



New Techniques for Atrial Fibrillation Ablation



Seongwook Han, MD.PhD.

Professor of Medicine, Keimyung University School of Medicine
Arrhythmia Service, Cardiology, Dongsan Medical Center

Disclosure

- **Speaker Bureau/Honoraria:** Bayer, Biosense Webster, Boehringer Ingelheim, Bristol-Myers Squibb, Daiichi-Sankyo, Medtronic Inc., Pfizer
- **Grants/Research support:** Boston Scientific, Boehringer Ingelheim, Chong Kun Dang, Medtronic Inc., Servier, Yuhan
- **Advisory board:** Boehringer Ingelheim, Bristol-Myers Squibb, Medtronic Inc.



Summary

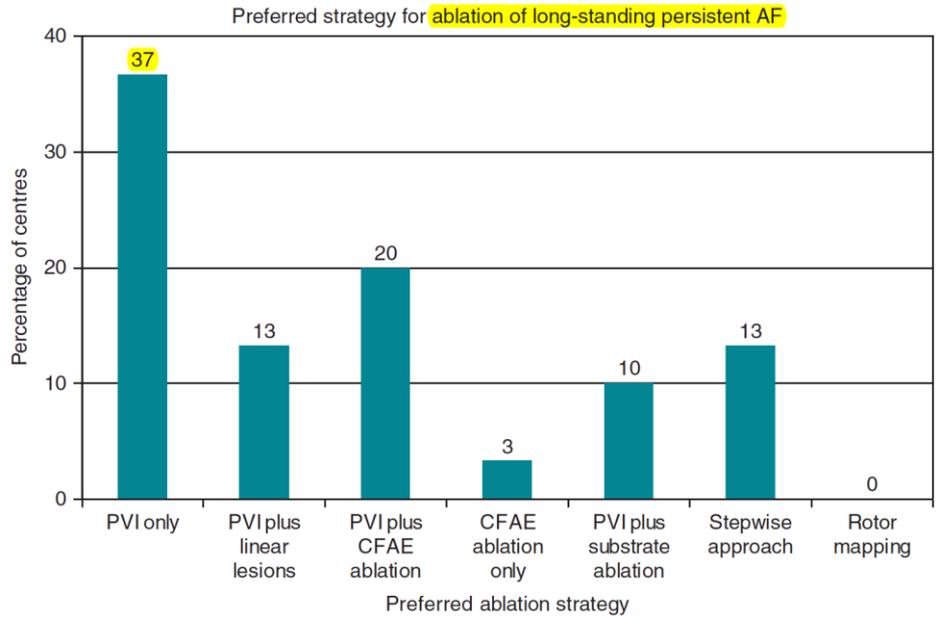
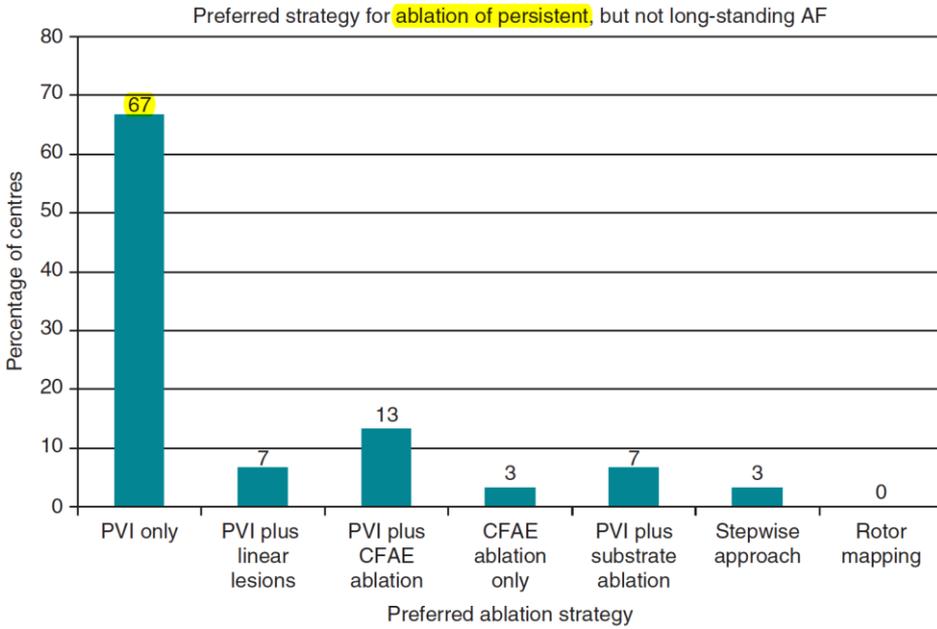
Mechanism-driven ablation strategies (combination of ***localizing atrial fibrosis plus mapping of specific functional areas*** allowing re-entrant/rotor activation) may be the next era of catheter ablation for the persistent AF

2012 HRS/EHRA/ECAS Expert Consensus Statement on Catheter & Surgical Ablation of Atrial Fibrillation

- ❖ Ablation strategies that ***target the PVs and/or PV antrum are the cornerstone*** for most AF ablation procedures
- ❖ If patients with ***longstanding persistent AF*** are approached, operators should ***consider more extensive ablation based on linear lesions or complex fractionated electrograms***

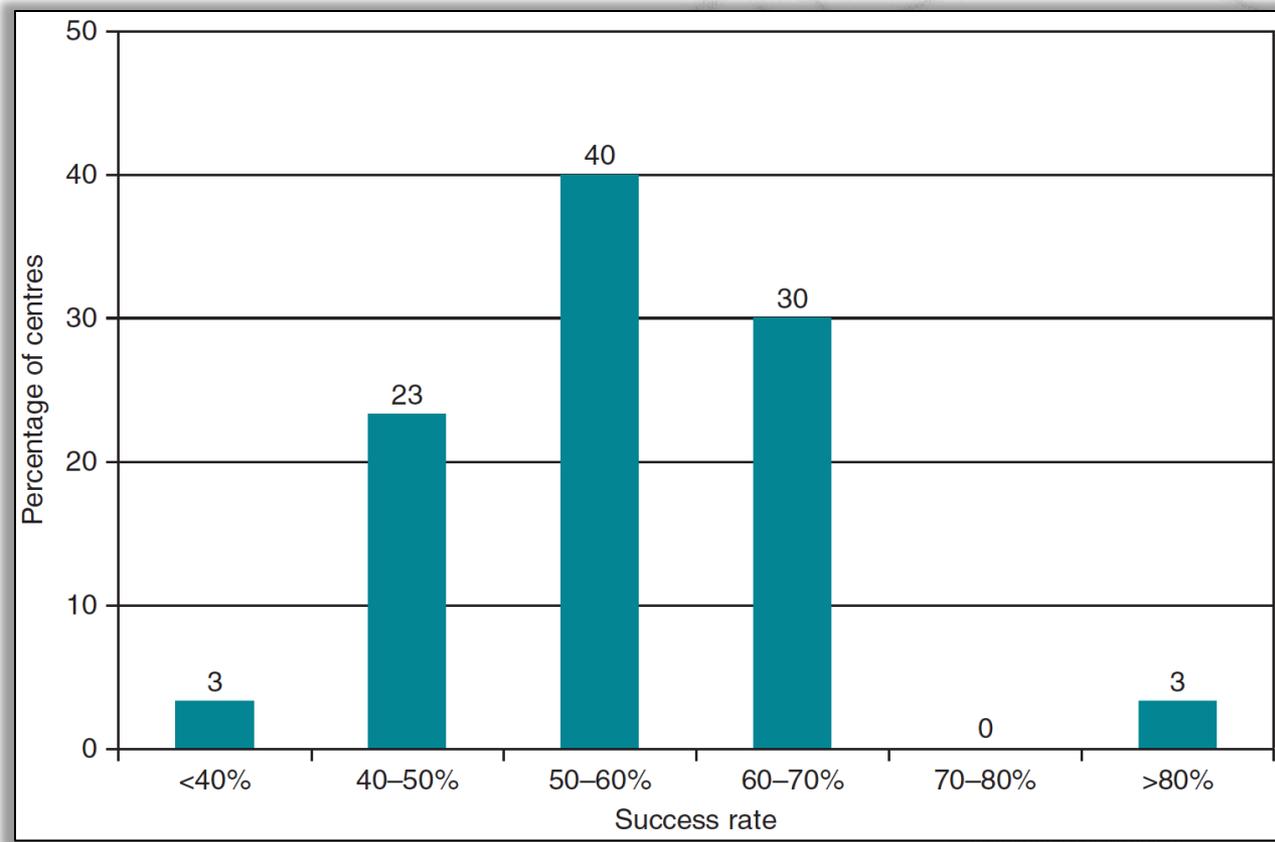
Current ablation techniques for persistent atrial fibrillation: results of the European Heart Rhythm Association Survey

- 22 centers from 10 European countries
- RFCA: PAF (57%), PeAF (32%), LSPeAF (12%)



Current ablation techniques for persistent atrial fibrillation: results of the European Heart Rhythm Association Survey

