New Technology in Ablation

Pohang SM Christian Hospital
Sang-Hee Lee
Development of AF Ablation Tech.

- **Build a better mouse trap**
  1. Improve patient outcomes (reducing recurrence)
  2. Reduce procedure time
  3. Keep safety better

- **Right now we are getting......**
  1. **PaAF** has better outcomes, but it still may require repeat procedures.
  2. Procedural success rates at curing **PeAF** are about 50-60% at 18 months. [1]
  3. **very time-consuming** to perform electromapping and the ablation procedure itself.

Evolution of Ablation Devices for AF

- Better lesion durability
- Improve procedure outcome
Need for Advance in AF Ablation Devices.

**Standard RF vs. Open irrigated RF**

- Maintain lower tip temperature and higher power delivery to tissue
- Much deeper lesion formation – getting more transmurality.
- Decreased char formation
- Increased risk of esophageal injury
Need for Advance in AF Ablation Devices.

Closed irrigated RF vs. Open irrigated RF

- Thrombus occurred frequently with the closed loop electrode (interface temp. ≥ 80°C).
- With the open irrigation electrode, interface temperature was low (all ≤ 71°C) with no occurrence of thrombus.

W.M. Jackman. Circulation. 2006;113:11-19
Determinants of Lesion Size During Radiofrequency Catheter Ablation: The Role of Electrode-Tissue Contact Pressure and Duration of Energy Delivery

David E. Haines M.D. JCE. 1991; 509-515

Determinants of Radiofrequency Lesion Size. Introduction: Radiofrequency (RF) catheter ablation is a promising modality in the management of cardiac arrhythmias, but the optimum protocol for energy delivery has not yet been determined. The purpose of this study was to examine the effects of varying electrode-tissue contact pressure and varying duration of RF energy delivery on the size of the resultant lesion in an in vitro model of isolated perfused and superfused canine myocardium. Methods and Results: RF power (500 kHz) was delivered through the tip of a specially-designed thermistor-tipped 1.6-mm diameter electrode mounted on an adjustable fulcrum so that contact force could be varied. RF power was adjusted to maintain a constant electrode-tissue interface temperature of 80°C during lesion production. Seventy-nine lesions were created with a 90-second RF energy delivery, and a contact force that was varied between 0 and 400 newtons (N) (0-41 g). Lesions produced with a small contact force (10 N) were significantly larger than those with a contact force of zero (width 5.5 mm vs 3.8 mm, P <0.0002), but not significantly different from those produced with the maximum contact force of 400 N (width 6.5 mm, P = NS). However, the greater contact force significantly decreased the power required to maintain a constant electrode-tissue interface temperature. Ninety-six lesions were then created using a constant contact force, but duration of energy delivery was varied from 10 to 600 seconds. Lesion size grew monoexponentially with time. The t1/2 of lesion growth was 7.6 and 9.6 seconds for depth and width, respectively. Conclusion: Thus, close electrode-tissue contact is essential for adequate lesion formation during RF ablation of myocardium, but increasing contact force does not significantly increase lesion size if power is adjusted to maintain a constant electrode-tissue interface temperature. In order to approach steady-state and maximize lesion size, duration of RF energy delivery should be at least 40 seconds.

First recognition about the importance of CF 28 years ago
Need for Advance in AF Ablation Devices.

Currently available CF-sensing RF cath.

- **Fiber optic sensor**
  Force on the distal catheter tip changes the length of an air cavity, altering the reflection pattern of light shining through adjacent semireflective mirrors.

- **Spring-based sensor**
  Force on the distal tip of the catheter compresses a precision spring. Deflection (x) of the spring is determined by measuring micromovements of a transmitter coil distal to the spring, and the contact force is calculated using the known spring characteristics (k).
New advances in AF ablation devices are needed.

