2019 Atrial Fibrillation
Ablation Strategy

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AF Ablation Strategies

Paroxysmal AF
- 4PVI, only

(Long-standing) Persistent AF
- 4PVI with/without
  - Left atrial lines ablation
  - Posterior wall isolation
  - Non-PV triggers ablation
  - CFAE ablation
  - Fibrotic areas ablation
  - Driver (or rotor) ablation
AF Ablation Strategies

Outcomes of Three Ablation Strategies

Technical Improvement in AF Ablation

- Contact-force-sensing RF ablation catheters
  - SmartTouch catheter from Johnson & Johnson
  - TactiCath catheter from Abbott

- Cryoballoon AF ablation
  - Arctic Front from Medtronic

- Thoracoscopic epicardial AF ablation
  - Atricure

- High-density mapping catheter and 3D system
  - Rhythmia and Orion catheter from Boston
  - Advisor Grid catheter and Ensite Precision system from Abbott
What are 2019 strategies in AF ablation?

- Conventional strategies + new technologies
  - 4PVI using contact-force-sensing ablation catheter for paroxysmal AF
  - 4PVI using cryoballoon for paroxysmal AF
  - 4PVI & LA lines ablation using endocardial & epicardial hybrid ablation for persistent AF
  - Substrate mapping & ablation using high-density mapping system for persistent AF
Pulmonary Vein Isolation
by Cryoballoon Catheter
Catheter Ablation vs Cryoballoon Ablation

Catheter Ablation vs Cryoballoon Ablation

A Primary Efficacy End Point

Hazard ratio, 0.96 (95% CI, 0.76–1.22) 
P<0.001 for noninferiority

90-Day blanking period

35.9%

34.6%

Patients with Primary Efficacy Event (%)

Days since Procedure

No. at Risk
Cryoballoon 374 338 242 194 165 132 107 70 57 34 12
RFC 376 350 243 191 149 118 93 58 44 25 12

C Primary Safety End Point

Hazard ratio, 0.78 (95% CI, 0.52–1.18) 
P=0.24

Patients with Primary Safety Event (%)

Days since Procedure

No. at Risk
Cryoballoon 374 323 298 261 229 189 159 117 94 55 21
RFC 376 315 292 247 215 176 146 110 87 52 27

# Efficacy Outcomes of Cryoballoon Ablation


## Table 2. Efficacy End Points.*

| End Point                                      | Radiofrequency Group (N = 376) | Cryoballoon Group (N = 374) | Hazard Ratio (95% CI)† | P Value  
|------------------------------------------------|--------------------------------|----------------------------|------------------------|---------
| Primary efficacy end point — no. of patients (%)‡ | 143 (35.9)§                   | 138 (34.6)§                | 0.96 (0.76–1.22)       | <0.001¶ |
| Components of the primary efficacy end point — no. of patients |                                |                            |                        |         |
| Recurrent atrial arrhythmia                     | 87                             | 80                         | —                      | —       |
| Antiarrhythmic drug treatment                   | 49                             | 51                         | —                      | —       |
| Repeat ablation                                 | 7                              | 7                          | —                      | —       |
| Secondary efficacy end points                   |                                |                            |                        |         |
| Death from any cause — no. of patients          | 0                              | 2‖                         | —                      | 0.25**  |
| Death from arrhythmia — no. of patients         | 0                              | 0                          | —                      | —       |
| Total procedure duration — min                  | 140.9±54.9                     | 124.4±39.0                 | —                      | <0.001††|
| Left atrial dwell time — min‡‡                  | 108.6±44.9                     | 92.3±31.4                  | —                      | <0.001††|
| **Total fluoroscopy time — min§§**              | **16.6±17.8**                   | **21.7±13.9**              | —                      | <0.001††|
| Rehospitalization for cardiovascular causes — no. of patients (%) | 55 (13.5)§                   | 44 (9.4)§                  | 0.78 (0.53–1.16)       | 0.28**  |


†Hazard ratio with 95% confidence interval.

‡Primary efficacy end point: 
- No. of patients (%)

§Values are mean ± standard deviation.

‖Death from any cause: 
- No. of patients

¶Significant at the 0.01 level (two-tailed).

**Significant at the 0.05 level (two-tailed).
# Safety Outcomes of Cryoballoon Ablation

Table 3. Safety End Points.

