How to Do Durable Anterior or Lateral Mitral Isthmus Ablation

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[AF 3] KHRS 2017

June 24, 2017
Aim of Linear Lesions

- **Substrate modification**
  - Adopted form the surgical Cox Maze procedures
  - Electrically compartmentalize the atrium, disrupting the critical mass needed to sustain fibrillation
  - Most common form: roof line & mitral isthmus line

- **Prevention of macroreentry**
  - Perimitral or roof dependent AT
PVI + Linear vs. PVI Alone

- Randomization: PVI alone vs. PVI + linear ablation (roof-line and mitral isthmus line)
- BDB for the roof-line and mitral line: 44-91% and 31-72%, respectively.
- Ablation result was significantly better in PVI + linear group.
- Though BDB were often hard to accomplish, linear ablation seems to be an effective strategy when added to PVI.
STAR AF II Trial

P = 0.15 for the overall comparison, by the log-rank test

No. at Risk

<table>
<thead>
<tr>
<th>Treatment</th>
<th>6 Months</th>
<th>12 Months</th>
<th>18 Months</th>
<th>24 Months</th>
<th>30 Months</th>
<th>36 Months</th>
</tr>
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<tbody>
<tr>
<td>Pulmonary-vein isolation</td>
<td>61</td>
<td>60</td>
<td>50</td>
<td>41</td>
<td>36</td>
<td>23</td>
</tr>
<tr>
<td>Isolation plus electrograms</td>
<td>244</td>
<td>242</td>
<td>161</td>
<td>137</td>
<td>124</td>
<td>72</td>
</tr>
<tr>
<td>Isolation plus lines</td>
<td>244</td>
<td>240</td>
<td>152</td>
<td>133</td>
<td>115</td>
<td>57</td>
</tr>
</tbody>
</table>

Adjunctive ablation strategies

[Table showing study results]

Macro-reentry

- Circuit involving 3 or more segments
- >75% of the CL is mapped along the circuit
- Good PPI in 2 opposite segments

JaisP et al. JCE 2009;20:480
Roof Dependent AT

- Opposite activation fronts on anterior and posterior LA

JaisP et al. JCE 2009;20:480
Perimitral AT

- Opposite activation fronts on anterior and posterior LA around mitral annulus
- Parallel activation fronts of anterior and posterior LA
Shortcomings of Linear Lesions

- **Technically challenging & time consuming**
  - Acute success: 30 ~ 90%
  - Epicardial ablation (70% within CS in MI line)

- **Incomplete conduction block ➔ proarrhythmic**
  - A gap in the line: a pre-requisite for the development of macroreentrant AFL
Ideal linear lesion

- As short as possible
- Easy to perform
- Easy testing for bidirectional block
Lateral MI Line and Anterior Line
Lateral Mitral Isthmus Line

- **Advantages**
  - Most common, most studied
  - Short length
  - Minimal hemodynamic effect on LA function

- **Disadvantages**
  - Coronary artery injury (LCx)
  - Atrio-esophageal fistula
Lateral Mitral Isthmus Line

- **Anatomy**
  - Average length: 35mm
  - Average depth: 4mm
  - Longer than the CTI with similar myocardial thickness

- **Where to draw**
  - No fixed optimal position d/t the anatomical heterogeneity
  - Proximal: greater myocardial thickness and higher incidence of myocardial sleeves around the CS
  - Distal: greater proximity to the LCx
  - Usually 3 to 4 o’clock in LAO
Assessment of Block

- Presence of widely spaced double potentials along the line

- Activation mapping around the MVA when pacing on either side of the line showing activation detours

- Differential pacing utilizing 2 sites on one side of the line and measuring conduction time to a fixed point on the other side of the line
LAA pacing - PMI Block(-)

CS 9,10

CS 1,2
LAA pacing - PMI Block (+)

CS 9,10

CS 1,2
CSDd Pacing to LAA interval: 115 ms
CS 5,6 Pacing to LAA interval: 85 ms
Possible Obstacles

- Long and thick mitral isthmus
- Pouch in the isthmus area
- Muscular sleeve around the CS
- Convective cooling by CS and LCx
- Epicardial connections (LoM)
Impact of Anatomy on Success

- Incomplete block
  - Pouch at the isthmus (40% vs 9%; P=0.01)
  - Greater isthmus depth (8.1 ± 4.2 mm vs 5.7 ± 3.4 mm; P =0.04)
  - Higher prevalence of an interposed LCx between the CS and the MI (60% vs 20%; P =0.003)
- An interposed circumflex artery was the only independent predictor

Yokokawa et al. Heart Rhythm 2011;8:1404–1410
- Needed in about 70% of cases
- The catheter is advanced into the dCS beyond the CS distal bipole
- The ablation catheter is deflected towards the endocardial surface opposite to the endocardial lesions to minimize the LCx damage
Balloon Occlusion of the CS

