The Long-Lasting Diatribe between Epicardial and Endocardial Ablation

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Clinical Impact of AF

- Decreases quality of life
- Increases risk of death two-fold
- Increases risk of heart failure three-fold
- Increases health care costs for associated CV disease
- Increases dementia in the absence of stroke

2. Ezekowitz MD. JAMA. 1999;281:1830-5
Cumulative Incidence of Events in the 5 Years after Diagnosis of In-Hospital AF in Medicare Patients

Impact of AF on Cardiovascular Event-Free Survival

**Philosophy**

- Maps cannot be used to “tailor” the surgical approach. “Fall-back” position is to make the atria incapable of fibrillating.
- >90% successful for PAF and Non-PAF

- >80% successful for PAF
Intervention for Atrial Fibrillation

**SURGERY**

- Maze I
- Maze II
- Maze III
- MIS Cryo-Maze III
- Maze IV

1970 - 1980 - 2010

**CATHETER**

- PVI

**Patterns**

- > 80% for PAF
- 20-45% for Persistent AF
- > 90% for PAF & Persistent AF
- 44-60% for Persistent AF

**Philosophy**

- None
- Make PVI easier and quicker
Intervention for Atrial Fibrillation

SURGERY

1970
Maze I
1980
Maze II
Maze III
MIS Cryo-Maze III
Maze IV
> 90% for PAF & Persistent AF
> 44-60% for Persistent AF

CATHETER

PVI
> 80% for PAF
20-45% for Persistent AF
Pertinent Questions

• Is there a difference in endocardial and epicardial electrical activity?

• Are endocardial and epicardial activation always in synchrony?

• If the focal lesions are \textit{non-transmural}, does it make a difference whether they were placed endocardially or epicardially?

• If the focal lesions are \textit{transmural}, does it make a difference?
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Endocardial Mapping
Endocardial Mapping
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Endocardial Mapping
Endocardial Mapping

Modified from Ruchat P: Eur J Cardiothorac Surg 2007
Paroxysmal Atrial Fibrillation (PAF)

Self-Limiting Episode of Atrial Fibrillation
Persistent Atrial Fibrillation (Persistent AF)

NSR

Persistent, L-S Persistent, or Permanent Episode of Atrial Fibrillation
Once an episode of AF has been initiated by the focal “triggers”, the episode is sustained by non-focal macro-reentrant rotors (“drivers”).

The “drivers” are non-focal and rarely, if ever, remain stationary.

Therefore, focal triggers are no longer important and their focal ablation or isolation by PVI has little or no effect on the treatment of long-standing persistent AF.
Global mapping assumes that the atrial endocardium and epicardium activates synchronously, i.e., the entire thickness of the atrial wall activates at the same time. (2D Atrial Wall)
Global Mapping – Endocardial vs. Epicardial

- 2D Atrial Wall
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Global Mapping – Endocardial vs. Epicardial

• 2D Atrial Wall

• Experimental studies by Allessie showed that electrical activation can propagate more rapidly in the endocardium and can appear to “break through” to the epicardium to mimic a focal “site of origin” if only epicardial mapping is being performed.
Global Mapping – Endocardial vs. Epicardial

- 2D Atrial Wall
- 3D Atrial Wall
Global Mapping – Endocardial vs. Epicardial

- 2D Atrial Wall

- 3D Atrial Wall
Direct Proof of Endo-Epicardial Asynchrony of the Atrial Wall During Atrial Fibrillation in Humans


Direct Proof of Endo-Epicardial Asynchrony of the Atrial Wall During Atrial Fibrillation in Humans

• AF-induced structural atrial remodeling gradually transforms the atrial wall into multiple layers of narrow dissociated wavelets.

• With time, more and more focal breakthroughs will be generated, occurring virtually everywhere in the atria.

• There can be up to 10,000 such “focal breakthroughs” spread throughout both atria in AF that has persisted longer than 6 months.
Epicardial-Endocardial Asynchrony

- 3D Atrial Wall
Epicardial-Endocardial Asynchrony

- 3D Atrial Wall
Destroying the wrong Target

• 3D Atrial Wall
Destroying the wrong Target

- 3D Atrial Wall
The Attempted Ablation
Destroying the wrong Target
Destroying the wrong Target
Destroying the wrong Target

• 3D Atrial Wall
Destroying the wrong Target
Destroying the wrong Target
Destroying the wrong Target
Pertinent Questions

