Mechanisms of arrhythmia and their implications for diagnosis mapping and ablation

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Mechanisms of tachycardia

• Physiological - sinus
• Focal
• Micro-reentry
• Macro-reentry
Implications for diagnosis

- Focal - Paroxysmal, short lived, related to physiological conditions (cf AFL vs AT/AF)
- Reentry - longer lasting, random, may be associated with underlying abnormality
Implications for diagnosis

• Microreentry - associated with scar/prior ablation. Often in predictable locations
• Macroreentry - more likely to be associated with prior surgery or linear ablation (exception typical AFL - anatomical)
Mapping

• Map before the procedure starts
  – Focal with no PH can be anywhere but often RA- crista, appendage
  – Microreentry - sites of previous ablation, ligament of marshal, anterior LA (often near LAA/LA junction)
  – Macro-reentry RA flutter, LA roof, Mitral isthmus, rotating around previous ablation (veins or ant LA)
  – Rotas?
VT - mapping

• Macroreentry
  – Haemodynamically stable scar or scar and MV annulus
  – Unstable - scar or edge of scar in functional myocardial block
Basic principles of tachycardia ablation

• The primary goal is to ablate the clinical tachycardia
  – keep it simple
  – keep it “quick” (there may be more than one to chase)
  – 4 step plan to happiness
Basic kit - AT ablation

- Decapole - CS
- Circular map - PV/LAA
- Cooled ablation catheter
- 3D mapping system
Luxury kit

- Force sensing
- Steerable sheath
Step 1

• Check and isolate PV’s
  – LA tachycardia difficult to map if there is a question over PV conduction
  – PV isolation mandatory endpoint
  – PV isolation doesn’t stop LA tach unless it’s the mechanism
Step 2

- Place PV in LAA
- Assess CS activation
  - Prox    Dist →
  - Dist    Prox →
  - Chevron mid CS earliest ⬆
  - Chevron mid CS latest ⬇
Step 3

- Record Activation on LA ant wall in 3 locations
  - mid
  - septal
  - roof
CS prox→distal

**Differential:**
- MV isthmus flutter
- RA flutter
- Focal Septum/RA
- RPV (now excluded by isolation)

**Diagnosis:**
- LA lat → sept
- LA sept → lat
- LA sept → lat
CS prox → distal

• **Differential:**
  - MV isthmus flutter
  - RA flutter
  - Focal Septum/RA
  - RPV (now excluded by isolation)

• **Diagnosis:**
  - LA lat → sept
  - LA sept → lat
  - LA sept → lat
CS distal → prox

• Differential:
  - MV isthmus flutter
  - Focal lateral wall
  - LPV (now excluded by isolation)

• Diagnosis:
  - LA sept → lat
  - LA lat → sept
CS distal → prox

- Differential:
  - MV isthmus flutter
  - Focal lateral wall
  - LPV (now excluded by isolation)

- Diagnosis:
  - LA sept → lat
  - LA lat → sept

PA
AP
• Differential:
  – Roof Dependent
  – Focal from posterior roof
  – L/RPV tachy (now excluded)

• Diagnosis:
  - LA ant inf → sup
  - LA ant sup → inf
• Differential:
  – Roof Dependent
  – Focal from posterior roof
  – L/RPV tachy (now excluded)

• Diagnosis:
  - LA ant inf $\rightarrow$ sup
  - LA ant sup $\rightarrow$ inf
• Differential:
  – Roof Dependent
  – L/RPV tachy (now excluded)

• Diagnosis:
  - LA ant sup→inf
Step 4

• Check that activation is continuous through target area and ablate
Special circumstances

- Prior linear ablation will change activation patterns
- This interferes:
  - Intact mitral isthmus/roof line and focal from either side of line
  - CS roof line
Special circumstances

Intact roof line focal attachment

PA

AP
Special considerations scarring/odema

- Focal tachy more likely (shorter CL)
- Progressive mapping important
- Move earlier and change direction if starts getting later
- Know that not all signal may be visible
What about entrainment?

- High risk:
  - if AF has just organised to AT
  - multiple AT seen in case
- Low risk if established AT
- Useful if mechanism not clear or no response to ablation
Baseline Signals
RLPV
RUPV
Step 1 Isolate the veins

- For PAF: unknown
- Quinidine NNH 109 pts/yr (CI 34 to 4895)
- Sotalol OR death 2.09 (p=0.06)
- Flecainide?
PV tachycardia

Extremely unusual

• more common to have reentry through WACA
  – RF 1 terminates tachy
  – RF2 on opposite side of WACA isolates vein
Example 2

Persistent AF:
- Short time in persistent AF: 6 months, 1 year, 3 years, 5 years
- LA size (correlates with time in AF)
- Other disease: MV disease, HOCM
Step 2 CS

- Differential:
  - Roof Dependent
  - Focal from posterior roof
Step 3
Step 5 - Check the lines
Example 3 post surgery
AF ablation and MVR
Step 4 - ablate

- Start line below CS
- Small A large V
- Start at smallest CS A
Step 4
Step 4 - ablation within CS
Step 5 - check your lines

Pace LAA

Pace CS34

Pace CS78
Example 4 Redo - all PVs isolated
Example 4 - micro mapping for multiple simultaneous AT

- Mantra - PAF first line therapy
  - 20 endpoint - freedom from AF
  - 20 mortality/comps/QOL/Health economics/LV function

- Cabana - high risk AF patients
  - 20 mortality
  - 20 MACE/Costs/QOL
MV isthmus block
Micro mapping
STAR mapping

Aim to identify organised activity in AF
Used in conjunction with whole-chamber basket catheters
Main principle is to identify sites that are consistently earlier than neighbouring sites through comparing activation times
  Statistical picture is created
  100% leading compared to all paired poles=red
  0% leading compared to all paired poles=blue
Star mapping

- Activation time given a weighted score according to repetitive nature of pattern
Early site of activation posterior-inferior wall
Conclusions

• Pre-existing understanding of likely mechanisms simplifies the process
• Even AF can be mapped if one looks for patterns in focused limited areas
• Global mapping technologies are not dead yet and may open up the mapping of complex irregular rhythms