Concomitant Maze Procedure
In Open Heart Surgery

Jae Won Lee
Asan Medical Center
AF incidence : 1~3% in general population

In patients undergoing cardiac surgery?
AF in patients undergoing cardiac surgery?

In AMC database: 17.8%

- During last 10 years (1852/10403)
- Valve, Coronary, Aorta, CHD and cardiac tumor etc.
- excluded heart transplantation, pediatric cardiac surgery.
...AF in patients undergoing cardiac surgery

What should we do?
Cox-Maze procedure

In 1987, **Dr. James Cox** introduced the first successful surgical treatment for AF.

The most **effective** treatment to restore **sinus rhythm** in AF patients.
AMC method (Since 2001) = Simplification

- No septal lesion
- Isthmus isolation
- Single PV box lesion
+ Various energy source
Since 2005
Argon based cryo-ablation system

• **Flexible probe**
  - Easy to maneuver
  - Adjustable insulation sleeve
Maze procedure in AMC

...During last 10 years (2007-2016)

Annual Trends

- 2007: 123
- 2008: 139
- 2009: 85
- 2010: 97
- 2011: 117
- 2012: 141
- 2013: 150
- 2014: 151
- 2015: 197
- 2016: 203
Concomitant Maze procedure

During last 10 years (2007-2016)

In cardiac surgery: 13.3% (1377/10377)

- Ablation Surgery: 1403
- Stand-Alone AF surgery: 26
Concomitant Maze procedure

...During last 10 years (2007-2016)

With AF patients: 75.4% (1377/1826)
Concomitant Maze in MV surgery
AF in MV surgical patients?

37-54%
Maze Procedure in Valvular AF patients?

Number of patients

48-55% 62-84% 78-85%

P<0.001
Maze procedure in MV surgery

...During last 10 years (2007-2016)

Maze on valvular AF: 84% (1119/1332)
MVP: 90.6% (384/424)
MVR: 80.9% (735/908)

Early mortality: 1.6% (n=18)
Concomitant Maze in No Left Atriotomy Surgery
Maze procedure without Left atriotomy surgery

...During last 10 years (2007-2016)

AVR + Maze: 70 cases
CABG (or OPCAB) + Maze: 30 cases

Surgical concerns
- Incision: Minimally invasive AVR?
- Energy source: Epicardial RF?
Epicardial Maze

F/U duration: 38.4 ± 25.1 (month)
Limitations of Epicardial Maze

- Difficulty in linear ablation
- Doubtful about transmurality
  \(\rightarrow\) depends on the thickness of epicardial fat
- No intraoperative EP confirmation of the effect & quality
  \(\rightarrow\) impossible to prevent ‘reconnection’
Hybrid Concept

Percutaneous epicardial ablation by cardiac surgeon & endocardial ablation by cardiologist

Surgery: Epicardial bipolar RF clamping: PVs
       Epicardial bipolar RF pen
Catheter: Entrance-Exit block confirmation
       Additional endocardial ablation (connection) ± RA isthmus isolation

Pison et al. (J Am Coll Cardiol 2012;60:54-61)
### Hybrid Concept in AMC

#### Hybrid operation (n=18)

<table>
<thead>
<tr>
<th>A-fib type</th>
<th></th>
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<tbody>
<tr>
<td>Sustained</td>
<td>16</td>
</tr>
<tr>
<td>Paroxysmal</td>
<td>2</td>
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<table>
<thead>
<tr>
<th>Isolated Maze</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>11</td>
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</table>

<table>
<thead>
<tr>
<th>Co-operation</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>MVP</td>
<td>3</td>
</tr>
<tr>
<td>TVP</td>
<td>4</td>
</tr>
<tr>
<td>David op</td>
<td>1</td>
</tr>
<tr>
<td>AVR</td>
<td>1</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Immediate rhythm</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NSR</td>
<td>13</td>
</tr>
<tr>
<td>Junctional</td>
<td>5</td>
</tr>
</tbody>
</table>

#### In-hospital AF event
- NSR: 10 (55.6%)
- A-fib: 8 (44.4%)

#### At discharge AAD:
- 8 (44.4%)

#### At discharge
- NSR: 17 (94.4%)
- A-fib: 1 (5.6%)

Maybe good alternative to standard open surgery, catheter ablation or minimally invasive surgery
Factor associated with the Performance of Maze procedure

- **Surgical year** (OR, 1.16, P<0.001)
- **Surgeon factor** (P<0.001)
- **Redo surgery** (OR, 0.13; P<0.001)
- **Renal impairment** (OR, 0.65, P=0.005)
- **Hb** (OR, 1.34; P<0.001)
- **LA dimension** (OR=0.94; P<0.001)
- **Other procedural factors** (i.e. MVP vs. MVR: P=0.09-0.95)
In Minimally Invasive setting?

