Hybrid thoracoscopic and transvenous ablation: updates in 2017

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Contents

• Introduction
• Recent rhythm outcome
• Interesting cases
• Current studies
• Issues
Minimal invasive?
Totally thoracoscopic !!!
Totally thoracoscopic ablation

- Easy pulmonary vein isolation
  - Bipolar: transmurality
  - Shorter time, narrow ablation lines
  - May result in early LA function restoration.

- Epicardial ablation
  - Marshall vein, GP, Superior, inferior lines

- LA resection
  - Stapling, LA clip
  - 3mm instruments
Surgical procedures

- PV isolation
- Superior and inferior line ablation
- GP ablation
- LA auricle resection
- Division of Marshall vein
- SVC ablation (±)
Roof line ablation
Ablation of ganglionated plexi
Division of huge marshall tract
Huge LA appendage
LAA stapling in huge LAA
Signals at the right atrial lateral wall
Ablation at the right atrial lateral wall
RA linear cryoablation
Ablation site: Right atrium

- Ablation site: SVC isolation, CS os
SVC circular ablation
### Staged EP study

<table>
<thead>
<tr>
<th>When AF burden is zero</th>
<th>When AF burden is not zero</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Confirmation of PVI lines</td>
<td></td>
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<tr>
<td>• CTI ablation</td>
<td></td>
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<tr>
<td>• Confirmation of PVI lines</td>
<td></td>
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<tr>
<td>• 3D mapping and additional ablation</td>
<td></td>
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<tr>
<td>• CTI ablation</td>
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</table>

Recently, 3 months later according to 24 holter
Insufficient PVI
Follow up

Discharge

Follow up
Every 3 months
- EKG

24 hours holter
- 3 months
- 6 months
- 12 months

Echocardiography
- 6 months
- 12 months

Based on evaluation at 6 months
- Stop anticoagulation
- Stop antiarhythmic drugs

Chest MDCT
- 12 months

2 weeks event after 12 months
RECENT RHYTHM OUTCOME
Results (12 months)

- Total EPS performed: 108
- Full scale EPS: 60
- AF at EPS: 31 (28.7%)
- Additional ablation (left atrium): 22 (20.3%)
- CTI ablation: 93
- Mitral annulus ablation: 5
Results

- No death or conversion to open heart surgery
- 92.6% (100/108) patients were in sinus rhythm during follow up 1 year (including AAD and additional RFCA)

Perioperative complications
- Pericardial effusion
- Bleeding
- Stroke
- Pulmonary vein to esophageal fistula
Rhythm outcomes

At discharge

6 months

12 months

AAD: 30%

SR

AFL

AF
## Update: Patients (n=150)

<table>
<thead>
<tr>
<th></th>
<th>Preoperative</th>
<th>Range</th>
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</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>55 ± 9</td>
<td>29 ~ 78</td>
</tr>
<tr>
<td>Sex (M/F)</td>
<td>140 / 10 (7%)</td>
<td></td>
</tr>
<tr>
<td><strong>BMI, m²</strong></td>
<td>25±2.8</td>
<td>18 ~ 34</td>
</tr>
<tr>
<td><strong>AF duration, months</strong></td>
<td>44 ± 49</td>
<td>3 ~ 242</td>
</tr>
<tr>
<td>Previous RFCA</td>
<td>23 (15%)</td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>18 (12%)</td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>60 (40%)</td>
<td></td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>9 (6%)</td>
<td></td>
</tr>
<tr>
<td>Stroke history</td>
<td>24 (16%)</td>
<td></td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>4 (3%)</td>
<td></td>
</tr>
<tr>
<td><strong>LA volume index, ml/m²</strong></td>
<td>48 ± 16</td>
<td>16 ~ 87</td>
</tr>
<tr>
<td><strong>LA diameter, mm</strong></td>
<td>45 ± 7</td>
<td>30 ~ 63</td>
</tr>
<tr>
<td><strong>CHAD² score</strong></td>
<td>1.2 ± 1.2</td>
<td>0 ~ 5</td>
</tr>
</tbody>
</table>
Updated Results (median 17 months)

- 14 of 150 patients recurred and no additional intervention

Prevalence (%)

- NSR at last follow up: 91%
- Off drug NSR: 50%
- NSR without event: 84%
- NSR with event: 7%
- AF/AFL: 9%
Durability of TTA