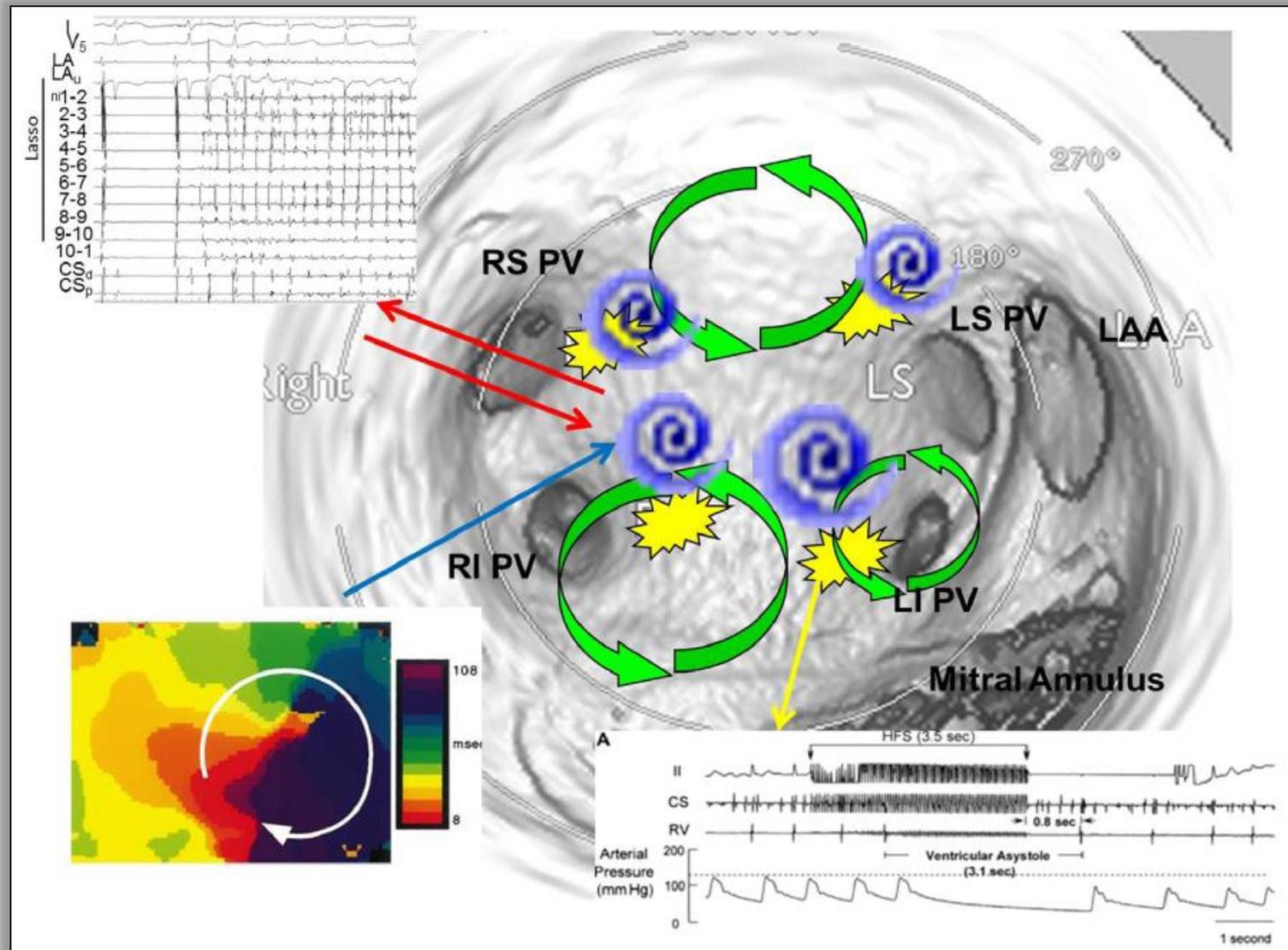
Overall success rate after single catheter ablation for PeAF



Current ablation techniques for persistent atrial fibrillation: results of the European Heart Rhythm Association Survey

In conclusion, ~~ There is a ***shift towards stand-alone PVI being the primary choice in many centers for the first-time ablation in these patients.*** The wide variation in the use of additional techniques and in the choice of endpoints reflects the ***uncertainties and lack of guidance regarding the most optimal approach.*** Procedural success rates are modest and long-term outcomes are unknown in most centers

Multifactorial Nature of the Genesis of AF



Pathophysiology of AF

Multiple reentrant wavelet hypothesis

- Fractionation of wavefront → self-perpetuating “daughter wavelets”
- Wavelets are separated by functional conduction block
- **Cons**
 - ✓ AF ablation terminates the AF in the early phase of ablation
 - ✓ Little acute impact of extensive ablation

Localized source hypothesis

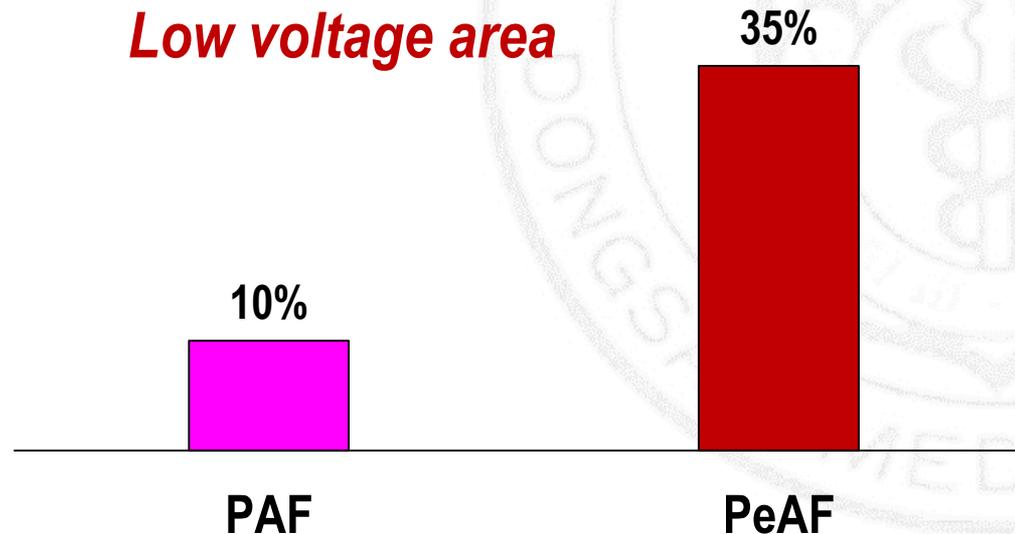
- localized spiral waves (rotors) or focal sources disorganize into AF
- Structural remodeling → spatial “non-uniform anisotropic” impulse propagation → initiation & perpetuation of AF

Pathophysiology of AF

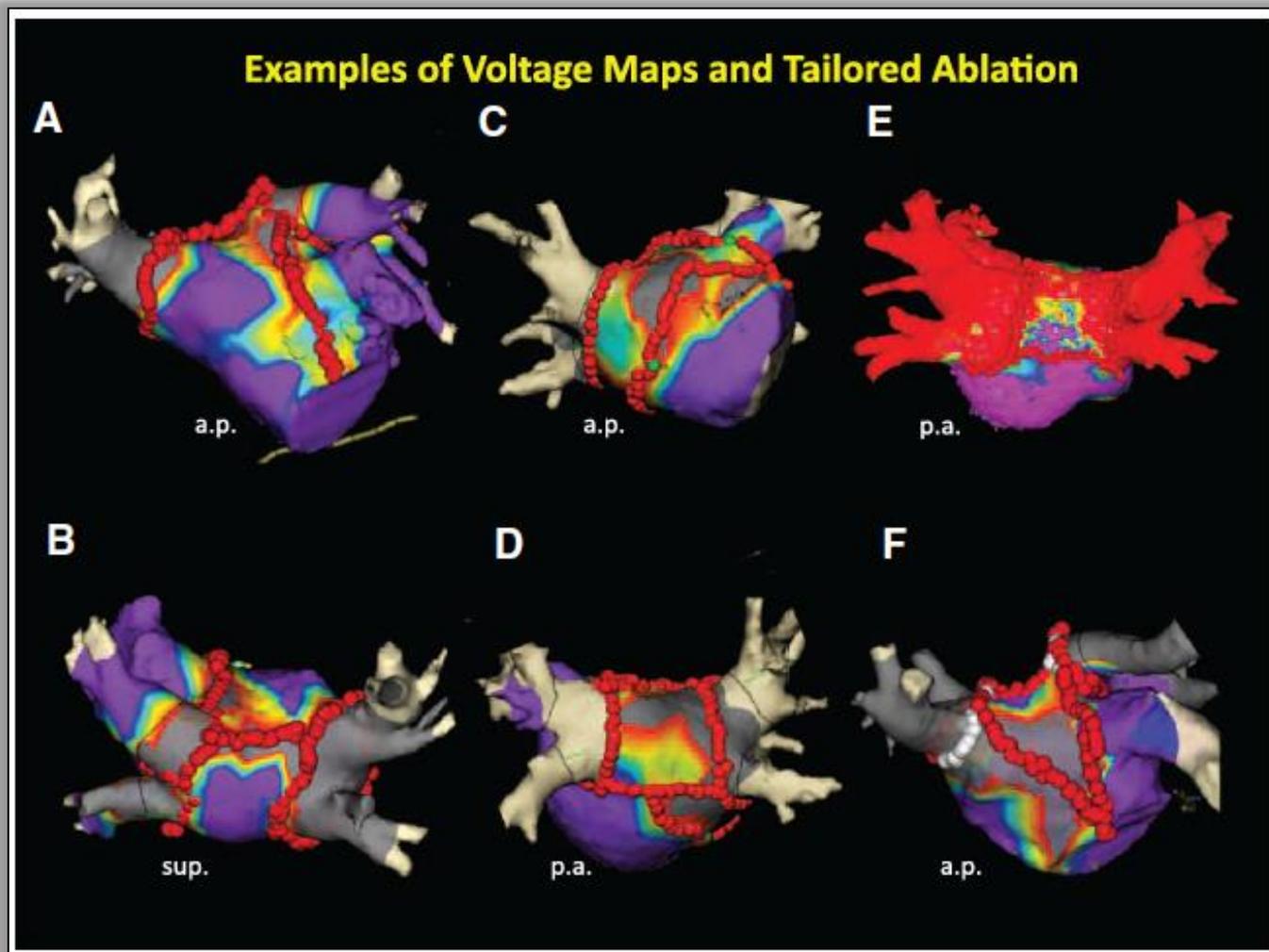
- The fibrillatory activity is maintained by ***intramural reentry*** centered on fibrotic patches
- Voltage mapping may assist in the identification of fibrotic areas
- **Stable rotors** display the ***higher dominant frequency*** and possibly ***drive AF***
- Single ***rotor*** is usually consistent with the ***organized AF electrogram without fractionation***
- It is therefore quietly possible that **rotors are located at relatively “healthy islands” within the patchy fibrosis**

