How to Ablate Atrial Tachycardia

Nadir SAOUedi, Monaco (whose very modest disclosures are depicted below)

Company Name

Biosense Webster, Sorin
Medtronic, St. Jude

Sanofi

Biosense Webster, Sorin, Medtronic,
St. Jude, Stereotaxis, Daichí Sankyo,
Spectrum Dynamics, Boston Scientific,
Biotronik, Medico
Boehringer Ingelheim, General Electric

Relationship

Sponsored Humanitarian missions
Lecture fee (almost nothing, a misery, believe me...)

MUAC 15 Sponsorship
One of the nicest Course in the French Riviera
You should come...
Classification of AT

Macroreentrant Atrial Tachycardia (MRAT)
1. Reentry around a ‘large’ central obstacle
2. Endocardial activation covers ATCL: no early activation
3. Transient entrainment is always possible
4. Lines of block reflected by DS Eg
5. Isthmus participation proven by AT interruption with pressure/ablation
6. Very complex/multiple reentry circuits after baffle atrial surgery (Mustard, Senning), Fontan procedure, Maze, line ablation for AF
7. PPI-TCL at pacing site < 20 ms = inside the circuit.
8. MRAT if PPI=TCL from ≥ 2 A sites, separated by > 2 cm

Focal AT
1. Activation starts rhythmically at a small area and spreads centrifugally without covering TCL
2. May also be reentrant (microreentry = very small circuits)

Atrial Pace Mapping is of Little Help

- Spatial Resolution is 32 mm in the CS (configurational changes)

Mac Lean et Waldo et Al; Circulation 1975: 52, 426-433

Man et Al, Circulation 1996; 94: 1357-1363
Double Potentials During Post Lesion AT

- Canine RA Crush-Injury Model

- SR and A Pacing

- Sustained A Flutter

Second degree block within a Double Spike electrogram may identify local dead end Pathway

- Spontaneous 3:2 and 2:1 within DS electrogram
- PAC induced 2:1 within DS electrogram

Concealed Entrainment

- Tachycardia may be transiently entrained and even interrupted without being able to demonstrate any of the entrainment criteria
- 2 types of concealed entrainment

1. Pacing within a protected isthmus
2. Pacing from a site orthodromically distal to an area of slow conduction

Waldo A et Al. Circulation 1983; 67: 73-83
Saoudi N, Castellanos A et al. PACE 1998 (21): 2105-2125
Limits of the use of Entrainment in the EP Lab

Misleading Long PPI After Entrainment

- 76 pts with confirmed typical AFL
- Ent at 4 CTI sites (10-40 ms < TCL)
- Long PPI in 18% as a function of ≠ PCL/TCL/P site
- Conduction delay caused by local pacing latency (MAP) at different sites within CTI

Alteration/Termination during Attempted Entrainment dg/after AF Abl

- 386 pacing attempts 5–40 ms < TCL
- AT altered if CL or activation pattern altered ≥ 10 s (5/386)
- If TCL - PCL ≤ 20ms, 2/353 (0.5%) altered/terminated AT
- If TCL - PCL > 20ms, 3/33 (9%) altered/terminated AT
- Greater CL instability in ATs altered/terminated vs unchanged (11% vs 4.5%; P < .007)
Number Needed to Entrain: A New Criterion for Entrainment Mapping in Pts With IART

- 317 attempts in 76 IART
- Median = 2 NNE within the reentrant circuit
- Correlated to PPI - TCL ($r = 0.906; P < 0.001$).
- Interesting if difficulties in PPI measurements or AT alteration/termination

Maruyama M et Al. Circ Arrhythm Electrophysiol. 2014;7:490-496

Ent From Downstream Sites on Multielectrode Catheters to Diagnose MRAT

- 66 ATs in 62 pts
- P within CS from electrodes showing later A than adjacent ones
- A at neighboring upstream Egs: time S to last upstream accelerated A Eg (S-Au)
- Long S-Au despite short distance = orth. activation of upstream site (Constant fusion)