• 2012.2 ~ 2014.6
  – Minimum 3 years follow up
• 82명 중 65명이 persistent AF (79%)
• Postprocedural EPS
  – Before discharge:
  – 3 months later
  – TTA only
• 24 hours holter every 6 months
Durability of TTA

Mean follow up: 49 months (36 ~ 65)

- 60명 (73%)
- 69명 (84%)

RFCA: 11명
Interesting cases
PV stenosis after RFCA

- M/32 Long standing atrial fibrillation
- 2011년 심방세동 진단
- 2012, 2013, 2015년 RFCA 시행
  - 2016 재발하여 DC cardioversion: failed
- EchoCG
  - LVEF: 68%
  - LA diameter: 43mm
  - LAVI: 27.5ml/m²
- Symptom: palpitation and DOE
PV stenosis after RFCA
PV stenosis after RFCA
PV stenosis after RFCA
PV occlusion after RFCA

- M/69 Long standing atrial fibrillation
- RFCA 3회 시행 (마지막 2009)
- EchoCG
  - LVEF: 55%
  - LA diameter: 28mm
  - LAVI: 29.8ml/m²

- Symptom: 가슴이 답답하고 숨이 참. (1달전부터)
PV occlusion after RFCA
PV occlusion after RFCA
PV occlusion after RFCA

[PID: 37384228 / Date: 2017-06-12]

Unconfirmed Diagnosis
• M/39 Long standing atrial fibrillation
• 2012년 심방세동 진단
• 2014, 2015년 7월 RFCA 시행
  – Hemopericardium: PCC
• 다시 6개월 후 재발
• EchoCG
  – LVEF: 25-30%
  – LA diameter: 53mm
  – LAVI: 83.5ml/m²
Previous RFCA injury
Previous RFCA injury
Previous RFCA injury
Huge LAA
• M/54 Long standing atrial fibrillation
• 2015년 심방세동 진단
• 어지러운 증상이 자주 있어 불안
• 지하철 조종사: 재발에 대한 불안
• DC cardioversion 재발
• EchoCG
  – LVEF: 59%
  – LA diameter: 37mm
  – LAVI: 44 ml/m²
Pulmonary anomaly

어머니: 심장 기형 수술
딸: TOF 수술
Current studies
Randomized controlled trial
Criteria

- **Inclusion Criteria:**
  - Long-lasting persistent AF refractory to antiarrhythmic drug therapy
  - Persistent AF of more than 6 months confirmed on ECG
  - 18 ~ 85 years

- **Exclusion Criteria:**
  - Valvular heart disease of more than moderate degree
  - Unresponsive ischemic cardiomyopathy
  - Follow-up of over 1 year was not possible
  - Warfarin was unable to be used
  - Refusal of informed consent
Early results

<table>
<thead>
<tr>
<th>Before discharge</th>
<th>At discharge</th>
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</thead>
<tbody>
<tr>
<td>23 TTA only</td>
<td>3 CTI ablation</td>
</tr>
<tr>
<td>23 Hybrid</td>
<td>15 EPS confirmed</td>
</tr>
<tr>
<td></td>
<td>8 additional LA side ablation</td>
</tr>
<tr>
<td></td>
<td>All prophylactic CTI ablation</td>
</tr>
</tbody>
</table>
Follow up duration

TTA group
Hybrid group

* accumulated numbers
CA, additional Catheter Ablation; AAD, antiarrhythmic drugs.
2 YEAR RESULTS

Arrhythmia free survival at 1 year (P=0.210 by log rank test)

Freedom from arrhythmia events (%)

TTA 89.2 ± 7.2%
Hybrid 77.3 ± 8.9%

Number at risk

TTA 19 18 17 15 11 6
Hybrid 21 20 16 14 11 7

TTA, totally thoracoscopic ablation.
**Patient 6 (Atrial flutter)**

Ablation sites: Perimital, roof, superior vena cava, cavo-tricupid-isthmus

- Spontaneous sinus conversion during perimital ablation

**Patient 17 (Atrial fibrillation)**

Ablation sites: Perimital, crista terminalis, cavo-tricupid-isthmus

- Spontaneous sinus conversion during low crista terminalis ablation

**Patient 44 (Atrial fibrillation)**

Ablation sites: Right pulmonary vein, superior vena cava, cavo-tricupid-isthmus

- Spontaneous sinus conversion during right inferior pulmonary vein (residual potential (+))

