Catheter and Surgical Ablation of Atrial Fibrillation

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Pathogenesis of AF

Focal triggers and a susceptible substrate $\rightarrow$ AF
Pulmonary veins are the crucial source of triggers that initiate AF

Haissaguerre, NEJM 1998
Aim:
1. Eliminate PV trigger
2. Alter arrhythmogenic substrate

⇒ Pulmonary vein isolation
Catheter ablation technique 1

“Point by point” RF ablation lesions

Uses electroanatomical mapping system

Multipolar electrode catheter used to confirm isolation of pulmonary veins
Catheter ablation technique 2

Uses cardiac cryoballoon

Freezes tissue to −80 degrees Celsius

No need for mapping system

Endpoint is pulmonary vein isolation

Await results of Fire and ICE trial (2014)...
An Investigator Initiated, Randomized, Open, Blinded Outcome Assessment, Comparing Efficacy and Safety of Isolation of the Pulmonary Veins With a Cryoballoon Catheter Versus a RF Ablation With a ThermoCool Catheter in Patients With PAF
## Indications for catheter ablation of AF

<table>
<thead>
<tr>
<th>Indications</th>
<th>Class</th>
<th>Level</th>
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<tr>
<td>Symptomatic AF refractory or intolerant to at least one Class 1 or 3 antiarrhythmic medication</td>
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<td>I</td>
<td>A</td>
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<td>IIa</td>
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<td>C</td>
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<td>IIb</td>
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Outcomes

Pulmonary vein isolation:
- AF reduction
- Improve symptoms of AF

Improve QOL

Decrease stroke
Decrease heart failure
Improve survival

Await CABANA, EAST trial results
**Efficacy**

<table>
<thead>
<tr>
<th>Study</th>
<th>Experimental Events</th>
<th>Control Total Events</th>
<th>M-H, Random [95% CI]</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Krittayaphong et al. [8]</td>
<td>3</td>
<td>15</td>
<td>0.33 [0.11, 0.99]</td>
<td>2003</td>
</tr>
<tr>
<td>RAAFT [9]</td>
<td>4</td>
<td>33</td>
<td>0.20 [0.08, 0.53]</td>
<td>2005</td>
</tr>
<tr>
<td>APAF [12]</td>
<td>14</td>
<td>99</td>
<td>0.19 [0.11, 0.31]</td>
<td>2006</td>
</tr>
<tr>
<td>Oralet et al. [11]</td>
<td>25</td>
<td>77</td>
<td>0.42 [0.30, 0.60]</td>
<td>2006</td>
</tr>
<tr>
<td>CACAF [10]</td>
<td>30</td>
<td>68</td>
<td>0.48 [0.37, 0.64]</td>
<td>2006</td>
</tr>
<tr>
<td>A4 [14]</td>
<td>7</td>
<td>53</td>
<td>0.19 [0.09, 0.38]</td>
<td>2008</td>
</tr>
<tr>
<td>PABA-CHF [13]</td>
<td>8</td>
<td>41</td>
<td>0.20 [0.11, 0.37]</td>
<td>2008</td>
</tr>
<tr>
<td>Forleo et al. [15]</td>
<td>7</td>
<td>35</td>
<td>0.35 [0.17, 0.72]</td>
<td>2009</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>421</td>
<td>423</td>
<td>0.29 [0.20, 0.41]</td>
<td></td>
</tr>
<tr>
<td>Total events</td>
<td>98</td>
<td>324</td>
<td></td>
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</tr>
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Heterogeneity: $\chi^2 = 22.47$, df = 7 ($P = 0.002$); $I^2 = 69$

Test for overall effect: $Z = 6.91$ ($P < 0.00001$)

**Paroxysmal AF who have failed 1 AAD**

Catheter ablation is successful in about 60–70% of patients
(Reduces recurrent AF by 71% compared to AAD)

Bonanno, J Cardiovasc Medicine 2010
Rationale for AF ablation as initial therapy

No difference in AF burden between the 2 groups within first 2 years

Ablation group had lower AF burden and better QOL at 2 years

85% (ablation) versus 71% (AAD) free of AF at 24 months

Nielsen et al., NEJM 2013
## Safety

<table>
<thead>
<tr>
<th>Type of Complication</th>
<th>No. of Patients</th>
<th>Rate, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>25</td>
<td>0.15</td>
</tr>
<tr>
<td>Tamponade</td>
<td>213</td>
<td>1.31</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>15</td>
<td>0.09</td>
</tr>
<tr>
<td>Hemothorax</td>
<td>4</td>
<td>0.02</td>
</tr>
<tr>
<td>Sepsis, abscesses, or endocarditis</td>
<td>2</td>
<td>0.01</td>
</tr>
<tr>
<td>Permanent diaphragmatic paralysis</td>
<td>28</td>
<td>0.17</td>
</tr>
<tr>
<td>Total femoral pseudoaneurysm</td>
<td>152</td>
<td>0.93</td>
</tr>
<tr>
<td>Total artero-venous fistulae</td>
<td>88</td>
<td>0.54</td>
</tr>
<tr>
<td>Valve damage/requiring surgery</td>
<td>11/7</td>
<td>0.07</td>
</tr>
<tr>
<td>Atrium-esophageal fistulae</td>
<td>6</td>
<td>0.04</td>
</tr>
<tr>
<td>Stroke</td>
<td>37</td>
<td>0.23</td>
</tr>
<tr>
<td>Transient ischemic attack</td>
<td>115</td>
<td>0.71</td>
</tr>
<tr>
<td>PV stenoses requiring intervention</td>
<td>48</td>
<td>0.29</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>741</strong></td>
<td><strong>4.54</strong></td>
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- Multi-national registry
- 5% major complication rate