<table>
<thead>
<tr>
<th>End Point</th>
<th>Radiofrequency Group (N = 376)</th>
<th>Cryoballoon Group (N = 374)</th>
<th>P Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary safety end point†</strong></td>
<td>51 (12.8)‡</td>
<td>40 (10.2)‡</td>
<td>0.50</td>
</tr>
<tr>
<td><strong>Death from any cause§</strong></td>
<td>0</td>
<td>2 (0.5)¶</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Stroke or TIA from any cause§</strong></td>
<td>2 (0.5)</td>
<td>2 (0.5)</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Groin-site complication</strong>**</td>
<td>16 (4.3)</td>
<td>7 (1.9)</td>
<td>0.09</td>
</tr>
<tr>
<td><strong>Unresolved phrenic nerve injury††</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At discharge</td>
<td>0</td>
<td>10 (2.7)</td>
<td>0.001</td>
</tr>
<tr>
<td>At 3 months</td>
<td>0</td>
<td>2 (0.5)</td>
<td>0.25</td>
</tr>
<tr>
<td>At &gt;12 months</td>
<td>0</td>
<td>1 (0.3)</td>
<td>0.50</td>
</tr>
<tr>
<td><strong>Cardiac tamponade or pericardial effusion</strong></td>
<td>5 (1.3)</td>
<td>1 (0.3)</td>
<td>0.22</td>
</tr>
<tr>
<td><strong>Pulmonary or bronchial complication</strong></td>
<td>4 (1.1)</td>
<td>2 (0.5)</td>
<td>0.69</td>
</tr>
</tbody>
</table>


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**N Engl J Med**: *New England Journal of Medicine*

**KH Kuck**: Dr. Kunihiko Kuck

**N Engl J Med 2016;374:2235-45**: Published in Fall 2016

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<table>
<thead>
<tr>
<th>Cryoballoon Ablation</th>
<th>RFCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less specialized training</td>
<td>More specialized training</td>
</tr>
<tr>
<td>Less procedure time</td>
<td>More procedure time</td>
</tr>
<tr>
<td>Less established</td>
<td>Better established</td>
</tr>
<tr>
<td>14.5-Fr catheters</td>
<td>8.5-F catheters</td>
</tr>
<tr>
<td>More fluoroscopy time</td>
<td>Less fluoroscopy time</td>
</tr>
<tr>
<td>More phrenic nerve injury</td>
<td>More cardiac tamponade (?)</td>
</tr>
<tr>
<td>Unfeasible for extra-PV ablation</td>
<td>Feasible for extra-PV ablation</td>
</tr>
<tr>
<td>Only de novo ablation</td>
<td>De novo &amp; repeat ablation</td>
</tr>
</tbody>
</table>

**Cryoballoon Ablation vs RFCA**

- **Cryoballoon Ablation**
  - Less specialized training
  - Less procedure time
  - Less established
  - 14.5-Fr catheters
  - More fluoroscopy time
  - More phrenic nerve injury
  - Unfeasible for extra-PV ablation
  - Only de novo ablation

- **RFCA**
  - More specialized training
  - More procedure time
  - Better established
  - 8.5-F catheters
  - Less fluoroscopy time
  - More cardiac tamponade (?)
  - Feasible for extra-PV ablation
  - De novo & repeat ablation
Epicardial and Endocardial Hybrid Ablation for Atrial Fibrillation
<table>
<thead>
<tr>
<th>Surgical Ablation</th>
<th>RFCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anatomy-based</td>
<td>Electrophysiology-based</td>
</tr>
<tr>
<td>Easy to achieve transmural lesions</td>
<td>Difficult to achieve transmural lesions</td>
</tr>
<tr>
<td>Feasible for LAA resection</td>
<td>Unfeasible for LAA resection</td>
</tr>
<tr>
<td>Unfeasible for confirming bidirectional block</td>
<td>Feasible for confirming bidirectional block</td>
</tr>
<tr>
<td>Unfeasible for mapping of atypical AFL, AT</td>
<td>Feasible for mapping of atypical AFL, AT</td>
</tr>
<tr>
<td>Inaccessible to mitral isthmus, CTI</td>
<td>More accessible to mitral isthmus, CTI</td>
</tr>
</tbody>
</table>
Epicardial & Endocardial Hybrid AF Ablation

- takes the advantages of surgical and catheter ablation
  - Anatomy- and electrophysiology-based
  - Easy to achieve transmural lesions
  - Feasible for LAA resection
  - Feasible for confirming bidirectional conduction block
  - Feasible for mapping atypical AFL or AT
  - Accessible to mitral line and CTI

- Two strategies
  1. Staged hybrid ablation
  2. Simultaneous hybrid ablation
Process of Staged Hybrid AF Ablation