Robotic assisted cardiac surgery
AESOP 3000 robot surgery
Right mini-thoracotomy
<table>
<thead>
<tr>
<th>AESOP 3000</th>
<th>Da Vinci System</th>
</tr>
</thead>
</table>

Since 2002  
Since 2007
From 2004 to 2013, MICS AF Surgery (N = 335)

MICS AF Surgery
N = 335

AESOP
N = 279

Da Vinci
N = 56

Age: 52.1 ± 12.1
Male: 150 (44.8%)

Early mortality: 2 (0.6%)
SSS or CAVB: 2 (0.6%)

5-year 88.2%
Endocardial cryo-ablation: Reliable transmurality

Takes less than 30 minutes for an additional Maze procedure
...Tips and tricks in minimally invasive setting

Spread the atrial wall !!
Transmurality !!
LAA procedure !!
Avoid damage to surrounding structures
(SA node, AV node, phrenic nerve etc)
Issues in Concomitant Maze with Cardiac Surgery !!
Do? or not? in these situations.

- Mechanical valve replacement?
- Significant LV dysfunction?
- Giant LA?

![Diagram showing high risks, already on WARF, and increased cardiac ischemic time.]

Increased cardiac ischemic time (20-40 min) + complexity of the procedure
• Mechanical valve replacement?
• Significant LV dysfunction?
• Giant LA?

Table 3. Adjusted Hazard Ratios for Clinical Outcomes of the Maze Procedure Compared With the Control Group

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>HR</th>
<th>95% CI</th>
<th>P</th>
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<tbody>
<tr>
<td>Death</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Crude</td>
<td>0.91</td>
<td>0.53–1.56</td>
<td>0.73</td>
</tr>
<tr>
<td>Propensity score*</td>
<td>1.13</td>
<td>0.63–2.01</td>
<td>0.69</td>
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<tr>
<td>IPTW</td>
<td>1.15</td>
<td>0.65–2.03</td>
<td>0.63</td>
</tr>
<tr>
<td>Thromboembolism</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crude</td>
<td>0.42</td>
<td>0.17–1.03</td>
<td>0.059</td>
</tr>
<tr>
<td>Propensity score*</td>
<td>0.28</td>
<td>0.10–0.77</td>
<td>0.014</td>
</tr>
<tr>
<td>IPTW</td>
<td>0.29</td>
<td>0.12–0.73</td>
<td>0.008</td>
</tr>
</tbody>
</table>

With Mechanical valve replacement!!

- Improved Symptoms
- Superior Hemodynamics
- Decreased CVA
- Similar Survival

Benefits vs. Risks
• Mechanical valve replacement?
• Significant LV dysfunction?
• Giant LA?

Kim JB et al. Int J Cardiol 2014
With LV dysfunction (LVEF < 40%)!!

**Benefits**

- Improved Symptoms,
- Superior LV function,
- Superior Event-
  free survival

**Risks**
• Mechanical valve replacement?
• Significant LV dysfunction?
• Giant LA?

Figure 3  Adjusted curves using inverse-probability-of-treatment weighting for (A) overall survival, (B) freedom from thromboembolism (TE), (C) TE-free survival and (D) major event-free survival.
With Giant LA (> 60mm) !!

Improved Rhythm status, Superior LV function, Superior Event-free survival

Benefits

Risks
Unexpected Benefits of Maze:

Improvements in TV/ MV functions
Impact of the Maze operation on the progression of mild functional tricuspid regurgitation

Hyung Gon Je, MD, Hyun Song, MD, Sung Ho Jung, MD, Suk Jung Choo, MD, Jong Min Song, MD, Duk Hyun Kang, MD, Sung Cheol Yun, PhD, Cheol Hyun Chung, MD, Jae Kawn Song, MD, and Jae Won Lee, MD
Echocardiographic evaluation of mitral durability following valve repair in rheumatic mitral valve disease: Impact of Maze procedure

Gwan Sic Kim, Chee Hoon Lee, Joon Bum Kim, Sung-Ho Jung, Suk Jung Choo, Cheol Hyun Chung, and Jae Won Lee, MD
How to Perform Maze?

Left side only?
Biatrial?
### Surgical ablation as treatment for the elimination of atrial fibrillation: A meta-analysis

