The Decision Tree for Ablation Therapy in Atrial Fibrillation

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Catheter Based Therapy for AFIB

Why?
Epidemiology of Atrial Fibrillation

- Risk for developing AFIB is 1 in 4 men and women over >40 years of age
- Most common sustained cardiac arrhythmia
- AFIB is associated with more hospitalizations than any other arrhythmia
- Prevalence: AF affects > 2.9 million in USA
- Incidence: 160,000 new cases dx per year

Clinical Consequences of AFIB

- Symptomatic
  - Palpitations, dyspnea, fatigue, chest pain, lightheadedness
- Cerebrovascular accident
  - 15% of all strokes
  - Incidence of all cause stroke in AFIB is 5%
  - greater severity….2.23 Odds ratio for bedridden state
Clinical Consequences of AFIB

- Heart failure
  - Tachycardia mediated cardiomyopathy
  - Exacerbates heart failure

- Impaired quality of life

- Increased mortality
  - 2 to 3 fold increase in mortality

Treating Atrial Fibrillation

- 30% of all AF patients are left undiagnosed
- 70% of AF patients are suitable for treatment

  - Rhythm Control
    - Suppressive (Anti arrhythmic Drug) Therapy
      - 50% effective

  - Rate Control therapy
Treatment for Atrial Fibrillation

- Why are there more than 5 Antiarrhythmic Drugs for the treatment of AFIB?

- Answer: Not one of them is universally effective!

Drug Therapy for Prevention of Recurrent Atrial Fibrillation

[Graph showing effectiveness of different drugs over time]

Rate Control Strategy: AFFIRM

![Graph showing cumulative mortality over years for rhythm control and rate control.](image)

<table>
<thead>
<tr>
<th>Years</th>
<th>Rate control</th>
<th>Rhythm control</th>
</tr>
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<tbody>
<tr>
<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>1</td>
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<tr>
<td>2</td>
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<td>4</td>
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<td>20</td>
</tr>
<tr>
<td>5</td>
<td>25</td>
<td>25</td>
</tr>
</tbody>
</table>

- P = 0.08

Flaws in Rate Control Strategy

- Minimize symptoms related to atrial fibrillation
- Committing young patients without heart disease to lifelong drug therapy and anticoagulation [outcome unknown!!]
- Forcing patients to accept rate controlling drug side effects [fatigue, ED, constipation, orthostasis]
- Organ toxicity [amiodarone] and proarrhythmia [dofetilide - SCD]
Rate-control vs. Rhythm-control Strategy

 AFFIRM: Predictors of Mortality

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Risk Ratio</th>
<th>95% CI</th>
<th>P-value</th>
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</thead>
<tbody>
<tr>
<td>Sinus Rhythm</td>
<td>0.54</td>
<td>0.42 - 0.7</td>
<td>&lt;0.001</td>
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<tr>
<td>Warfarin</td>
<td>0.47</td>
<td>0.36 - 0.64</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Digoxin</td>
<td>1.50</td>
<td>1.18 - 1.89</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>AA Drugs</td>
<td>1.41</td>
<td>1.10 - 1.83</td>
<td>&lt;0.005</td>
</tr>
</tbody>
</table>

*Other significant factors in model: age, CAD, CHF, smoking, stroke/TIA, normal LVEF, MI.


The Promise of Catheter Ablation

- Curative procedure
  - Effectively maintain sinus rhythm
- Avoid side effects of AADs
  - Improve left ventricular function
  - Improve Quality of Life
  - Reduce mortality
What does Catheter Ablation Provide?

- Tissue destruction
  - Point lesions
  - Non-linear/non-contiguous lesions

Can AFIB be cured by destroying atrial tissue?

- What is the mechanism of AFIB?
- What tissue needs to be destroyed?
- Can catheter ablation lesions be?
  - Reliable
  - Reproducible
  - Safe
“Learning by Burning”

What do we know?
Atrial Fibrillation

Natural History of Paroxysmal AF
PACs initiating Paroxysmal AF

SPONTANEOUS INITIATION OF ATRIAL FIBRILLATION BY ECTOPIC BEATS ORIGINATING IN THE PULMONARY VEINS

MICHÉL HABSAUGUIRE, M.D., PIERRE JANS, M.D., DIPEN C. SHAH, M.D., ATSUSHI TAKAHASHI, M.D., MELEZE HOCIN, M.D., GILLES QUINOU, M.D., STEPHANE GARRIOUX, M.D., ALAIN LE MOIRER, M.D., PHILIPPE LE MEYER, M.D., AND JACQUES CLEMENNY, M.D.

