Mechanisms of atrial fibrillation terminations in humans: insights from non-invasive cardiac mapping

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DISCLOSURE

I have nothing to declare
Epidemiology and clinical significance of atrial fibrillation

- Atrial fibrillation is the most common sustained cardiac arrhythmia (approximately 8 millions adults over 55 years had AFib in 2010)
- AFib is associated with an increased risk of mortality and morbidity due to thromboembolism and heart failure (AFib is the most common factor in the stroke in the elderly)
What is Noninvasive ECG Imaging?

Noninvasive ECGI is the technology of numerical reconstruction and visualization of the electrical heart activity based on the ECG data measured on the body surface.
Noninvasive Phase Mapping

Rotors visualization using phase mapping.

Objective

To investigate the process of atrial fibrillation induction and termination in humans
## Patient characteristics

<table>
<thead>
<tr>
<th></th>
<th>Patient 1</th>
<th>Patient 2</th>
<th>Patient 3</th>
<th>Patient 4</th>
<th>Patient 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>52</td>
<td>50</td>
<td>47</td>
<td>46</td>
<td>70</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td>female</td>
<td>male</td>
<td>male</td>
<td>male</td>
<td>female</td>
</tr>
<tr>
<td><strong>Type of AFib</strong></td>
<td>paroxysmal</td>
<td>paroxysmal</td>
<td>paroxysmal</td>
<td>paroxysmal</td>
<td>paroxysmal</td>
</tr>
<tr>
<td><strong>LA diameter (mm)</strong></td>
<td>42</td>
<td>44</td>
<td>40</td>
<td>38</td>
<td>41</td>
</tr>
<tr>
<td><strong>EF LV (%)</strong></td>
<td>&gt;55</td>
<td>&gt;55</td>
<td>&gt;55</td>
<td>&gt;55</td>
<td>&gt;55</td>
</tr>
<tr>
<td><strong>Spontaneous initiation of AFib</strong></td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Termination of AFib</strong></td>
<td>Propafenone (1mg/kg)</td>
<td>spontaneous</td>
<td>spontaneous</td>
<td>spontaneous</td>
<td>Propafenone (1mg/kg)</td>
</tr>
</tbody>
</table>
Noninvasive endocardial end epicardial mapping system «AMYCARD 01C» by EP SOLUTIONS SA, Switzerland
Typical phase maps during atrial fibrillation
Typical phase maps during atrial fibrillation
CW rotor movement: Dominant trajectory

- **RSPV**: Rapid movement
- **LSPV**: Slow drifting
- **RIPV**: Rapid movement
- **LIPV**: Slow drifting
- **SVC**: Slow drifting
- **IVC**: Rapid movement
- **RA**: Rapid movement
- **LA**: Rapid movement
CW rotor movement: Dominant trajectory
ATRIAL FIBRILLATION
INDUCTION
### Baseline Patient Characteristics: AFib induction and termination Study

<table>
<thead>
<tr>
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<th>Patient 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spontaneous initiation of AFib</strong></td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Spontaneous termination of AFib</strong></td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>The mechanism of induction</strong></td>
<td>LIPV</td>
<td>_____</td>
<td>_____</td>
<td>RSPV</td>
<td>_____</td>
</tr>
</tbody>
</table>
Ectopical activity in LIPV triggered AFib

Red arrow indicates the PAC
Ectopical activity in LIPV triggered AFib

the red star- ectopic focus
the white star- the emergence of the rotor
Ectopical activity in LIPV triggered AFib

[video]
TERMINATION OF ATRIAL FIBRILLATION
Spontaneous atrial fibrillation termination
Termination of atrial fibrillation
Event A
Event B
Pharmacological cardioversion
Estimated parameters
(on baseline condition and under propafenone administration)

- Rotors stability (score of rotation)
- Rotors cycle length
- Rotors meandering area square
- Number of events PhS collision (A and B type)
- The type of the final event, which led to sinus rhythm recovery
Termination of atrial fibrillation in vitro

Conclusions

• Mutual annihilation of rotors with opposite direction of rotation is the basic mechanism of spontaneous and propafenone-induced AFib termination.

• The most of rotors annihilation events didn’t lead to AFib termination, because the second re-entrant wave could be a cause of AFib maintenance.

• AFib termination is a stochastic process. The probability of AFib termination depends on rotors collision probability and a random number of co-exited reentrant waves.

• It is difficult to explain drug-induced AFib termination using the conception of wave length (i.e. conduction velocity and refractory period duration).

• The influence of drug-induced changes of myocardial cellular EP properties on a complex and stochastic mechanism of AFib termination required further investigations.
Thank you very much for attention!