Catheter Ablation of Atrial Fibrillation

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Willem Einthoven and Sir Thomas Lewis
The first ECG in 1903
Willem Einthoven (Leiden/NL)
First ECG Documentation of „Auricular“ Fibrillation

"Dear Professor Einthoven,

By this post I am sending you some curves, experimental and clinical.

Please treat the curves I send as if they were your own."

Sir Thomas Lewis,
London, January 30, 1910
The Nature of Auricular Fibrillation

Definition:

“conspicuous and continuous oscillations of varying form and dimensions, and of auricular origin, in ECG leads from the limbs.”

Mechanism:

“in general the whole auricular surface is covered by the same excitation wave or offshoots from it.”

Sir Thomas Lewis, Heart 1921; 8: 193-227
Atrial Fibrillation

*Increased prevalence in the elderly*

Growing Epidemic of Atrial Fibrillation

Miyasaka et al, Circulation 2006
SPONTANEOUS INITIATION OF ATRIAL FIBRILLATION BY ECTOPIC BEATS ORIGINATING IN THE PULMONARY VEINS
- Mapping of 45 patients with paroxysmal AF
- AF originating in 94% in pulmonary veins
- Response to local radiofrequency ablation

Pulmonary Vein = Trigger

Electrical Isolation of Pulmonary Veins by RF Ablation

Steerable Ablation Catheter
(uni-/bi-directional)
Circular Mapping Catheter
Procedural Endpoint: Pulmonary Vein Isolation
Pulmonary Vein Isolation: Cornerstone of AF Ablation

- Point-by-point RF lesions
- Encircling 2 left and 2 right PVs
- Irrigated RF ablation catheter
- Circular mapping catheter
- 3-dimensional mapping system
- Integration of pre-acquired MRI/CT image of left atrium/PVs

