Entrainment directions in mapping complex arrhythmias

Shahnaz Jamil-Copley
Consultant Cardiologist and Electrophysiologist
Nottingham University Hospitals NHS Trust
Background

Important pacing manoeuver that can be used to identify re-entry as a tachycardia mechanism and define components of the circuit.

Entrainment is the continual or repeated resetting of a re-entrant tachycardia by each of a series of consecutive beats of a pacing train.
Arrhythmias and entrainment

Well established role in simple arrhythmias such as SVT/typical CTI dependant atrial flutter as the critical area for ablation is clear.

The role of entrainment must be carefully considered in complex arrhythmias.
Complex atrial tachycardia

Lee et al. Catheter ablation of atrial arrhythmias: state of the art. The Lancet 2012
Complex atrial tachycardia

A Perimtrial flutter

B Left atrial flutter circuits

C After previous atrial surgery

Lee et al. Catheter ablation of atrial arrhythmias: state of the art. The Lancet 2012
Complex atrial tachycardia

Post RF/surgical AF ablation
- Complex scar substrate

Post cardiac surgery
- Fixed and functional block

Idiopathic scar
- Complex tachycardia circuits
- Multiple tachycardias
Complex atrial tachycardia

- Post RF/surgical AF ablation
- Post cardiac surgery
- Idiopathic scar

- Complex scar substrate
- Fixed and functional block
- Complex tachycardia circuits
- Multiple tachycardias
Complex atrial tachycardia

- Post RF/surgical AF ablation
  - Complex scar substrate
- Post cardiac surgery
  - Fixed and functional block
- Idiopathic scar
  - Complex tachycardia circuits
  - Multiple tachycardias

- Equidistant high-density activation mapping
- Voltage mapping
- Electrogram complexity and timings
Complex atrial tachycardia

- Post RF/surgical AF ablation
  - Complex scar substrate
- Post cardiac surgery
  - Fixed and functional block
- Idiopathic scar
  - Complex tachycardia circuits
  - Multiple tachycardias

Equidistant high-density activation mapping
Voltage mapping
Electrogram complexity and timings
?Focused Entrainment
Left atrial tachycardia
Left atrial tachycardia
Left atrial tachycardia
Left atrial tachycardia
Left atrial tachycardia
Complex arrhythmias
Complex atrial tachycardia

- Post RF/surgical AF ablation
- Post cardiac surgery
- Idiopathic scar

Complex scar substrate
Multiple tachycardias
Complex tachycardia circuits

Risks of entrainment
- Alteration of the tachycardia
- Degeneration to AF
- Termination of the tachycardia
• 61 patients
• 133 atrial tachycardias
• Entrainment from minimum 6 pacing sites x2
• Termination of AT ~ 4%
• Conversion to a different AT ~ 3%
Complex Atrial Tachycardias

30 post AF ablation patients with 62 ATs in which overdrive pacing for entrainment mapping was performed

AT was classified as altered if the CL or activation pattern remained altered 10 seconds after pacing

CLD max - the difference between the shortest and the longest CL expressed as a percentage of the CL

Barbhayia et al. Avoiding tachycardia alteration or termination during attempted entrainment mapping of atrial tachycardia related to atrial fibrillation ablation. Heart Rhythm 2015
Left atrial tachycardia

12-lead ECG
Left atrial tachycardia

Intracardiac electrograms
Left atrial tachycardia

Entrainment distal CS

PPI-TCL=28ms
Left atrial tachycardia

CARTO-3 LAT map

AP

PA
Left atrial tachycardia

CARTO-3 propagation map
Left atrial tachycardia

Ripple map - LAO
Left atrial tachycardia

Entrainment from base of LAA

PPI-TCL=15ms
Left atrial tachycardia

Ripple map - AP
Left atrial tachycardia

Ripple map - RL
Left atrial tachycardia

Ripple map - PA
Left atrial tachycardia

Ripple map - PA
Left atrial tachycardia

Entrainment from posterior roof

PPI-TCL=0ms
Increase in TCL during isthmus* ablation

Left atrial tachycardia
Further entrainment around the mitral valve annulus confirmed a peri-mitral atrial flutter (PPI-TCL=0-5ms)

Left atrial tachycardia
Scar related VT

Scar related VT

Challenges

➢ Large substrate
➢ Non-inducible VT
➢ Haemodynamically unstable
➢ Non-sustained
➢ Unmappable
➢ If sustained – inability to capture within scar tissue
➢ Multiple VT morphologies
Scar related VT

Challenges

➢ Large substrate
➢ Non-inducible VT
➢ Haemodynamically unstable
➢ Non-sustained
➢ Unmappable
➢ If sustained – inability to capture within scar tissue
➢ Multiple VT morphologies

SUBSTRATE ABLATION
Scar related VT

Linear ablation lesions sets
Scar border zones
Scar transection
Connecting scars and anatomic boundaries

Late Potential abolition

Della Bella

LAVA ablation

Jais, Haissaguerre

Marchlinski, Reddy, Morady, Soejima, Antz
Scar related VT

SINUS RHYTHM
Scar related VT
Scar related VT
Scar related VT
Scar related VT
Scar related VT
Scar related VT

ENTRAINMENT-concealed fusion
Scar related VT
EPICARDIAL BIPOLAR VOLTAGE MAP

Pre-Ablation  Post-Ablation
EPICARDIAL BIPOLAR VOLTAGE MAP

EPICARDIAL LATE POTENTIAL MAP

Pre-Ablation    Post-Ablation
Pre-Ablation    Post-Ablation
Conclusion

There is a significant diversity of application of entrainment mapping in complex arrhythmia ablation.

Targeted entrainment in complex atrial tachycardias can provide surrogate information to activation mapping allowing guided ablation of the critical isthmus.

Substrate based ablation is the mainstay of treatment for scar-related VT.

If the clinical VT is inducible and stable every attempt should be made to guide ablation - activation and entrainment mapping.