1. Bilateral thoracoscopic off-pump epicardial ablation using Dallas lesion set
2. LAA resection
3. Confirmation of 4PV & SVC isolation in OR
4. After 4 days, confirmation of 4PVI, block across the roof & mitral lines and SVC lines.
5. CTI & coronary sinus lines ablation
6. AF induction → CFAE ablation

Process of Simultaneous Hybrid AF Ablation

1. Placement of EP catheters and PV mapping
2. Epicardial PV isolation using Atricure™
3. Endocardial confirmation of PV isolation using Lasso catheter
4. Epicardial roof and inferior line ablation
5. Endocardial confirmation of posterior LA isolation
6. Epicardial cavocaval line ablation and endocardial confirmation
7. Epicardial left isthmus line ablation and endocardial confirmation
8. Endocardial CTI ablation
9. LAA resection using stapling device

Lesion Patterns of Hybrid AF Ablation

- Epicardial surgical lesions
- Endocardial RFCA lesions

Catheter Ablation of Cardiac Arrhythmias 2020
# Outcomes of Hybrid Ablation for Persistent AF

## Table 2  List of studies on hybrid AF ablation

<table>
<thead>
<tr>
<th>First author</th>
<th>Patients (number)</th>
<th>AF duration (years)</th>
<th>LAD (mm)</th>
<th>(ls)pAF (%)</th>
<th>FU (months)</th>
<th>SR (%) +/- AAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bisleri [35]</td>
<td>45</td>
<td>7 ± 6</td>
<td>51 ± 10</td>
<td>100</td>
<td>28 ± 2</td>
<td>89/−</td>
</tr>
<tr>
<td>Bulava [27]</td>
<td>50</td>
<td>4 ± 3</td>
<td>48 ± 4</td>
<td>100</td>
<td>17 ± 5</td>
<td>94/84</td>
</tr>
<tr>
<td>Gehi [36]</td>
<td>101</td>
<td>6 ± 6</td>
<td>51 ± 10</td>
<td>83</td>
<td>12</td>
<td>66/37</td>
</tr>
<tr>
<td>Gersak [37]</td>
<td>50b 45</td>
<td>5 ± 5</td>
<td>48 ± 1</td>
<td>94</td>
<td>12</td>
<td>88/75</td>
</tr>
<tr>
<td>Krul [38]</td>
<td>31</td>
<td>8 (1-25)</td>
<td>47 ± 7</td>
<td>48</td>
<td>12</td>
<td>−/86</td>
</tr>
<tr>
<td>La Meir [39]</td>
<td>19</td>
<td>5 (3–8.5)</td>
<td>49 ± 20</td>
<td>74</td>
<td>12</td>
<td>63/37</td>
</tr>
<tr>
<td>Mahapatra [40]</td>
<td>15</td>
<td>5 ± 1</td>
<td>52 ± 10</td>
<td>100</td>
<td>16 ± 2</td>
<td>93/87</td>
</tr>
<tr>
<td>Muneretto [34]</td>
<td>36</td>
<td>6 (0.5–20)</td>
<td>50 ± 6</td>
<td>100</td>
<td>30 (1–58)</td>
<td>92/78</td>
</tr>
<tr>
<td>Richardson [41]</td>
<td>83</td>
<td>−</td>
<td>49 (42–53)</td>
<td>99</td>
<td>12</td>
<td>71/61</td>
</tr>
<tr>
<td>Zembala [42]</td>
<td>27</td>
<td>4 ± 3</td>
<td>46 ± 5</td>
<td>82</td>
<td>12</td>
<td>0/80</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>535b</strong></td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td><strong>5</strong></td>
<td><strong>49</strong></td>
<td><strong>86</strong></td>
<td><strong>17</strong></td>
<td><strong>82/70</strong></td>
<td></td>
</tr>
</tbody>
</table>

## Endo- & Epicardial Hybrid AF Ablation

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Easy to achieve transmural lesion</td>
<td>• Risk of surgical complications</td>
</tr>
<tr>
<td>• Endo mapping after epi ablation identifies gaps in epi ablation lines.</td>
<td>• Difficult to create lesions to the mitral or tricuspid annulus</td>
</tr>
<tr>
<td>• Avoidance of esophageal injury</td>
<td>• Challenging detailed mapping of ablation lines in OR</td>
</tr>
<tr>
<td>• LAA resection</td>
<td></td>
</tr>
</tbody>
</table>
Summary

- 2019 AF Ablation Strategies?
  - Conventional strategies + “new technologies”
    - 4PVI using cryoballoon for paroxysmal AF
    - 4PVI & LA lines ablation using endocardial & epicardial hybrid ablation for persistent AF
Thank all of you!