Conclusion: The pulmonary veins are an important source of ectopic beats, initiating frequent paroxysms of atrial fibrillation. These foci respond to treatment with radio-frequency ablation. (N Engl J Med 1995;333:659-66.)

©1995, Massachusetts Medical Society.
Mechanism of Paroxysmal AFIB

Focal Triggers

This procedure ablates foci (trigger sites) thought to be responsible for initiation of AF.

Care must be taken to avoid ablating within pulmonary veins to avoid potential complication of pulmonary vein stenosis.

Pulmonary Vein Isolation
Encircling Ostial Ablation Isolating PV Triggers
- Segmental or circumferential lesions placed at ostia of the pulmonary veins (PV)
- Highly effective ablation strategy for paroxysmal AFIB

Persistent and Chronic AFIB
- Why is Pulmonary Vein Isolation alone Less effective?
  - Technical issue
    - Unable to accomplish PVI
  - Mechanistic issue
Technical Innovations

- **Visualization**
  - 3D Mapping systems – ESI and CARTO
  - Merging with CT angiograms, MRI
  - Intracardiac ECHO

Advanced Mapping Tools
Technical Innovations

Lesion creation
- Large tip catheters – 8mm
- Irrigated catheters – Chili and Thermocool
- Balloon catheters – Cryocath, Laser, HIFU
- Multipolar – Ablation Frontiers
- Contact Force catheter

Catheter Manipulation
- Deflectable catheters and sheaths

Robotics catheter
- Hansen
  - Hansen Stereotaxis
- Stereotaxis
Mechanistic issues

Multiple Wavelet Hypothesis

HRS Expert Consensus Statement 2007

Mechanistic issues

Non Pulmonary Vein Triggers

Non PV triggers for atrial fibrillation

Marchlinski et al.
Mechanistic issues

If PVI is inadequate what else can we destroy? “substrate modification”

- Multiple Wavelet Hypothesis
  - Linear lesions
    - Reproduce the MAZE
    - Destroy atrial tissue that may allow atrial tachycardias
  - Continuous Fractionated Atrial Electrograms
    - Destroy atrial tissue displaying disorganized electrical activity
    - Constituting 40% of the atrium

- Non Pulmonary Vein Triggers
  - Other Thoracic Vein Triggers - LOM, SVC, Coronary sinus

- Destroy the ganglionic plexi
- Target Rotors
MAZE III for persistent AFIB

Critical number of reentrant wavelets

Critical mass of atrial tissue

Ablation Methods
Complex Fractionated Electrograms

Organized E-gram

More Complex E-gram

Nademane et al.

GPs + CFAE

CAFE and Ganglionic Plexi

Anterior Right GP  Superior Left GP  Superior Left CFAE

Anterior Right CFAE  Inferior Posterior CFAE  Inferior Left GP

PAO View  PA View
If smart bombs do not work then...

- Resort to... carpet bombs

Hybrid Approach
Complications

- Vascular access
- Coagulation
- Lesion delivery
- Collateral Damage

Pulmonary Vein Stenosis
Cardiac Tamponade

Phrenic nerve paralysis
Atrio-Esophageal Fistula

Ablating the Esophagus?
Cerebrovascular accident

What are the Outcomes?
Classification of Atrial Fibrillation

- **Paroxysmal**
  - Self-terminating, usually <48 hours

- **Persistent**
  - Lasts > 7 days, requires CVN

- **Long-standing persistent**
  - Lasts > 1 year

- **Permanent**
  - Presence of arrhythmia is accepted as permanent

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Figure 3. Efficacy of catheter ablation in patients with AF.


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Efficacy of Catheter Ablation vs ADT
Paroxysmal AFIB

Kaplan-Meier curve of time to recurrence of symptomatic atrial arrhythmia following second line antiarrhythmic drug therapy (ADT)

Patients who had catheter ablation have fewer episodes of Afib than patients who took medication

RF Catheter Ablation is Safe and Effective in Octogenarians

- Up to 10% of people over 80 years of age have AF
- Up to 25% of strokes in this group are due to AF
- This study compared safety and efficacy of RF ablation in two groups; greater and less than 80 years of age
- Success rates and complications were similar between the two groups

**From: Catheter Ablation of Long-Standing Persistent Atrial Fibrillation: 5-Year Outcomes of the Hamburg Sequential Ablation Strategy**

Kaplan-Meier event-free survival curve after the first procedure (blue line) and after the last procedure (red line). Plus sign (+) indicates censored. Numbers at bottom indicate patients at risk. ATa = atrial tachyarrhythmia.

