Thoracoscopic Surgical Ablation for Stand-Alone AF

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The Society of Thoracic Surgeons 2017 Clinical Practice Guidelines for the Surgical Treatment of Atrial Fibrillation

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Stand-Alone Surgical Ablation for AF

- Surgical ablation for symptomatic AF in the setting of **left atrial enlargement (4.5 cm)** or more than moderate mitral regurgitation by **PVI alone** is **not** recommended. (Class III no benefit, Level C expert opinion)
Brief History of Maze operation
Scars and Arrhythmias


Scars used to *study* arrhythmias

Reentry Explained
(1914)
Using Scars to Study Arrhythmias

- Automaticity
- Micro-Reentry
- Macro-Reentry
Using Scars to Study Arrhythmias
Using Scars to Study Arrhythmias
Using Scars to Treat Arrhythmias

Using Scars to Treat Arrhythmias

Reentry Explained (1914)

WPW Surgery (1968)

1900 1930 1960 1990 2020

2011

Scars used to treat Arrhythmias
Induction of Atrial Fibrillation

Pulmonary Vein “Trigger”

Atrial Fibrillation

Non-Pulmonary Vein “Trigger”
Interruption of Reentrant Circuits
Goal 1: Cure the Atrial Fibrillation
Goal 2: Leave Atrium Capable of NSR

Option 1: “Breadloafing”
Goal 1: Cure the Atrial Fibrillation
Goal 2: Leave Atrium Capable of NSR

Option 1: “Breadloafing”
Option 2: Radial Pattern
Goal 1: Cure the Atrial Fibrillation
Goal 2: Leave Atrium Capable of NSR

Option 1: "Breadloafing"
Option 2: Radial Pattern
Option 3: Maze Pattern
Why a Maze Pattern?

Goal 1: Cure the Atrial Fibrillation
Goal 2: Leave Atrium Capable of NSR
Maze - It’s the Principle not the Pattern
Maze – The Principle

Responsible for Lesion Failure:
1. Energy Source, 2. Surgeon
“Maze” – Not a Maze

Responsible for Violating the Maze Principle:
1. Surgeon
Many Patterns but only one Principle
An 8½-Year Clinical Experience with Surgery for Atrial Fibrillation

James L. Cox, M.D.,* Richard B. Schuessler, Ph.D.,* Demetrios G. Lappas, M.D.,† and John P. Boneau, M.D.*

From the Divisions of Cardiothoracic Surgery* and Cardiothoracic Anesthesiology, † Washington University School of Medicine and The Barnes Jewish Hospitals, St. Louis, Missouri
Basic pattern of bilateral thoracic approach.
Maze procedures for AF

Valve disease combined case?
- Yes
  - Sternotomy
    - Cox maze III or IV
  - Mini thoracotomy
    - Cox maze III or IV
- No
  - CPB assist
    - Yes
      - Nic Ad
        - Cox maze III or IV
      - Wolf mini Maze
    - No
      - Sirak / La meir
      - TTS (Total thoracoscopic surgery)
Proven Device for maze operation
Modified Cox Maze III operation
5 Box lesion set by John, Sirak
Total thoracoscopic maze operation
Severance Wolf mini-Maze
Severance TTS case
Surgical ablation of atrial fibrillation trends and outcomes in North America

- Society of Thoracic Surgeons Adult Cardiac Surgery Database, 91,801 (2005-2010) surgical AF ablations were performed of which 4893 (5.3%) were stand-alone procedures

- Isolated surgical ablation is safe, performed “on” or “off” cardiopulmonary bypass. These results support consideration of surgical AF ablation as an alternative to percutaneous ablation for patients with lone AF.

**TABLE 5. Patient outcomes—matched groups**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Overall (n = 1708)</th>
<th>On−CPB (n = 854)</th>
<th>Off−CPB (n = 854)</th>
<th>P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operative mortality (%)</td>
<td>1.23</td>
<td>1.32</td>
<td>0.94</td>
<td>0.2792</td>
</tr>
<tr>
<td>Stroke (%)</td>
<td>1.00</td>
<td>1.29</td>
<td>0.70</td>
<td>0.2253</td>
</tr>
<tr>
<td>Dialysis, newly required (%)</td>
<td>0.76</td>
<td>1.05</td>
<td>0.47</td>
<td>0.1655</td>
</tr>
<tr>
<td>New pacemaker (%)</td>
<td>1.29</td>
<td>0.82</td>
<td>1.76</td>
<td>0.0081</td>
</tr>
<tr>
<td>Perioperative AF (%)</td>
<td>2.46</td>
<td>3.04</td>
<td>1.87</td>
<td>0.1228</td>
</tr>
<tr>
<td>Gastrointestinal complication (%)</td>
<td>0.88</td>
<td>1.05</td>
<td>0.70</td>
<td>0.4306</td>
</tr>
<tr>
<td>Prolonged ventilation (&gt;24 h) (%)</td>
<td>5.27</td>
<td>6.56</td>
<td>3.98</td>
<td>0.0139</td>
</tr>
<tr>
<td>Recuperation for bleeding/lupus (%)</td>
<td>1.29</td>
<td>2.22</td>
<td>0.35</td>
<td>0.0003</td>
</tr>
<tr>
<td>Discharge medication (warfarin) (%)</td>
<td>74.53</td>
<td>73.89</td>
<td>75.18</td>
<td>0.5067</td>
</tr>
<tr>
<td>Total length of stay (d)</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Median</td>
<td>5</td>
<td>6</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>IQR</td>
<td>4–8</td>
<td>5–9</td>
<td>3–6</td>
<td></td>
</tr>
</tbody>
</table>

