Arrhythmias and Clinical EP
Atrial Fibrillation:
Contemporary Management Strategies

Samuel Asirvatham, MD & Enrique Melgarejo Rojas, MD
Saturday, June 24, 2017
2:40 to 3:25 p.m.
AF Ablation and The Impact on Clinical Practice

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Disclosures

Relevant financial relationship(s) with industry

• I receive royalties for work licensed through Mayo Clinic to a privately held company for contributions related to the use of nerve signal modulation to treat central, autonomic and peripheral nervous system disorders, including pain. Mayo Clinic receives royalties and owns equity in this company. The company does not currently license or manufacture any drug or device in the medical field.
• Co-patent holder for technique to minimize coagulum formation during radiofrequency ablation
• Products or techniques related to the above disclosures are not being discussed in this presentation
• Pertains to inventions/startup companies that include Nevro, Aegis and the Phoenix Corp

Honoraria/Speakers

• Abiomed, Atricure, Biotronik, Blackwell Futura, Boston Scientific, Medtronic, Medintelligence Sanofi-aventis, Spectranetics, St. Jude, Zoll

Consulting

• Aegis, ATP, Nevro, Sanovas, Sorin Medical, FocusStart
Impact of AFFIRM and Other Trials on Clinical Management

Rate control
- Safe
- Effective
- Preferred method for majority
- Optimal control cannot be determined at rest

Maintenance of sinus rhythm
- Symptom driven
Atrial Fibrillation: Rate Control

Medications

- Ca++ blockers
- Beta blockers
- Digitalis
- AVN ablation
- AV junction ablation
  - 99%+ success rate
  - Regular and controlled HR
  - PPM required
  - Freedom from medications

For both: AF persists in the atria
- Stroke prophylaxis needed

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47yrs female with paroxysmal palpitations and fatigue
Mechanisms of AF

**Substrate**
- All atrial myocardium
- Underlying disease
- Anatomical/electrical
- Remodeling

**Trigger**
- Autonomic modulation
- Atrial stretch→channels
- Other tachycardia

**Persistent**

**Paroxysmal**
Mechanisms of AF

Extracardiac factors:
- Hypertension
- Obesity
- Sleep apnea
- Hyperthyroidism
- Alcohol/drugs

Atrial tachycardia remodeling

Atrial Structural Abnormalities:
- Fibrosis
- Dilation
- Ischemia
- Infiltration
- Hypertrophy

AF

Inflammation
- Oxidative stress

RAAS activation

Genetic Variants:
- Channelopathy
- Cardiomyopathy

Atrial Structural Abnormalities:
- ↑Heterogeneity
- ↓Conduction
- ↓Action potential duration/refractoriness
- ↑Automaticity
- Abnormal intracellular Ca++ handling

Autonomic nervous system activation

ACTIVATION OF THE LEFT ATRIUM IN SINUS RHYTHM

Asirvatham, Packer JCE '98
Pulmonary Vein Ostial Histology

- Pyloric Spasm
- Acalculous Cholecystitis
AFIB Terminates Tachycardia Continues

Gurevitz Friedman et al.
Lasso in SVC: ERAF
Anatomy of Complications of Atrial Fibrillation Ablation: Ablation, Understanding the Anatomy

- Pulmonary vein stenosis
- Coronary arterial damage
- Pulmonary artery damage
- Aorta
- Esophagus
- Phrenic nerve
- Mitral valve
- Thrombus formation
- Sequela of autonomic ganglia ablation
THE PULMONARY VEIN POTENTIAL

- SVC
- RIGHT SUPERIOR PULMONARY VEIN
- LEFT SUPERIOR PULMONARY VEIN
- OSTIUM
- RA
- LEFT INFERIOR PULMONARY VEIN
- RIGHT INFERIOR PULMONARY VEIN
- LA
- IVC

Graph showing LA, PVP, and Ostial Delay.
Anatomy of Complications of Atrial Fibrillation Ablation: Esophagus

- Immediate posterior relation of the left atrium/posterior wall of pulmonary vein
- Posterior relation of the mid coronary sinus
- Esophageal arterial supply, mostly on the anterior wall
- Pericardial esophageal arteriovenous drainage
- Azygous vein and posterior mediastinial tissue anchors esophagus limiting lateral mobility
Atrio-Esophageal fistula

Left Lateral View

Aortic Arch
Asc Aorta
RPA
LA
LB
Desc Thor Aorta
Eso

Aorta
External Cardiac Anatomy
Pericardium

Oblique Sinus (Anterior View)

Heart Removed
Esophageal-LA interface Identification
Non-invasive Assessment of Tissue Heating During Cardiac Radiofrequency Ablation Using MRI Thermography

A) Temperature Change > 50°C

B) Delayed Gadolinium Enhancement image

C) TTC Stained Gross Pathology

D) Lesion Transmurality by Pathology and MRI
Bragg Peak

X-ray beam

Contouring and Carbon Ion Beam Treatment Planning Outcome

Transverse view

Coronal view

Sagittal view

Treatment planning: contoured volume dissected into its voxels, optimal amount of accelerator energies, scanning in x- and y- dimension are determined

Target volume outcomes:

<table>
<thead>
<tr>
<th>AV node contour (cm³)</th>
<th>Treated volume (cm³)</th>
<th>Volume Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 ± 0.3</td>
<td>25 ± 2</td>
<td>100%</td>
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</table>
WACA Contouring Outcome

Lesion Dimension = 6x6 mm

WACA-ring metrics (0% RR)

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Mean ± SD (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPVs ant.-post.</td>
<td>34.6 ± 4.2</td>
</tr>
<tr>
<td>RPVs sup.-inf.</td>
<td>33.8 ± 5.8</td>
</tr>
<tr>
<td>LPVs ant.-post.</td>
<td>28.4 ± 4.3</td>
</tr>
<tr>
<td>LPVs sup.-inf.</td>
<td>29.1 ± 5.7</td>
</tr>
</tbody>
</table>

Lesion Dimension = 6x6 mm

RPVs WACA ring

Esophagus

Coronal

RPVs WACA ring

LSPV

LA wall

Esophagus

Transverse

Sagittal
Rationale For AF Ablation

**Anatomy**
- Wide area circum
- Complex fractionated, Egms / DFs
- Perpetuators Rotors
- Triggers/Drivers

**Physiology**
- Fibrillatory Conduction
- Ganglion plexus

**Ultra wide area lasso/ICE**
- PV isolation
Four Stages of Left Atrial Tissue Fibrosis Based on 3D Delayed Enhancement MRI Scans

Marrouche, et al. JAMA 2014:498
Singularity Points Revealed by Phase Plane Analysis

Time: 117ms
Distribution of Atrial Ganglionated Plexuses

Restoration of Atrial Mechanical Function After the Surgical Maze Procedure

Outcome

- NSR: n=26 (81%)
  - AF: n=6 (19%)

LA Function

- Restored: n=19 (63%)
  - Not: n=11 (37%)

A Wave Velocity

- Maze: n=19
  - 0.75 ± 0.19
  - P < 0.01

- No Maze: n=16
  - 0.46 ± 0.14

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