Ablation of Left Atrial Tachycardia

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Arrhythmogenic substrate of left atrial tachycardia

EP mechanisms of left atrial tachycardia
Arrhythmogenic substrate of left AT
Linear catheter ablation of atrial fibrillation

Years 1994 – 1997

RA linear lesions
- Success without drugs = 13%
- Success with drugs = 27-40%

LA linear lesions
- Success without drugs = 47%
- Success with drugs = 87%

- High prevalence of post ablation reentrant atrial tachycardias related to gaps within the RF lines

Haïssaguerre M et al. JCE 1996
Follow-up after ablation of atrial fibrillation

Occurrence of atrial flutter and other atrial tachyarrhythmias should be considered as treatment failures


HRS/EHRA/ECAS Expert Consensus - Europace 2007;9:335-79
Atrial tachycardia after surgical ablation of atrial fibrillation

Magnano AR et al. JCE 2006;17:366-73
20 patients
Atrial tachycardia after surgical ablation of atrial fibrillation
Mapping and ablation of LA flutters

22 patients
History of open heart surgery in 4 patients

Presence of silent left atrial areas (voltage <0.05mV) in 11/22 patients

Mapping and ablation of LA flutters

22 patients
History of open heart surgery in 4 patients

Presence of 32 zones of conduction block (>1 /patient)

Mapping and ablation of LA flutters

Mapping and ablation of LA flutters

Isthmus barriers
Scar = 32/42 LAMRT
Mitral valve = 10/42 LAMRT
Pulmonary vein = 17/42 LAMRT

Mostly related to presence of ‘natural’ zones of scar, usually located on the posterior LA wall

- Spontaneous left atrial tachycardia
- Iatrogenic left atrial tachycardia

Prevalence higher and even increasing in relation with the number of AF ablation procedures performed worldwide

- Mesas CE et al. J Am Coll Cardiol 2004;44:1071-9 ➔ incidence = 4.7%
- Chae S et al. J Am Coll Cardiol 2007;50:1781-7 ➔ incidence = 8.5%
- Ouyang F et al. Circulation 2005;111:127-35 ➔ incidence = 29.0%

Incidence higher with circumferential or linear LA ablation as compared to PV ostium or PV antrum ablation: 17% vs. 1% (Katritsis et al. JICE 2006;16:123-30)
EP & arrhythmia mechanisms
‘Non re-entrant AT’

‘Re-entrant AT’
Reentrant or not reentrant: that may NOT be the question!
Focal or not focal: that is the question!

for arrhythmia ablation purpose...
How to ablate reentrant left atrial tachycardia?

Where is the arrhythmia ‘weak point’?
LAT in Virgin Atria
Case Study #1

- 36 year-old woman / no structural HD
- No evidence of documented AF.
- Symptoms = dyspnea on exercise
- Drug-refractory atrial tachycardia
- Patient referred for atrial tachycardia ablation
12-lead ECG during atrial tachycardia
**Step 1: check for ECG characteristics**

Leads II, III and aVF differentiate superior from inferior foci. (Tang et al. JACC Nov 2008-11-05)

The sensitivity and specificity of a positive P wave in lead V1 in predicting a left atrial focus was 93% and 88%
**Step 2: Mapping during AT**
Step 3: Ablation of AT
LAT in Non-Virgin Atria
Case Study #2

- 46 year-old man / no structural HD
- Persistent atrial fibrillation for 6 years
- Symptoms = dyspnea on exercise
- Drug-refractory = amiodarone + flecainide
- Patient referred for atrial fibrillation ablation
  
  PV isolation + roof line + CS line + CFAE ablation ...
  
  Atrial fibrillation transformed into AT ➔ cardioversion

- 9 months later ... referred for left AT ablation
12-lead ECG during atrial tachycardia
Spontaneously induced & self-terminating episode
Episode induced and terminated by programmed atrial stimulation
Step 1: check whether PV conduction has recovered

LSPV

LIPV
Step 2: PV isolation
After the LSPV was disconnected ...
... SR resumed and AT was no longer inducible
Comments
Recovered Pulmonary Vein Conduction as a Dominant Factor for Recurrent Atrial Tachyarrhythmias After Complete Circular Isolation of the Pulmonary Veins
Lessons From Double Lasso Technique

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Background—Atrial tachyarrhythmias (ATa) can recur after continuous circular lesions (CCLs) around the ipsilateral pulmonary veins (PVs) in patients with atrial fibrillation (AF). This study characterizes the electrophysiological findings in patients with and without ATa after complete PV isolation.

Methods and Results—Twenty-nine of 100 patients had recurrent ATa after complete PV isolation by use of CCLs during a mean follow-up of $\approx 8$ months. A repeat procedure was performed in 26 patients with ATa and in 7 volunteers without ATa at 3 to 4 months after CCLs. No recovered PV conduction was demonstrated in the 7 volunteers, whereas recovered PV conduction was found in 21 patients with recurrent ATa (right-sided PVs in 9 patients and left-sided PVs in 16 patients). The interval from the onset of the P wave to the earliest PV spike was $157 \pm 66$ ms in the right-sided PVs and $149 \pm 45$ ms in the left-sided PVs. During the procedure, PV tachycardia activated the atrium and resulted in atrial tachycardia (AT) in 10 patients. All conduction gaps were successfully closed with segmental RF ablation. After PV isolation, macroreentrant AT was induced and ablated in 3 patients. In the 5 patients without PV conduction, focal AT in the left atrial roof in 2 patients and non-PV foci in the left atrium in 1 patient were successfully abolished; in the remaining 2 patients, no ablation was performed because of noninducible arrhythmias. During a mean follow-up of $\approx 6$ months, 24 patients were free of ATa without antiarrhythmic drugs.