CPB, Cardiopulmonary bypass; AF, atrial fibrillation; IQR, interquartile range. *P values based on McNemar’s tests for categorical outcomes and Wilcoxon signed rank tests for continuous outcomes.

*J Thorac Cardiovasc Surg 2012;144:1051-60*
Superiority of Surgery in Initial failed PVI cases
A Randomized Controlled Trial

Thoracoscopic off-pump RF PVI plus LAA resection Early multicenter results

- 3 North American institutions
- February 2005 ~ August 2007
- 100 patients
- AF : 5.0 years
- Paroxysmal : 39 patients (39%)
  Persistent : 29 patients (29%)
  Permanent : 32 patients (32%)
- Mean follow-up : 13.6 ± 8.2 months

J Thorac Cardiovasc Surg 2009;137:521-6
Thoracoscopic off-pump RF PVI plus LAA resection
Mid-term multicenter results

- 3 North American institutions
- July 2005 ~ November 2011
- 86 patients
- AF duration: 30 months
- paroxysmal 86%, persistent 14%
- median follow-up: 24 months

**FIGURE 1.** Freedom from arrhythmia at 3-, 6-, 12-, 24-, and 36-month follow-up, with and without antiarrhythmic drugs (AADs).

Innovations 2013;8:410
Long-term outcomes of minimally invasive surgical ablation for atrial fibrillation

AF FREE SURVIVAL

Cumulative Survival

Time (years)

Log Rank (Mantel-Cox) p=0.166

No. at risk
All 109 88 67 54 50 45
PVI & GPI 73 55 40 29 26 21
BOX 36 31 23 19 18 18

Heart Rhythm 2017;xx:1–8
Long-Term Results of a Minimally Invasive Surgical PVI and GP Ablation

Xu Meng, PlosOne 2013
What is real?

Graph showing the percent of patients in sinus rhythm at different time points for Endocardial Cox-Maze, Epicardial Surgical Ablation, and Hybrid Surgical Ablation.

- 3M: 93% (Endocardial), 89% (Epicardial), 76% (Hybrid)
- 6M: 92% (Endocardial), 83% (Epicardial), 87% (Hybrid)
- 6M Off: 87% (Endocardial), 65% (Epicardial), 81% (Hybrid)
- 12M: 93% (Endocardial), 80% (Epicardial), 70% (Hybrid)
- 12M Off: 87% (Endocardial), 72% (Epicardial), 71% (Hybrid)
In Yonsei AF ablation cohort

- Among 225 patients underwent redo-ABL, 9 had Maze procedure previously.

<table>
<thead>
<tr>
<th>Pt.No.</th>
<th>PV</th>
<th>Roof</th>
<th>P-I</th>
<th>CTI</th>
<th>LLI</th>
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<tbody>
<tr>
<td>1</td>
<td>○</td>
<td>○</td>
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<td>8</td>
<td>●</td>
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<td>●</td>
<td>○</td>
<td>○</td>
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<tr>
<td>9</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>○</td>
</tr>
</tbody>
</table>

Arrhythmia foci or Reentry circuit

- Multiple trigger (1)
- Cavo-caval (1)
- CTI (2)
- CTI+Perimtrial (1)
- Septal (2)
- Perimtrial (2)