Tailored Atrial Substrate Modification Based on Low-Voltage Areas in Catheter Ablation of Atrial Fibrillation

- ❖ 178 patients: PAF & PeAF
- ❖ Electroanatomical voltage mapping during sinus rhythm after PVI
- ❖ Mapping with circular catheter roughly then point-by-point acquisition using ablation catheter @ low voltage area
- ❖ Ablate the low voltage area: < 0.5 mV

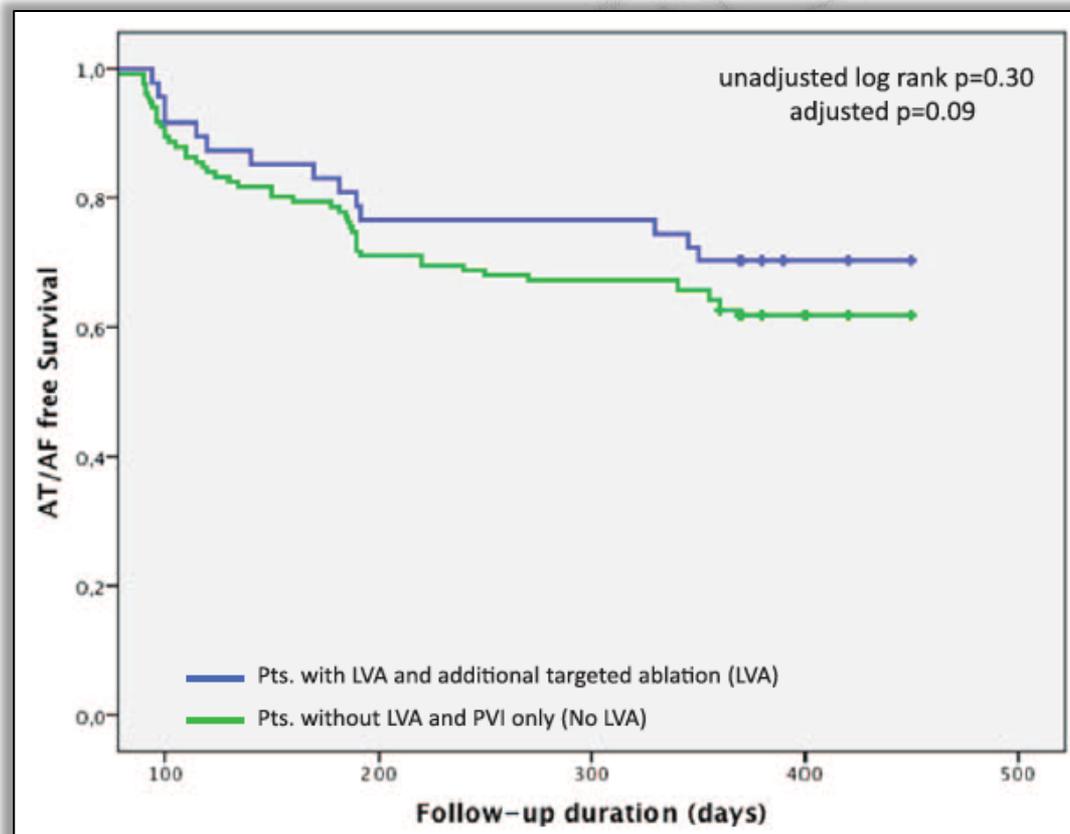


Tailored Atrial Substrate Modification Based on Low-Voltage Areas in Catheter Ablation of Atrial Fibrillation



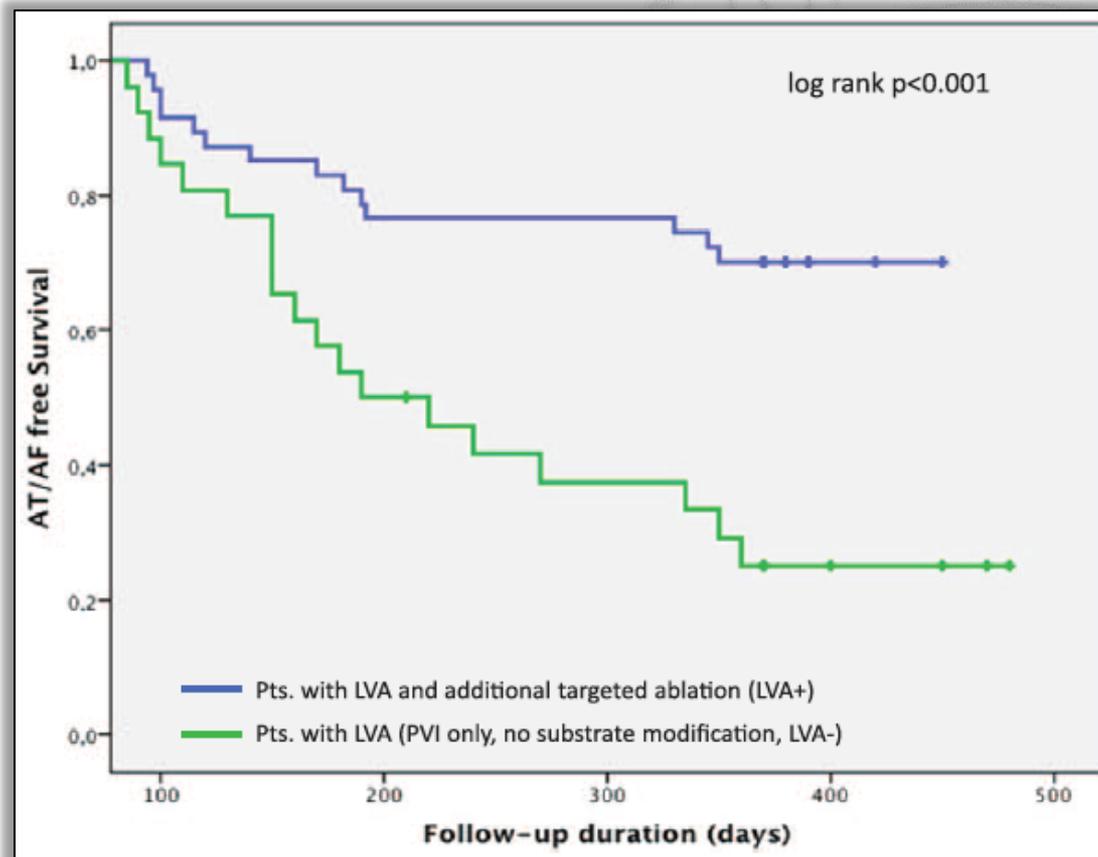
Tailored Atrial Substrate Modification Based on Low-Voltage Areas in Catheter Ablation of Atrial Fibrillation

The 12-month AT/AF-free survival was **62% for patients without LVAs** & **70% for patients with LVAs and tailored substrate modification**



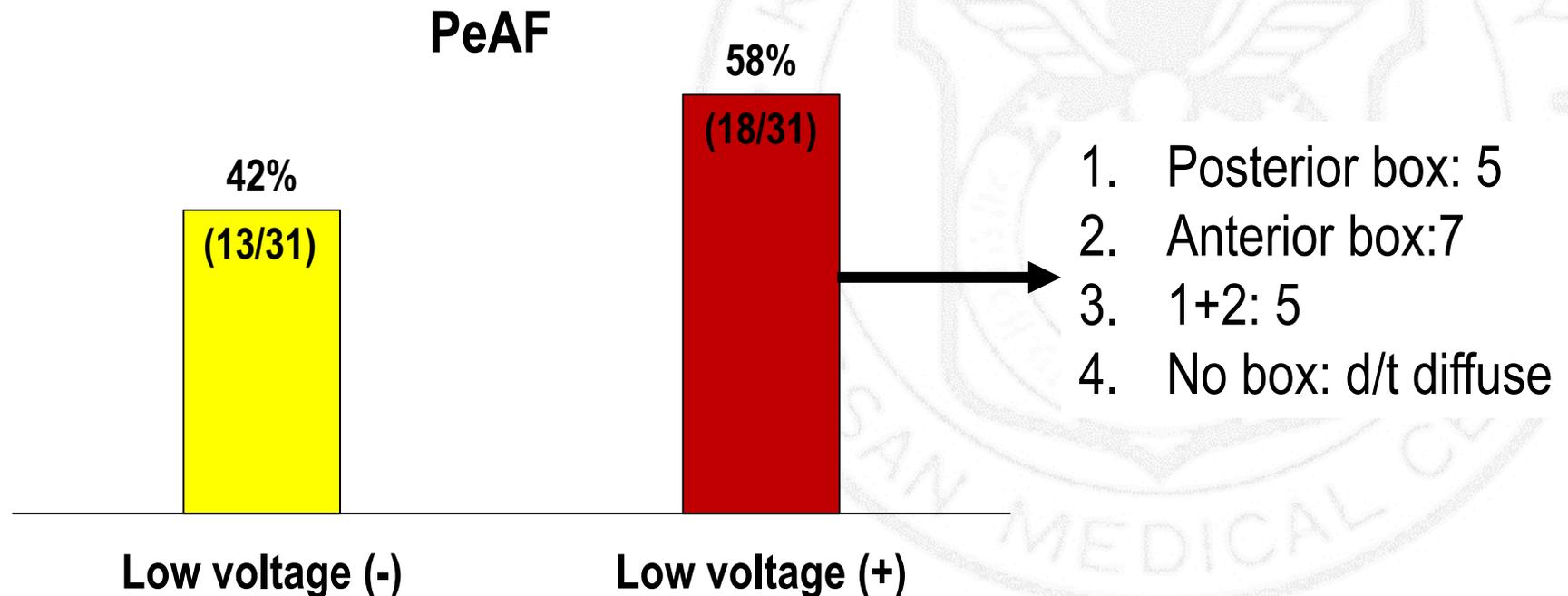
Tailored Atrial Substrate Modification Based on Low-Voltage Areas in Catheter Ablation of Atrial Fibrillation