Scott D. Barnett, PhD, and Niv Ad, MD

**TABLE 4. Average weighted reported postoperative survival and freedom from recurrent atrial fibrillation by lesion**

<table>
<thead>
<tr>
<th></th>
<th>Biatral</th>
<th></th>
<th>Left Atrial</th>
<th></th>
</tr>
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<tbody>
<tr>
<td></td>
<td>No. of studies</td>
<td>Total sample size</td>
<td>Mean ± SD*</td>
<td>No. of studies</td>
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<tr>
<td>Surgical subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1-y survival</td>
<td>32</td>
<td>2391</td>
<td>94.9 ± 0.0</td>
<td>20</td>
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<tr>
<td>2-y survival</td>
<td>14</td>
<td>1159</td>
<td>94.2 ± 0.0</td>
<td>4</td>
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<tr>
<td>3-y survival</td>
<td>13</td>
<td>1136</td>
<td>92.8 ± 0.0</td>
<td>3</td>
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<tr>
<td>3-mo freedom from AF</td>
<td>23</td>
<td>1985</td>
<td>92.0 ± 4.0</td>
<td>16</td>
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<tr>
<td>1-y freedom from AF</td>
<td>24</td>
<td>2260</td>
<td>68.9 ± 8.2</td>
<td>13</td>
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<tr>
<td>2-y freedom from AF</td>
<td>15</td>
<td>1523</td>
<td>85.8 ± 5.0</td>
<td>6</td>
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<tr>
<td>3-y freedom from AF</td>
<td>16</td>
<td>1684</td>
<td>87.1 ± 4.7</td>
<td>2</td>
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<tr>
<td>Control subjects</td>
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<tr>
<td>1-y survival</td>
<td>9</td>
<td>378</td>
<td>97.9 ± 0.0</td>
<td>2</td>
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<tr>
<td>2-y survival</td>
<td>5</td>
<td>299</td>
<td>97.7 ± 0.0</td>
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</tr>
<tr>
<td>3-y survival</td>
<td>6</td>
<td>334</td>
<td>95.1 ± 0.0</td>
<td>—</td>
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<tr>
<td>3-mo freedom from AF</td>
<td>5</td>
<td>185</td>
<td>48.3 ± 14.9</td>
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<tr>
<td>1-y freedom from AF</td>
<td>7</td>
<td>234</td>
<td>32.8 ± 18.4</td>
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<tr>
<td>2-y freedom from AF</td>
<td>4</td>
<td>149</td>
<td>35.4 ± 20.5</td>
<td>1</td>
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<tr>
<td>3-y freedom from AF</td>
<td>5</td>
<td>287</td>
<td>53.1 ± 34.5</td>
<td>1</td>
</tr>
</tbody>
</table>

SD, Standard deviation; AF, atrial fibrillation. *Sample weighted mean and corrected standard deviation.
Left Atrial Ablation Versus Biatrial Ablation in the Surgical Treatment of Atrial Fibrillation

Joon Bum Kim, MD, Ji Hyun Bang, MD, Sung Ho Jung, MD, Suk Jung Choo, MD, Cheol Hyun Chung, MD, and Jae Won Lee, MD

Department of Thoracic and Cardiovascular Surgery, Asan Medical Center, University of Ulsan College of Medicine, Seoul, South Korea

![Graph showing cumulative incidence of late AF off AAD (%) with LA group and Biatrial group.](image)

- **HR 3.06, 95% CI 1.41-6.66**
- **P=0.005**

<table>
<thead>
<tr>
<th>No. at risk</th>
<th>Years after surgery</th>
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<tbody>
<tr>
<td>LA</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>42</td>
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<tr>
<td></td>
<td>16</td>
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<td></td>
<td>7</td>
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<tr>
<td>Biatrial</td>
<td>191</td>
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<tr>
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<td>124</td>
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<tr>
<td></td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>33</td>
</tr>
</tbody>
</table>
How to Perform Maze?

Then...

Is biatrial maze superior?

How about in the patients without any right-side lesion?
How to Perform Maze?

Then...
Is biatrial maze superior?

How about in the patients without any right-side lesion?
Without Right Side Lesion; Sequential method

**Indication**
Patients with AF undergoing MV surgery *without* right lesion

**Left atrial ablation + MV surgery**

- Spontaneous sinus conversion
- AF

- No Right atrial ablation
- Right atrial ablation
Left Side First and Selective Right Side Maze

After Only Left side Maze (N=51)

Sinus conversion = 50

Postop. A-fib=1

⇒ additional Rt. Side Maze op

- From January 2013 through June 2016
- Total 51 patients (55.7±12.5yrs; 26 females)
Left Side First and Selective Right Side Maze

No SSS, no CAVB

Freedom from late AF off AAD: \(96.7 \pm 3.3\%\) up to 2 years.

- In hospital stay AF event = 12 (23.5\%) patients
- Follow up: median 13.7 m
- Before 3 months: 6 (11.8\%) patients were occurred AF
- After 3 months: 1 (2.2\%) was showed late recurrence
...Left Side First and Selective Right Side Maze

- Reduce procedure time
- Reduce extent of surgery
- Reduce postoperative bradyarrhythmia
- Well suited to minimally invasive surgery
- Preserving RA function
Take Home Message

✓ Appropriate methods for each patient
  Simple and time preserving
  May reduce trouble some bradyarrhythmia (SSS, Complete block)

✓ High-risk patients
  Could be done without increased operative mortality
Thank you!