Mapping System CARTO™
„GPS navigation within the heart“

Navistar® mapping- and ablation-catheter
Electro-Anatomical 3D-Mapping

CARTO™

Posterior view
3D-Mapping + Image-Integration

CARTO™

Posterior view

CT
3D-Mapping + Image-Integration

CARTO™

Posterior view
3D-Mapping + Image-Integration

CARTO™

CT

Posterior view
„Merge“ of CT and Map

CARTO™ + CT

Anterior view

Posterior view
Success Rates?
RF Ablation versus AAD

- n=167
- 19 hospitals
- Paroxysmal AF
- ≥ 1 AAD failed
- After 9 months: no AF

66% in ablation arm
16% in AAD arm

Quality of Life Assessment from Baseline to 3 Months

Success Rates of Pulmonary Vein Isolation for Paroxysmal AF

## Randomized Trials Ablation versus AAD

<table>
<thead>
<tr>
<th>Study</th>
<th>Reference</th>
<th>Patients (n)</th>
<th>Age, years</th>
<th>Type of AF</th>
<th>Previous use of AAD</th>
<th>Ablation technique</th>
<th>Repeat ablation in the ablation group</th>
<th>Crossed to ablation in the AAD group</th>
<th>AF free at 1 year</th>
<th>Ablation</th>
<th>AAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kristynsphong et al.2003</td>
<td>Online</td>
<td>30</td>
<td>55 ± 10 (ablation) 47 ± 15 (AAD)</td>
<td>Paroxysmal, persistent</td>
<td>≥1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>PVI + LA lines + CTI ablation + RA lines</td>
<td>Not stated</td>
<td>Not stated</td>
<td>79%</td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td>Wazni et al. 2005 (RAAFT)</td>
<td>134</td>
<td>70</td>
<td>53 ± 8 (ablation) 54 ± 8 (AAD)</td>
<td>Mainly paroxysmal</td>
<td>No</td>
<td>PVI</td>
<td>12&lt;sup&gt;5&lt;/sup&gt;</td>
<td>49&lt;sup&gt;c&lt;/sup&gt;</td>
<td>87%</td>
<td>37%</td>
<td></td>
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<tr>
<td>Sabikie et al. 2005 (CACAFA)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>Online</td>
<td>245</td>
<td>62 ± 9 (ablation) 62 ± 10 (AAD)</td>
<td>Paroxysmal, persistent</td>
<td>≥2</td>
<td>PVI + LA lines + CTI ablation</td>
<td>No exact data</td>
<td>57%</td>
<td>56%</td>
<td>9%</td>
<td></td>
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<tr>
<td>Oral et al. 2006&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Online</td>
<td>245</td>
<td>57 ± 9</td>
<td>Persistent</td>
<td>≥1 (mean 2 ± 1.2)</td>
<td>CPVA</td>
<td>16% for AF; 6% for LA flutter</td>
<td>77%</td>
<td>74%</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>Pappone et al. 2006 (APAF)</td>
<td>135</td>
<td>198</td>
<td>55 ± 10 (ablation) 57 ± 10 (AAD)</td>
<td>Paroxysmal</td>
<td>≥2 (mean 2 ± 1)</td>
<td>CPVA + CTI ablation</td>
<td>6% for AF; 3% for atrial tachycardia</td>
<td>42%</td>
<td>86%</td>
<td>21%</td>
<td></td>
</tr>
<tr>
<td>Jais et al. 2008 (A4 study)</td>
<td>133</td>
<td>112</td>
<td>51 ± 11</td>
<td>Paroxysmal</td>
<td>≥1</td>
<td>PVI ± LA lines + CTI ablation</td>
<td>Mean 1.8 ± 0.8, median 2 per patient</td>
<td>63%</td>
<td>89%</td>
<td>21%</td>
<td></td>
</tr>
<tr>
<td>Forleo et al. 2008&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Online</td>
<td>70</td>
<td>63 ± 9 (ablation) 65 ± 6 (AAD)</td>
<td>Paroxysmal, persistent</td>
<td>≥1</td>
<td>PVI ± LA lines + CTI ablation</td>
<td>Not stated</td>
<td>Not stated</td>
<td>80%</td>
<td>41%</td>
<td></td>
</tr>
<tr>
<td>Wilber et al. 2010 (Thermocool)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>96</td>
<td>167</td>
<td>55.5 (ablation) 56.1 (AAD)</td>
<td>Paroxysmal</td>
<td>≥1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>PVI ± LA lines ± CFAEs ± CTI ablation ± RA lines</td>
<td>12.6% within 80 days after 1st procedure&lt;sup&gt;d&lt;/sup&gt;</td>
<td>59&lt;sup&gt;c&lt;/sup&gt;</td>
<td>66%</td>
<td>16%</td>
<td></td>
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<tr>
<td>Packer et al. 2010 (STOP-AF)</td>
<td>Online</td>
<td>245</td>
<td>56.7 (ablation) 56.4 (AAD)</td>
<td>Paroxysmal</td>
<td>≥1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Cryo-PVI ± LA lines</td>
<td>19% within 90 days after 1st procedure</td>
<td>79%</td>
<td>69.9%</td>
<td>7.3%</td>
<td></td>
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</tbody>
</table>

Success Rates?

• Patient selection
  • Type of AF (paroxysmal, persistent, or long-lasting persistent)
  • Comorbidities (obesity, sleep apnea)

• Ablation strategy

• Definition of success
  
  *HRS consensus*: „freedom of symptomatic or asymptomatic AF, atrial tachycardia, or atrial flutter lasting ≥30s one year following AF ablation“

• Duration of rhythm monitoring

• Duration of F/U

• Small randomized clinical data from highly experienced centers
Ablation as First-Line Therapy for AF

- Prospective, randomized
- n=70 (19 hospitals)
- Paroxysmal AF
- Flecainide, sotalol

- No AF after 12 months
  - 87% in RF group
  - 37% in AAD group

- Hospitalization rate
  - 9% in RF group
  - 54% in AAD group

Success Rates of Ablation in Patients with Chronic AF?
Pulmonary Vein Isolation for Persistent AF

AF – Progressive Atrial Cardiomyopathy

Right time for ablation?

Electrical and structural remodelling

- SR/5% fibrosis
- CPAF/14% fibrosis
- CAF/35% fibrosis
Trigger and Substrate

Paroxysmal

Persistent

Permanent

Trigger/Initiation

Substrate/Maintenance

Significance

AF duration
Left Atrium = “Substrate” for Chronic AF

Ganglionic plexi

Wavelets, drivers, rotors

Non-PV triggers

Common Lesion Sets in AF ablation

PVI
+
Substrate Modification

for Chronic AF

Stepwise Ablation Approach for Chronic AF

Long Term Success Rates?
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100 patients
175 procedures
63% paroxysmal AF
F/U 5 years
40%, 37% and 29% success rates after 1, 2 and 5 years

Long Term Success Rates?