26 LVA patients *without further substrate modification* was **27%**

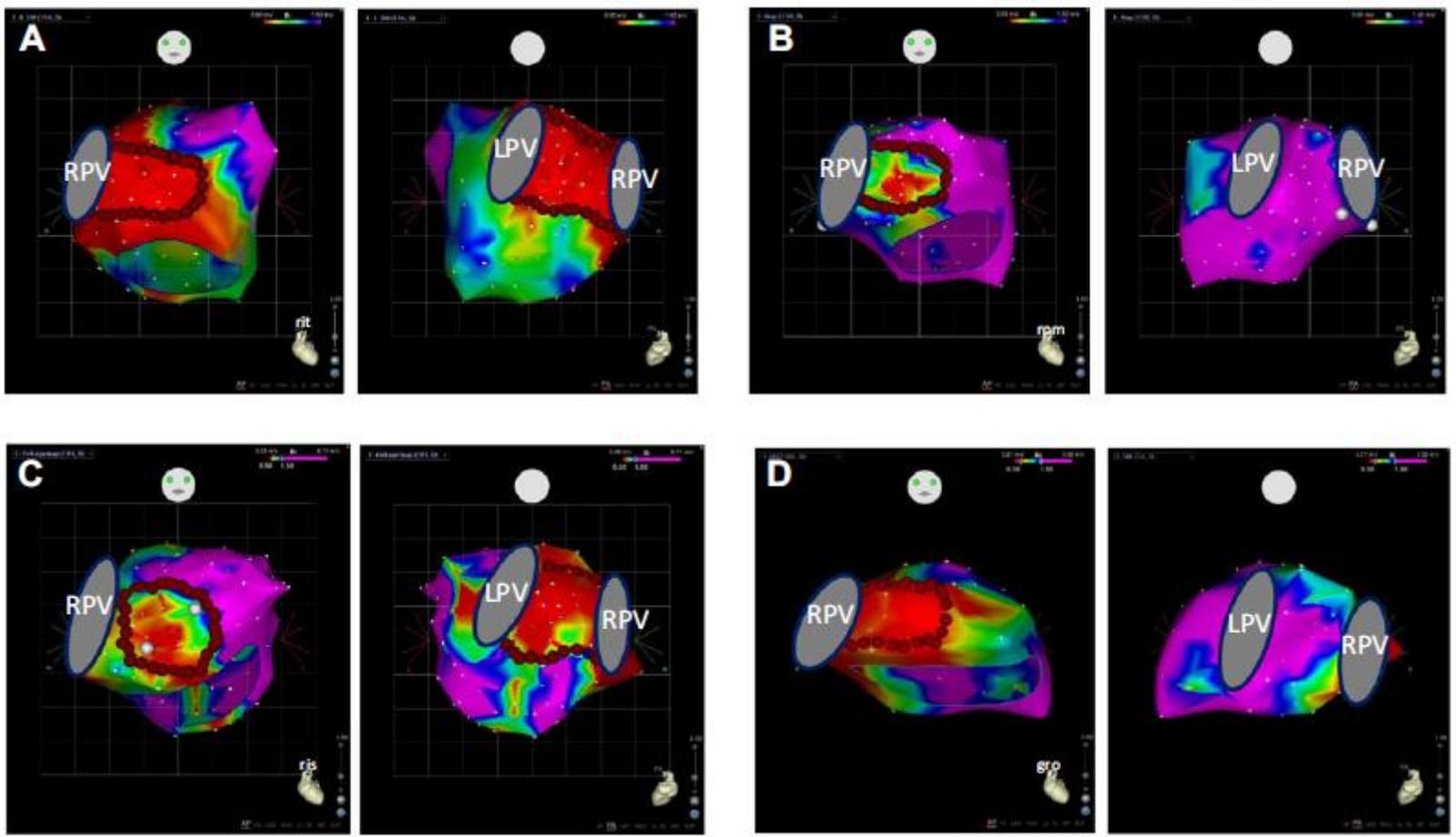


Box Isolation of Fibrotic Areas (BIFA): A Patient-Tailored Substrate Modification Approach for Ablation of Atrial Fibrillation

- ❖ 41 patients: electroanatomical voltage mapping during sinus rhythm
- ❖ Point-by-point acquisition using ablation catheter: 100~120 points
- ❖ Redo PAF (10): PeAF (31)
- ❖ Box isolation of Low voltage area: < 0.5 mV

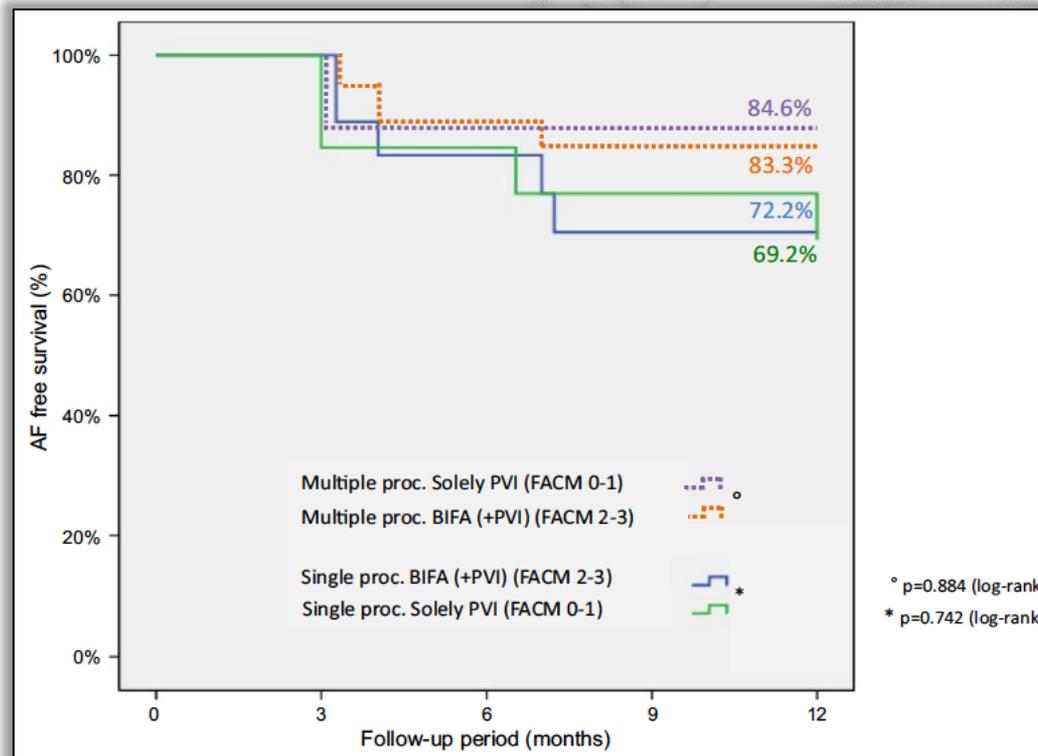


Box Isolation of Fibrotic Areas (BIFA): A Patient-Tailored Substrate Modification Approach for Ablation of Atrial Fibrillation



Box Isolation of Fibrotic Areas (BIFA): A Patient-Tailored Substrate Modification Approach for Ablation of Atrial Fibrillation

- ❖ **Single-procedure** freedom from AF/atrial tachycardia was achieved in **72.2%** of pts and in **83.3%** of pts with **1.17 procedures/patient** @ FU of 12.5 ± 2.4 months



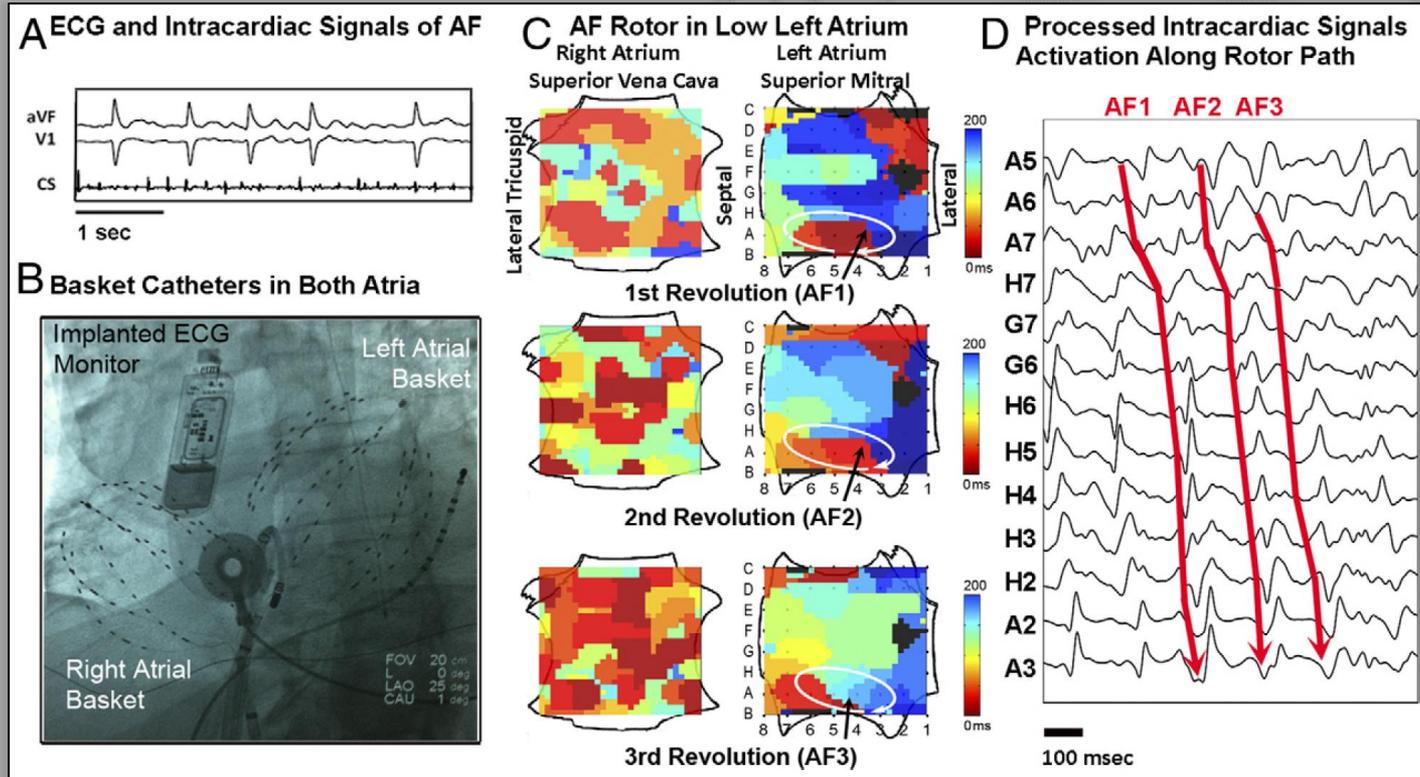
Voltage Guided Substrate Ablation

- ❖ **Definition of scar** in the atrium by electroanatomical voltage mapping: 3.5mm tip catheter vs small multipolar catheter
- ❖ **Box lesion durability** with point by point ablation: **Proarrhythmia**
- ❖ **LE-MRI of LA** from Utah group: **non-reproducible** by others
- ❖ AF patients with large area of fibrosis
- ❖ Acquisition of voltage: during sinus rhythm vs during AF
- ❖ LA function (stiff LA syndrome) ?