### Table 1: Summary of Randomized Controlled Trials in CF Ablation in AF

<table>
<thead>
<tr>
<th>First Author, Year (Trial Name) (Ref.)</th>
<th>Number of Patients/Groups</th>
<th>Type of AF, Ablation Methodology</th>
<th>Design</th>
<th>AF Outcomes</th>
<th>Other Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kimura et al., 2014 (12)</td>
<td>CF+, n = 38; CF-, n = 38</td>
<td>PAF + check for dormant conduction with ATP + isoproterenol</td>
<td>Single center; Physicians had performed minimum of 5 CF ablation procedures prior to trial</td>
<td>No difference in freedom from AADs after single procedure (± AAD): CF+ 95%, CF- 84%</td>
<td>CF+ vs. CF- had: Higher mean CF; Shorter procedure time; Shorter fluoroscopy time; Fewer residual conduction gaps on completion of anatomic ring</td>
</tr>
<tr>
<td>Reddy et al., 2015 (TOCCSTAR) (15)</td>
<td>CF catheter, n = 150; non-CF catheter, n = 150</td>
<td>PAF; PVI, 30-min wait, elimination of isoproterenol-induced triggers</td>
<td>Multicenter; No prior experience with CF needed; CF with TactiCath system (Abbott); No CF target given; Non-CF with CARTO ( Biosense Webster)</td>
<td>No difference in freedom from AA after single procedure a AADs: CF+ 68%, CF- 69%</td>
<td>When CF was optimal (≥90% ablations with ≥10 g), freedom from AF/AT or flutter was higher in CF vs. non-CF group (75.9% vs. 58.1%, p = 0.02)</td>
</tr>
<tr>
<td>Nakamura et al., 2015 (13)</td>
<td>CF+, n = 60; CF-, n = 60</td>
<td>PVI + CTI ± SVC isolation</td>
<td>Single center; Physicians with variable experience with CF</td>
<td>No difference in 12-month freedom from AA ≥30 single procedures a AADs: CF+ 90%, CF- 88%</td>
<td>CF+ vs. CF- had: Fewer acute PVRs; Shorter procedure time; Higher mean CF</td>
</tr>
<tr>
<td>Conti et al., 2017 (TOUCH-AF Trial) (11)</td>
<td>CF+, n = 62 vs. CF-, n = 62</td>
<td>PeAF; PVI + roof line</td>
<td>All physicians had prior experience with CF; ThermodCool SMART-TOUCH both arms; CF+ target 10-40 g vs. CF- no display</td>
<td>No difference in 12-month freedom from AA ≥30 single procedures a AADs: CF+ 60%, CF- 63%</td>
<td>CF+ vs. CF- had: 1. No difference in median CF 2. Less time spent in CF range 5-10 g; more time in 10-20 g 3. Acute reconnection less common only in LIPV Gaps associated with less CF, FTI vs. no gaps No difference in RF time</td>
</tr>
<tr>
<td>Pedrote et al., 2016 (119)</td>
<td>CF+, n = 25; CF-, n = 25</td>
<td>PAF with VisiTag both groups; 30-min wait + ATP</td>
<td>Single center; ThermodCool SMART-TOUCH both arms; CF+ targets were CF≥10 g 75% of the time, stability 1.5 mm for ≥10 s; CF-targets: no CF displayed but stability 1.5 mm for ≥10 s</td>
<td>No difference in 12-month freedom from AAs after single procedure a AADs: CF+ 84%, CF- 75%</td>
<td>CF+ vs. CF- had: Higher CF in left but not right PVs; Shorter procedural and fluoroscopy time; Higher acute PVI at anatomic completion of ring</td>
</tr>
<tr>
<td>Ullah et al., 2016 (16)</td>
<td>CF+, n = 59; CF-, n = 58</td>
<td>PAF; CF 60-min wait ± adenosine</td>
<td>Multicenter; ThermodCool SMART-TOUCH both arms; CF+ target 5-40 g vs. CF- no display</td>
<td>No difference in 12-month freedom from AA after single procedure a AADs: CF+ 49%, CF- 52%</td>
<td>CF+ vs. CF- had: Greater proportion within CF range 5-40 g; Lower rate of acute PVR; No difference in procedure, fluoroscopy, or ablation time</td>
</tr>
<tr>
<td>Borregaard et al., 2017 (83)</td>
<td>CF+, n = 25; CF-, n = 25</td>
<td>PAF or short-lasting PeAF; 20-min wait ± adenosine</td>
<td>Single center; ThermodCool SMART-TOUCH both arms; CF+ target 10-40 g vs. CF- no display</td>
<td>No difference in 12-month freedom from AF after single procedure a AADs: CF+ 48%, CF- 64%</td>
<td>CF+ vs. CF- had: No difference in mean CF, ablation, fluoroscopy, procedure time, or acute PVR. Patients without recurrent AF had lower proportion of ablation time with CF &lt;10 g than recurrent AF patients</td>
</tr>
</tbody>
</table>
Need for Advance in AF Ablation Devices.