Cappatto, Circ EP 2010
Long term results

Weerasooriya et al. JACC 2011

Single-centre experience
66% paroxysmal AF
100 patients underwent PVI
Major complications (3%)

Sustained results but 50% will require second ablation
Success rate of AF catheter ablation

Variables:
Type of AF (paroxysmal, persistent)
Structural heart disease
Co-morbidity

Definition of success = marked reduction in the AF burden associated with a reduction of symptomatic AF

Duration of follow-up
Surgical ablation of AF

- Dr James Cox developed the Maze Procedure – first performed in 1987 at Barnes Jewish Hospital in US

- Incisions in the right and left atria to interrupt multiple macro-reentrant circuits preventing fibrillation
The Cox Maze Procedure: Evolution of the Surgical Approach

- The Cox Maze I was abandoned because of a high incidence of chronotropic incompetence and pacemaker implantation

- The Cox Maze II was replaced because of it’s technical difficulty

- The Cox Maze III has remained the gold standard since 1988 and has extraordinary long term efficacy
Cox–Maze III

“Cut and sew”
Biatrial incisions
“Mini–Maze”
**Cox–Maze III experience**


- 198 underwent procedure
  - 112 for lone AF
  - 86 with valve or coronary surgery

- 64% paroxysmal AF (lone AF)
- 52% paroxysmal AF (other)

Over 5 year follow-up:
- 96%–97% were free of AF (70–80% drug free)

**Cox–Maze III procedure is very effective**

J Thorac Cardiovasc Surg 2003
Persistent AF > 1 month
Efficacy less with structural heart disease

Kim, Eur J Cardiothorac surg 2007
Shortcomings of the COX–MAZE III

- NOT WIDELY ADOPTED
- Requires cardiopulmonary bypass and an arrested heart
- Adds to cross-clamp time (adds 93 minutes…)
- Few surgeons perform the operation due to its’ complexity
- Longer hospital stays
- Significant morbidity
  - pacemaker requirement (15%)
The Cox Maze Procedure: Goals of a Less Invasive Approach

- Preserve the high success rates of the Cox–Maze III procedure while decreasing its’ morbidity
- Simplify and/or decrease the number of atrial incisions to shorten the procedure and increase its’ adoption rate among surgeons
- Replace surgical incisions with linear lines of ablation using various energy sources:
  - Cryosurgery
  - Radiofrequency
  - Microwave
  - Laser
  - Ultrasound
Radiofrequency energy

- similar to electrocautery
- very fast AC current
- monopolar or bipolar
- irrigated or non-irrigated
- Significantly reduces procedure times compared to Cox–Maze III
COX–MAZE IV


198 underwent procedure
- 101 for lone AF
- 99 with valve or coronary surgery

• Bipolar RF ablation

At 1 year follow-up, 77% were free of AF and AADs at 1 year

Cox–Maze IV procedure has now replaced Cox III procedure

Ann Thorac Surg 2012
Single RCT showed that SICTRA was effective in restoring sinus rhythm in patients undergoing MVR and persistent AF.

80% AF free at 12 month follow-up

Filfo et al. Circulation 2005
Cox–Maze Procedure
Patient Populations

- Lone atrial fibrillation
- Atrial fibrillation in association with organic heart disease:
  - valvular heart disease
  - ischemic heart disease
Valvular and Ischaemic heart disease

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HRS/EHRA guidelines 2012
# Stand–alone AF ablation

Indications for stand alone surgical ablation of AF

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HRS/EHRA guidelines 2012
Cox–Maze Procedure for AF
Postoperative Management

- **Diuretics**
  - Lasix
  - Spironolactone

- **Coumadin**
  - 3 months
  - Discontinue if in NSR

- **Anti-arrhythmic drugs**
  - 2 months
  - Discontinue if in NSR

- **Postoperative sinus node dysfunction**
  - 10 – 15% of patients
  - Wait 7–10 days before implanting pacemaker
Management of Atrial Fibrillation

- Symptomatic
- Asymptomatic

- Rate control
  - Ablation/Device-therapy
  - Rhythm control (antiarrhythmics drugs)

- Persistent
- Paroxysmal
- Permanent

Auer, Europace 2010