Treatment of Atrial Fibrillation by the Ablation of Localized Sources

CONFIRM (Conventional Ablation for Atrial Fibrillation With or Without Focal Impulse and Rotor Modulation) Trial

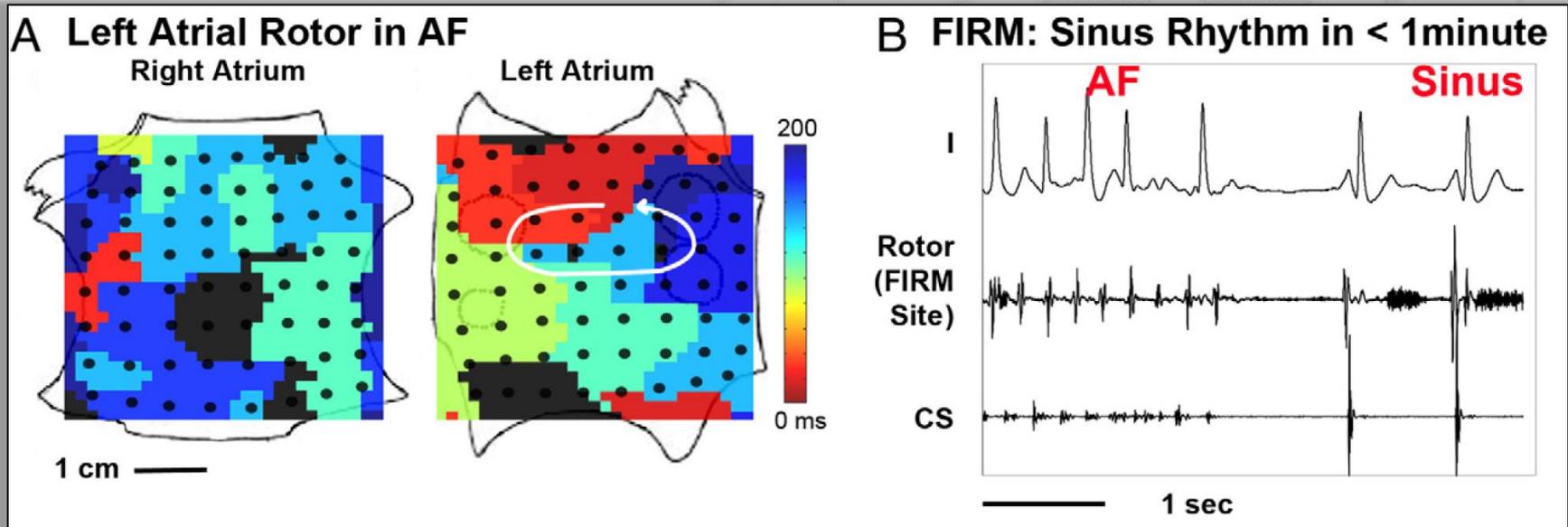
- 92 patients; 107 consecutive ablation procedures; PeAF (72%)
- **Conventional** ablation vs **Conventional + FIRM**: 71 vs 36



Treatment of Atrial Fibrillation by the Ablation of Localized Sources

CONFIRM (Conventional Ablation for Atrial Fibrillation With or Without Focal Impulse and Rotor Modulation) Trial

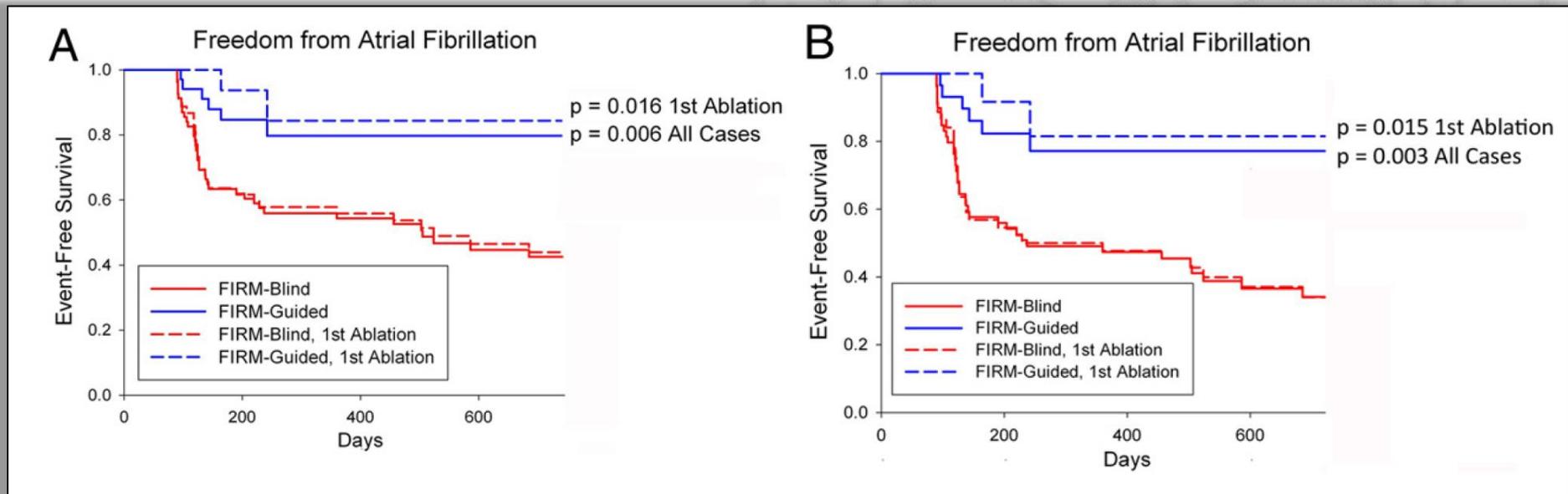
- **97%** (98/101) of sustained AF: localized rotors or focal impulse (+)
- 2.1 ± 1.0 sources in each patients
- **AF termination or consistent slowing: 86% (FIRM guided) vs 20%**
- FIRM ablation alone at primary source terminated AF in 2.5 min



Treatment of Atrial Fibrillation by the Ablation of Localized Sources

CONFIRM (Conventional Ablation for Atrial Fibrillation With or Without Focal Impulse and Rotor Modulation) Trial

- Median **273 days** (132~681) FU after single procedure
- Freedom from AF: 82.4% (FIRM guided) vs. 44.9%



Entire population

Off antiarrhythmics

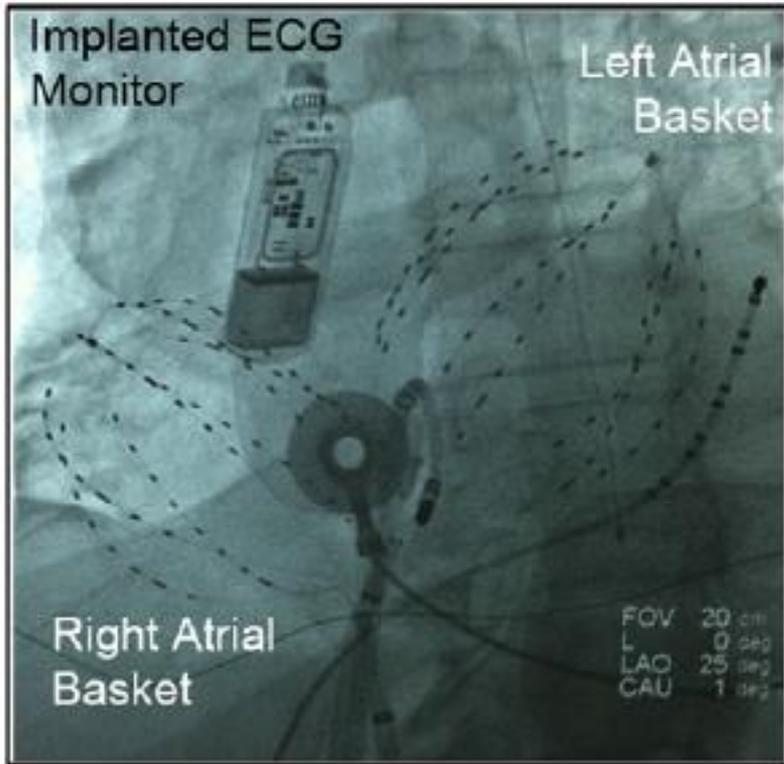
Quantitative Analysis of Localized Sources Identified by Focal Impulse and Rotor Modulation Mapping in Atrial Fibrillation

Background—New approaches to ablation of atrial fibrillation (AF) include focal impulse and rotor modulation (FIRM) mapping, and initial results reported with this technique have been favorable. We sought to independently evaluate the approach by analyzing quantitative characteristics of atrial electrograms used to identify rotors and describe acute procedural outcomes of FIRM-guided ablation.