100 patients
175 procedures
63% paroxysmal AF
F/U 5 years
87%, 81% and 63% success rates after 1, 2 and 5 years

Risks of AF Catheter Ablation

- **Pulmonary vein stenosis (<1%)**
  Avoidance of ablation inside of PV

- **Pericardial tamponade (1-2%)**
  Percutaneous drainage

- **Thromboembolism (1%)**
  TEE beforehand, anticoagulation during and after procedure

- **Atrio-esophageal fistula (<1:10.000)**
  Esophageal monitoring during procedure, energy reduction, antacids

- **Vascular access complication**

- **Left-atrial flutter (Pro-arrhythmia)**
  Redo procedure

→ Total = 2-4 %

Bertaglia et al., Heart Rhythm 2007
Technical Advancements

- Energy sources
- Application
- Mapping
- Remote catheter control
- and much more
Point-by-point ablation

Single-shot ablation by balloon shaped catheter

Cryoballoon Catheter

Arctic Front® (Medtronic CryoCath LP Ltd.)
Energy Delivery Visually Guided

Multielectrode Ablation Catheter

Rotational Angiography

Remote Magnetic Catheter Navigation

NIOBE magnetic navigation system (Stereotaxis Inc., USA)
Remote Robotic Catheter Navigation

Sensei robotic navigation system
(Hansen Medical, USA)
Catheter Contact Measurement

SENSORS receive transmitter coils location signal and micro-movements of the spring.

PRECISION SPRING allows small amount of electrode deflection.

Ring Spacing: 1-7-2

TRANSMITTER coil in the tip sends location reference signal.
Good candidates for AF ablation?
AF Ablation in the Elderly

Ablation of atrial fibrillation after the retirement age: considerations on safety and outcome

Laurent M. Haegeli · Fırat Duru · Evan E. Lockwood · Thomas F. Lüscher · Laurence D. Sterns · Paul G. Novak · Richard A. Leather

Abstract

Background Although the incidence of atrial fibrillation (AF) progressively increases with age, the vast majority of AF ablation is done in middle-aged patients. We evaluated the feasibility and safety of catheter ablation in patients older than 65 years of age with paroxysmal and persistent AF.

Methods Out of a total of 230 consecutive AF ablation procedures, 45 patients were older than 65 years of age and underwent 53 procedures. The ablation strategy consisted of wide-area circumferential lines around both ipsilateral pulmonary veins using a three-dimensional mapping system.

Results The mean age was 69±3.5 years (35 males). The mean duration for AF was 8.7±6.5 years. Thirty-nine had paroxysmal and six persistent AF despite use of 1.38±0.77 antiarrhythmic drugs. All patients had a structurally normal heart. Eleven had systemic hypertension. Mean procedure time was 187±33 min. Acute procedural success rate with abolition of all pulmonary vein potentials was achieved in all patients. Pericardial tamponade requiring percutaneous drainage occurred in one (1.9%) patient. There were no cardioembolic events. Among the 43 patients whose clinical outcome was assessed at 6 months, 34 (79%) had a significant reduction (>90%) of the total symptomatic AF

Table 3  Procedural statistics

<table>
<thead>
<tr>
<th></th>
<th>n=53</th>
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<tbody>
<tr>
<td>Average procedure time (minutes)</td>
<td>187±33</td>
</tr>
<tr>
<td>Fluoroscopy time (minutes)</td>
<td>43±12</td>
</tr>
<tr>
<td>Major complications</td>
<td>None</td>
</tr>
<tr>
<td>Thromboembolic event and stroke</td>
<td>None</td>
</tr>
<tr>
<td>Pericardial tamponade</td>
<td>1 (1.9%)</td>
</tr>
<tr>
<td>Vascular access complications</td>
<td>None</td>
</tr>
</tbody>
</table>

ACT activated clotting time, IU international units

J Interv Card Electrophysiol
DOI 10.1007/s10840-010-9490-8
2011 ACC/AHA/HRS Guidelines

Maintenance of Sinus Rhythm

- No (or minimal) heart disease
  - Dronedarone
  - Flecaïnide
  - Propafenone
  - Sotalol
    - Amiodarone
    - Dofetilide
    - Catheter ablation

- Hypertension
  - Substantial LVH
    - No
      - Dronedarone
      - Flecaïnide
      - Propafenone
      - Sotalol
        - Amiodarone
        - Dofetilide
        - Catheter ablation
    - Yes
      - Amiodarone

- Coronary artery disease
  - Dofetilide
  - Dronedarone
  - Sotalol
    - Amiodarone
    - Catheter ablation

- Heart failure
  - Amiodarone
  - Dofetilide
  - Catheter ablation

Indications for Catheter Ablation of AF

- Symptomatic patients with paroxysmal and persistent atrial fibrillation!
Indications for Catheter Ablation of AF

- Symptomatic patients with paroxysmal and persistent atrial fibrillation!

- After one antiarrhythmic drug failure

- No indications are:
  - asymptomatic patients with AF
  - patient wish to discontinue anticoagulation
Summary

• Catheter ablation of atrial fibrillation has become an established therapy in cardiology

• **Success rates** for paroxysmal atrial fibrillation are **70-90%** (with 1-2 procedures)

• Major complications occur in 2-3 %
Auricular fibrillation!
It's a pity that it cannot be treated.

100 Years Ago
Today  Yes, We Can!
Thank you!