuvers

- Success at the early meets late
Annotation

- Determine the origin of the activation or timing of local activation
- Bipolar vs. Unipolar recording
- Annotating to the onset of bipolar electrogram is widely used and may correspond to the unipolar signal of the proximal electrode, while the point location is at the position of the distal electrode
오프라인 프로그램

부정맥학회에서 개최한 학술행사의 아젠다(Agenda)와 강의자료를 제공합니다.

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ERC

ERC2017 - II Program

일시 : 2017년 10월 21일(토) 08:00
장소 : 세브란스심장혈관병원 3층 강당 및 PCI Staff Lounge
주관 : 대한부정맥학회

학술대회요약보기 >
Tools for the DDx of tachycardia

- Activation mapping

- Entrainment mapping
Tools for the DDx of tachycardia

- Activation mapping
- Overdrive pacing
Why do we need overdrive pacing?

- **Overdrive pacing** can aid in choosing target site for ablation
  - By helping determine *tachycardia mechanism*
  - By helping *validate putative ablation sites*

- **Ablation target**
  - Focal tachycardia: *presystolic potential* (late diastolic)
  - Microreentry: *long fragmented diastolic potential*
  - Macreoreentry: *mid-diastolic potential*
What is the Resetting?

Advancement in timing of a tachycardia cycles as a result of a premature stimulus
What is the ENTRAINMENT?

- Continuous resetting of a tachycardia by overdrive pacing, *typically in the presence of fusion*
- Must be differentiated with overdrive suppression: *resetting (+) but fusion (-)*
Criteria for the Entrainment

1. **Fixed fusion** of the paced complexes at a constant pacing rate: each complex an identical blend of pure pacing during sinus rhythm and tachycardia at any given PCL.

2. **Progressive fusion** or different degrees of fusion at different pacing rates: greater contribution of pacing to fused complex at faster pacing rate.

3. **Resumption of the same tachycardia following cessation of pacing**, with the first post-pacing complex displaying no fusion but occurring at a return cycle equal to the pacing CL.
Entrainment

To declare entrainment is present, fusion must be unequivocally demonstrated (except, microreentry)

FUSION is NOT

- Mere capture with overdrive pacing
- Overdrive pacing followed by tachycardia termination
- Overdrive pacing followed by change in tachycardia
**Entrainment**

- **FUSION** is **PRESENT** when

- A clear *blend* of *fully paced* + *full tachycardia* complexes

- *Progressive fusion*: Show graded change in activation at different paced rates

- Observe *stimulus artifact after onset of accelerated complex*
  - evidence that the tachycardia wavefront have exited from the circuit
How can we see the **FUSION** of wavefronts?

- **Ventricular tachycardia (VT)**
  - QRS complex on the surface ECG

- **Atrial tachyarrhythmia**
  - P wave on the surface ECG
  - Hard to use due to T wave or prior ablation/scar
  - Intracardiac electrograms: *mainstay*
FUSION

- **Simultaneous activation** of the atria or ventricles by two wavefronts
- Two wavefronts \((n - 1 \& n)\) activate the same chamber at the same time

**Antidromic propagation**
Wavefronts collided & perished

**Orthodromic propagation**
Penetrated the circuit & continuous reset

Almendral J, et al. PACE 2013; 36:508
CS 1-2 Pacing@245 ms

Tachycardia

Pure CSd pacing

Evidence of fusion

:: Macroreentry
PROGRESSIVE FUSION

450 msec Overdrive pacing

350 msec Overdrive pacing
Evidence of **progressive fusion**

:** Macroreentry**
Atrial Tachycardia after MAZE procedure

TCL: 291 msec
Overdrive pacing @ CSd with 280 msec
Overdrive pacing @ CSd with 250 msec
Evidence of Progressive FUSION

∴ Macroleentry
Tachycardia intracardiac EGM

1
F
V_1
V_6
HRA-p

HRA-d
His-p

His-d
CS-p

CS-d

200 ms
No evidence of Progressive FUSION :: Focal tachycardia
66 YO gentleman with ICM & NICM

TCL: 605 msec
Overdrive pacing with 590 msec
Overdrive pacing with 570 msec
Overdrive pacing with 550 msec
Evidence of *progressive fusion* :: Macroleentry
74 YO woman with NICM, CRF on HD, S/P ICD

I
II
III
aVR
aVL
aVF
V₁
V₂
V₃
V₄
V₅
V₆
Overdrive pacing @ RV with 520 msec

I
II
III
aVR
aVL
aVF
V₁
V₂
V₃
V₄
V₅
V₆
Hisₚ
His₃
RV

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Overdrive pacing @ RV with 490 msec
Overdrive pacing @ RV with 470 msec
Overdrive pacing @ RV with 450 msec
No progressive fusion  
∴ Focal Tachycardia
**Entrainment**

- **FUSION is PRESENT** when
  - A clear *blend of fully paced + full tachycardia complexes*
  - *Progressive fusion*: Show graded change in activation at different paced rates
  - Observe *stimulus artifact after onset of accelerated complex*
    - evidence that the tachycardia wavefront have exited from the circuit
Baseline intracardiac recording

1
F
V₁
V₆
HRA-p
HRA-d
His-p
His-d
CS-p
CS-d

100 ms
Overdrive Pacing @ HRA\textsubscript{d} with 280 msec

TCL: 300 msec
Overdrive Pacing @ HRAd with 280 msec

- Observe *stimulus artifact after onset of accelerated complex*

- Provide the evidence that the tachycardia wavefront have exited from the circuit

**Evidence of Fusion**

- Macroreentry
Baseline intracardiac recording

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Overdrive pacing from RAL @ 210msec
Overdrive pacing technique

1. Start with *stable tachycardia*
2. Decide the *chamber to pace first*
3. *Synchronization* at the pacing site
4. Overdrive pacing at a fixed rate *slightly faster* (10~30 msec) than tachycardia for several cycles
5. Overdrive pace until *all relevant electrograms are accelerated to paced cycle length*
6. Assess the response to overdrive pacing
7. *Find the target and validate it*
Responses to overdrive pacing

- **No capture !!**

- **Changes in tachycardia**
  - Change to a different circuit
  - Change to a different exit from the same circuit
  - Acceleration

- **Termination**

- **Entrainment**
Focal vs. Macroeentry: How to tell?

Focal Tachycardia

- Shows activation *typically* \( \leq 50\% \) of the tachycardia cycle length
- Centrifugal spread of activation
- **Response to overdrive pacing**
  - Automaticity: overdrive suppression
  - Triggered activity: overdrive acceleration
  - Microreentry: concealed entrainment
Focal vs. Macroeentry: How to tell?

**Macroeentrant Tachycardia**

- Shows activation ~ 95% of the tachycardia cycle length
- Shows the Early meets Late
- *Response to overdrive pacing*
  - Entrainment
Summary

- Activation mapping & overdrive pacing maneuver are fundamental tools in complementary

- It is essential to understand the principles of both methods
Thank You for Your Attention!

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