- No difference in acute success rate
- Significant reduction
  - Need for CS ablation (48% vs. 83%, P = 0.01)
  - Mean total ablation time (9.4 ± 5.5 vs. 13.3 ± 4.6 min, P < 0.02)
  - Mean CS ablation time (1.5 ± 2.8 vs. 3.4 ± 2.7 min, P < 0.05)

Wong et al. Heart Rhythm 2011;8:833–839
Ethanol Infusion into VOM

Steerable Sheaths

- The acute rate: 97.5%
- Mean ablation time: 11.8±6.4 mins
- Need for CS ablation: 12.5%

Matsuo et al. JCE. 2011;22:1331-8
Contact Force and Clinical Outcome

Table 1  Baseline patient characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Atrial fibrillation (N = 34)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>59.9 ± 7.8</td>
</tr>
<tr>
<td>Range</td>
<td>42–73</td>
</tr>
<tr>
<td>Sex: Man, n (%)</td>
<td>23 (68)</td>
</tr>
<tr>
<td>Cardiovascular history, n (%)</td>
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</tr>
<tr>
<td>Cardiac disorders</td>
<td>8 (24)</td>
</tr>
<tr>
<td>Secondary arrhythmia</td>
<td>4 (12)</td>
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<tr>
<td>Coronary artery disease</td>
<td>1 (3)</td>
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<tr>
<td>Heart failure</td>
<td>2 (6)</td>
</tr>
<tr>
<td>Valvular disease</td>
<td>1 (3)</td>
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<tr>
<td>Other cardiac disorders</td>
<td>3 (9)</td>
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<tr>
<td>Vascular disorders</td>
<td>20 (59)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>18 (53)</td>
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<tr>
<td>Left atrium diameter (mm)</td>
<td>(N = 18)</td>
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<tr>
<td>Mean ± SD</td>
<td>41.5 ± 4.2</td>
</tr>
<tr>
<td>Range</td>
<td>34–51</td>
</tr>
</tbody>
</table>
Anterior lines

- **Advantages**
  - ✓ No need for ablation within the CS
  - ✓ Easier to achieve BDB, less anatomical obstacles

- **Disadvantages**
  - ✓ Long length
  - ✓ Delayed activation of the LAA
  - ✓ Inadvertent isolation of the LAA
Anterior vs. Lateral MI Line

- LAAW (n =100) vs. LLMI ablations (n =100) in PeAF
- Mean voltage: LAAW < LLMI (P <0.001)
- Ablation length: LAAW > LLMI (37.9±3.4 vs 26.6±3.2 mm, P <0.001)
- BDB: LAAW > LLMI (68.0 vs 32.0%, P <0.001)
- Mean ablation duration: LAAW = LLMI (19.3±2.9 vs. 18.2±3.7 min, P =0.086)

Pak et al. Heart Rhythm 2011;8:199–206
Catheter manipulation
Assessment of Block
LAA pacing, LAA to Lt Septum: 97ms
LAA pacing, LAA to Ant. wall: 174ms
Delayed activation of LAA
Consequences of Delayed activation of LAA

<table>
<thead>
<tr>
<th></th>
<th>No Delayed LAA activation (n = 92)</th>
<th>Delayed LAA activation (n = 31)</th>
<th>p value</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Baseline LA</td>
<td>97.6</td>
<td>42.3</td>
<td>113.7</td>
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<tr>
<td>F/U LA</td>
<td>74.7</td>
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<tr>
<td>∆ LA</td>
<td>-20.8</td>
<td>23.9</td>
<td>-39.1</td>
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<tr>
<td>Baseline LAA</td>
<td>19.9</td>
<td>7.3</td>
<td>18.0</td>
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<tr>
<td>F/U LAA</td>
<td>23.5</td>
<td>8.5</td>
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<tr>
<td>∆ LAA</td>
<td>3.7</td>
<td>5.6</td>
<td>6.2</td>
</tr>
</tbody>
</table>

Kim YG et al. KHRS 2017
My Practice

- Use an irrigated-tip catheter & 3D mapping system
- Duodecapolar catheter in CS, circular mapping catheter in LAA
- Lateral MI line
  - Usually for perimitral AT, rather than substrate modification
  - From MA between 3 and 4 o'clock, drag technique
  - CS ablation in most cases, steerable sheath if possible
  - Mitral isthmus: 30-35 W, CS: 25-30 W
- Anterior line
  - Usually for substrate modification, rather than for PM AT
  - Power: 30 W
Summary

● Linear ablation은 proarrhythmic 하므로 꼭 필요하다고 판단되는 경우에만 시행하고 BDB을 반드시 확인한다.

● Reason for linear ablation, anatomy, voltage mapping, possible complications 등을 고려하여 Anterior line or lateral mitral isthmus line을 결정한다.

● Mitral isthmus line은 대부분의 경우 (70%)에서 CS ablation이 필요하다.

● Technology의 발전으로 linear ablation의 성공률이 점차 향상될 것으로 예상된다.
Contact Force and Clinical Outcome

Reduction in AF recurrence at follow-up.

- 37% reduction in AF recurrence at 12 months
- Reduced RF duration
- No difference in procedure & fluoroscopy time