Conclusions—In patients with recurrent ATa after CCLs, recovered PV conduction is a dominant finding in $\approx 80\%$ of patients and can be successfully eliminated by segmental RF ablation. Also, mapping and ablation of non-PV arrhythmias can improve clinical success. (Circulation. 2005;111:127-135.)
Why should PV be the first target?

Epidemiology: Hamburg paper on PV 'responsibility' in AT following atrial fibrillation ablation

PV musculature may be involved in the circuit or may be bystander and then fool the physician!

Mapping (and understanding !) a PV circuit is difficult, even with a multipolar array catheter
Case Study #3

- 64 year-old man / no structural HD
- Paroxysmal atrial fibrillation for 10 years
- Symptoms = palpitations & fatigue
- Drug-refractory = amiodarone + flecainide
- Patient referred for atrial fibrillation ablation
  ➔ Circumferential PV ablation
- 6 months later ... referred for left AT ablation
12-lead ECG during atrial tachycardia

Looks like atrial fibrillation, is not it?
Step 1 = PV isolation (here: all 4 veins)

No change: tachycardia goes on

Step 2 = 3D mapping of the tachycardia
LA mapping during AT
Comments
Macroreentry:

1. Circuit involving 3 or more segments of the atrium
2. 80 to 100% of the CL is mapped along the circuit
3. Good PPI in 3 or more segments

Definition proposed by the Bordeaux group

Example of entrainment of a peri-mitral circuit

Pacing site = anterior mitral annulus

PPI = TCL

Pacing site = close to the RSPV

PPI > TCL

Limitations:

Many other possible macro-reentry
Influence of previous RF sites ++ (patient dependent)
53 year-old man / Ischaemic HD
- Paroxysmal atrial fibrillation for 4 years
- Symptoms = dyspnea & fatigue
- Drug-refractory = amiodarone + B-blockers
- Patient referred for atrial fibrillation ablation
  ➔ Circumferential PV isolation (Ablation Frontier system)
- Incessant left AT during PV isolation.
Step 1: PV Isolation
Step 1: LA mapping
Peri-mitral atrial tachycardia
Step 2: LA mapping remapping
RPV related focal LAT
From macro-reentry to ‘small-loop’ reentry
Case Study #5

- 73 year-old woman / no structural HD

- Recurrent atrial tachycardia for 2 years
  
  Diagnosis = commun atrial flutter
  Treatment = cavotricuspid ablation

- Recurrences of AF/ atrial tachycardia episodes
  
  Diagnosis = ‘atypical’ atrial flutter
  EPS study consistent with a LA origin

- Patient referred for left AT ablation
LA mapping during SR
LA mapping during SR

Isochronal step = 20ms
Step 1 = PV isolation

Left veins

Right veins
ECG changes during PV isolation...
LA mapping during AT

Isochronal step = 20ms
LA mapping during AT
Ablation at endocardial breakthrough site
ECG changes after RF application ???

300ms

50.0 mm/sec
LA re-mapping during AT

Isochronal step = 20ms
Ablation at new endocardial breakthrough site

Second RF application zone
25mm
First RF application zone
ECG changes after RF application at this second site???
LA re-mapping during AT

Isochronal step = 20 ms

slow conduction
Ablation at new endocardial breakthrough site
ECG changes after RF application at this third site???
LA re-mapping during AT
LA re-mapping during AT

Isochronal step = 20ms
Ablation at new endocardial breakthrough site
ECG changes after RF application at this fourth site???
LA re-mapping during AT
then ablation at earliest site
ECG changes after RF application at this fifth site???
To summarize ...

‘Hunting’ a changing arrhythmia ...

![Diagram showing heart with annotations]
Comments
Focal Tachycardia:

1. Centrifugal activation to the other segments
2. Less than 70-80% of CL is recorded
3. PPI increases with increasing distance from the focal source

Definition proposed by the Bordeaux group
Focal AT is common in patients with history of documented atrial fibrillation

It is frequently (30-40%) observed during a chronic atrial fibrillation ablation procedure, after atrial fibrillation has been ‘organized’ by extensive RF applications

Not so easy to ablate when running after a ‘moving’ target!
Conclusions

1. Precise mapping is very important for effective ablation of LAT.

2. Accurate mapping starts from surface ECG (especially for idiopathic LAT), aided by classic entrainment and PPI measurements, and using 3-D mapping systems (for delineation of arrhythmogenic substrate).

3. In LAT following AF ablation, stepwise diagnostic approach, starting by ensuring PV isolation, excluding macroreentrant circuits and hunting the focal ones is the road map to successful ablation.

4. Be patient!