Methods and Results—All FIRM-guided ablation procedures (n=24; 50% paroxysmal) at University of California, Los Angeles Medical Center were included for analysis. During AF, unipolar atrial electrograms collected from a 64-pole basket catheter were used to construct phase maps and identify putative AF sources. These sites were targeted for ablation, in conjunction with pulmonary vein isolation in most patients (n=19; 79%). All patients had rotors identified (mean, 2.3±0.9 per patient; 72% in left atrium). Prespecified acute procedural end point was achieved in 12 of 24 (50%) patients: AF termination (n=1), organization (n=3), or >10% slowing of AF cycle length (n=8). Basket electrodes were within 1 cm of 54% of left atrial surface area, and a mean of 31 electrodes per patient showed interpretable atrial electrograms. Offline analysis revealed no differences between rotor and distant sites in dominant frequency or Shannon entropy. Electroanatomic mapping showed no rotational activation at FIRM-identified rotor sites in 23 of 24 patients (96%).

Conclusions—FIRM-identified rotor sites did not exhibit quantitative atrial electrogram characteristics expected from rotors and did not differ quantitatively from surrounding tissue. Catheter ablation at these sites, in conjunction with pulmonary vein isolation, resulted in AF termination or organization in a minority of patients (4/24; 17%). Further validation of this approach is necessary. (*Circ Arrhythm Electrophysiol.* 2015;8:554-561. DOI: 10.1161/CIRCEP.115.002721.)

Focal Impulse and Rotor Modulation



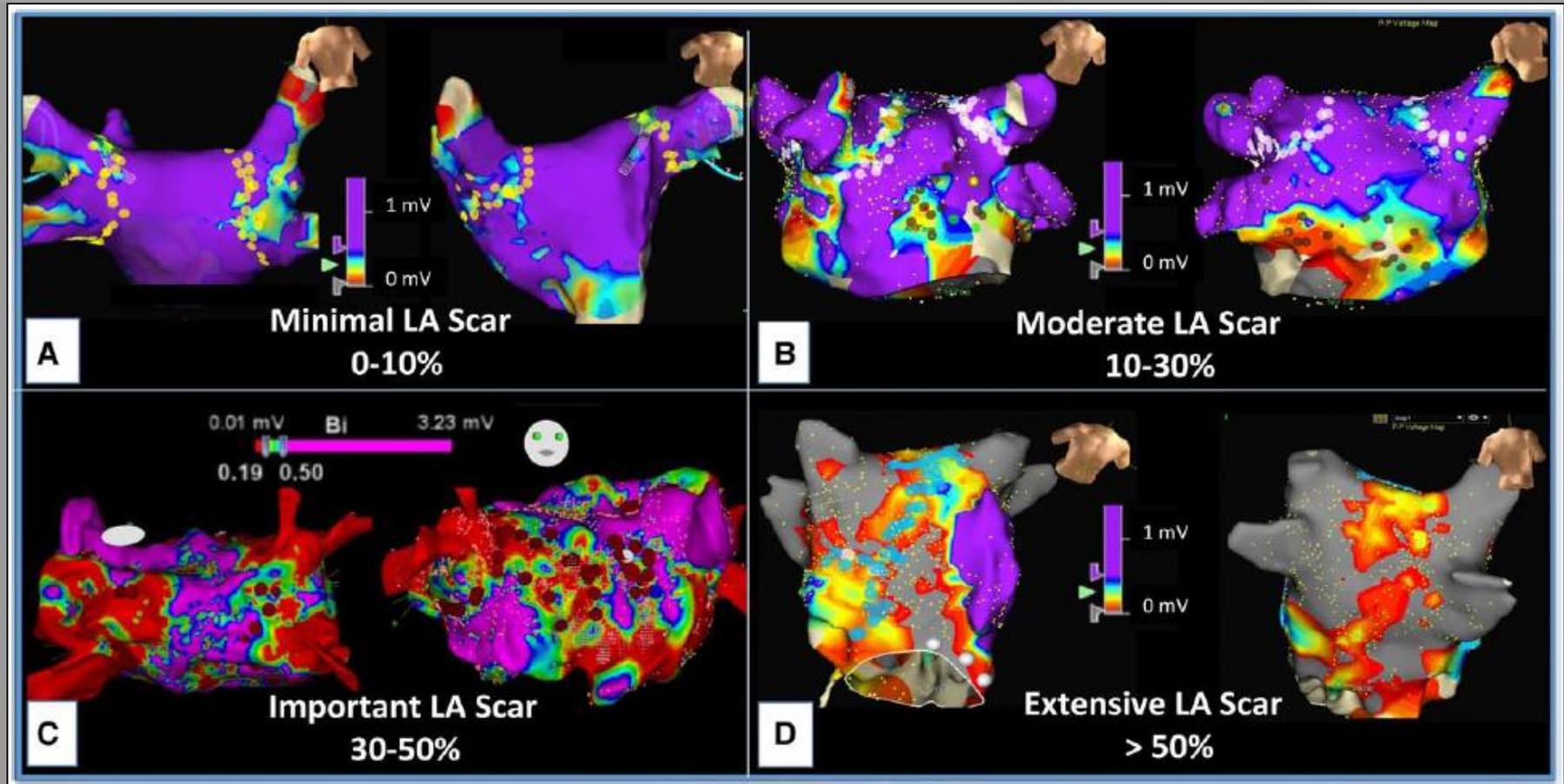
- ❖ Low number of **64 basket electrodes**
- ❖ **Nonuniform distribution of electrodes** with stable contact to the atrial wall
- ❖ The mapping data require propriety computational software (Topera)
- ❖ Results **have yet to be reproduced by others**

Ablation of Persistent Atrial Fibrillation Targeting Low-Voltage Areas With Selective Activation Characteristics

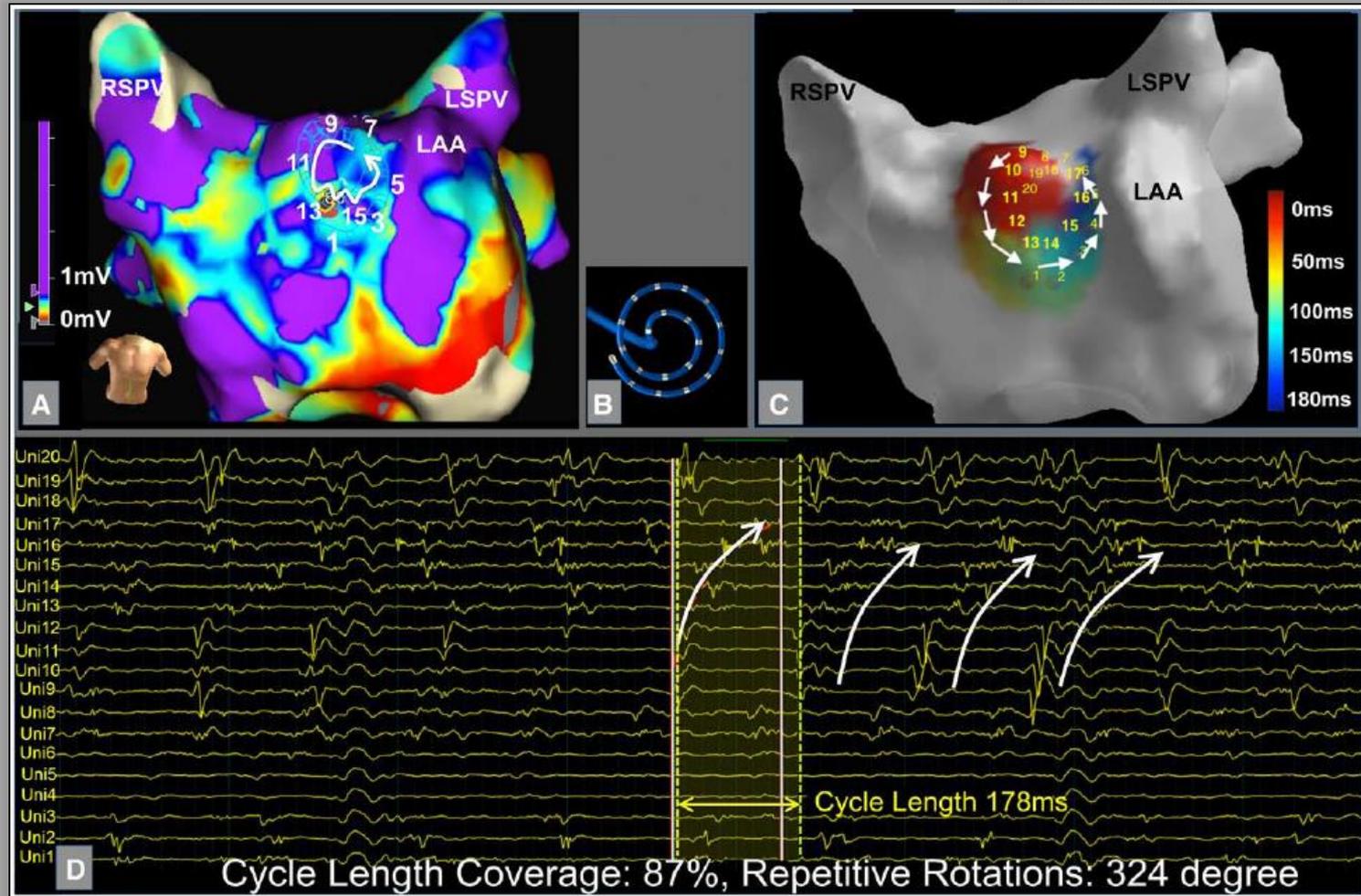
- ❖ Group I (85 patients with persistent AF) PVI + **Ablation target**
 - **low voltage area (<0.5mV during AF) &**
 - electric activity lasting >70% of AF cycle length on a single electrode (**fractionated activity**)
 - multiple electrodes around the circumferential mapping catheter (**rotational activity**)
 - discrete **rapid local activity**
- ❖ Group II: PVI only (66 patients)
- ❖ **Procedure end point: termination of AF**



Ablation of Persistent Atrial Fibrillation Targeting Low-Voltage Areas With Selective Activation Characteristics