**Patient 40 (Atrial flutter)**

Ablation sites: Cavo-tricupid-isthmus (typical atrial flutter)

- Spontaneous sinus conversion during cavo-tricupid-isthmus ablation

**Patient 43 (Atrial flutter)**

Ablation sites: Superior vena cava, cavo-tricupid-isthmus

- Spontaneous sinus conversion during superior vena cava ablation
Freedom from AF events

- **AF events:**
  - Atrial arrhythmia at 24-Holter (over 10%)
  - Symptom: dyspnea, palpitation
  - Cardioversion
  - Additional Ablation after 3 months

- **Predators of AFib events**
  - LAVI (OR 1.1, 95CI 1.0 ~ 1.1, P = 0.045)
  - Lack of post-procedural EPS (OR 9.5, 95CI 1.1 ~ 80.6, P = 0.039)
Marshall: □ Untouched □ Divided
Appendage: □ Untouched □ Stapler □ Atriclip (Size mm)
Tump: □ Unchecked □ None □ Remnant (Size mm)
Type: □ Cactus

□ Windsock

□ Cauliflower

☑ Chicken wing
Hybrid versus RFCA

From Jan. 2012 to Apr. 2015
342 of consecutive patient undergoing either hybrid or RFCA alone for drug-refractory lone AF

Patients with previous history of ablation for AF were excluded (n=7)

Study patients (n=335)

Hybrid group (n=90) RFCA alone group (n=245)

Propensity score-matching

Hybrid group (n=65) RFCA alone group (n=102)

Europace: on revision
Hybrid versus RFCA

A Paroxysmal AF (n=155)

Log Rank P=0.62

- Hybrid + LAVI < 35 (median)
- Hybrid + LAVI ≥ 35
- RFCA + LAVI < 35
- RFCA + LAVI ≥ 35

No. at risk (AF-free survival rate, %)

<table>
<thead>
<tr>
<th>Follow-up (year)</th>
<th>Hybrid + LAVI &lt; 35</th>
<th>Hybrid + LAVI ≥ 35</th>
<th>RFCA + LAVI &lt; 35</th>
<th>RFCA + LAVI ≥ 35</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5 (100%)</td>
<td>10 (100%)</td>
<td>72 (100%)</td>
<td>68 (100%)</td>
</tr>
<tr>
<td>1</td>
<td>4 (100%)</td>
<td>8 (90.0%)</td>
<td>54 (89.6%)</td>
<td>51 (89.4%)</td>
</tr>
<tr>
<td>2</td>
<td>2 (100%)</td>
<td>7 (90.0%)</td>
<td>24 (80.8%)</td>
<td>28 (75.7%)</td>
</tr>
<tr>
<td>3</td>
<td>2 (100%)</td>
<td>2 (90.0%)</td>
<td>7 (67.0%)</td>
<td>13 (75.7%)</td>
</tr>
</tbody>
</table>

Europace: on revision
Hybrid versus RFCA

![Graph showing Persistent AF (n=99) with survival rates and follow-up years.](https://example.com/graph)

Europace: on revision
# Hybrid versus RFCA

<table>
<thead>
<tr>
<th></th>
<th>Hybrid ($n = 90$)</th>
<th>RFCA alone ($n = 245$)</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AF recurrence</strong></td>
<td>1-year</td>
<td>2-year</td>
<td>3-year</td>
</tr>
<tr>
<td>AF recurrence</td>
<td>13 (14.7)</td>
<td>19 (24.3)</td>
<td>19 (24.3)</td>
</tr>
<tr>
<td>Sustained AT</td>
<td>1 (1.1)</td>
<td>3 (4.1)</td>
<td>6 (12.6)</td>
</tr>
<tr>
<td>Atypical AFL</td>
<td>6 (6.7)</td>
<td>10 (12.0)</td>
<td>12 (16.7)</td>
</tr>
<tr>
<td>Atrial arrhythmia</td>
<td>15 (17.0)</td>
<td>23 (29.5)</td>
<td>26 (39.9)</td>
</tr>
</tbody>
</table>

*Europace: on revision*
Conclusions

• Hybrid approach for persistent AF was safe and showed excellent mid-term durability.

• the incidence of residual potentials around the pulmonary veins was not negligible.

• Atrial arrhythmias from enlarged right atrium