Temperature-Controlled RF. – TRACT-AF trial

(A) The distal ablation tip electrode is 4.1 mm long, with 3-mm spacing between the tip and first ring electrode. Embedded near the tip electrode are 3 distal and 3 proximal thermocouples (TCs) that monitor tip–tissue surface temperature, which is influenced in part by the thermal diffusivity of the (B) diamonds embedded in (C) the ~1 cm tip. (D) The highest temperature recorded from all thermocouples, power (increases over time), and change in impedance. (E) Temperatures recorded from all 6 TCs over the course of a single ablation. RF – radiofrequency.

DiamondTemp ablation cath.
Need for Advance in AF Ablation Devices.

Other tech. available in near future

The QDOT Micro Ablation Catheter is based on the Thermocool SmartTouch SF Catheter. It incorporates 6 thermocouples symmetrically embedded in the circumference of the tip electrode (A) and an improved irrigation system (B). See text for details.

Right Atrial Lesion Dimensions

- Standard 25W/20sec
  - Postero-Septal: Surface Width 3.8mm, Width 4.4mm, Depth 3.5mm
  - Postero-Lateral: Surface Width 3.7mm, Width 4.1mm, Depth 1.6mm

- HP-SD (90W/4sec; $T_m 65^\circ$C)
  - Postero-Septal: Surface Width 6.4mm, Width 6.0mm, Depth 3.6mm
  - Postero-Lateral: Surface Width 6.5mm, Width 6.2mm, Depth 1.8mm
Need for Advance in AF Ablation Devices.

Multi-Electrode RF – for single shot RFA

![Diagram showing electrode shapes and energy delivery]

<table>
<thead>
<tr>
<th>Electrode Shape</th>
<th>Electrode Surface Area</th>
<th>Power Input</th>
<th>Current Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>4mm Tip</td>
<td>33.7 mm²</td>
<td>30 W</td>
<td>0.016 A/mm²</td>
</tr>
<tr>
<td>PVAC</td>
<td>13.64 mm²</td>
<td>Max 10W</td>
<td>0.015 A/mm²</td>
</tr>
<tr>
<td>MASC</td>
<td>9.09 mm²</td>
<td>Max 10W</td>
<td>0.018 A/mm²</td>
</tr>
</tbody>
</table>

- **Multi-electrode RF vs. conventional RF: meta-analysis**
  - Procedural outcomes which include procedural and fluoroscopy times improved with multi-electrode radiofrequency ablation in comparison with conventional point-by-point radiofrequency ablation with a mean reduction of 34 min and 7 min respectively.
  - There was a trend for lower arrhythmia recurrence by a non-significant 10% relative risk reduction with multi-electrode radiofrequency ablation.
Need for Advance in AF Ablation Devices.

Multi-Electrode RF – for single shot RFA

Boston Scientific Corporation has announced a definitive agreement to acquire Apona Medical, a privately-held company that specializes in developing the Apona Radiofrequency (RF) Balloon Catheter System for the treatment of atrial fibrillation (AF). The transaction consists of US$175 million in cash up-front and a maximum of US$125 million in contingent payments over the period of 2018–2020 based on achievements of clinical and regulatory milestones.