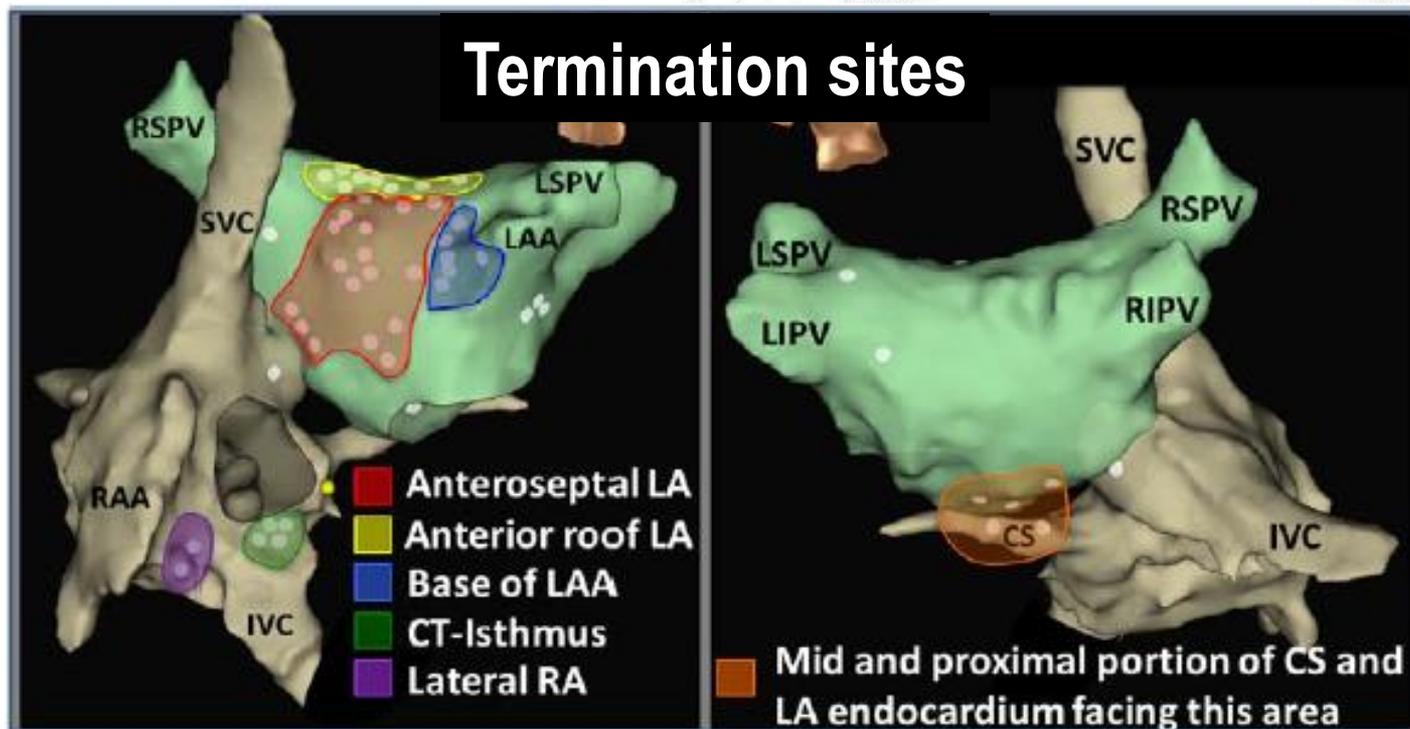


Ablation of Persistent Atrial Fibrillation Targeting Low-Voltage Areas With Selective Activation Characteristics



Ablation of Persistent Atrial Fibrillation Targeting Low-Voltage Areas With Selective Activation Characteristics

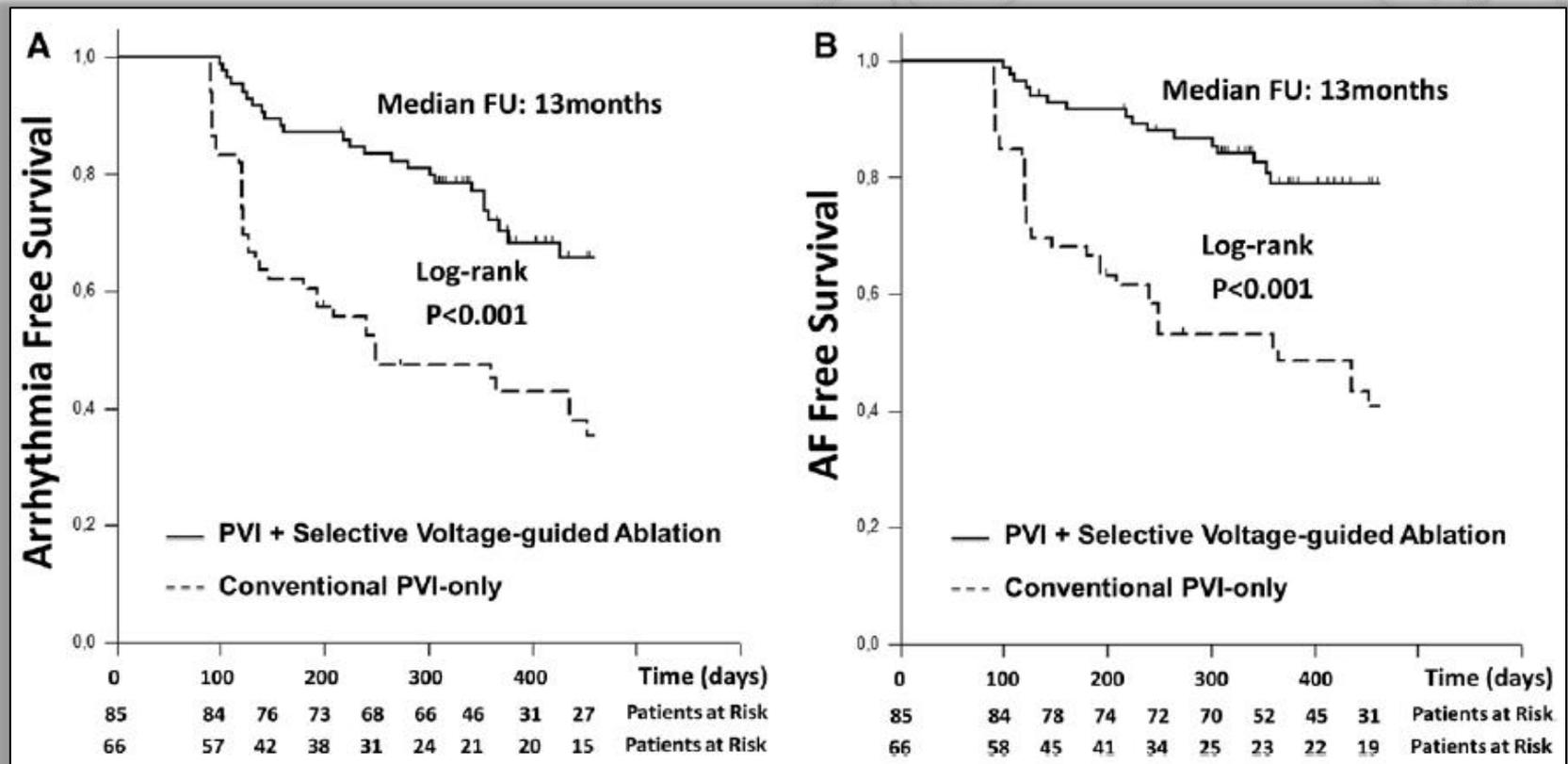
- Selective atrial ablation + PVI was performed in 62 patients
- **Termination of AF: 45 (73%)**
- AF-termination sites: **within LVA (80%), @ border zones (20%)**



Ablation of Persistent Atrial Fibrillation Targeting Low-Voltage Areas With Selective Activation Characteristics

Single procedural arrhythmia freedom @ 13 months median FU

- **Group I: 59/85 (69%)** vs **Group II: 31/66 (47%)**, $p < 0.001$



Ablation of Persistent Atrial Fibrillation Targeting Low-Voltage Areas With Selective Activation Characteristics

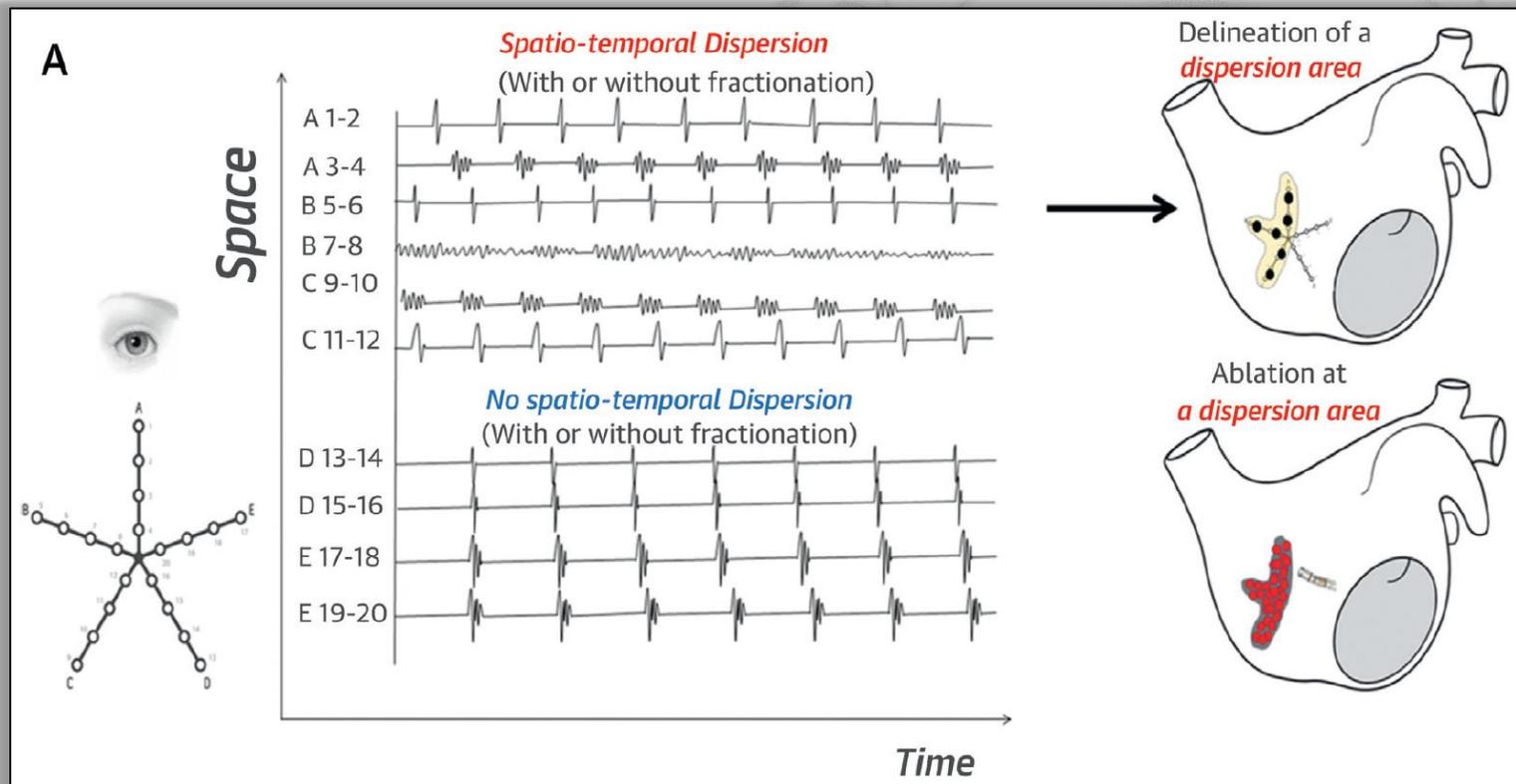
Conclusions — *Ablation of sites with distinct activation characteristics within/@ border zones of LVA in addition to PVI is more effective* than conventional PVI-only strategy for persistent AF.