● Blocked
○ Connected
Severance experience

- **2014.08 ~ 2016.12**
- **N=25**
- **TTS: 10**
- **Thoracoscopic cryoablation : 15 (CPB assist)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, year</td>
<td>56.8 ± 10.6</td>
</tr>
<tr>
<td>Age ≥ 65, %</td>
<td>28.6</td>
</tr>
<tr>
<td>Male Gender, %</td>
<td>71.4</td>
</tr>
<tr>
<td>AF duration, months</td>
<td>41.8 ± 40.8</td>
</tr>
<tr>
<td>Paroxysmal AF, %</td>
<td>14.3</td>
</tr>
<tr>
<td>Persistent AF, %</td>
<td>28.6</td>
</tr>
<tr>
<td>Longstanding Persistent, %</td>
<td>57.1</td>
</tr>
<tr>
<td>Previous Stroke, %</td>
<td>7.1</td>
</tr>
<tr>
<td>Hypertension, %</td>
<td>66.7</td>
</tr>
<tr>
<td>Heart Failure, %</td>
<td>21.4</td>
</tr>
<tr>
<td>Diabetes, %</td>
<td>21.4</td>
</tr>
<tr>
<td>Dyslipidemia, %</td>
<td>35.7</td>
</tr>
<tr>
<td>Coronary artery disease, %</td>
<td>7.1</td>
</tr>
<tr>
<td>Chronic kidney disease, %</td>
<td>7.1</td>
</tr>
<tr>
<td>CHA2DS2-VASc</td>
<td>2 ± 1</td>
</tr>
<tr>
<td>Follow-up duration, days</td>
<td>369.4 ± 222.5</td>
</tr>
</tbody>
</table>
LV EF

P = 0.477

LA AP

P = 0.509

LA Volume Index

P = 0.084
AF free survival rate (%)

AF Late Recurrence

- Open (AAD: 44.4%)
- Epicardial (AAD: 40.0%)

Log rank P = 0.515
# Epicardial RF vs. Mini-thoracotomy Cryo Maze

<table>
<thead>
<tr>
<th></th>
<th>Epicardial RF Maze</th>
<th>Cryo Full Maze</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Recurrence, %</td>
<td>80.0</td>
<td>44.4</td>
</tr>
<tr>
<td>Late Recurrence, %</td>
<td>20.0</td>
<td>11.1</td>
</tr>
<tr>
<td>Current AAD use, %</td>
<td>40.0</td>
<td>44.4</td>
</tr>
<tr>
<td>Current Anticoagulation, %</td>
<td>100.0</td>
<td>85.7</td>
</tr>
<tr>
<td>Aspirin, Plavix, %</td>
<td>60.0</td>
<td>85.7</td>
</tr>
<tr>
<td>Warfarin, NOAC, %</td>
<td>40.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Postop Cath ablation, %</td>
<td>60.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Final sinus rhythm, N (%)</td>
<td>60.0</td>
<td>73.0</td>
</tr>
</tbody>
</table>
Take home messages

- Thoracoscopically ablation for AF has been improved until now
- But, **right side maze missing** is a big problem compared with bi-atrial maze operation using right mini-thoracotomy and CPB
- So, we should consider overcoming the above problem by hybrid EP technique or other evolving techniques
Personal experience

- 2013.05 - 2015.12
- 107 cases maze operation
- Excluding stand alone AF cases
- MVR : 52
- MVP : 34
- DVR (AVR+MVR) w/ or w/o TAP : 12
- AVR : 5 / TAP or TVR : 3
From 2015.06 ~

- Alternately LAA lesion
- Immediately SR conversion rate : 95%
- ADD : 92 % vs. 93%
- ADD off : 89% vs. 90%
- All LAA resected
Comparison of group according to LAA set

차트 제목

LAA (Yes)
LAA (No)
Definition of AF type

- **Paroxysmal AF**: less than 7 days in duration and self-terminated
- **Persistent AF**: 7 days in duration or terminated by direct-current cardioversion or pharmacologically within 7 days
- **Permanent AF (long-standing persistent)**: AF lasting more than 1 year in duration.
Thoracoscopic approach
Thoracoscopic approach
Figure 5: Schematic drawing of ablation lines performed in the LA during an epicardial approach. 1: roof line; 2: inferior line; 3: line between the superior line and the left fibrous trigone; 4: connecting line from the superior PV and the LAA; 5: line from the right inferior PV to the CS; 6: isthmus line. LAA: left atrial appendage; MV: mitral valve; CS: coronary sinus.
Figure 6: Schematic drawing of retro-atrial GP. 1: superior right atrial in the posterior superior surface of the RA adjacent to the junction of the SVC and the right; 2: superior left atrial in the posterior surface of the LA between the PVs; 3: posterior right atrial in the posterior surface of the RA adjacent to the interatrial groove; 4: posteromedial left atrial in the posterior medial surface of the LA; 5: posterior-lateral left atrial in the posterior lateral surface of the LA based on the atrial side of the AV groove; 6: interatrial: fusion of the posterior right and posteromedial left atrial GP, extending interiorly into the interatrial septum.