The standard of care in AF ablation is pulmonary vein isolation (PVI)—the application of energy to create lines of scar tissue around the pulmonary veins in the left atrium to block unwanted electrical signals that trigger AF. PVI is currently performed using two different technologies: point-by-point RF-based ablation and single-shot balloon-based ablation.

The Apona RF balloon—a single-shot, multi-electrode technology—is designed to combine the primary benefits of both RF point-by-point and balloon-based ablation approaches, notably the ability to deliver differentiated levels of energy and shortened procedure times. The technology incorporates built-in cameras with LED lights and sensing electrodes on the balloon that allow for real-time visualisation and assessment of catheter electrode contact. This is intended to provide physicians with higher confidence of effective energy delivery and the ability to customise the amount of energy delivered around the circumference of the balloon, while further reducing procedure times when compared to existing balloon technologies.

First patient treated in STELLAR US study evaluating next-generation balloon ablation catheter for atrial fibrillation

Boston Scientific has enrolled and treated the first patient in its STELLAR US investigational device exemption (IDE) study. The study will evaluate the safety and effectiveness of the Heliostar multi-electrode radiofrequency balloon ablation catheter in treating symptomatic drug refractory paroxysmal (intermittent) atrial fibrillation. Up to 600 patients will be enrolled in as many as 40 clinical sites worldwide.

The Heliostar radiofrequency balloon ablation catheter has 10 electrodes, which allows electrophysiologists to deliver different levels of energy depending on the tissue during lesion creation. Additionally, the balloon design makes it possible to achieve pulmonary vein isolation with a single application of radiofrequency energy. The device is compatible with the Biosense Webster CARTO 3 mapping system. A press release reports that the use of the CARTO 3 system during an ablation procedure can reduce exposure to radiation from fluoroscopy.

Andrea Pahor, Texas Cardio Arrhythmia Institute, St David's Medical Center, Austin, USA, who treated the first patient in the study with Rodney Hotten (University of Texas Cardio Arrhythmia Institute, St David's Medical Center, Austin, USA), says: “The Heliostar catheter design has the potential to overcome the limitations of current balloon ablation catheters in terms of catheter exchanges and, most importantly, shorter procedure times. Heliostar is an exciting technology and we look forward to seeing the final results.”

Ongoing study:

- AF-FICIENT I study using luminize RF balloon (Boston),
- STELLAR US study using Heliostar (Biosense Webster)
Need for Advance in AF Ablation Devices.

Balloon-based ablation device: for single shot ablation

2\textsuperscript{nd} and 3\textsuperscript{rd} G cryoballoon

Hot balloon

Laser balloon
AF Ablation with Cryoenergy

- The FIRE AND ICE trial
  1. Purpose: compare the performance of the rather complex yet well-established approach of RFA with that of the apparently simpler approach of CBA in a larger population of patients with PaAF.
  2. CBA: using a 23- or 28-mm 1stG Arctic Front and 2ndG Arctic Front Advance; Medtronic, Inc.
  3. RFA: a 3.5 mm irrigated open tip catheter - ThermoCool and ThermoCool SF (1stG), ThermoCool SmartTouch (2ndG)

Kuck, NEJM, 2016
AF Ablation with Cryoenergy
CBA vs. RFA: Result of Fire and ICE study

Event-free Survival for the Primary Efficacy End Points in the Modified ITT Cohort

- The primary efficacy end point: 138 Pts in the CB group and in 143 Pts in the RF group (1-year Kaplan–Meier event-rate estimates, 34.6% and 35.9%, respectively; P<0.001 for noninferiority)
- A prespecified comparison of the primary efficacy end point among the four separate types of catheters revealed no significant heterogeneity (P=0.25)

Kuck, NEJM, 2016
AF Ablation with Cryoenergy
CBA vs. RFA: Result of Fire and ICE study

Event-free Survival for the Primary Safety End Points in the Modified ITT Cohort

- The primary safety end point: 40 Pts in the CB group and 51 Pts in the RF group
- The most common safety events were groin-site complications (16 in the RF group and 7 in the CB group) and PNI (10 in the CB group)
CB Ablation for PeAF
CRYO4PERSISTENT AF Trial: multi-center, prospective study

