Atrial Fibrillation: An Odyssey

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Cardiac Electrophysiology
Objectives

• Review mechanisms underlying initiation and maintenance of atrial fibrillation.
• Summary of AADs for AF.
• Fundamentals of catheter-mediated therapies for AF.
• Progress:
  • Mapping
  • Energy Delivery
  • Targets
  • Efficacy
  • Safety
• Future directions in the field.
Role of Pulmonary Veins in Atrial Fibrillation

Hassiaguerre et al. NEJM 1998
Role of Pulmonary Veins in Atrial Fibrillation

Figure 1. Diagram of the Sites of 69 Foci Triggering Atrial Fibrillation in 45 Patients. Note the clustering in the pulmonary veins, particularly in both superior pulmonary veins. Numbers indicate the distribution of foci in the pulmonary veins.

Hassiaguerre et al. NEJM 1998
Natural History of Atrial Fibrillation

- Rate vs Rhythm Control
  - Age, Co-morbidities
- AADs 60-70% effective
- Paroxysmal
  - In/out
  - ~80% Success PVI
- Persistent
  - DCCV to terminate
  - ~60-70% Success PVI
- Permanent
  - No clear cut-off (2y?, 3y?)
  - Typically requires multiple procedures

Iwasaki et al. Circulation. 2011
Anti-Arrhythmic Drugs for AF made simple(r)

**PAROXSYMAL**

**SQUEAKY CLEAN**

Normal Heart, no CAD
- Class IC agents
  - Propafenone
  - Flecainide (*)
- Pro-arrhythmic if scar
- Avoid in athletes
- 1:1 flutter

**SOME ISSUES**

CAD, but EF normal
- Dronedarone (2009)
  - Avoid in HfP EF
- Sotalol (class III)
  - Renally cleared
  - QT prolonging, TdP
  - Potent BB

Severe LVH (>1.5cm)
- Mostly amio
- Sometimes sotalol

**SICK HEARTS**

Cardiomyopathy
- Amiodarone
  - Low prob TdP
  - Organ toxicity
- Dofetilide (class III)
  - Renally cleared
  - QT prolonging, TdP
  - No beta-blockade
  - P450 interactions

* Ruskin et al (CAST), NEJM. 1989
  Andersen et al. Europace. 2009
Mapping Then & Now: More than Pretty Pictures
Single-circuit Reentry (Patient w/ Prior PVI)
Single-circuit Reentry (Patient w/ Prior PVI)
Energy Delivery: Hot vs Cold

A Cryoballoon Ablation of Pulmonary Vein

B Radiofrequency Current Ablation of Pulmonary Vein

Comparison of Catheters

- First-generation cryoballoon
- Advanced-generation RFC
- First-generation RFC
- Second-generation cryoballoon

No. at Risk

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Enrolled 2012 - 2015

Kuck et al. (FIRE&ICE). NEJM 2016
Recent Cryo Balloon Data for Paroxysmal AFIB

- Documented Recurrence of 30s is defined as treatment failure

344 Patients
11 Phrenic Nerve Injuries (as above)
1 Stroke
3 effusions

Knight et al. (STOP AF Post Approval). JACC EP Dec 2018
Contact Force in Radio Frequency Ablation

- Contact Force & Efficacy
- Mixed data in RCTs
- Improved Success in Observational Studies
- Moving Target

Shurrab et al. JAHA. 2015
Moving Beyond Contact Force: Higher Efficacy

- Fifty patients with Paroxysmal Atrial Fibrillation
- At 12 months, single-procedure freedom from ATA was 94% in ‘CLOSE’ vs. 80% in ‘CONV-CF’ group ($P < 0.05$).
- Screening Holters at 3, 6, 12 months.
  - 30s AT/AF defined as failure
- Needs replication on a larger scale.
  - Learning curve
Future Directions in Pulmonary Vein Isolation
Hot Balloon, Laser, Electro-poration
**Current Dilemma: What to do for Persistent AF**

**Mechanisms of Atrial Fibrillation**

- Single source:
  - Automatic focus
  - Mother wave
  - Fixed rotor
  - Moving rotor

- Multiple source:
  - Multiple foci
  - Unstable circuits
  - Multiple wavelets
  - Focus + multiple wavelets

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**Focal Impulse & Rotor Modulation**
- TOPERA, not widely adopted; mixed results

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**Autonomic Modification**

- Superior Left GP
- Anterior Right GP
- Marshall Tract GP
- Inferior Left GP
- Inferior Right GP

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Stavrakis et al. JACC EP. 2015
Our Approach: Empiric Posterior Wall Isolation for Select Patients with Persistent AFIB

Sugumar et al. JCE. 2017
Katritsis et al. AER. 2014

Intentional Overlap with Sites of Ganglia
Incidence of Serious Complications

- Single Center (CCF) 10,000+ patients over 15 years.
- Serious Complications (0.9%)
  - Effusion 0.5%
    - 0.07% needed surgery
  - Stroke 0.3%
  - Vascular → Shock 0.06%
  - ACS 2 patients
  - No esophageal complications
    - Likely undetected / under-reported

Rehman et al. JACC EP. March 2019
"Epidemic" of Atrial Fibrillation

- ATRIA Study: 1.9 million pts → Cross-sectional in 1996.
- Prevalence: 1% overall
- 0.1% for <55yo → 9% for 80+
- Much more common in younger patients now than previously.

Wang et al. JAMA. 2004;292:2471 (Framingham)

Gami et al. JACC. 2007;49:565 (Olmstead)
Atrial Fibrillation & Systolic Heart Failure

Iwasaki et al. Circulation. 2011
Marrouche et al. (CASTLE-AF). NEJM. Feb 2018

CASTLE - AF

63% in sinus in Ablation Grp vs 22% @ 60 months
3 Take Home Messages

• Progress has been made in terms of Ablation Efficacy, but still more effective in paroxysmal AF than persistent AF.
  • Rationale for intervening early before progression to persistent.

• Safety profile has improved with major adverse events occurring approximately 1/200 cases (0.5%).

• Long-term maintenance of sinus may be harder to achieve in systolic heart failure, but those patients may benefit more.