- S-A upstream/ TCL >75%
- Sites remote from MRATs or focal ATs S-A upstream/TCL <25%
Mapping Strategy for AT Following AF Ablation

- 128 pts (246 AT) after stepwise approach in LS pers AF
- 238/246 (97%) AT successfully mapped

- FAT = 14%
- Localized R = 40%
- MRAT = 109 46%
  - 61 (25%) PM
  - 31 (13%) Roof dependant
  - 17 (7%) CTI dep

AT post AF Abl

- 140 AT during or after Pers AF ablation
- 223 diagnosed AT: 124 MRAT (56%) and 99 centrifugal (44%)

Pascale P et Al. Circ Arrhythm Electrophysiol 2013;6;481-490

CS Activation Pattern

Mid CS Timing

- 10-40% of PP = CW PM MRAT (PPV=82%, NPV=75%)
- 50-70% of PP = CTI dep MRAT (PPV=70%, NPV = 93%)
- 80-20% of PP = CCW PM MRAT (PPV=41%, NPV=91%)
Peri Mitral MRAT

- Always flutter aspect
  - $F_0 >$ in V1

- 40 recurrent PM MRAT at 1 year
  - Previous MI linear block in 13 (32.5%)
  - MI ablation (delay wo block) in 13 (32.5%)
  - Termination in 26/40
  - 73.5% free from TA/AF at 13 mths

Conduction delay $> 149$ ms predicted spontaneous PMAT

Roof Dependant MRAT


MRAT After Surgical Repair of CHD
Isolated Channels Between Scars Allow “Focal” Ablation

- 16 pts post ASD repair (6), ToF (4), and Fontan procedure (6)
- 65/69 AT from the RA
- Carto RA maps (15 MRATs, 2 focal AT, and 2 A pacing (no stable AT)
- Circuit within a large low V area (bip ≤0.5 mV)

- Many sites within circuit, but outside isolated channel exhibited diastolic potential, ent with concealed fusion and PPI =TCL
- Ablation at one such site (RF1) failed to terminate tachycardia.

- Single RF2 application within channel identified from the map terminated AT despite local pacing failure to capture

Nakagawa H et Al. Circulation 2001;103;699-709
AT post surgery

MRAT After Surgical Repair of CHD
Isolated Channels Between Scars Allow “Focal” Ablation

- Extremely small A potential in mimicking dense scar in 7/15 cases terminating MRAT (<0.1 mV)

Nakagawa H et Al. Circulation 2001;103;699-709
FAT and High Density Mapping

- Multispline catheter mapping
- 27 FAT: Local focus in 19 (70%) and local reentry in 8 (30%)

A. Annie. 66 ans
- IM dystrophique
- 2004: Plastie mitrale avec annuloplastie et fermeture de FOP
- 2013: Flutter atypique rebelle aux drogues

Courtesy of DG Lateu and SS Bun
RHYTHMIA Mapping System and Orion™ High-Resolution Mapping Catheter

- Station processes high quality signals Very low Noise level (bip <0.01 mV): 192 channels + ECG

- 8 Splines (Each with 8 Electrodes)
- 18 mm
- 64 Low Noise Electrodes (0.4 mm²)
  (2.5 mm center-to-center)

- Magnetic/Impedance Location Sensors
- Electrogram Recording Only from Outside
  (Less Far-filed Potential)

- Automated Beat Selection based on: Eg time stability + Location stability + Respiratory phase
- Geometry / Anatomy Creation updated continuously
- Reference Eg from 2 separate sites (other catheters) to exclude PB’s
- Multiple Potentials: System uses Eg timing in surrounding area to decide which one to use for timing annotation

LA Activation Map During AT

- Mapping EGMs: 9,645
- Mapping Time: 15.7 min
- Manual Verification of 59 EGMs (12.1 min)