Single-Procedure Outcomes and Quality-of-Life Improvement

12 Months Post-CBA in PEAF

130 Patients
Enrolled

107 Patients
Cryoablation per Protocol

101 Patients
With FU in Primary Analysis

- 15 patients without 100% AF documented before ablation or patients did not met inclusion/exclusion criteria
- 3 patients withdrew informed consent
- 3 patients are withdrawn by the Investigator for medical reason
- 1 patient with ablation performed not following protocol
- 1 patient lost to FU

- 5 patients withdrew informed consent without FU data
- 1 patient lost to FU

Defaye, JACC, 2018
CB Ablation for PeAF
CRYO4PERSISTENT AF Trial: multi-center, prospective study

(A) Arrhythmia-related symptoms reduction (baseline to 12 months). (B) 36-Item Short Form Health Survey (SF36) quality-of-life (QoL) improvement (baseline to 12 months). (C) European Heart Rhythm Association (EHRA) atrial fibrillation (AF) symptom score reduction (baseline to 12 months).
Conclusion

- a 61% single-procedure success rate at 12 months post-ablation with a highly significant reduction in arrhythmia-related symptoms, and improved QoL.
- These outcomes are combined with a beneficial safety profile and considerably short procedure times.

Freedom From Atrial Fibrillation, Atrial Flutter, Atrial Tachycardia Recurrence

Defaye, JACC, 2018
Need for Advance in AF Ablation Devices.

HeartLight X3: for single shot ablation

Freedom from AA at 1 year with AAD, RF ablation, and balloon catheters are shown. The success rates shown are the drug-free single procedure success rates, with the exception of the RF ablation arm of ThermoCool AF (asterisk), which included redo procedures during the blanking period.

The visually guided laser balloon: the aiming and ablation spot of light (arrow).

An endoscopic view: the balloon positioned in the LSPV. The maneuverable aiming and ablation spot is shown, and the left inferior pulmonary vein and left atrial appendage are seen.
Need for Advance in AF Ablation Devices.

HeartLight X3

<table>
<thead>
<tr>
<th>Event</th>
<th>VGLB (n = 170)</th>
<th>Control (n = 172)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke</td>
<td>2 (1.2)</td>
<td>1 (0.6)</td>
<td>0.56</td>
</tr>
<tr>
<td>TIA</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>—</td>
</tr>
<tr>
<td>Cardiac tamponade, perforation, or significant effusion</td>
<td>2 (1.2)</td>
<td>3 (1.7)</td>
<td>0.66</td>
</tr>
<tr>
<td>Diaphragmatic paralysis</td>
<td>6 (3.5)</td>
<td>1 (0.6)</td>
<td>0.05</td>
</tr>
<tr>
<td>Atrio-esophageal fistula</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>—</td>
</tr>
<tr>
<td>PV stenosis &gt;50%</td>
<td>0 (0.0)</td>
<td>5 (2.9)</td>
<td>0.03</td>
</tr>
<tr>
<td>Cardioversion for atrial arrhythmias</td>
<td>14 (8.2)</td>
<td>16 (9.3)</td>
<td>0.73</td>
</tr>
<tr>
<td>Major bleeding requiring transfusion</td>
<td>0 (0.0)</td>
<td>1 (0.6)</td>
<td>0.32</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>—</td>
</tr>
<tr>
<td>Death</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>—</td>
</tr>
<tr>
<td>Total PAEs</td>
<td>24 (14.1)</td>
<td>27 (15.7)</td>
<td>NS</td>
</tr>
<tr>
<td>Total PAE rate*</td>
<td>20 (11.8)</td>
<td>25 (14.5)</td>
<td></td>
</tr>
</tbody>
</table>

VGLB Operator Learning Curve

<table>
<thead>
<tr>
<th></th>
<th>VGLB - LOW</th>
<th>VGLB - HIGH</th>
<th>CONTROL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure Time</td>
<td>p=0.006</td>
<td>p=0.003</td>
<td>p=0.038</td>
</tr>
<tr>
<td>Fluoroscopy Time</td>
<td>p=0.06</td>
<td>p=0.58</td>
<td></td>
</tr>
<tr>
<td>Primary Efficacy</td>
<td>p=0.58</td>
<td>p=0.10</td>
<td></td>
</tr>
<tr>
<td>Primary Safety</td>
<td>p=0.08</td>
<td>p=0.70</td>
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</table>

J Am Coll Cardiol 2015;66:1350–60
Need for Advance in AF Ablation Devices.