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Destroying the wrong Target

Non-Transmurality of Unipolar Ablation

Endocardial Focal Ablation
Destroying the wrong Target

Non-Transmurality of Unipolar Ablation

Endocardial Focal Ablation
Destroying the wrong Target

Non-Transmurality of Unipolar Ablation

Epicardial Focal Ablation
Destroying the wrong Target

Non-Transmurality of Unipolar Ablation

Epicardial Focal Ablation
Pertinent Questions

- Is there a difference in endocardial and epicardial electrical activity? Yes

- Are endocardial and epicardial activation always in synchrony? No

- If the focal lesions are non-transmural, does it make a difference whether they were placed endocardially or epicardially? No

- If the focal lesions are transmural, does it make a difference? No
Destroying the Correct Target
Destroying the Correct Target
The Ideal Lesion

Contiguous

Uniformly Transmural
“Trying to create a line with the tip of a catheter is like trying to cut off the corner of a sheet of paper with a straight-pen. It is virtually impossible to do.”

- Michel Haissaguerre
Catheter Ablation

Non-Transmural

Non-Contiguous (Gaps)
Actual Lesions after Catheter Ablation

Endocardial RF Catheter Ablation Lesions
Actual Lesions after Catheter Ablation
Actual Lesions after Catheter Ablation

Gaps Between Lesions
Actual Lesions after Catheter Ablation

- Gaps Between Lesions
- Non-Transmurality
Ablation Procedures for Atrial Fibrillation

There are three things that can cause failure of catheter ablation or surgical ablation for atrial fibrillation:

• Creating incomplete lesions of conduction block because of an inadequate energy source
  (Bad lesions)

• Placing complete lesions of conduction block in the wrong place
  (The wrong operation)

• Placing incomplete lesions of conduction block in the wrong place
  (Bad lesions & the wrong operation)
Pulmonary Vein Isolation (PVI)

Isolation of the PV Orifices

This fails for long-standing persistent AF because it is the wrong operation.
Pulmonary Vein Isolation (PVI)

Isolation of the PV Orifices & “Antrum”

This fails for long-standing persistent AF because it is the wrong operation.
Pulmonary Vein Isolation (PVI)

Isolation of the PV’s and Posterior LA Wall “Box Lesion”

This fails for long-standing persistent AF because it is the wrong operation AND the energy source fails.
Pulmonary Vein Isolation (PVI)

What Cardiologists *think* they are doing
Pulmonary Vein Isolation (PVI)

Actual Lesions following Catheter Ablation
STAR AF II Trial for Persistent AF

Pulmonary-vein isolation
- Superior vena cava
- Left superior pulmonary vein
- Left inferior pulmonary vein
- Coronary sinus

Pulmonary-vein isolation with ablation of complex fractionated electrograms
- Left superior pulmonary vein
- Left inferior pulmonary vein
- Region of complex fractionated electrograms

Pulmonary-vein isolation with additional linear ablation
- Left superior pulmonary vein
- Left inferior pulmonary vein
- Right superior pulmonary vein
- Right inferior pulmonary vein

Right atrium
"We found no reduction in the rate of recurrent atrial fibrillation when either linear ablation or ablation of complex fractionated electrograms was performed in addition to pulmonary-vein isolation."

"Less Is More" When Using Ablation to Treat Persistent Atrial Fibrillation

When all treatment is lousy, administer the lesser treatment

Surprise! Surprise!
This is NOT a Maze Procedure!
Macro-Reentrant Circuits mapped during AF
The Maze-IV Procedure
The Maze-IV Procedure

All documented Reentrant Circuits known to sustain AF have been precluded or eliminated.
Importance of the RA Lesions
Sustaining Drivers in LSPAF

The RA and LA are **NOT** separated electrophysiologically!

Therefore, you cannot ignore the Right Atrium!
Recurrent Atrial Fibrillation following a “Left-Atrial Maze” Procedure
Recurrent Atrial Fibrillation following a “Left-Atrial Maze” Procedure
Mini-Cryomaze III for Stand-Alone LSPAF (n = Last 60)

"Success is in the Details"

Courtesy of Niv Ad, MD, 2015
Critical Interventional Concepts

• Regardless of the sophistication of current EP mapping, we still cannot use EP maps to “tailor” our catheter ablation or surgery for individual patients with Persistent AF.

• PVI for PAF is an example of performing a set lesion pattern based on anatomy, not on electrophysiology, to lessen the likelihood that AF will be induced by a trigger in and around the pulmonary veins.

• Likewise, the only recourse for attaining optimal interventional results for Persistent AF is to apply a consistent pattern of lesions based on anatomy, not on electrophysiology.

• Neither is optimal for Persistent AF if the lesions are not complete and if they are not placed in the correct position based on anatomy, not EP mapping.
Thank You