AT CL 181 ms

Peri Mitral MRAT

61 M, Prior Surgical & Catheter Ablation of AF/AT

Courtesy of H Nakagawa MD and WM Jackman, MD
LA Activation Map During AT

Courtesy of H Nakagawa MD and WM Jackman, MD
LA Activation Map During AT

Double Potentials

Courtesy of H Nakagawa MD and WM Jackman, MD
LA Activation Map During AT

Courtesy of H Nakagawa MD and WM Jackman, MD
LA Activation Map During AT

LAA
LSPV
LIPV

RIPV
RSPV

LL Projection
Caudal Right Lateral Projection

Courtesy of H Nakagawa MD and WM Jackman, MD
LA Activation Map During AT

LAA
LSPV
LIPV

LL Projection

RSPV
RIPV

Caudal Right
Lateral Projection

Courtesy of H Nakagawa MD and WM Jackman, MD
LA Activation Map During AT

LAA
LSPV
LIPV

RIPV
RSPV

LL Projection
Lateral Projection

Caudal Right

Courtesy of H Nakagawa MD and WM Jackman, MD
LA Activation Map During AT

Courtesy of H Nakagawa MD and WM Jackman, MD
Ablation at the Mitral Isthmus

- AT#1 (CL 181 ms)

Linear Lesion Along the Mitral Isthmus Terminated AT

Mitral Annulus

LAA

LSPV

LIPV

RIPV

LL Projection

Courtesy of H Nakagawa MD and WM Jackman, MD
LA Activation Map During induced AT #2 (CL 266 ms)

- Mapping EGMs: 8,365
- Mapping Time: 22.7 min

PA Projection

Possible Reentry Around RIPV

Cranial RAO Projection

Courtesy of H Nakagawa MD and WM Jackman, MD
LA Activation Map During induced AT # 2

- Mapping EGMs: 8,365
- Mapping Time: 22.7 min

Not Reentry Around RIPV

Cranial RAO Projection

Courtesy of H Nakagawa MD and WM Jackman, MD
LA Activation Map During induced AT # 2

- Mapping EGMs: 8,365
- Mapping Time: 22.7 min

Possible Reentry Around Right PVs

PA Projection

Cranial RAO Projection

Courtesy of H Nakagawa MD and WM Jackman, MD
LA Activation Map During induced AT # 2

- Mapping EGMs: 8,365
- Mapping Time: 22.7 min

100 ms-166ms

PA Projection

Cranial RAO Projection

Not Reentry Around Right PVs

Roof Line is Blocked

266 ms

Courtesy of H Nakagawa MD and WM Jackman, MD
Ablation at Channel During induced AT # 2

100 ms - 166 ms

Fractionated Potentials

RIPV

RSPV

Courtesy of H Nakagawa MD and WM Jackman, MD
Ablation in Persistent AF (STAR AF 2)

- 589 pts (median =2.2 y) randomised to
  - PVI alone (67)
  - PVI + ablation abnormal Egs (263)
  - PVI+ linear LA lesions (259)
- Successful PVI in 97% of all pts

<table>
<thead>
<tr>
<th></th>
<th>PVI</th>
<th>PVI+Eg</th>
<th>PVI+Lines</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proc Time (mn)</td>
<td>167</td>
<td>229*</td>
<td>223*</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>No AA 18 mths</td>
<td>59%</td>
<td>48%</td>
<td>44%</td>
<td>ns</td>
</tr>
<tr>
<td>No AA dg 18 mths</td>
<td>48%</td>
<td>37%</td>
<td>33%</td>
<td>ns</td>
</tr>
<tr>
<td>No AF after 2 proc</td>
<td>72%</td>
<td>60%</td>
<td>58%</td>
<td>ns</td>
</tr>
</tbody>
</table>

Verma A. NEJM 2015; 372:1812-22
Welcome to the Monaco USA Arrhythmia Course 2015, March 19-21
http://muacmonaco.wix.com/monacousaarrhythmiacourse