Kardium Globe mapping and RF: other single shot tech

The new catheter (Globe®, Kardium Inc., Burnaby, BC, Canada) is fitted with a distal multielectrode array consisting of 16 ribs upon which 122 gold-plated electrodes are positioned. Each electrode can perform multiple functions, and in addition to ablating can also measure tissue contact, temperature, current, and intracardiac electrograms, as well as apply stimulation pulses.

Need for Advance in AF Ablation Devices.

Kardium Globe mapping and RF

- **Fluoroscopic RAO and LAO view.** The preshaped ribs that overlay each other are coiled in the left atrium after transseptal puncture.
- After coiling-in, the array is fanned and shaped. → The Globe is positioned in target areas for ablation. → After completion of ablation, the array is unfanned. → the unfanned array is retracted into the sheath.

**FLOW map**: color-coded area of the degree of contact between the array’s electrodes and the atrial tissue.

**Voltage map**: amplitude of the EGM over a portion of the cardiac cycle.
Novel VT Ablation Tech.

Noninvasive Cardiac Radiation for Ablation of Ventricular Tachycardia

Phillip S. Cuculich, M.D., Matthew R. Schill, M.D., Rojano Kashani, Ph.D., Sasa Mutic, Ph.D., Adam Lang, M.D., Daniel Cooper, M.D., Mitchell Faddis, M.D., Ph.D., Marye Gleva, M.D., Amit Noheria, M.B., B.S., Timothy W. Smith, M.D., D.Phil., Dennis Hallahan, M.D., Yoram Rudy, Ph.D., and Clifford G. Robinson, M.D. et al.

- Noninvasive mapping of cardiac arrhythmias with electrocardiographic imaging + noninvasive delivery of precise ablative radiation with stereotactic body radiation therapy (SBRT) for VT.
- Targeted arrhythmogenic scar: anatomical imaging with noninvasive electrocardiographic imaging during VT that was induced by means of an ICD.
- Patients were treated with a single fraction of 25 Gy while awake.
- Efficacy was assessed by counting episodes of VT, as recorded by ICDs.
- Safety was assessed by means of serial cardiac and thoracic imaging.

- In five patients with refractory VT, noninvasive treatment with electrophysiology-guided cardiac radioablation markedly reduced the burden of ventricular tachycardia.
Novel VT Ablation Tech.
Novel VT Ablation Tech.

Needle RF ablation: bunker buster?

Irrigated Needle Ablation Creates Larger and More Transmural Ventricular Lesions Compared With Standard Unipolar Ablation in an Ovine Model

Benjamin Berte, MD; Hubert Cochet, MD, PhD; Julie Magat, MD, PhD; Jérôme Naulin; Daniele Ghidoli; Xavier Pillois, PhD; Frédéric Casassus, MD; Seigo Yamashita, MD, PhD; Saagar Mahida, MD, PhD; Nicolas Derval, MD; Mélèze Hocini, MD; Bruno Quesson, PhD; Olivier Bernus, PhD; Rukshen Weerasooriya, MD, PhD; Michel Haïssaguerre, MD; Frédéric Sacher, MD, PhD; Pierre Jais, MD, PhD
Novel VT Ablation Tech.

Needle RF ablation: bunker buster?

In patients with recurrent ventricular arrhythmias refractory to medications and conventional catheter ablation, intramural needle radiofrequency ablation offers significant arrhythmia control with an acceptable procedural risk.
Advance in RF Ablation Devices.