PVI only seems to be sufficient to treat patients with left atrial low voltage <10%.



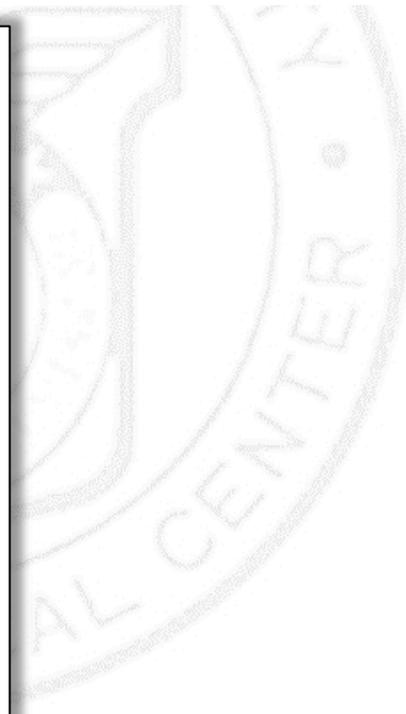
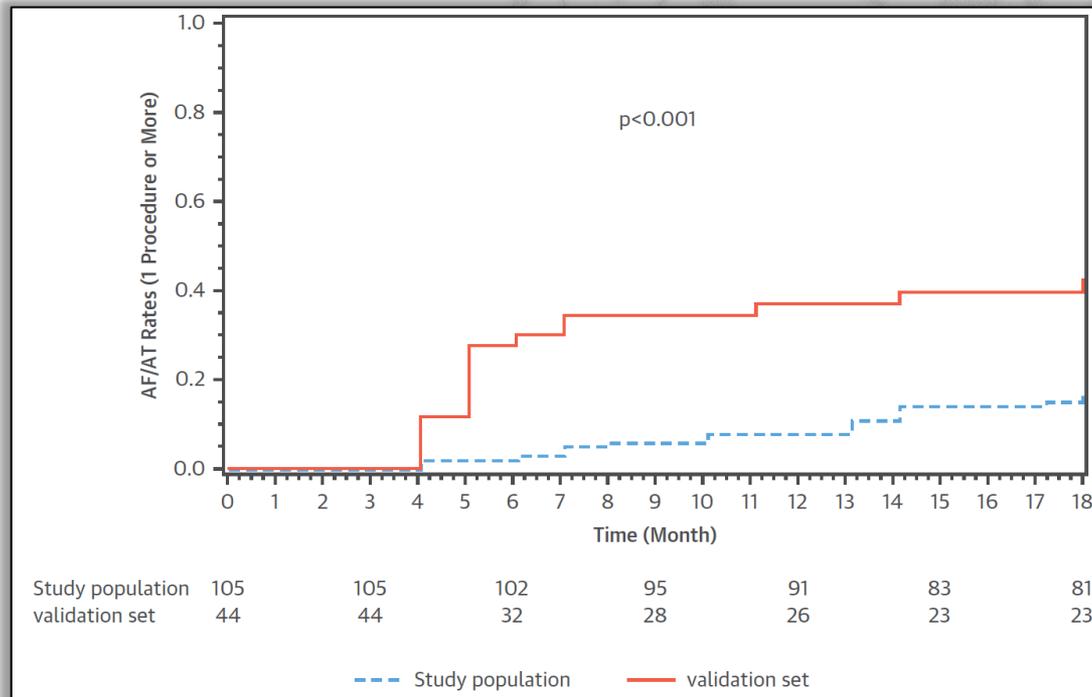
AF Ablation Guided by Spatiotemporal Electrogram Dispersion Without Pulmonary Vein Isolation

- 105 patient
- Mapped with PentaRay™ (20-pole) during AF



AF Ablation Guided by Spatiotemporal Electrogram Dispersion Without Pulmonary Vein Isolation

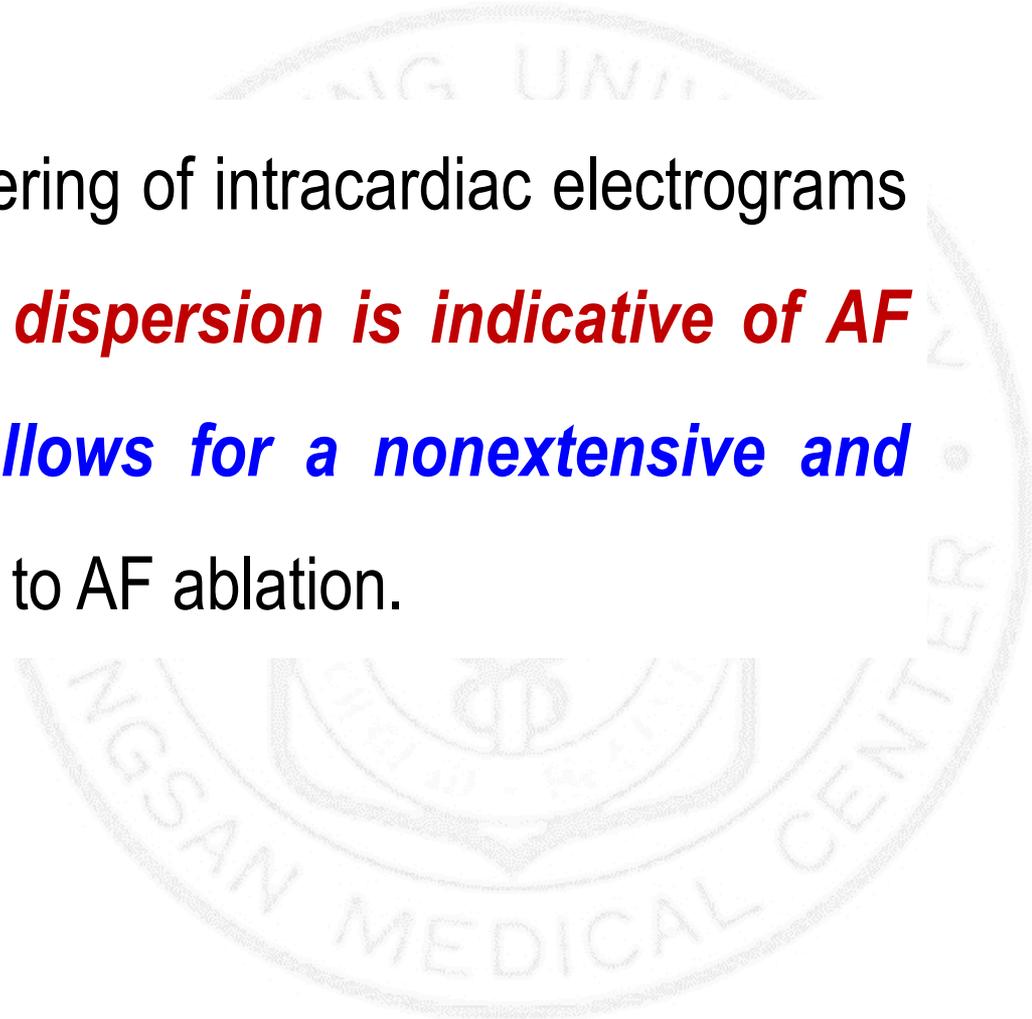
- @18 months of FU: **15% recurrence rate after 1.4 ± 0.5 procedure**
- In **simulations and optical mapping experiments**, virtual PentaRay recordings demonstrated that **electrogram dispersion is mostly recorded in the vicinity of a driver**



AF Ablation Guided by Spatiotemporal Electrogram Dispersion Without Pulmonary Vein Isolation



CONCLUSIONS The clustering of intracardiac electrograms exhibiting *spatiotemporal dispersion is indicative of AF drivers. Their ablation allows for a nonextensive and patient-tailored approach* to AF ablation.



Summary

Mechanism-driven ablation strategies (combination of ***localizing atrial fibrosis plus mapping of specific functional areas*** allowing re-entrant/rotor activation) may be the next era of catheter ablation for the persistent AF



**Thank You for
Your Attention !**

Seongwook Han, MD.PhD.

**Professor of Medicine, Keimyung University School of Medicine
Arrhythmia Service, Cardiology, Dongsan Medical Center**