**Figure Legend:**

Single and Multiple Procedure Outcomes

**From: Paroxysmal AF Catheter Ablation With a Contact Force Sensing Catheter: Results of the Prospective, Multicenter SMART-AF Trial**

Investigators working in their selected ranges $\geq80\%$ of the time during radiofrequency application demonstrated a significant increase of 15% in the effectiveness success at 12 months compared to those working in their selected ranges $<80\%$ of the time (effectiveness cohort, $n = 122$).

**Figure Legend:**

Kaplan-Meier Curve of Time to First Atrial Fibrillation/Atrial Flutter/Atrial Tachycardia Recurrence Through 12 Months
Why is RFA not more common?

- 33% Complications
- 5% Success
- 62% Recurrence

Why is AF Ablation not always effective?

- Atrial fibrillation is not one disease
- We do not yet understand the underlying mechanism
- Technical challenge
Mechanism of AFIB 2015

- AF requires a trigger and susceptible substrate

Goal of catheter ablation:
- Eliminate the triggers and alter the arrhythmogenic substrate

Who is a Good Candidate for a Catheter –Based Ablation

- Frequent symptomatic atrial fibrillation

- Limited structural heart disease
  - LA < 5cm, no significant mitral valvular disease

- Younger patient

- Medically refractory/intolerant

- First line therapy [occupation or declines AAD Rx]
Caution! Anticoagulation

- AFIB ablation should not be performed with the sole intent to obviate the need for anticoagulation.

- AFIB ablation cannot be performed in patients who cannot be anticoagulated.
Indications for Catheter Ablation of AF

<table>
<thead>
<tr>
<th>Class</th>
<th>Level</th>
<th>Indications for Catheter Ablation of AF</th>
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<tbody>
<tr>
<td>I</td>
<td>A</td>
<td>Symptomatic AF refractory or intolerant to at least one Class 1 or 3 antiarrhythmic medication</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Paroxysmal: Catheter ablation is recommended*</td>
</tr>
<tr>
<td>IIA</td>
<td>A</td>
<td>Persistent: Catheter ablation is reasonable</td>
</tr>
<tr>
<td>IIB</td>
<td>B</td>
<td>Longstanding Persistent: Catheter ablation may be considered</td>
</tr>
<tr>
<td>IIA</td>
<td>B</td>
<td>Symptomatic AF prior to initiation of antiarrhythmic drug therapy with a Class 1 or 3 antiarrhythmic agent</td>
</tr>
<tr>
<td>IIB</td>
<td>C</td>
<td>Paroxysmal: Catheter ablation is reasonable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Persistent: Catheter ablation may be considered</td>
</tr>
</tbody>
</table>

2014 AHA/ACC/HRS Guidelines for the Management of Patients with Atrial Fibrillation
Case: Paroxysmal Atrial Fibrillation

- 55 yo WM with PAFIB since 2005
  - Originally precipitated by ETOH
  - Recurrent ER visits with *symptomatic* AFIB
  - Tx: Propafenone, Diltiazem and Rivoroxaban
  - Increasingly frequent events [6 per month]

- ECHO:
  - EF 55%, LA 4.7cm, mild MR, PAP 35mmHG
Case: Paroxysmal Atrial Fibrillation

- 45 yo WM
- PMH:
  - Presented with persistent atrial fibrillation 10 years ago. Treated with Propafenone, Diltiazem and ASA. No DM, HTN or Vascular disease
- Present:
  - No symptoms
  - Feels skipped beats when taking his pulse
  - Normal ECHO
  - Medications expensive and inconvenient

Case: Persistent Atrial Fibrillation

- 54 yo WF
- PMH:
  - PAFIB since 2009 ppted by ETOH
- Present:
  - Palpitations, SOB/dizziness
  - Persistent AFIB – Unsuccessful CVN
  - Loaded with flecainide/CVN returned in AFL
  - CVN to sinus with EF 40% on ECHO
  - Prolonged QT with dofetilide
  - Maintaining sinus rhythm on amiodarone
Case: AFIB of Unknown Duration

- 68 yo WM
  - Asymptomatic atrial fibrillation
  - Controlled ventricular response rate

- PMH:
  - Hypertension, Type II DM, no CAD

- Medications
  - Metoprolol, Lisinopril, Apixaban, Glucophage

- ECHO
  - EF 55%, Mild MR and LA 5.6cm