Walk with Improved outcomes?

- In the literature review on RF ablation between 2014 and 2017.
  - Current AF free survival at 1yr follow-up: 46 - 94%
  - Point-by-point ablation still requires longer procedure times compared with single-shot techniques (mean procedural times range between 101 and 284 minutes).
  - The use of image integration and EAM has been associated with fewer complications.
    - Phrenic nerve palsy is rare (0.01–0.6 %) and mainly transient.
    - Esophageal and vagal injury is low, ranging between 0.05 and 0.5 %.
    - The incidence of atrial-esophageal fistula as a percentage of all reported complications for CF catheters was higher (5.4 %: 65 of 1202 cases) compared with non-CF catheters (0.9 %: 13 of 1487 cases).
Advance in RF Ablation Devices.

Walk with Improved outcomes?

- In the literature review on RF ablation between 2014 and 2017.

**Irrigated RF:**
- reduced coagulum formation, improved outcome.
- Thromboembolic event rates range between 0.2 and 1 % for irrigated catheters.

**CF measurement during ablation:**
- improve lesion formation with a reported one-year AF free survival between 52 and 94 %
- reduced procedure, ablation and fluoroscopy times
- high-power-short-duration RF applications to further reduce procedure time are currently under investigation.
- randomized trials have failed to show improved outcomes with CF-sensing over non–CF-sensing catheters during RF ablation
Advance in RF Ablation Devices.

Walk with Improved outcomes?

**Multi-electrode RF**

- For the PVAC-Gold catheter shorter procedure times (94–117 minutes) have been reported.

- **Complications**
  - Asymptomatic cerebral embolisms were significantly higher with PVAC (incidence 38–39 %) than with irrigated RFCA and CBA.
  - Despite technical improvements, the second-generation PVAC-Gold catheter still showed a high incidence of asymptomatic cerebral embolism (20 % versus none, p=0.011).
  - PNP is uncommon after PVAC ablation.
  - Detectable narrowing of the PV diameter has been reported in 23 % of patients and 7 % of veins.
Advance in RF Ablation Devices.

Walk with Improved outcomes?

Balloon based ablation

- **CBA vs point-by point RFCA:**
  - similar efficacy, acceptable AE, shorter procedure time.
- **CBA vs other single shot tech:** not known difference in the efficacy. similar?
- **Laser balloon vs RFCA:**
  - no difference in outcome (71 versus 69 %, p=0.40) at 1-year follow-up (off AAD).
- **Laser balloon vs CBA:**
  - the efficacy at 1 year off AAD - comparable between the two techniques (73. vs 63 %).
  - Comparable ablation time (Laser balloon 144min, CBA 136min)
- **Complication:**
  - RFCA compared with balloon-based devices is associated with an increased risk for cardiac tamponade (1.5 versus 0.1 %).
  - in a randomised study comparing laserballoon (n=33), cryoballoon (n=33) and irrigated RFCA (n=33), the incidence of asymptomatic cerebral lesions was not significantly different (24 %, 18 % and 24 %, respectively).
Novel VT Ablation Tech.

**Radiation for VT:**
- Limitation of RFCA is that some VT substrate is difficult to locate and not accessible to catheters.
- The use of **SBRT** for ablation of drug-resistant, recurrent VT in five patients with severe heart disease, all of whom had a **dramatic reduction in VT episodes**.
- Clinically significant **advantages**:
  - Delivery of therapy is non-invasive and brief (<18 minutes),
  - Favor in patients with severe LV dysfunction and hemodynamic compromise.
  - VT substrate that is inaccessible to current catheter techniques can be targeted.
- Important concerns and issues:
  - Not required invasive EP in all patients with same condition?
  - The therapeutic effect is often delayed, with VT episodes diminishing over 6 weeks, so that such ablation may not be useful when urgent control of recurrent or incessant VT is required.
Development of Ablation Tech.

- Build a better mouse trap
- After Building a better mouse trap......

DOES "BUILDING A BETTER MOUSE TRAP" ACTUALLY WORK?
Thank you for your attention